Agent-Based Mediation System to Facilitate Cooperation in Distributed Design

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Abstract: - In this article we present the use of knowledge for a Mediation System, developed to give support to participants in mechanical-system-designer activities. To use a cooperative system sufficient assistance is needed to facilitate and coordinate actors' activities. To accomplish this goal we introduce an artificial actor: *Mediator*. The *Mediator* forms part of the group of collaborative, with the specific role of facilitating the cooperative activity. This role of assistance, differentiate the *Mediator* from other actors. This one is endowed with specific skills of cooperation (communication; awareness, coordination, co-memorization), requiring some acquired knowledge, which allow them to give assistance to the human actors. We will define the types of knowledge defined for our proposed Mediation System. Then we will illustrate the use of memorized knowledge by the *Mediator* during an activity of technical functional analysis.

Key-Words: - CSCW, Intelligent Agent System, Knowledge and Data technology, Mediation System

1 Introduction

The use of cooperative systems, strongly interactive and often distributed, must be accompanied by sufficient assistance levels. The identification and implementation of these levels of assistance can result in designing a real *Mediation System* [15]. Such a *Mediation System* must be used as an intermediary of cooperation, not only between the users and the system, but between the users themselves (called actors from now on). Indeed, the system cannot carry out the tasks which are assigned to it without the cooperation of the actors. Dynamic, cooperative and autonomous processes, necessary to this interaction, must include the representation of the actor's knowledge and behavior, as well as a real capacity to communicate.

The objective of this paper is to present the context for the use of the knowledge produced by the introduction of a *Mediator* actor in a group of actors that work together at distance with the help of a cooperative system.

Cooperative systems (or cooperative applications) that we consider in this article are designed for the collaborative design of products, in distributed design. In such systems, the main collective practices of actors are: assignment of tasks according to an individual actor's skills, the synchronization of actions, cognitive synchronization to share knowledge, management of problems, and the multiple communications of actions. The cooperative system has to offer the functions for the development of the collective activity to allow the creating partners to cooperate in order to identify objectives and share definitions. It should determine and distribute the sub-goals and tasks, follow the evolution of the activity, evaluate the results of the collective design, and have the support of the *Mediator* actor. The design of the cooperative application is not the object of this communication, but, is a better distinction of the constitutive elements of the application and its *Mediation System*.

This article will be structured as follows: section 2 describes the assistance instrumented for the cooperative work. Section 3 introduces the notions of the *Mediation System*. Section 4 describes the design of the knowledge base of the *Mediator* for a workspace of technical functional analysis (*WS-TFA*). Section 5 describes the design for the *WS-TFA*. Section 6 presents an example of the use of knowledge in the integration of *Mediator* in a cooperative workspace for *TFA*.

Finally, in section 7, holds the conclusions and the possible future work. We especially propose the increase of the actor *Mediator* capacities through the use of this knowledge.

2 Assistance instrumented for the cooperative work

2.1 User assistance

Prior to describe in a detailed manner the concept of mediation system, we will discuss about the problem of assisting cooperation. Works concerning this problem include different domains. The interactive environment for human learning (IEHL) is a very prolific example which will be taken by us as a reference.

Assistance subjects treated in (IEHL) [22], concern mainly: the councillor systems, the synchronous tracking of learning activities, the delivery of information, and the usage help. However, the terminology associated to the concept of "user assistance" is till fuzzy. It contains by itself many other concepts like assistance, guidance, counselling, explanation or reminder. In fact, the word "help" is often associated to the "on-line" help available in most software and which can be assimilated to a "how-to" manual (interface, functions procedures).

The user's assistance takes in charge a part of the task. It is often assured by agents which execute a part of task or which strongly guide the user. When tasks are totally assured by the system, we will call it substitution.

Guidance consists in withstanding the user in the accomplishment of a task by: advising, reminding and relieving the user from routinely tasks.

Advising produces very often methodological information. It is also important to distinguish between advises associated to processes or to final products [11].

The explanation goal, is to describe the functioning or the result of an action or reasoning in the user's context

The remainder given to an actor, subscribed in a collective activity different type if data such as delays, product state, actions to do, etc, in concordance with his responsibilities and his roll within the work group.

Many other domains interested in the development of operative work applications, have treated the assistance problem, and within it, the cooperative design (our experimentation domain) [5].

All domains agree in the complexity of computer assisted cooperative work, partially given by its sociological and technical dimension. In order to better approach this problem, we have developed our study by splitting it in three different fields: theoretical, cognitive and technical field.

The cooperative work design, benefits from the activity theory [27], the model of 3C [7] and the coordination theory.

The user's knowledge is essential for the relevance of a *Mediation System*. This one consists in defining the characteristics and the needs of the potential user of the cooperative system. It seems sensible to develop a *Mediation System* model of man-centered; each user has a different perception of the application, depending on its role and activity.

Therefore, the techniques developed for groupware are: communications mediating, sharing objects, organization and management of contexts, and the group consciousness [5].

2.2 The instrumentation of mediation for cooperation

The concept of mediation is described by psychologists such as *Vygotski*, *Piaget* or *Brunner*. For *Vygotski* [26], the language is the first tool for mediation, in particular through its social and psycholinguistic dimensions. *Peraya* [18] proposes a typology of the mediation in three classes:

1) the technological mediation, which includes any cognitive tool in one way or another being able to contribute to human activities;
2) the sensor-motor mediation, which is considered driving mediators such as the mouse of computer;
3) the social mediation, which relates to the interactions between people, causing an individual reflexive activity.

To facilitate the cooperative applications use, it appears appropriate to interface with a *Mediation System* (which we call *Mediator* thereafter), whose role is to issue a precise answer to each case of using the application and each actor identified in a collective action. A repository on different levels of contextual cooperative system becomes essential.

Figure 1, extending the proposals of *David* [6], establishes an anthropocentric point of view, for the upper layers and a techno-centered point of view for the lower layers. Our work covers the central part, the functional area of mediation at interface between the two points of view.

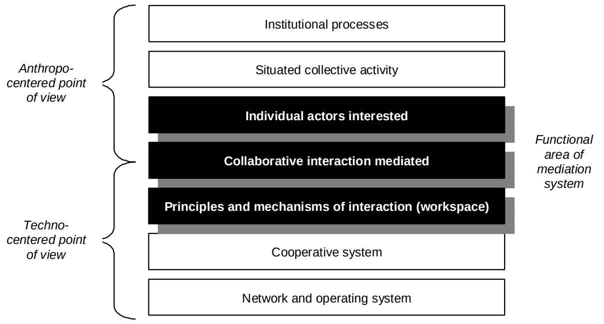


Fig.1. Context of cooperative system

In literature the concept of *Mediator* includes multiple meanings: facilitator of collective decision-making [2] or electronic assistant for carrying out collective tasks, for example. For us, it is an actor through cooperation which can attend individual action, as well as collective action to improve collective production when it is instrumented. This mediation is even more relevant than the fact interact cooperative actors remote.

We propose a *Mediation* instruments remains under the control of natural actors. This *Mediation* is assistance and not an automation that generates more dissatisfaction from users: loss of expertise, the satisfaction of optimal solutions, reckless confidence, and loss of adaptability.

3 Mediation System notions

Cooperation refers to a human activity, and we can only contemplate man/system cooperation if the system can be considered intelligent. A cooperative *Mediation System*, is in fact a knowledge based system. In addition, considering its objectives, the *Mediation System* becomes a real actor of cooperation and it will be named "*Mediator*". Thus, in reference to the works of Simon [23] on the data processing systems, which include the computer and the brain, we propose that cooperation should regroup a group of human actors (natural systems) and an actor *Mediator* (the artificial *Mediation System*).

The actor design can then be inspired in the symbolic -calculation model proposed: a treatment of symbols system that includes input and output functions, a long-term memory and a processor composed itself by an inference engine and a work memory of (or short-term memory). Let's annotate that on this problematic (human teams and numerical agents) [8] have synthesized the state of the art.

The interdependences between the knowledge and the activity are approached very often for the design of knowledge systems. They take in consideration the knowledge and the activity as the scientific particular criteria, for which it is necessary to develop practices and appliances to give assistance to the activity.

The knowledge and the action are naturally linked in the human activities in organizations. The devices of collective actions are particularly interesting to observe the processes of creation, transformation and utilization of knowledge [13].

The role of the *Mediator* is as to be an intermediary of cooperation. This role is revealed more pertinent when the actors are compromised in distant situations of work with the cooperative system (Fig.2). To illustrate our approach, we present the design of the μ-tools and the *Mediation System* that we integrate in a cooperative workshop of technique functional analysis (the workspace *WS-TFA*).

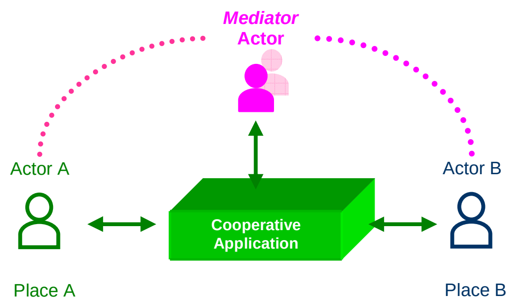


Fig.2. The conceptual framework of the Mediator

3.1 State of the art elements

The majority of systems developed in CSCW support relatively well the actor's cooperative activities working with a common goal, but they are not sufficient for management activities, knowledge and interactions. It is necessary to assist these interactions (actor-actor and actor-application) and to capitalize cooperatives knowledge in order to produce a *Mediation*.

Several concepts of Mediation exist. We are going to try to delimit the problematic of the Mediation taking different works of assistance as: [10, 28].

In literature, the *Mediator*'s concept can be associated to multiple meanings like decision taking facilitator [2] or electronic assistant for collective tasks accomplishment, for example. Another current perception of the *Mediation* consists in considering it as an specific help to the user, assured by a personal agent ("intelligent interface"). The question is then to conceive the assistants, users or collaborators [14, 19, 20, 21]. It is the case, for example, in [4], where the authors introduce a mediating agent in the interaction between a user and a service of information seek. The role of this *Mediator* is to formalize user's demand according to its profile and the environment. For us, it is a cooperation actor, capable to give assistance to the individual and collective actions, in order to improve the collective production when it is orchestrated. This *Mediation* is so much more pertinent since the cooperative situation makes distant actors interact.

We want to take a look at mediation from different cooperation points of view, looking forward to find the deficiencies in mediation that will be considered for the design of the *Mediation System*. We can actually, distinguish two major strongly different options for assistance in the domain of assistance to cooperative work: the assistance for the prescriptive regulation and the assistance for the emergent regulation.

3.2 Proposals for Mediation System design

A *Mediation System* must be used as intermediary of cooperation, not only between the users and the system, but between the users themselves. Indeed, the system cannot carry out the tasks which are affected to him without the cooperation of the actors. The dynamic, cooperative and autonomous processes, necessary to this interaction, must integrate a representation of the actor knowledge and behaviors, as well as a real capacity to communicate.

The mediation proposed remains under the natural control of actors. In this way, it is assistance and not an automation that drains a lot of dissatisfaction from users: loss of expertise, contentment for optimal solutions, reckless confidence, and loss of adaptability. The articulation of our work on the development of Systems of Mediation is then based on the following four proposals:

- **P1:** assistance adapted to the use of a complex system is multi-assistance (distributed assistance);
- **P2:** the *Mediation System* must be independent of the application part of the tool and its interface;
- **P3:** the Multi Agent Systems are well suited for the design of systems like *Mediation System*;
- **P4:** the situations of cooperation was very diverse, it seems useful to work on the basis of typical scenarios to design a system of mediation (Scenario-based approach [27]).

3.3 Mediation system design

The expected benefits of the integration of a *Mediation* System in a cooperative system are:

- to provide users with a private space activity and a public space to share information;
- to give the opportunity to users to work individually or cooperatively;
- to facilitate the identification, assistance and monitoring cooperatives tasks.

For these tasks the *Mediation* needs to observe and interpret the interaction between actors and the cooperative system.

To meet these objectives, including the implied characteristics such as distribution, cooperation and assistance to the user, we propose that the design and development of the *Mediator* actor is agent oriented – we presented the *Mediator*'s agent modelling in [17]. Of course, the interaction efficiency between actors (human and artificial) depends on agent identification and distribution [9]. Figure 3 presents the reference activity diagram of the *Mediator* and its relationship with actors. It respects the pattern of a cognitive actor, using the knowledge contained in a memory [16]:

Actor = <Perception, Interpretation, Decision, Action>

The *Mediator* actor is integrated into the group of human actors engaged in a co-operative activity, meaning that it is able to interact and to cooperate with them. Thus, it must achieve the cognitive tasks of observation, interpretation, decision and action (Fig.3). Of course, the range of these tasks is more limited than that of a natural actor. However, they enable him to communicate relevant co-operative information with the various members of the group.

The observation of cooperation acts carried out by actors working in proxemic co-operative spaces, then distant, enabled us to identify a first list of interactions necessary to the relevance of *Mediation* in a distant co-operative space.

An interaction can thus be represented by means of a quadruplet:

Interaction = <*Transmitter, Receiver, Act, Objet*>

and corresponds to the expression of a co-operative act belonging to the set:

Act = {Communication, Coordination, Co-production, Co-memorizing, Control of process}

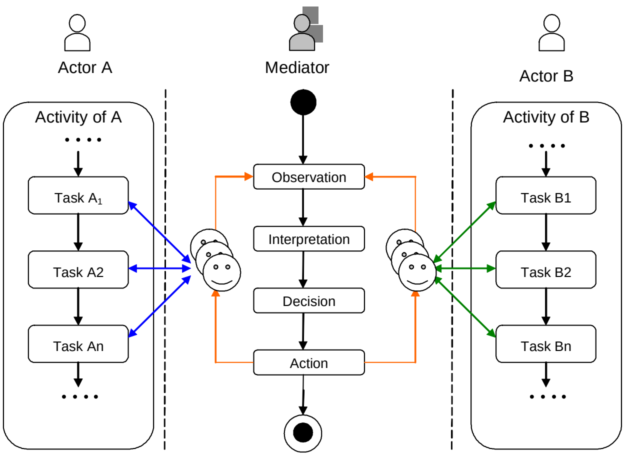


Fig.3. Activity schema of the *Mediator* actor

To specify the interactional domain between *Mediator* agents and actors, we defined a language (Table 1).

The cooperation between the *Mediator* and the other members of the group of actors can seem problematic. To make it implicit, we make a strong assumption of cooperation by considering the four maxims of Grice [12]. These maxims (quantity, quality, relation and manner), although initially stated like linguistic principles of cooperation, are frequently called upon within more general contexts of interactions. This assumption of cooperation is justified by the fact that there cannot be interactions without a minimum level of cooperation, all the more, when this one concerns at the same time human and artificial actors.

3.4 Cooperate Aptitude

The *Mediator* is an artificial actor; he forms part of a group of actors who cooperate to make a cooperative activity, with the help of a computing tool (ie, a system or a cooperative application). The role of the *Mediator* is to facilitate and to help to the cooperative activity.

The role of assistance, differentiate the *Mediator* from other actors. This one is endowed with specific skills of cooperation (communication, awareness, coordination, and co-memorization), requiring some acquired knowledge, which allow them to give assistance to the human actors.

Elements of language	Significance
x, e, a, m, t, i, g	*respectively are agent or actor, event, action, message, type of message, intention and goal*
observe(x, e);	*x observes the event e*
realize(x, a);	*x realizes the action a*
inform(x_e, x_r, m, t, i)	*x_e sends to x_r the message m of type t, with the intention i*
diffuse (x_e, x_i, m, t, i)	*x_e sends to the list x_i the message m of type t, with the intention i*
propose(x_e x_r,a)	*x_e proposes to x_r the action a*
counter-propose(x_e,x_r,a,a')	*x_e counter-proposes to x_r the action a' more than action a*
memorize(x,a)	*x co-memorises the action a*
refuse (x_e,x_r,a)	*x_e refuses proposition of action a made by x_r*
accept(x_e, x_r,a)	*x_e accepts proposition of action a made by x_r*
ask (x_e,x_r,r,t)	*x_e asks to x_r the request r of type t*
answer(xe, x_r,m,t)	*x_e answers x_r the message m of type t*
order(x_e, x_r,a)	*x_e orders with x_r to make the action a*
confirm(x_e,x_r,a)	*x_e confirms to x_r that it will make the action a*

Table 1. Communicative interaction language

3.5 Use knowledge Aptitude

The aptitude to use knowledge is generally alike to the one of knowledge systems or expert systems. The *Mediator* exploits different types of knowledge:

knowledge of skill and domain, users and group knowledge, the knowledge on the specific application, and the knowledge for assistance.

In this case the system based on knowledge directly is not accessed by the actor but by the *Mediator*, the following figure illustrates these differences.

The *Mediation System* design is based on the experience of a general domain needs to design the knowledge process used by the actor in the moment of activity [3, 17]. During the accomplishment of cooperative activities, the actors produce knowledge that they will be useful for the continuation of the project, or to serve for others actors in future similar works. These propositions suppose, on the part of the different actors, the respect of minimal rules of cooperation.

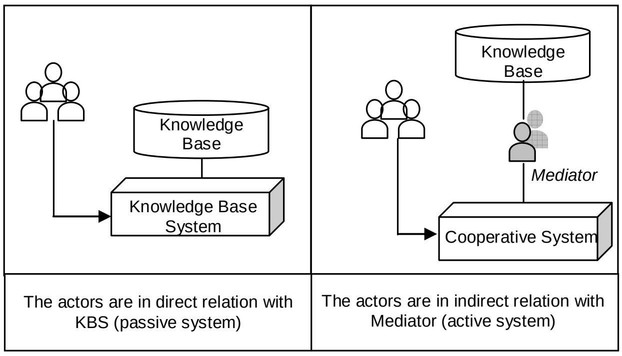


Fig.4. Direct interaction of the actors with a knowledge system (a), and hint (b) with *Mediator*.

4 Model of knowledge

The knowledge necessary for interacting with other actors is described in our knowledge model, which is divided in two parts: the first one concerns the initial knowledge which it's composed by the assistance and the domain knowledge. The second part concerns the knowledge acquired when interactions between the cooperative systems and the interaction with *Mediator* take place. It concerns in particular the memory of the activities and the resolutions of assisted problems.

4.1 Knowledge for assistance

The domain knowledge is the base of the *Mediator* assistance in a given application. The assistance knowledge, such as advices or typical cases, are more specific. As for the knowledge to assist cooperation, it is quasi- generic.

Our initial work concerned the analysis and design of cooperative activities, induced by intellectual tasks which are meditated by the new technologies of information and communication. The goal was to better understand the functioning and the conditions of development of a collective and distributed cognition in user activities, in order to identify the principal criteria needed while conceiving assistance.

4.2 Knowledge for cooperation

For the design of the knowledge acquired, we were inspired by the model of project memory proposed by [15] and in the case based reasoning [1]. This different experience knowledge allows the improvement of assistance relevancy contributing to future cooperative activities.

The model that we develop [16] integrates the following categories of knowledge: user, context, group of work and domain knowledge, as well as application and content of work memory.

- The user knowledge and its context of utilization are personal information; for example, the set of the specific tasks that a user makes according to the application.
- The group knowledge concerning collaboration activities: every negotiation, decision, or collaboration group task achieved, thanks to the application resources.
- The domain knowledge is essential to construct a precise context of the relations, actions and communications that can take place between the users and the application.
- The application knowledge (cooperative system) is fundamental to supply help and advices to users with a maximum of efficiency and relevancy.
- The treatment of their content allows the Mediation System to intelligently guide the users.

To summarize, we can enunciate that *Mediation Systems* (as knowledge base based systems) are strongly structured by the exchanged knowledge and stored in their knowledge bases, and by a knowledge engineering process which is considered in a continuous design.

5 *Mediation system* for technical functional analysis workspace

In this section, we illustrate our works on *Mediation System* design, by a *TFA* workspace composed of µ-tools (*WS-TFA*). The design of µ-tools is proposed for instrument collaborative activities of design (or co-design). The concept of µ-tool [25] corresponds to light, easy to use software applications, than can be inserted in a shared environment.

Our first experimental observation and evaluation frame of the concept of *Mediation System* refers to the cooperative management of students' projects joined an environment of learning. The goal was to show the relevancy of using a multi assistance system to a *Mediation System* [16]. The present application, which concerns the cooperative use of µ-tools a functional analysis workshop, allows us to propose a methodological frame for the design of *Mediation System* [17].

5.1 µ-tools for TFA

The functional analysis (*FA*) is a method systematic and structured by design. It allows describing a product under functional shape in order to take in consideration the needs of the user. The final description functional is the result of two analyses: a functional internal analysis or technician functional external (*TFA*) and a functional external analysis (*FEA*). The origin of the project of development of µ-tools of AF results:

- of the report that if the method is recognized to rationalize the design, it remains a method of delicate appropriation and insufficiently used;
- of a need of tools identified well to support the management, guide the user and help in the appropriation.

We propose to identify now µ-tools capable of contributing assistance to the functional analysis. This process of identification leads to the elaboration of SADT graph, point of start of the design of µ-tools (12 µ-tools have been identified this way): activity analysis, then construction of activity graph of reference (Fig.5, Milex → Beso → Devo, Isys → Caraf → Hiera or Flux→Conta→Granu). The figure 5 presents the SADT activity diagram corresponding to the accomplishment of an *FEA*.

Then, *FA*'s management will be able to be founded on the use of the 12 µ-tools:

- µ-tools of functional external analysis: Milex, Devo, Beso, Isys, Caraf and Flux, to define the exterior means (limits of the system), to define the evolution of the system (cycle of life), to define the needs, to establish the list of the functions (systemic inventory), to characterize and to classify the functions;
- µ-tools of internal functional analysis: Nomen, Flux, Conta, Granu, Fast and Coll, to create a nomenclature, to realize a flow chart, to realize a graph of contact, to assure the adapted granularity, to realize a graph TFAS (Technical Functional Analysis System) and to gather the information of the process.

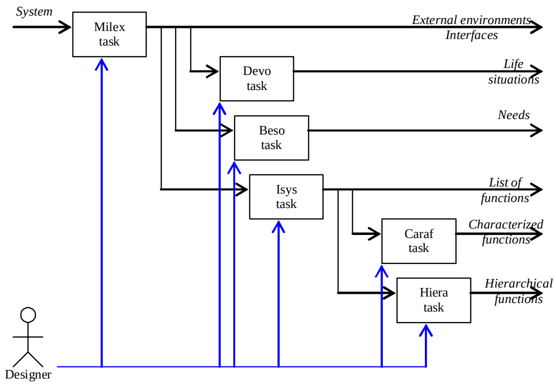


Fig.5. SADT activity diagram for *FAE*

5.2 Illustration : the task « Define the nomenclature»

The SADT activity diagram (Fig.5), starting point of our methodology, decomposes the reference activity, taken in the framework of an *AFT*, a set of tasks can determine his cooperative nature. These cooperative tasks can be translated by difficulties of making in work. It is the case, if we consider the task "To define the nomenclature" when the designers have for collective purposes of:

- to build the list of names (adapted and agree on them) and to obtain an ideal granularity;
- to identify the attributes and to associate them with the components, without minimal coordination between the designers;
- to validate components by adjustment of all the lists of components, without referring to an

organization (consensus of all the designers or decision of a coordinator of the group).

For the realization of this task, the actors have a vision shared by the nomenclature (list of components), communicate intensely and negotiate to produce a common and consensual nomenclature.

Contextes	Functional Analysis
Institutional Processes	Design in the Industry
Collective Activity	Design collaborative
Individual Actors	Presenter, group of designers
Interaction and mediatised collaborative	Intervention of the actor *Mediator*
Principles and devices of interactions (desk)	µ - tools of the workshop *WS-TFA*
Application collaborative	*PLACID*
Network and operating system	LAN, Windows

Table 2. Context of functional analysis activity

5.3 Mediator Design for WS-AFT

The Mediator's design includes the definition of the architecture of the *Mediator* (Fig.6), the agent-oriented design of the *Mediator* and the knowledge base design. The *Mediator* skills allow assuring the *Mediation* for all the tasks of *AFT* instrumented by µ-tools identified.

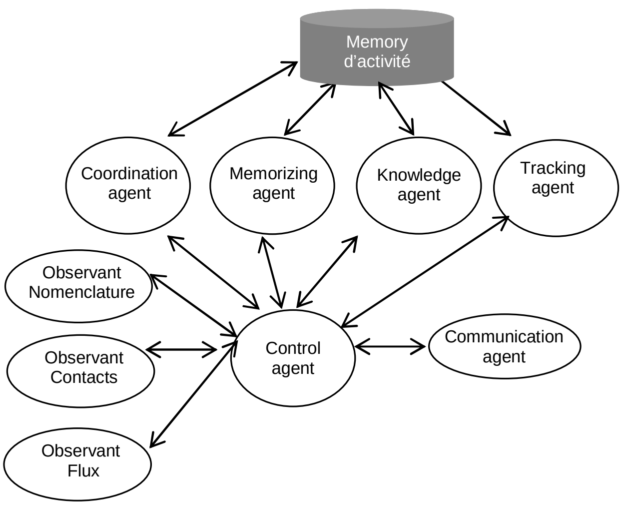


Fig.6. Agent structure of *Mediator* for the *WS-TFA*

UML design of *Mediator* appeals in a set of diagrams to model the structure, the activities and the interactions of every agent. The exhaustive presentation of these diagrams not offering particular interest, we shall illustrate this stage of design only with the sequence diagrams (Fig.7 and 8) corresponding to the collaboration scenario between *Mediator* and actors involved in the realization of our task reference: "Define the nomenclature".

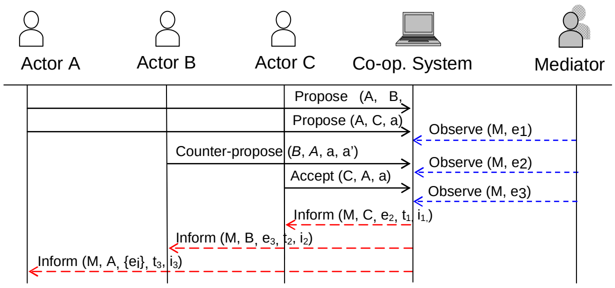


Fig.7. Interactions between three actors, the *Mediator* and the co-operative system in a scenario of component proposition for "Define the nomenclature"

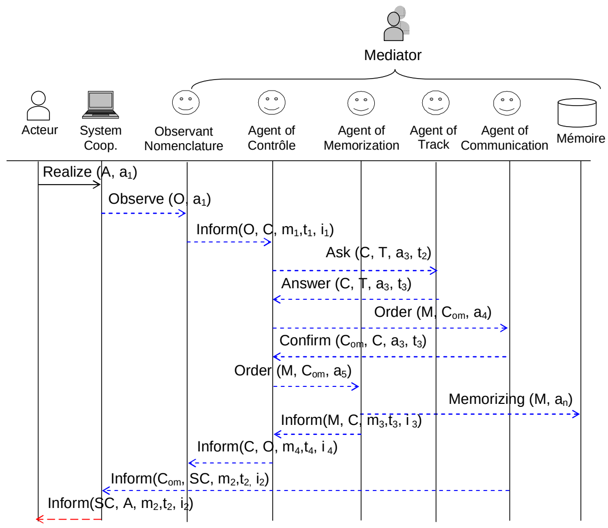


Fig.8. Interactions between the actors and the agents of the *Mediator*, and the co-operative system for the scenario "Define the nomenclature"

An agent platform (*PLACID*, Platform Help software for the Innovative and distributed Design) [9] was developed to support the usage of µ-tools. This software platform offers services for the use of a virtual environment of co-design (objects sharing, management tasks services, communications services).

The design of the *Mediator* targets the modeling of its knowledge base to facilitate its role and the accomplishment of its tasks.

The design of knowledge necessary for the *Mediator* proposed within the framework of the workspace of TFA is two natures: initial knowledge concerning the domain of the activity and the knowledge acquired through the activities assisted by the tool.

Attributes	Descriptions
Goal	Define Nomenclature of the system's components
Object	The nomenclature (names, attributes, granularity, contacts and stream) defined from the knowledge of the group of designers
Actors	The project team (presenter, designers)
Sub-task	To study components, to identify his attributes, to fix names, to define the granularity, to validate nomenclature
Periods / duration	Estimation in 40 % of the TFA (only if the task is prescribed in one)
Validation	Make for approbation of team designers
Input	Description of object for design and use of environment
Output	Complete nomenclature
Tools	µ-tools *NOMEN* and *PAPOT* (chat)
Cooperative context	Co-production emergent
Required knowledge	Knowledge of *TFA*
Required competences	Communication and co-production

Table 3. Task definition of « Define the nomenclature »

The *Mediator* design is oriented to knowledge base modelling in order to facilitate its role and to use its advantages.

To assist the first cooperative uses, the *Mediation System* has to refer to a set of stable and expert knowledge, resulting from a conceptualization of the activity context (here, the Technical Functional Analysis). The domain knowledge is such as: component standard libraries, typical contacts and predefined streams.

The domain knowledge includes the knowledge of the TFA definition and the activities knowledge associated with: defining the components list, defining the contacts and draw streams.

The figure 9 represents the general scheme of knowledge memorization under the form of case, realized by the Mediation System. The activity memorization process, which leads to the evaluation, is guided by a design of the activities (Activity i). The cases base enriched this way, increases the assistance capacity of the Mediation System for uses and future users.

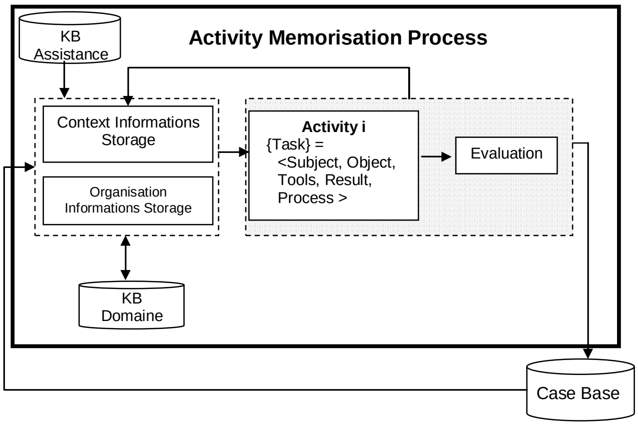


Fig.9. Scheme of knowledge utilization

6 The use of knowledge illustration

Figure 12 presents a screen shot of the usage by designer "AJF" of the functional analysis workspace for the cooperative task "Define the component list" in the project "Complete Stove". Three µ-tools are opened in the activity desk:

- NOMEN defines the components list (name, attributes),
- PAPOT allows communicating with the various designers; in this case we notice that three participants have for role to define the components list;
- INFO supplies to the participants information concerning its individual activity, as well as those produced by the *Mediator* on the tab " Med ". The designers can communicate to define the components list; in this case the *Mediator* can make communication visible, under the shape of a discussion report to the designer " AJF ".

"AJF" having already accepted this addition, the decision is thus consensual.

The use of the knowledge acquired during the work of design with the help of the ***TFA*** workshop, are available for designers request. The synthesis of the cooperative work under the shape of report will be assisted by the *Mediator*. In this case we will show the edition of the work report.

The list of components conceived in every µ-tool is showed to the designers with a mark made by the *Mediator* which allows designers have access to design detail.

We can make a typology of marks giving this way, more information, nevertheless at present every mark authorizes the possibility of displaying the acts of communication realized during the cooperative design.

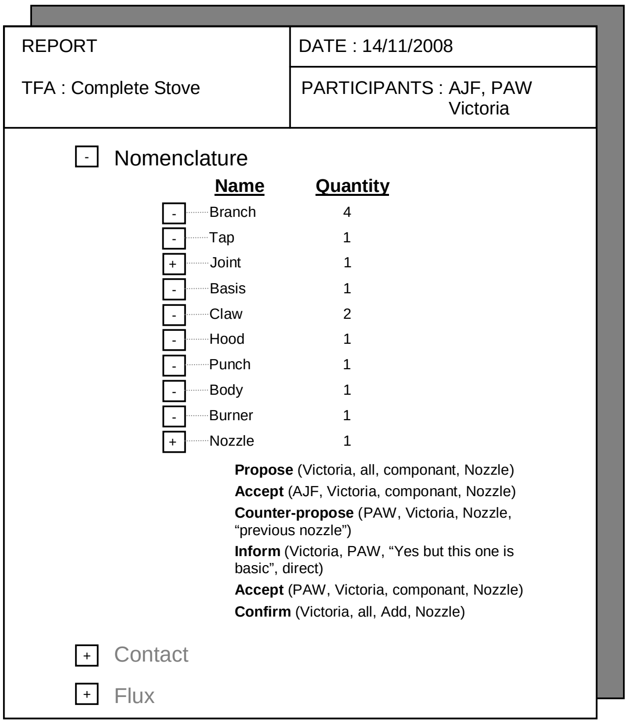
Figure 10 shows the knowledge structure of the Mediator, used to memorize the definition of elements of the nomenclature.

```
<nomenclature>
        <components>
          <name> </name>
          <quantity> </quantity >
          <trace>
                  <actor> </actor>
                  <transmitter> </ transmitter>
                  <receptor> </ receptor>
                  <act> </act>
                  <object> </ object >
          </ trace >
      </components>
</nomenclature>
<contact> </contact>
<flux> </flux>
```

Fig.10. Scheme of knowledge in XML

The structure of knowledge is represented in XML; this example is the trace of activity stored by the Mediator. Figure 11 illustrates the document produced with this knowledge. The document is composed by the Mediator which assists the actors to choose the relevant knowledge to be reported.

The µ-tool *NOMEN* associates the defined components while the *Mediator* adds work knowledge. In order to define the components of the stove, the designers have exchanged messages that the *Mediator* will recall during the edition of the report, if the group of designers agrees in their relevance, to include them in the report.



REPORT

TFA : Complete Stove

DATE : 14/11/2008

PARTICIPANTS : AJF, PAW Victoria

Nomenclature

Name	Quantity
Branch	4
Tap	1
Joint	1
Basis	1
Claw	2
Hood	1
Punch	1
Body	1
Burner	1
Nozzle	1

Propose (Victoria, all, componant, Nozzle)
Accept (AJF, Victoria, componant, Nozzle)
Counter-propose (PAW, Victoria, Nozzle, "previous nozzle")
Inform (Victoria, PAW, "Yes but this one is basic", direct)
Accept (PAW, Victoria, componant, Nozzle)
Confirm (Victoria, all, Add, Nozzle)

Contact

Flux

Fig.11. Components and trace of design stored by the *Mediator*

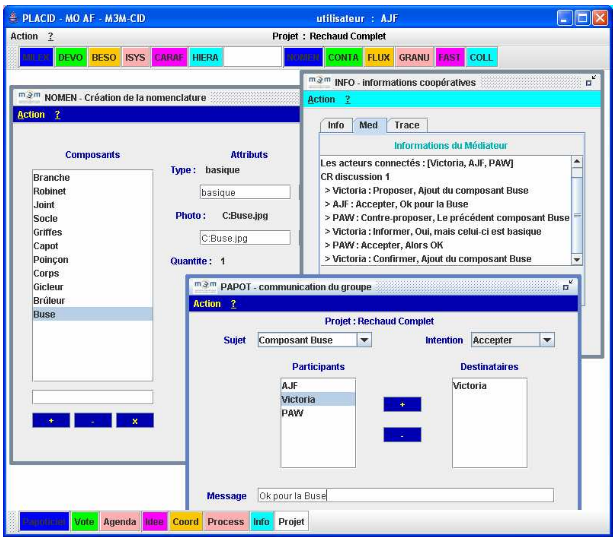


Fig.12. Collaborative scenario to draw up the list components

7 Conclusion

Our work on the development of a methodology of design of *Mediation System* (*Mediator* actor), us resulted in specifying knowledge base. We presented the utilization context of the knowledge induced by the introduction of a *Mediator* actor in a group of actors that cooperates distantly with the help of a cooperative system.

The ability to use knowledge in the general sense is of the same type as that of knowledge-based systems or expert systems. The *Mediator* operates various types of knowledge: knowledge of know-how and domain knowledge of users and the group, knowledge about the specific application, and knowledge for assistance. In this case the knowledge-based system is not activated directly by the actor but through the *Mediator*.

Following the instrumentation of a co-operative activity of *TFA* (μ-tools oriented), we integrated a *Mediator* actor to assure a better sharing of information in this context of collective work, and allow to more easily establish an effective connection between an actor and the co-operative application on the one hand, and between the co-operating actors, on the other hand. This experimentation thus allowed us to validate our proposition of *Mediator* actor integrated in the space of cooperation.

In our illustration, the *Mediator* memorizes knowledge during the activity of *TFA*. Then it can help the actors in the final phase of reporting. This example of *Mediator*'s intervention during the synthesis phase of activity is not the first we studied. Another one was the assistance to the evaluation of students' projects made by teachers using the knowledge memorized by a *Mediator* during the projects management.

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