Ontology to represent the knowledge domain of a creative workshop

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Abstract— **Creativity is a critical factor in the today's increasingly competitive business environment. In order to increase and accelerate the production of innovation, firms attempt to promote creativity and produce ideas by organizing creative workshops. The creative process, especially during creative workshop, is a knowledge creation and manipulation process. Despite creative production is unpredictable, there is key knowledge that is expected and required to implement a creative workshop and a creative dynamic. In a context of increasing use of groupware by team during creative problem solving, the identification of this knowledge is very important to provide assistance during the process. A literature review of creative support systems highlights some limitation in assisting the entire creative process, formalizing this area of knowledge related to creative workshop lead to large amounts of perspectives for the creation of intelligent creative support system. The present article suggests the use of an organizational approach to explicit the area of knowledge and use it for the creation of the creative workshop management ontology.**

Keywords- ontology; creative workshop; creative process; creative support system

I. INTRODUCTION

In order to create ideas and transform them into innovation projects, the organizations have to create a culture, a dynamic and an environment that promote creativity. A way to do it without change the entire organizational structure is to set up creative workshop. It consists of bringing together - in limited time span - a group of persons (if possible with different expertise) in order to apply creative techniques which ease the discussion, the confrontation of point of views and reduce the latent inhibition [1]. During this kind of workshop, we noticed six different roles assumed by individuals:

- Ideator who suggests ideas by notably applying creative technique.
- Facilitator who manages the ideator and the application of creative techniques.
- Industrialist who has an unsolved and complex problem.
- Organizer who interacts with the industrialist to define the modality of the workshop.
- Evaluator who evaluates the ideas according to the modality defined by the organizer and the industrialist.
- Expert who provides complementary information to develop idea or evaluate it.

The individuals interact according their role along a creative process which can be described through four steps: problem analysis, ideation, idea evaluation and communication/implementation [2]. These steps can be broken up into activities that involve some roles, material resources and knowledge. This level of detail will not be presented in this paper.

A derivative of the creative workshop is the organisation of innovation contest that externalize the production of ideas. Innovation contest could be generally defined as IT-based and time-limited competitions arranged by an organization or individual calling on the general public or a specific target group. This public make use of their expertise, skills or creativity in order to submit a solution for a particular task previously defined by the organizer and industrialist who strives for an innovative solution [3]. Whether it is creative workshop or innovation contest, it produces a large amount of information from persons with different roles and so different objectives and knowledge.

This managerial practice of creative workshop and innovation contest is associated with the increase of digital tools to assist creativity. A literature review of these creative support systems [4] highlights the limits of these systems to support the entire creative process over the various collaboration situations. Most of them focus on the ideation phase of the creative process and don't support a combination of different collaboration situations. These difficulties have been experimented during a creative workshop organised by the University of Lorraine that involves engineering students dispersed around France and worldwide to solve problem suggested by industrialist. In order to conceive a creative support system that addresses these limits in order to ease the creative workshop, we want to formalise the key knowledge of the creative workshop. The representation and the formalisation of knowledge could be done through ontology that can be defined as "an explicit specification of a conceptualization" which is an abstract, simplified view of the world that we wish to represent for some purpose [5]. The interest of formalizing the area of knowledge related to creative workshop into ontology is multiple. It would improve management of information [6] by providing a structure to capture knowledge involved in creative workshop and better distribute it to actors of the workshop. The use of ontology is furthermore interesting as it permits reasoning on the knowledge collected in order to infer and suggest it to the actors. This would permit a more precise and efficient information retrieval [6][7]. The

formalisation of the area of knowledge through ontology is also interesting for collaboration between human and interoperability between digital systems [8] as it permits an explicit information model that ease communications [6].

In order to describe the knowledge involved during a creative workshop, the engineering of ontology is based on organizational approach. The next section will present some research works about creativity and ontology. The third section present the methodology applied to build the ontology. The section 4 explains a part of the results before the section 5 provides some perspectives.

II. Ontology in the Domain of Creativity

Ontology is interesting for collaboration and interoperability as it disambiguates and provides a consensual conceptual vocabulary [9]. The inferring ability of ontology is essential in the artificial intelligence domain, it permits notably the creation of Decision support system [10].

Ontologies has been realized in various domains such as chemical [11], robotics [12], medicine [13][14], in order to provide further intelligence to decision in design [11] [15] [16] or in R&D management [6]. It is also promising to use in creative support system in order to support decision required during creative process and manage the knowledge in creative workshop. In the field of innovation and creativity, some experiments of ontology have already been done [8]. What differentiate ontology is the type of knowledge, the scope and the objective that constitute the ontology. There is various ontologies related to innovation and creativity, and each one has specificity and objectives that can be enumerated: innovation management [9] (e.g. OntoGate [17], Ontology for Innovation [1]), idea management (e.g. Idea Ontology [18], GI2MO [19]), creativity management (e.g. idspace [20]), brainstorming [21], collaborator matching [22], problem description [22], experience management for creative and non-deterministic design process [11]. Although several concepts are already introduced by ontologies, none describe the area of knowledge of creative workshop. Even if this area of knowledge reuses concepts from other ontologies, it is necessary to design a new one to determine the concepts and relation specific to this field. In this article, what we mean by knowledge is all the concepts that describe the creative workshop process (creative techniques, evaluation techniques…) and the produced artefacts (subject, ideas, evaluation…). As Creative Workshop Management Ontology, it doesn't pretend represent the specific knowledge domain of the problem to solve. The next section will present the methodology used to determine the concepts and the relations of the ontology.

III. Methodology to Design Ontology

Since it already exist methodologies to design ontology, they were compared by their phases. From this comparison represented by the Table , the merge of the methodologies leads us to 7 phases: (1) domain, scope, purpose, and commitment definition, (2) competencies of the ontologies, (3) acquisition/ conceptualization of the concept, (4) reuse of ontology, (5) formalization of the ontology (coding), (6) populating the ontology, and (7) evaluation of the ontology. The design process with its two alternatives following an evaluation fail can be represented by the Figure 1. This figure also shows the merge of phases into 4 larger phases in order to ease its explanation: scope, goals and competencies definition, conceptualization (with reuse), development, and validation/ evaluation.

A. *Scope, Goals and Competencies Definition*

As most of the methodology reviewed, the first phase of designing ontology is the preparation that means the definition of the domain, the scope, and the purpose of the ontology. This can be described and detailed as a motivating scenario [23]. This motivating scenario is also a way to determine the competencies-questions [24] that the ontology should satisfy. The term competence will be used equivalently to the term competency-question above by M. Gruninger. These competences can be seen as functionalities that can be verified by traducing them into SPARL request.

B. *Conceptualization*

The second step is the determination of the vocabulary of the ontology. The common way is to textually describe the area of knowledge and annotate it with subject, predicate and object to determine the concepts and their relations. Instead of this textual approach, an organizational approach has been adopted. It consists to model the human activity. Modelling the human activity in a way to illustrate the knowledge and artefacts used and produced by activities, and the actors involved permits to determine the concepts of the area of knowledge. These concepts can be indexed into a table with its name and its definition. According to the detail of the modelling, the concepts indexed are not sufficient and have to be extended. To do so, each concept indexed is reviewed to determine its relations and the concepts related. Each concept was reviewed by asking these questions: What characterize an instance of this concept? With which other instances is it related to and what is the relation? The relations indexed are differentiated into two types: concept relation that links two or more concepts and data relation that links a concept to value as integer, literal or strings. If a concept or relation is noticed to be part of the area of knowledge but it is not indexed, it is added to the index of concept or relation.

TABLE I. COMPARISON OF ONTOLOGY ENGINEERING PROCESS

	Domain, scope, purpose	**Competencies-Questions**	**Acquisition/ conceptualization**	**Reuse**	**Formalization**	**Populating**	**Evaluation**
KEM [24]	X	X	X	X	X	X	X
TOV [23]	X	X	X		X		
Onto methodology [25]	X		X	X	X		X
Design science ontology lifecycle [17]	X		X		X		X

[1] Ontology for innovation : http://www.lexicater.co.uk/vocabularies/innovation/ns.html (01/02/2016)

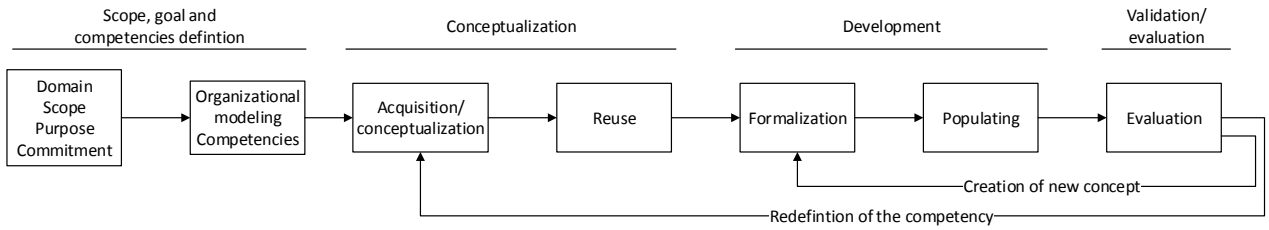

Figure 1.Ontology designing process

Simultaneously, concepts and their relations can be graphically represented. It permits to have an overall representation of the area of knowledge. It can be represented according to several formalisms as UML class [26], AML ontology diagram [27], G-OWL [28] or simply with circles and edges.

Once the vocabulary determined, the recommendation is to reuse concept from existing ontology [29]. It consists in replacing the indexed concepts by concepts from other ontologies at the condition they possess the same meaning.

C. *Development*

This phase is the translation of the concepts and relations indexed into a computer-readable language. There is different language used to describe knowledge: the eXtensible Markup Language (XML), the Resource Description Framework (RDF), and the Web Ontology Language (OWL). OWL extend RDF which itself extend XML. An alternative to OWL could be N3 or Turtle. It does not matter as most of them can be generated thanks to an ontology editor or translated with web application. As the previous conceptualization separated the concept, the data relations and the concept relations, the use of Protégé [30] ontology editor is advised as it possesses the same data structure.

D. *Validation and Evaluation*

Various things on ontology can be subject to evaluation: - the syntax error according to the standard used, - the consistency of the ontology according to the area of knowledge represented, and - the satisfaction of the competencies. There are several tools available online to verify the syntax of the ontology. If there is no syntax error, the consistency of the ontology is verified. It means check if there is no logical error between concepts, relations, and instances that does not permit the reasoner to infer knowledge. The validation concerns also the ability of the ontology to satisfy its competencies. To do so, the competencies should be translated to SPARQL [31] request in order to compare the generated results to the expected results. According to the results, if it is satisfying, nothing is changed, else either the ontology is modified [29] or the competencies and its SPQARL request is modified.

IV. DESIGNING THE CREATIVE WORKSHOP MANAGEMENT ONTOLOGY

A. *Definitions of the Ontology*

The scope of the present ontology is to describe, specify and represent all the concepts related to the organization and implementation of a creative workshop. This is why the presented ontology is named as Creative Workshop Management Ontology (CWMO). Describing the entire creative process of a creative workshop implies to represent the knowledge involved during the phases presented above. In order to determine the knowledge involved during these phases, we have modelled the organization of a creative workshop with a combination of IDEF-0 [32] that represent the succession of activities with their resources and their production, and RIOCK [33] that details the knowledge implied to the realization of each activity. The overall purpose of this ontology is to represent knowledge about the execution of a workshop in the perspective to ease it. Based on the different phases, this overall purpose can be decomposed into specific purposes as: assisting the analysis of the problem to solve, suggesting the adapted creative and evaluation techniques, assisting the evaluation of ideas, and capitalizing the information concerning the ideas, the problem and the evaluation. The competencies of the ontology are all the knowledge processing it should permit to achieve its purposes. The determination of the competencies can be structured according to the activities of each phase. The Table II shows this structure with an example of two different types of competencies for each.

B. *Vocabulary Determination*

As introduced previously, the determination of the vocabulary of the ontology is determined from the modelling. The IDEF-0 modelling mostly permits to determine the roles involved in the process (as organizer, facilitator…) and the outcome of the activities as creative technique, creative strategy, evaluation criteria and idea. As for RIOCK, it permits to explicit the knowledge required by each role to collaborate and achieve an activity. So, this formalism is used to detail every activity and deduce further concept of the area of knowledge.

In order to respect the recommendation about the reuse of concepts from others ontologies, we used the Linked

TABLE II. EXAMPLE OF ONTOLOGY COMPETENCIES ACCORDING TO THE PHASES DESCRIBED

Phases	Competencies
Problem analysis	Create a problem with the subject and the context. Which resources and conditions are necessary to apply a defined creative technique? …
Idea generation	What is the caracteristics of the creative technique applied? Create an idea with its descriptive caracteristics. …
Idea evaluation	Add the evaluation information to the idea. What are the evaluation criteria associated to the problem and the person? …

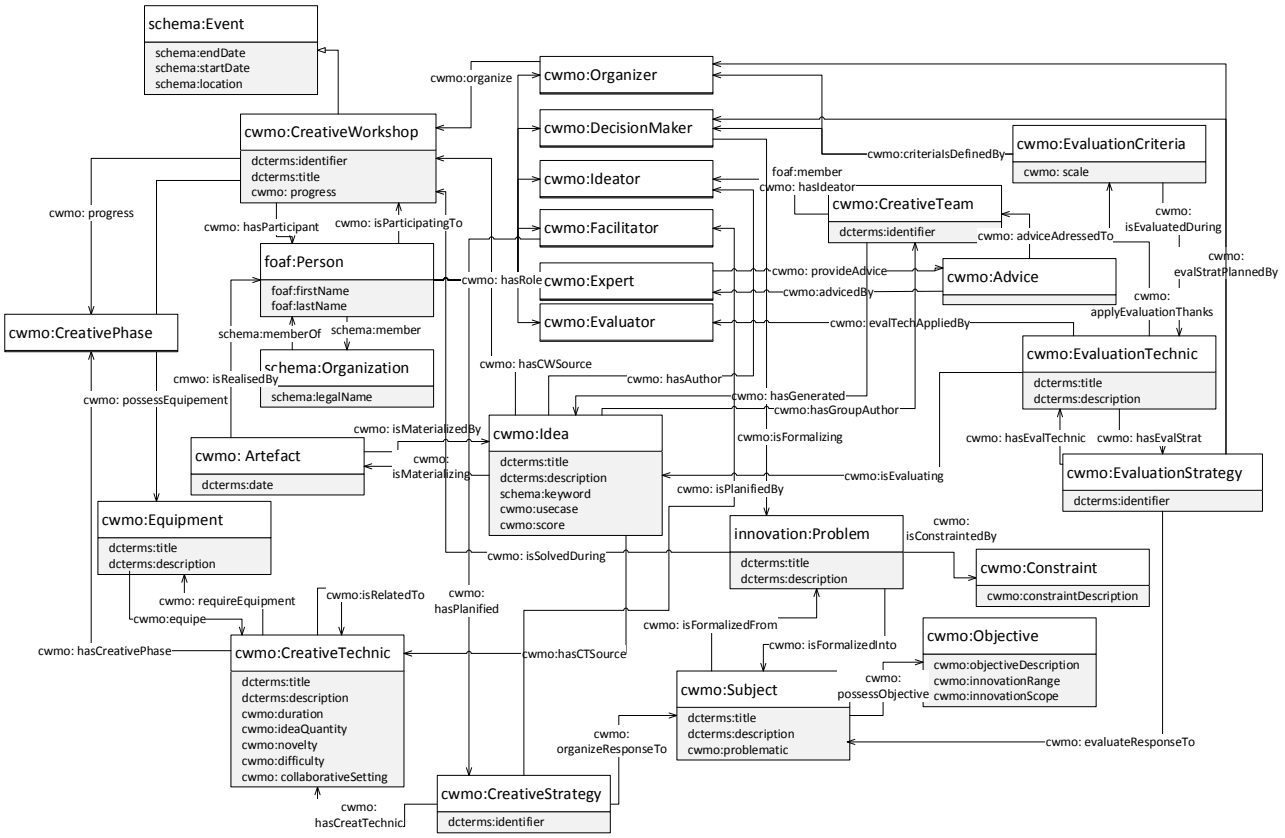

Figure 2. Extract of the Creative Workshop Management Ontology

Open Vocabulary[2] (LOV) search engine. It simplifies the concept reuse procedure but it is not exhaustive, as the authors of ontologies should register it in order to appear on LOV. CWMO was so enriched by concepts from GI2MO [19], FOAF [34], schema[3], dcterms[4], and SKOS [35].

C. Development and Verification

The development of the ontology consists to specify (name, definition, restriction…) of the 39 identified concepts, the 79 relationships between the concepts and the 32 relationships between data in the ontology editor Protégé. The Figure 2 represents an extract of all these concepts and relations of the CWMO ontology. Once the concepts and relations of the ontology are created, the ontology is adjusted thanks to the ontology editor and the Pellet reasoner to verify the consistency of CWMO. Then the competencies of the ontology were verified through the application of the SPARQL request corresponding to the competencies. The Figure 3 illustrates this verification with, in the top frame, the request applied to the ontology, and the result generated in the bottom frame. Iteratively, adjustments are done by testing a SPARQL request and modifying the ontology or the request according to the results.

V. EXAMPLE

CWMO has been created but not experimented in situation. However to ease the understanding of the usefulness of this ontology, a quick example will be presented. Assume a creative workshop about the subject: "the protective equipment for bike in urban context". This formulation of the concept of subject is done by an instance of individual that has the role of industrialist or organizer. The concept of subject is related to the concept of problematic with an instance as: "What would be the protective equipment in a context of evolving transportation in urban environment". Then other instance of individual related to the concept of facilitator defines an instance of creative strategy which is composed by several instances of creative techniques. The instance "quick workshop" of the concept of creative strategy is related to creative techniques as "brainpurge", "image boards", and "scenarios". The instance of individual related to the concept of ideator write ideas based on the application of creative techniques. The instance of individual related to the concept of evaluator apply instance of evaluation techniques as "feedback", "multicriteria evaluation" according to the instance of evaluation strategy "quick evaluation". This quick description of the execution of creative workshop provides an idea of what the CWMO workshop describes.

VI. DISCUSSIONS

Ontology is becoming crucial in modern collaborative product/process innovation [8]. It permits capturing,

[2] Linked Open Vocabulary : http://lov.okfn.org/dataset/lov/
[3] Schema : http://schema.org/
[4] Dublin Core Metadata Initiative : http://dublincore.org/documents/dcmi-terms/

SPARQL query:

```
PREFIX rdf: <http://www.w3.org/1999/02/22-rdf-syntax-ns#>
PREFIX owl: <http://www.w3.org/2002/07/owl#>
PREFIX rdfs: <http://www.w3.org/2000/01/rdf-schema#>
PREFIX xsd: <http://www.w3.org/2001/XMLSchema#>
PREFIX : <http://purl.org/cwmo/#>

SELECT ?subject ?evalTech
        WHERE {
                ?evalStrat :evaluateResponseTo ?subject.
                ?evalStrat :hasEvalTechnic ?evalTech.
        }
```

subject	evalTech
SportSubject	MultiCriteriaScore
HelmetSubject	UpAndDownVote
HelmetSubject	FreeReview

Figure 3. Examples of SPARQL and results concerning the evaluation techniques associated to a subject

sharing, reasoning on area of knowledge and so easing collaboration and interoperability. The presented engineering methodology based on organizational approach deals to the creation of the Creative Workshop Management Ontology. Despite the potential exhaustiveness of the methodology, CWMO describe explicitly few concepts related to collaboration even though collaborative activities are described by the modelling. As ontology is extendable, it could certainly be augmented with collaboration ontology.

The necessity to augment the area of knowledge represented by the ontology can be argued. Since the scope is to represent knowledge of the creative workshop along the entire process and the different actors' configurations, it is not necessary to represent the general concept related to collaboration but exclusively those related to actors' actions and interactions. The necessity to expand the vocabulary would be determined during the experimentation during a real creative workshop. Actually, the ontology has only been verified with data from past creative workshop in order to check its competencies. To pretend using the ontology during creative workshop, it requires the creation of a user-friendly interface to enter information and get the inferred knowledge. The engineering of the ontology is done in a context of designing an intelligent creative support system on which the validation of the ontology depends.

VII. CONCLUSIONS

This article presents an organizational approach to design ontology that describes the area of knowledge of creative workshop. In brief, the creative workshop process and its various interactions among actors are modelled in order to deduce the concepts manipulated to successfully realize the creative workshop. The Creative Workshop Management Ontology formalize a shared semantic that would be understood among all the actors. It constitutes an ontology which is the backbone for Creative Support System to ease the actors to communicate, coordinate, and collectively (and creatively) solve a problem.

There are multiple perspectives to this work. The first is to test the ontology in situation which implies the creation of a prototype to manipulate the ontology. As the engineering of the ontology is based on modelling, the designing and development of this software would be simplified. In order to provide the functionalities expected, the ontology have to be populated by knowledge. The way the knowledge is captured has so to be explored notably concerning the problem and the creative techniques. Others perspectives are to deepen the richness of the ontology and explore other functionalities made possible by this technology. One of these perspectives is to build up ontology for each idea based on natural language processing and integrate it into CWMO. It could be interesting notably for idea mining [36]. As most of the time the idea are also composed by images, the emergent idea ontology could be completed by a semantic analysis from the images [37].

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