Multi-Agent System to Support Creative Workshop

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Abstract—**The creative workshops (creative jam or design jam) are an increasingly used way to produce innovation avenue in a short time. Due to the increasing popularity in company and organization, it is subject to computer assistance to increase productivity, and information capitalization. The actual digital systems are limited in supporting the complex process of creative workshops. The actual papers propose to apply the multi-agent system approach and more specifically an organizational approach to design a creative support system that will cover the entire complexity of the creative workshop.**

Keywords—*multi-agent system; creative workshop; creative support system*

I. INTRODUCTION

In a worldwide competitive economy, the survival of a company depends on its ability to be innovative. Hence, the overall interest for innovation management increases. According to the goals and results expected by the company, the innovation approach can differ from analytic as TRIZ and inventive design to intuitive approach as brainstorming and other creative problem solving method. The approach considered presently is the creative problem solving. It attempts to respond to the injection of innovation by setting a problem and attempt to solve it by applying more or less structured methods. Undependably of the approach, the innovation process involves large amount of information and knowledge. The difficulty for a company is to know how and when use it to reduce time and cost of conception. The knowledge-based systems attempt to respond to this issue by capitalize and share knowledge from experts, foster the reuse of it and foster the collective learning [1]. According to the innovation approach, its complexity disqualified the use of knowledge-based systems. It is the case for the creative problem solving and more especially creative workshop which is the applying of creative problem solving methods (which will be called creative methods in this document) in a short time (from several hours to several days) by persons. It becomes even more complex when participants (who have different professional specialties and cultures) are locally or temporally distant. To provide assistance to these organizations where participants are by nature heterogeneous and distributed, we propose to embrace the agent paradigm. Indeed the agents have already proved their efficiency to manage complex problem in heterogeneous and distributed environment and more especially in the case of dynamical organizations. The current research work is so to define the architecture of a Multi-Agent Systems (MAS) that will support the different actors during a creative workshop (CW). The intent of this kind of systems is to be able to modeling behavior and information exchange between actors, anticipate behavior to provide the expected information, provide decisional support adapted to the situation and manage the knowledge involving during creative workshop.

A. Creativity field

Behind the concept of creative problem solving and creative workshop, it is the entire research domain concerning creativity which is implied. According to [2], creativity domain involves different research fields: (1) to determine how creativity is associated with personal characteristics (personality traits, cognitive ability); (2) to examine the cognitive and social processes that are involved in creativity; (3) to foster ideational creativity by means of computer tools; and (4) to identify the environmental factors that nurture or inhibit creativity. The challenge is to design a computer tool to foster the creative activity by considering the personal characteristics, the cognitive and social process and the environmental factors. In other terms, designing system to support creativity should consider the individual, the collective and the organizational levels as defined by [3]. In overall, the individual level is everything that empowers and supports individual during his creative activity but also the resources required to do it[4]. The collective level concerns the social influences of the persons that involves in creative activities. The organizational level concerns everything that is provided by the organization structure (environment, culture, workflow…).

Concerning the specific case of the creative workshop, the key success factor is the dynamic initiated by the facilitator to a group of participant. This dynamic of the group is based on the communication (synchronous and asynchronous) [5]. Communication is even more important in the case of virtual team. The facilitator and the creative methods are here to assist this communication, share the speech time and bend the perceptions of a problem through different cognitive mechanism.

B. Information systems field

Concerning the digital aspect of the creativity, Lubart in [6] suggests different nature of the assistance that a computer tool can provide. Lubart defines four categories:

- a creativity support can be considered as a coach giving advice and helps to implement and apply techniques;

- a pen pal. providing support for collaboration;

- a nanny monitoring the work's progress and provides a framework;

- a colleague generating its own ideas and solutions.

All approaches confounded, a large number of information systems that pretend support the creative process has been encountered in a systematic review of the literature [7]. 31%of them were commercial solutions whereas more than 69%were research experimentations. We have observed that the most of them were dedicated to brainstorming activities in a co-located collaboration. These systems was also analyzed through the support of the 4 steps of the creative process which are problem formalization, idea generation, idea evaluation and implementation [8]. For most of them, the creative process was limited to the ideation phase although some also consider either the problem formalizations or the idea evaluations phase. As already conclude by [9] [10], the domain of digital systems dedicated to creativity is incomplete. The support of the co-located and remote creative collaboration, respecting individual and collective conceptual space, and covering the entire creative process is not explored. Concerning the system features, the overall functionalities track was: collect and capitalization of the information/ ideas generated, assist the evaluation of the idea through specific evaluation mechanism, and bring support to collaboration and exchange of idea. However, several experimentations remain inspiring on the way they implement functionalities. From all these systems, none of them declare using the paradigm agent for their conception and so reach their goals.

C. Multi-Agent system for creativity

Creative workshop (CW) is based on a complex process that implies collaboration among persons with different professional specialties, culture and responsibilities. According to the properties of the agent (autonomy, reactivity, pro activity, adaptability, etc.) described in [11], we think that it is relevant to applied the MAS approach to support the creative workshops. Indeed it could permit to avoid the limitation of the actual Creative Support System concerning the exclusive support of the participants and the collect of information during ideation. The CW is more complex than only collect ideas from participant. These limits are also the overall limit of the Knowledge-Based systems which is the ability to formalize and capitalize information but the inability to perceive the complexity of the situation.

The interest of exploring the MAS field for creativity and innovation is increasing. It has been applied to model innovation dynamic and conceives a system based on predictive scenario [12]. More closer to the present interest, the CIMAS [13] is a system mainly oriented to the management of the idea during the creative workshop. In the same perspectives of managing the ideas, the GI2MO [14] web application has been created in addition to an ontology. It remains this system is not defined and designed as a MAS as it is suggested by CIMAS. Another MAS related to creativity exists, not in the goal to support creative activity but as structure to a personalized creativity learning system [15]. It remains that the MAS architecture is not detailed.

As highlighted previously from the literature review, the CIMAS and GI2MO examples are also exclusively dedicated to ideation. The ambition of a new MAS to support a creative workshop is:

- To capitalize the knowledge generated during the creative workshop (industrial problem, problem data, subject, idea, evaluation),

- To assist the organizations of the creative workshop through the formalizations of the information – assist the selection and the applications of the creative methods

- To assist the evaluation, the sorting and suggestion of ideas.

Build a creative support system based on the MAS architecture would provide reactive, proactive and flexible properties. Based on the function presented above, the present article attempts to respond to the following question: How to design a Multi-Agent System for support the entire distributed and collaborative process used in creative workshops? The hypothesis is to use the DOCK approach which is an organizational approach to formalize MAS architecture suggested by [16]. The next section will present the elements that are necessary to build the MAS architecture: the organizational model. The section 3 will present the first of level of the MAS architecture: the cognitive agent. The final section will present the perspective of this king of systems and the future work.

II. CREATIVE WORKSHOP ORGANIZATION

The design method used to develop a MAS to support creative workshop is inspired of the organizational approach [16]. The first step of the approach concerns the modeling of the humans' organization. Then the human organization model is translated into a virtual organization model (agentification). From this virtual organization, the agents' specifications are defined and finally the interactions between agents are described.

So to create the MAS that would support the CW, we take into account of the organizations structure, the created knowledge, the roles and the processes used by the humans. The formalization of this information can be done through four different models: organizational structure model, process model, activity model and role model.

1) Organizational structure model

Since an organization is a set of entities interacting together to achieve a common goal [17], there are different levels of organizations that can be considered during the creative

workshop. The workshop itself is an organization where the goal is to creatively solve a problem. The others organizations that can be considered are the variety of creative methods applied. Based on the organizational structure model of the creative workshop, four processes figured out: problem formalization, creative workshop organization, idea generation and idea evaluation.

2) Process model

These processes were modeled through the IDEF0 formalism according to the experience of the authors in organizing and managing creative workshop and complete with the literature. These models permit to represent the activities, and the deliverables generated by the different roles during the CW. There are six theoretical roles noticed during the process of the CW: participant/creative, facilitator, organizer, stakeholder/decision-maker, expert and evaluator. By experience, the distribution of the roles to the actors and their solicitation depends on the CW context; moreover actors can play different roles according to the phase of the creative process. More in detail, the creative/participant is the one who suggest ideas; the facilitator helps the participant to apply creative methods and manages group dynamic; organizer provides the resources and the information for the group of participants; stakeholder/decision-maker provides the problem to solve and select the ideas that will be further developed; and eventually the expert who provides expertize on specific field if participants do not have the required knowledge. Concerning the role of evaluator, it is the person that emits an evaluation concerning an idea; this role is always combined with one of the previous. The role combined with evaluator's roles influences the way the evaluation is processed.

3) Activity model

There is an activity model for each activity realized during a process model. The result of the activity models is to highlight the competence and knowledge necessary to carry on the tasks of the activity. For instance, concerning the activity "Evaluation method definition" (Fig.1), the decision and the organizer collaborate to explicit information required later in the creative workshop. The information is the "Evaluation method" and the "evaluation criteria" associated. To produce this information, the two actors apply there competences as the "Define the evaluation criteria" or "Organize the evaluation". The activity model permits to highlight the individual competences and knowledge required to produce a collective result, however it only describe the information necessary but not sufficient to reach this result.

1) Role model

From the three previous models, it is possible to create a detailed description of the six roles in the CW through the organizations, the missions, the competences, the knowledge and the interactions linked to a role. The table 1 provides specification of the role facilitator.
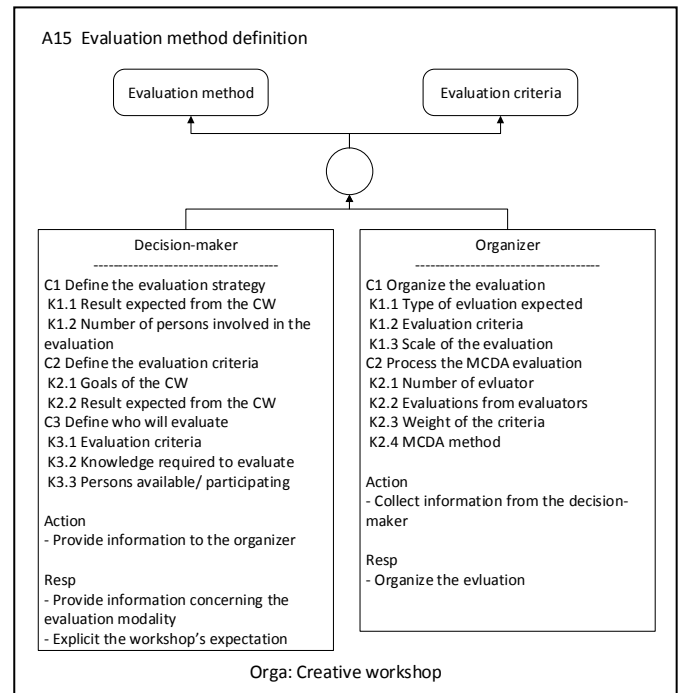

Fig. 1. Example of an activity model

III. TO A CREATIVE WORKSHOP MAS

On the hypothesis that the CW can be represented as organization of agents, the architecture of these MAS is based on the previous human organizational model (Fig. 2). A MAS can be described by two different types of agent: cognitive and reactive [11]. The cognitive agents have to assist the actor in their tasks according to their roles. The reactive agents have to support the business process(es). In the present case of CW, there is not a unique process instead it is several that can be considered, as the learning process and the process which support the idea life cycle. In other term the MAS modeling approach can be summarized by the figure 3. The first phase models the interaction between human during the creative workshop through the organization model, based on the organization model the cognitive agent are formalize to fit the human behavior. The third phase is the definition of the process that the reactive will support, i.e. the idea life cycle and/or the learning process, and then the reactive agents are defined in the fourth phase. Once both the cognitive and reactive agents are defined, the interactions between each other and eventually knowledge base are defined.

First of all, concerning the cognitive agents, their organizations are entirely dependent to the human organizational model as they are supposed to support human. These agents monitor the activity of the humans. Their behaviors are defined by the roles models of the human organizations. One cognitive agent is associated to one human actor; it is according to the human activity and the interaction that the role will be defined.

Concerning the reactive agents, their specifications is also based on the achievement of the four models proposed by DOCK i.e. the organizational structure model, the process model, the activity model and the role model.

However, since the objectives and the processes involved are totally different from the human process the four models have to be created. This aspect remains a work in progress as the present case consider at least two processes to cover i.e. learning process and idea life cycle process. It means there are two possibilities in term of conception: merge the two processes into the same reactive agents' organization or split into two different organizations and so create two reactive agents layers as illustrated in Fig. 2.

IV. CONCLUSIONS

Although the Creative workshop MAS is a work in progress and only the organizational level is defined, it distinguish from the other system by considering more knowledge upstream of the ideas. In comparison to CIMAS which is the only MAS architecture related to creativity encountered in the literature, the actual research expand the range of information and knowledge considered with a more precise description of the role involved during the creative workshop. Concerning the personalized creativity learning system, despite the lack of details concerning the MAS architecture, the use of the data mining based on decisional tree is inspiring for the future reactive agent which would process the data.

TABLE 1. THE FACILITATOR'S ROLE MODEL

| Role	Facilitator
Organization	Creative workshop
Missions	Select the creative methods adapted to the problem
Competences	C1 determine the relevant creative methods C2 Organize the creative methods C3 Validate the creative method plan …
Knowledge	K1.1 information concerning creative method K1.2 Result expected from the CW K1.3 organizational info concerning the CW K1.4 Expertize of the participant K2.1 creative method selection K2.2 Phase of the creative method …
Interaction domains	Creative method catalog …
Responsibility	Generate a list of creative methods Generate a creative method plan …
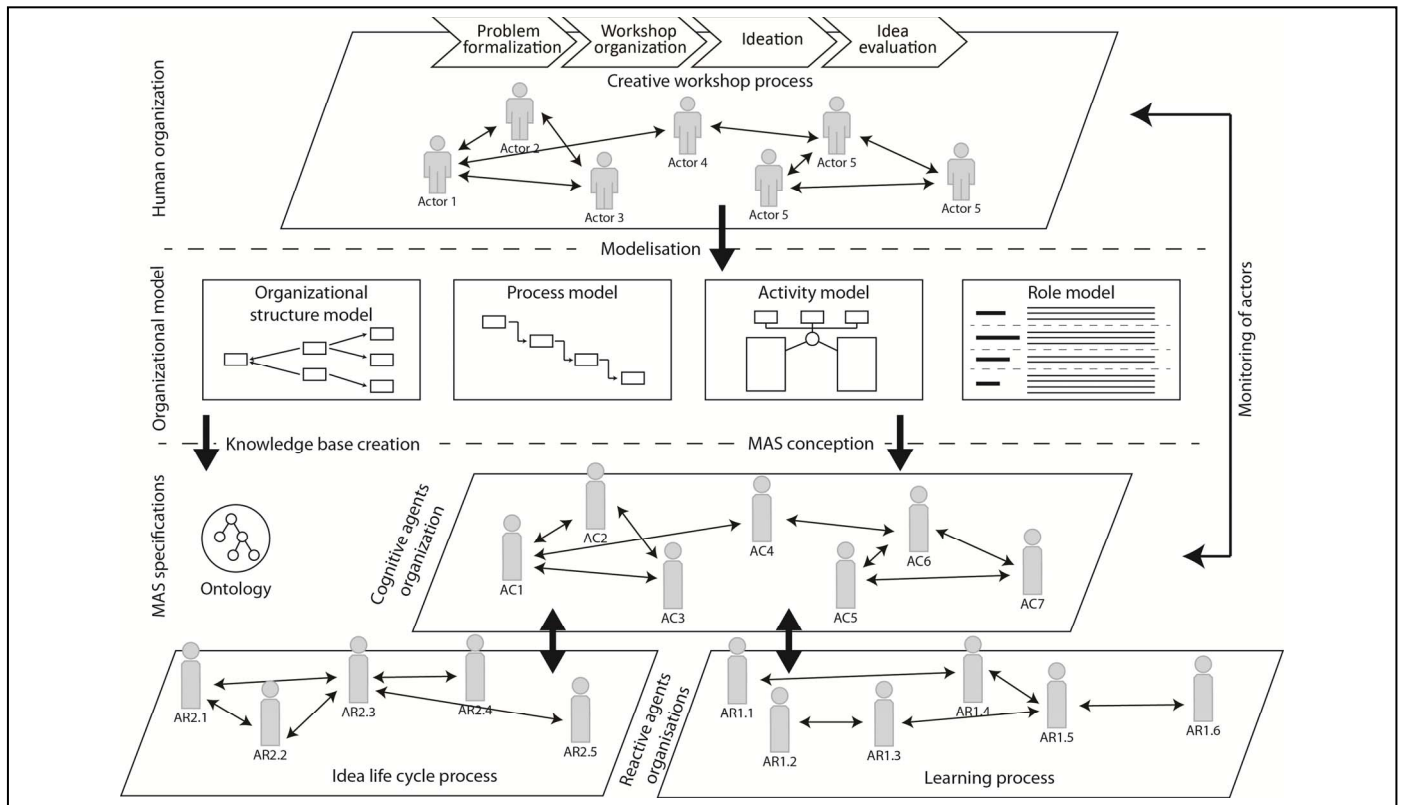
Fig. 2.   MAS architecture
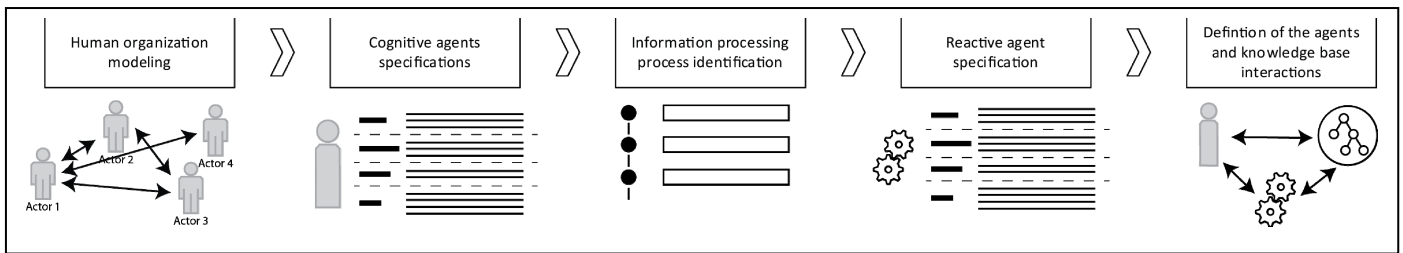
Fig. 3.   MAS modeling approach

V. Perspectives

Based on the actual advancement of the system conception, several work avenues remains open. First of all, the logical one is to figure out a solution to model the reactive agents' organization. In parallel to the determination of the different agent, the knowledge base has to be formalized. By pretending manage the knowledge during CW and provide assistance in the organization of CW, it is necessary to define a vocabulary that would be shared between the actors and the systems. This knowledge base would be a domain ontology that covers the vocabulary concerning: creativity, creative workshop, organization of CW and ideas. This vocabulary will be instantiated by the different creative method existing and continually instantiated by the information from the different workshop organized. All these things will constitute the entire multi-agent system.

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