Journal of Knowledge Management Practice, December 2005

Understanding The State Of Knowledge Management With Ontologies:

The Case Of The Canadian Military

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ABSTRACT:

Within the context of the present Revolution in Military Affairs (RMA), the *military profession* at all levels of Command is subject to some drastic transformations related to new technologies integration, ethics, intelligence, collaboration, sharing and learning. These changes will help the Canadian Forces in gaining more acute and real-time situational awareness and in responding to situations in a more effective fashion. In order to formulate proper Knowledge Management (KM) strategies for these changes and articulate effective implementation plans, a better organizational understanding is needed. This research project attempts to grasp and to formalize the meaning of three concepts related to KM in the military context. These are *knowledge creation*, *collaboration* and *learning*. Data was collected via a series of semi-structured interviews with high-level senior management officers and military practitioners. An ontological-based approach was used to compare findings from the military survey to the meaning of these concepts gathered from a literature review in the KM field. Results provide many interesting insights to the particular culture, structure, tools and organization of the work in the military environment.

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1. Introduction

The nature of operations has dramatically changed within the context of the present RMA, changes that have mainly been brought about by new technological advances in warfare and a more sophisticated international environment. The new socio-economico-political context requires non-traditional forms of engagement, such as peacemaking missions, urban and effect-based operations and even, assistance to face natural disasters. More importantly, the way of conducting military operations requires frequent and rapid adaptations. Consequently, the *military profession* at all levels of command is subject to a drastic transformation to integrate new technologies, organization structures, ethics, intelligence, collaboration, sharing and learning in order to gain an acute and real-time situational awareness and to collectively respond in an effective fashion (RMA, 1999; Knight, 2002; DLSC, 2003; DND, 2003).

An important question that has retained our attention is how professional military expertise is built, shared and transmitted, either as an informal practice on the Theater or as a formal discourse through doctrine. In particular, three key elements are addressed: *knowledge creation*, *learning* and *collaboration*. In short, we consider in this paper the intertwined relations between the creation and elaboration of specific knowledge within this evolutionary military culture, the ways of sharing it and collaborating to build a common, expert and significant understanding of a situation, and the manners by which newcomers can learn from previous knowledgeable culture, rules, critiques, debriefings, lessons learned, etc. Each of these elements plays an important role in the field of KM and the investigation of their meaning will bring new insights onto fruitful directions for knowledge management strategies within the Canadian Forces (CF). Moreover, it is obvious that these elements are embedded in the tenets of the Network-Centric Warfare (NCW) thesis. They are key processes, crucial to the overall assertion. Discovering their inherent significance and what they imply in the context of the NCW may certainly contribute to the desired end-state military capabilities as expressed by Albert and Hayes, which are to make sense of a situation, to work in a coalition environment, to respond by appropriate means and to orchestrate the response in a timely manner (Albert & Hayes, 2003).

We are at a turning point where the CF will gain to re-position the usage of technology advances in regards to knowledge creation, learning and collaboration (McIntyre et al., 2002; MacDonald, 2002a). The progressive adding of new technologies has changed the Military Business and is having a direct influence on how knowledge is developed. New abilities are required to ensure that technologies are supporting, but not driving, the Canadian Defense objectives (MacDonald, 2002b; MacDonald, 2002c). For instance, due to the multiplicity of information sources available and smarter search engines, knowledge military workers now require the compelling development of their judgment faculty to differentiate, select and restrain their attention on relevant information or knowledge. New military leaders must develop the skill to promote collaboration imperatives and innovative learning methods to cope with the fact that interoperability is to be achieved with an increasing number of stakeholders involved in the Force's missions including our allies and Non-Governmental Organizations (DND, 2002).

Although many definitions of knowledge creation, collaboration and learning exist in the literature on the KM field and that these topics are often discussed in military forums, this paper attempts to grasp and to formalize the meaning of these key concepts and those that are related, such as innovation, with respect to the new challenges that are faced in the RMA.

In this paper, we first describe the research design for the study, which includes the specification of the ontological model and the methodology used to perform both the literature review and the data collection. Then a literature review of the three research concepts is presented along with the resulting ontologies. In the next section, we comment on the general findings obtained from a series of semi-structured interviews with representative sets of military practitioners and compare them to the key concept ontologies built from the literature review. We conclude by discussing the implications of these findings in the present military environment and by proposing avenues for future research projects.

2. Research Design

2.1. Methodology

The methodology includes three phases: (1) establishing an ontological model to convey all meanings, (2) gathering the meanings both from a literature review and from the conduct of a survey within the CF military environment and (3) the analysis and comparison of findings.

The advantages of using ontologies are manifold; in addition to encapsulating the inherent meaning of the enclosed concepts, it illustrates and depicts the relationships between them; and it presents variations in their meaning according to different perspectives. Overall, the ontology forms the basis of a formal framework to express the numerous aspects inherent to the conveyed concepts. For instance, the concept of *collaboration* varies in the literature from an author to another. The ontology is quite useful to express these variations and could easily map the neighboring concepts that are related to it. The same idea works in the case of the data collected from the military survey. A concept such as *learning* may evoke different notions in regards to the development of military knowledge and expertise for instance, and could be as well represented within an ontology. Criteria to select the ontological model are presented in the next section.

The ontologies of knowledge creation, collaboration and learning that are produced with the literature review are put in perspective with the analysis of the findings from the conduct of the military survey. This comparison serves as a reflective platform to help visualize how to better address requirements for more effective collaboration, knowledge creation and learning processes.

2.2. Ontological Model

The ontological model and supporting tools have to illustrate the semantics of the three central concepts of this study: *knowledge creation*, *learning* and *collaboration*. In each ontology, the links between the central concept and its neighboring concepts are to be specified. At this level, the ontology might nearly be compared to a conceptual model showing a *network of concepts*. Moreover, the ontology must also contain the respective properties of each included concept, such as definition, variations in meaning, specification, and discussion areas. These attributes and their values are regrouped in a concept *card,* as illustrated in Figure 1.

Many ontologies on the same concept may be required. For example, an instance of the learning ontology is required to depict the literature search on this topic, and another one could be required to express the nature of learning within the Navy environment. Each of these ontologies is similar in terms of requirements.

Given that (1) the "world to be modeled" is restrained in terms of scope for each ontology of the study (only a restricted set of concepts will be part of the taxonomy); (2) ontology concepts do not include axioms to formally specify definitions and constraints in the domain ,Boury-Brisset, 2003); and (3) computerized exploitation of the ontology is not required, then a sophisticated and robust ontology construction tools, such as Protégé 2000© ™, Ontolingua© ™ or WebOnto© ™, will not be required, nor even deemed as an option for subsequent exploitation purposes. In order to draw out findings from the analysis of survey data, it is critical to be able to visualize each ontology, at both the network of concepts level and at the card level. On all automated ontology tools that were examined (Protégé 2000, Metis, Link Factory, WebOnto, Inxight and The Brain) and met the criteria described above, no one provides the required visualization browsing capabilities, flexibility and usability to navigate from and between each level. We therefore chose a solution that includes a graphical tool to express the network of concepts level and a mind-mapping tool to illustrate concept attributes or simply said, the card. The tools investigation led to the selection of Microsoft® Visio 2000 © ™ and MindGenius Business © ™ (MindGenius) respectively.

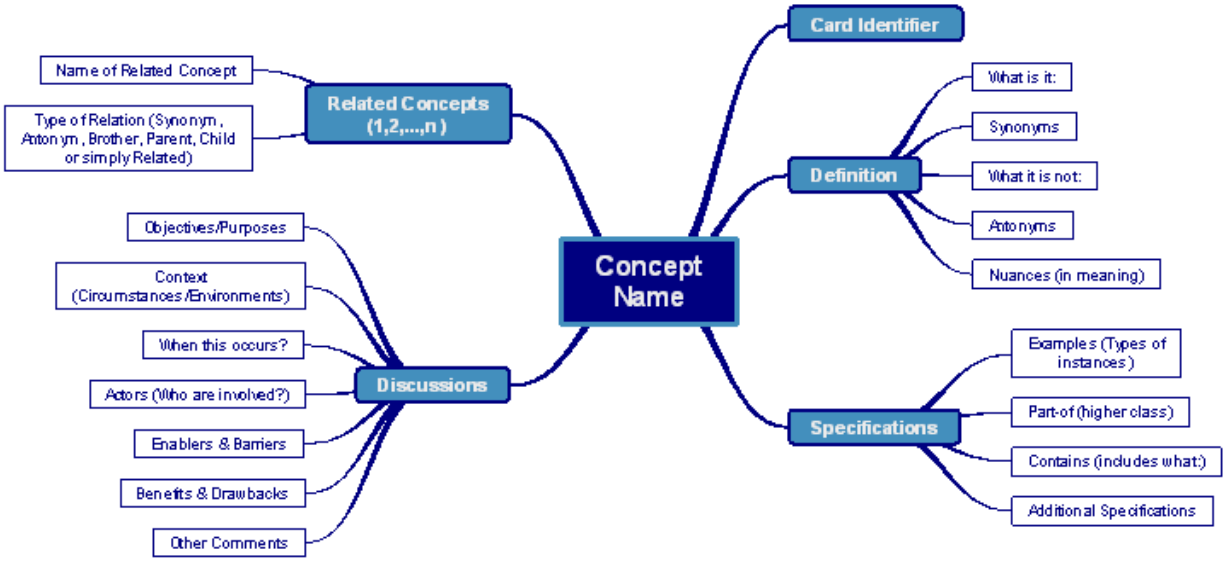

Figure 1. Concept Card with its Generic Attributes

2.3. Survey Protocol

2.3.1. Sample Requirements

In order to provide rich descriptions of the phenomenon of interest and to obtain contextual and holistic understanding of the military environment, an exploratory design was used to conduct the survey. The subjects were selected to maximize differences among them in order to increase the probability of collecting varied data and to draw a general picture of the CF military environment.

2.3.2. Data Collection

To find the required respondents, Commanders of military divisions in the CF (as opposed to the administrative divisions of the Department of National Defence) were contacted and asked to either participate in the survey (as representing high-level senior management) or to provide the names of some people in their division that would comply with our classification requirements (senior and/or junior military person working in their division). Initially, our sampling procedure intended to have six (6) respondents per CF environments in each sample category but in a few cases, the availability of respondents and their different classification, led to some inequalities in the sample sizes and a slight modification of the characteristics of the samples. For example, the sample representing junior practitioners in the Joint group was intended to have fewer respondents because most people in this environment are senior. An additional complication is that requests for junior practitioners often lead to junior-ranked personnel who have numerous years, and even decades, of experience.

Data was collected with semi-structured interviews conducted with a total of sixty-nine (69) military personnel representing the four different CF environments, Navy, Air force, Army and Joint. Each individual of a first sub-group of forty-three (43) military personnel, including experienced and junior practitioners, was questioned on one of the three elements of the study (*knowledge creation*, *learning* and *collaboration)* and asked to respond on an individual basis. Furthermore, a second sub-group of twenty-six (26) high-level senior management officers were interviewed with similar questions, but related to the organizational view of the three concepts. The sample distribution is illustrated in Figure 2.

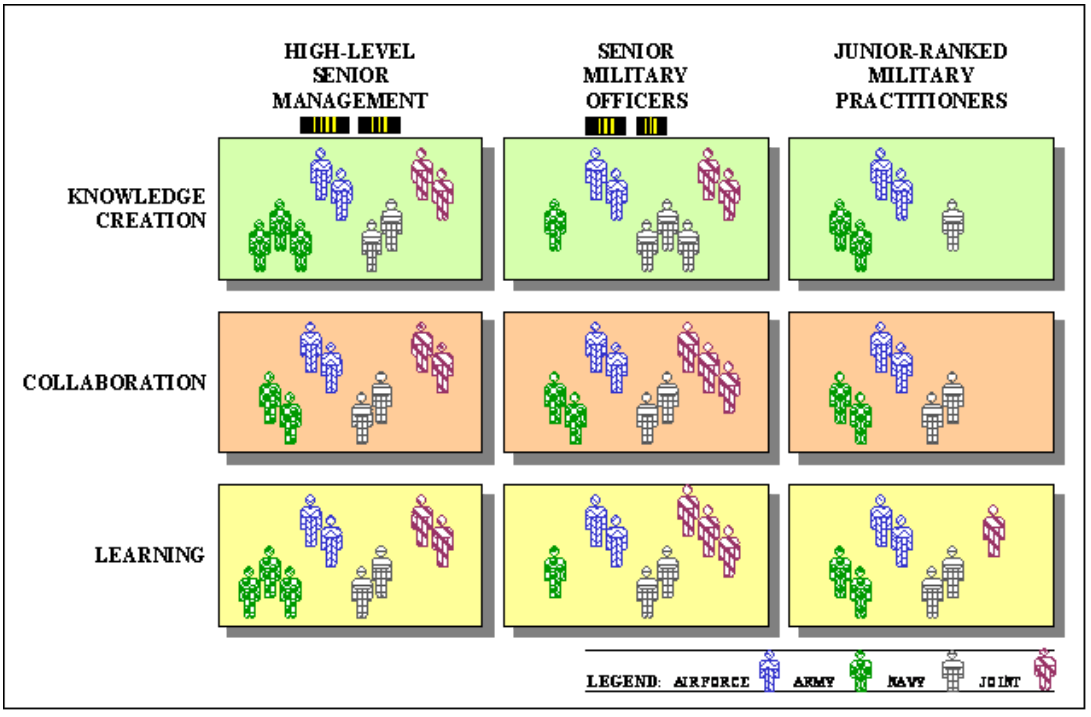

Figure 2. Sample Distribution

Although the sample was relatively small (sixty-nine (69) respondents), the distribution of respondents across different environments and units increased our confidence that responses were not biased by some specific or distinct working environments. However, the subjects were selected from the CF branch, so the findings could only apply to that setting.

2.3.3. Interview Questionnaires

Six (6) different questionnaires were developed to cover each key concept of the study at both individual and organizational levels. The interview questionnaires were designed to elicit general descriptions of the three concepts in the context of the interviewees' work on the dimensions illustrated in the concept card at Figure 1, such as when, where, why, advantages, drawbacks, barriers, actors, etc. For instance, in the case of the *collaboration* notion, we used questions such as "What does collaboration mean in your work?" or "What is the purpose of collaborating in your work?" Once the general questions were answered, interviewers used additional questions to elicit comments on some of the related concepts that were generated in the corresponding ontologies from the literature review (e.g. *virtual teams* or *communities* in the case of the *collaboration* concept). These questions were formulated such as "Do you collaborate through virtual teams?" or "*How do communities relate to collaboration?* ".

2.3.4. Survey Procedure

Potential interviewees were contacted by telephone to determine their willingness to participate in the study and to schedule an interview date. They were instructed that their participation was voluntary and that their responses would be kept confidential. Transcripts were based on notes taken by interviewers and on tape recordings, with the full consent of the participants. Three teams of two interviewers performed the data collection. They were rotated and assigned to all conditions in order to strengthen interpretative validity. The interviews lasted for about one hour.

2.3.5. Data Analysis

Given the exploratory nature of this research project, a qualitative analysis was used. The transcripts of every interview were collected in a separate concept card and identified with a unique designator number. The cards were sorted by concepts categories and analyzed to find general commonalities. For each key concept of the study, a consolidated card with all common observations was produced. It was then compared to the ontology originally built from the literature review. This exercise has led to the identification of the particular features in the military context.

3. Gathering of Meanings from the Literature Review

A literature review was performed based on the initial three concepts, *knowledge creation*, *collaboration* and *learning*, and their neighboring concepts. Articles were chosen according to the needs of this study. Each article was profiled in a concept card similar to the one presented in Figure 1. An ontology was then built to visualize the general meanings of the concepts and their relationships.

3.1. Knowledge Creation

Figure 3 illustrates the Knowledge Creation Ontology that was built from the literature review. According to Bhatt, *Knowledge development* in organizations is defined as a process with four (4) phases: *knowledge creation, knowledge adoption, knowledge distribution, knowledge review and revision.* The two first phases, *knowledge creation* and *knowledge adoption*, are sufficient to develop knowledge at the individual level, but distribution and review become crucial for converting knowledge at the organizational level (Bhatt, 2000).

Knowledge creation is at the heart of *knowledge development* and has received the most attention by KM authors. The most popular description of the creation process is the one formulated by Nonaka and Takeuchi, who distinguished *tacit knowledge* (the knowledge that exists only within people and is expressed in their actions) from *explicit knowledge* (which is easier to codify, articulate and share) (Nonaka & Takeuchi, 1995). The authors described the *knowledge creation* process as being composed of four conversion patterns: *socialization*, which involves sharing tacit knowledge between individuals, *externalization*, as tacit knowledge is articulated or translated into readily understandable forms (explicit), *combination*, the conversion of explicit knowledge into more complex sets of explicit knowledge, and *internalization*, where people identify explicit knowledge that is relevant to their work and apply it in their actions and practice (tacit knowledge).

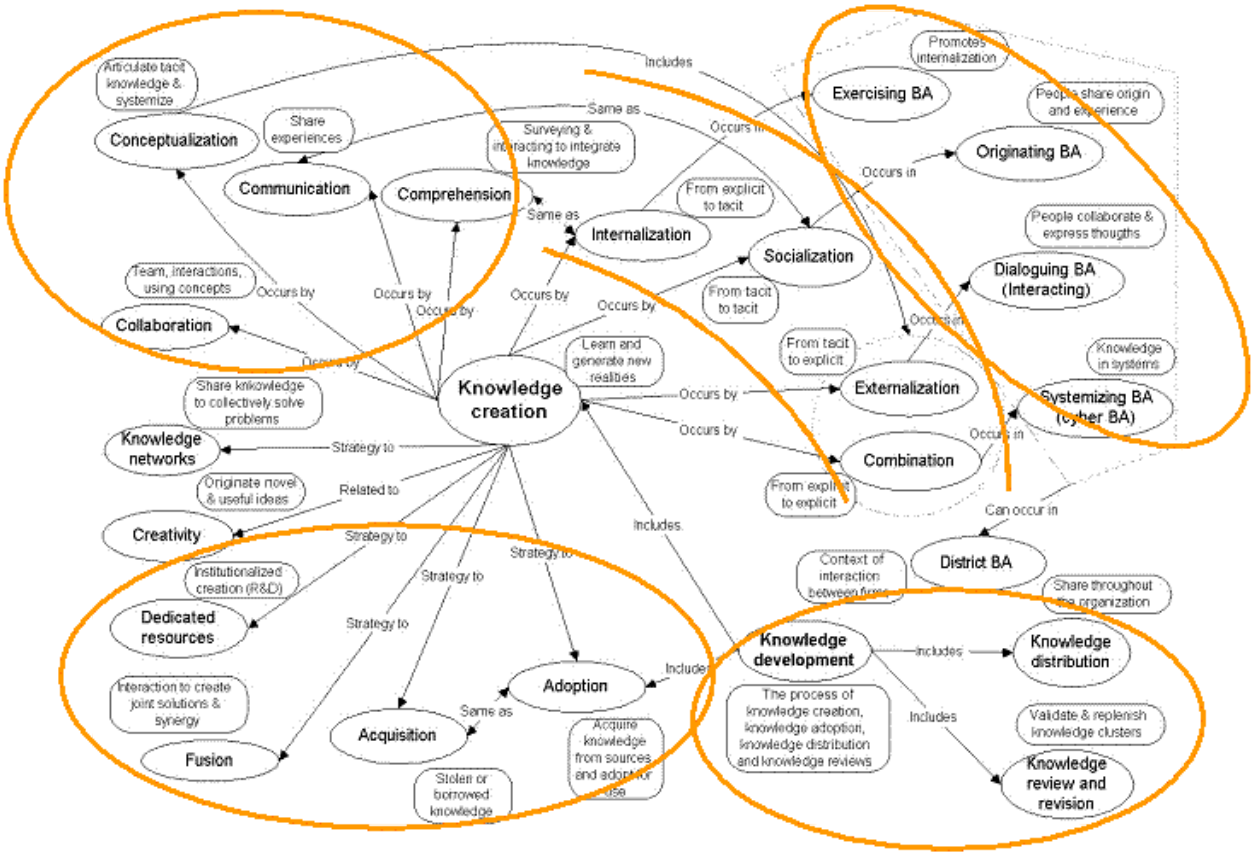

Figure 3. Knowledge Creation Ontology Built from the Literature Review

Oinas-Kukkonen also described *knowledge creation* as composed of four processes: *comprehension***,** as a complex process of surveying and interacting with the external environment and integrating the knowledge to identify problems, needs and opportunities, *communication*, for the sharing of experiences, *conceptualization*, as a reflection process articulating tacit knowledge to form explicit concepts, and finally *collaboration,* which is team interaction using the produced conceptualizations (Oinas-Kukkonen, 2001). The author mentioned that *comprehension* and *communication* are similar to Nonaka and Takeuchi's *internalization* and *socialization* concepts respectively, while *conceptualization* includes both *externalization* and *combination*. *Collaboration* has not been explicitly addressed in Nonaka and Takeuchi's framework.

Davenport and Prusack referred to four modes of *knowledge creation,* rather than phases*,* that are intentionally initiated by organizations: *acquisition* or rental (knowledge found elsewhere and applied locally), *dedicated resources* (institutionalized creativity activity such as Research and Development, *fusion* (adding complexity or conflicts to create new solutions), and *adaptation* (adjusting to a crisis or a forced change) (Davenport & Prusak, 1997). The authors stated that the common denominator for all these efforts is a need for time and space devoted to creation and acquisition of knowledge.

Nonaka and Konno specifically addressed the conditions and psycho-social locations for knowledge creation (Nonaka & Konno, 1998). They proposed the reference concept of *"ba"* as a shared space for emerging relationships and a platform for advancing individual and/or collective knowledge. Four categories of *ba* are especially suited for knowledge conversion modes: *Originating ba* is the world where individuals share feelings, emotions, experiences and mental models. *Interacting ba* is more consciously constructed, so people's mental models and skills are converted into common terms and concepts. *Cyber ba* is a place of interaction in a virtual world (where combination of explicit knowledge occurs) and *exercising ba* facilitates the internalization phase (i.e. training with mentors or colleagues). Corno et al later proposed *district ba* as the place where different organizations interact (Corno et al, 1999).

Bhatt defined the phase of *knowledge adoption* as the acquisition of knowledge from other sources and adopting it for internal use (Bhatt, 2000). This definition of adoption is similar to Davenport and Prusack's mode of *knowledge acquisition* (Davenport & Prusak, 1997). Therefore, this phase does not involve the emergence of new knowledge per se, but rather a new context for its application. Finally, Stenmark *et al.* defined *creativity* as the generation of new ideas (Stenmark et al, 2001).

3.2. Collaboration

Figure 4 illustrates the Collaboration Ontology that was built from the literature review. Collaboration, in its narrow Latin sense, is the "action of working together". Within the Information and Knowledge Management area, this concept is defined as "the methods and interactions of people actively sharing data, information, knowledge, perceptions of concepts when working together toward a common purpose" (Noble et al, 2000). There is the underlying assumption that the group's performance will be greater than the sum of the members' performances alone and also that people seem to need to collaborate with others to do their best (Nunamaker et al, 2001). This definition of collaboration, however, sets apart the concept of *communities of practice* (groups of people who share a concern, a set of problems or a passion about a topic and who deepen their knowledge by interacting), where people are willing to share knowledge even though their goals may vary greatly (Wenger et al, 2002).

Butler and Coleman categorized collaborative environments according to five collaboration models: *Library*, *solicitation*, *team*, *community* and *process support* (Butler & Coleman, 2003). A *library* does not involve direct interaction between people, but the reciprocal access to common content or data. The *solicitation* model involves requests from a small set of requestors and multiple replies from a larger set of respondents. There is some interaction between people, but it is minimal and specific. A *team* model of collaboration involves members that share objectives and a common stake, and who are interdependent, tightly controlled and bound by the parameters of a project. The authors described their fifth model, *process support*, as the use of collaboration technologies in a process or workflow. Since the people working with process support tools are focused on a specific task, it would make sense to include it in the team model.

Butler and Coleman (Butler & Coleman, 2003), as opposed to Noble and al. (Noble et al, 2000) included the concept of *community* in their description of collaboration. A *community* model facilitates the activities of members that have common interests, are loosely controlled, are willing to share information and seek to further their understanding of their practice or area of interest. They included *communities of practice* in their description of different forms of communities, and differentiated them from communities of interest (where members are less focused on a specific topic) as did Wenger *et al.* (Wenger et al, 2002).

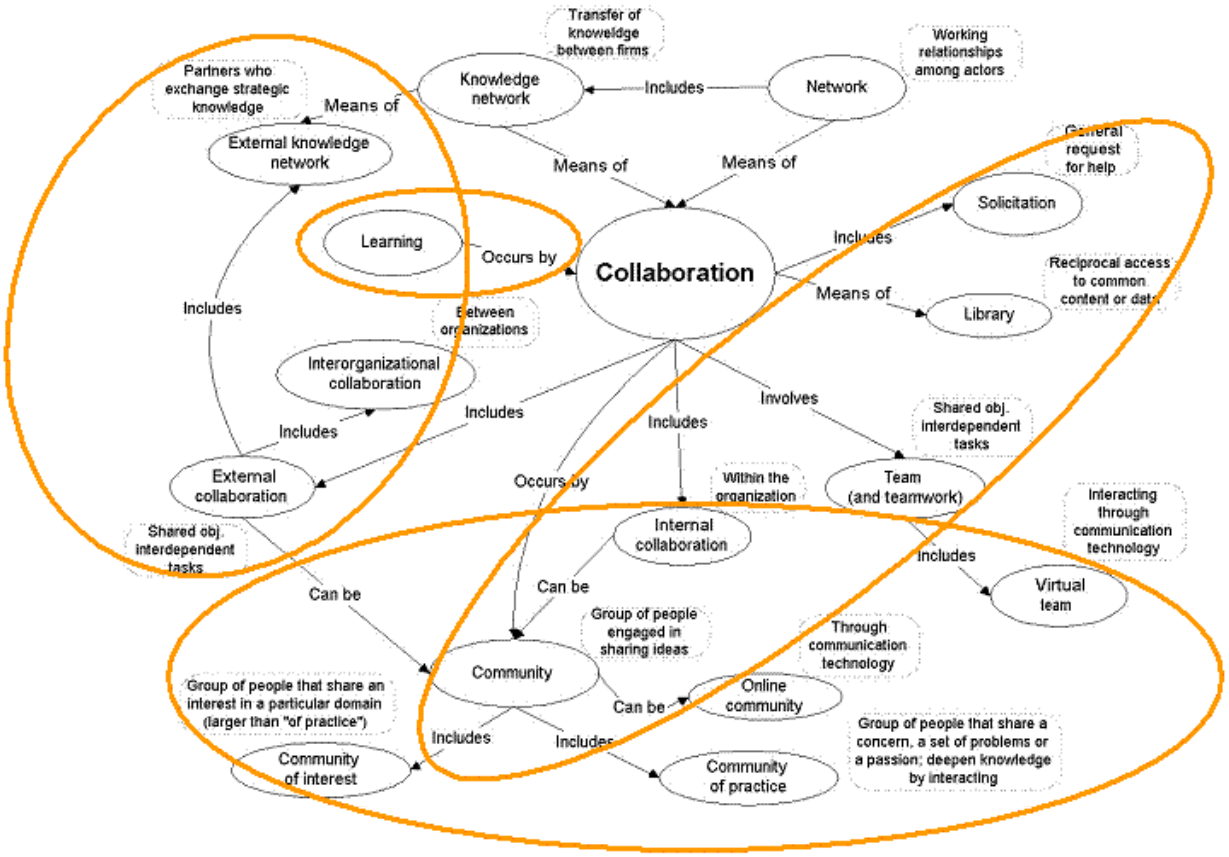

Figure 4. Collaboration Ontology built from the Literature Review

Many factors can influence the collaborative climate as depicted by Sveiby and Simons: values, beliefs and assumptions influence behaviors and willingness to share knowledge and to collaborate (Sveiby & Simons, 2002). Attitudes and trust also play a great role. Tschannen-Moran mentioned that the atmosphere and feelings of trust influence the outcome and can be considered as being enablers of collaboration. (Tschannen-Moran, 2001).

The concept of collaboration is also widely used to describe interactions with agents external to the organization. DeFillippi discussed collaboration in the light of the technology drivers of the new economy (DeFillippi, 2002). He described how new communication tools are affecting project teams, but also stated that organizations face complex demands for knowledge creation and knowledge sharing that span traditional organizational boundaries. This phenomenon leads to *virtual teams* (collaboration at a distance using groupware and other virtual collaborative tools, (Holton, 2001)), to *on-line communities* (Stanoevska-Slabeva & Schmid, 2001), and to inter-firm collaboration teams (or *external collaboration*). Also concerned with inter-firm knowledge exchange, Nielsen (Nielsen, 2002) and Warkentin et al (2001) described a *knowledge network* as the collaborative relationship existing at the interface of two firms collaborating in a dyadic alliance. Powell *et al.* emphasized the importance of such knowledge networks (through interorganizational collaboration) when the knowledge base in an industry is both complex and expanding and the sources of expertise are widely dispersed (Powell et al, 1996). Major achievements can necessitate the involvement of many participants and Mathiassen stated that collaborative activities could stimulate *learning* within the organisation, making those networks and relationships earlier mentioned of greater value (Mathiassen, 2002).

All forms of collaboration (including communities) mentioned above can be regrouped under the umbrella concept of *network*, defined by Bardach as "a set of self-organizing working relationships among actors such that any relationship has the potential both to elicit action and to communicate information in an efficient manner" (Bardach, 1994). Larsson also compared *networks* and *collaboration* as global teams working together across geographical, cultural and functional borders (Larsson, 2003).

As far as collaboration and technology issues are concerned, Duffy stated "*Collaboration and collaborative computing are undervalued and underutilized at present*". He proposed an approach to incorporate collaboration, collaborative computing and groupware technology into the workplace in order to maximize organizational knowledge and performance (Duffy, 1996).

There is an increasing recognition of organizational *knowledge* as a source of innovation. Through collaborative efforts to share and to transfer less perishable information from the intellectual material and through examining and addressing emergent problems, this knowledge base contributes intensely to both organizational *learning* and new knowledge *creation* (Neilson, 1997).

3.3. Learning

Figure 5 illustrates the Learning Ontology that was built from the literature review. Learning can be conceptualized at different levels: individual, team, organizational and inter-organizational. At the *individual* level, the behavioral approaches describe learning as a change of behaviour following the same set of stimuli. The cognitive science, on the other hand, describes it as a

change in cognitive processes that may or may not be reflected in behavior (Gredler, 1992). Learning has traditionally been associated with teaching, involving a subject matter expert who designs a training session, creates a computer program or writes a technical manual (Laiken, 2001). Since results derived from "teaching" have been disappointing, academics and practitioners have explored the impact of embedding learning within actual work processes.

Kauppi proposed a typology to explain individuals' learning responses that can be extracted from learning situations. *Reproductive learning* refers to the replication of a content or practice. R*eflective learning* leads to deeper ties with the individual's own interests or abilities to handle situation's circumstances. *Transformative learning* directs individuals to reflective monitoring of action, theoretical/discursive knowledge creation and transforming practices (Kauppi, 2003).

In terms of the contexts that will lead to or promote learning, McGee described *deeper learning* principles, as the learner is engaged to actively explore, reflect and produce knowledge rather than to recall and regurgitate it with no significance (McGee, 2003). These principles are: *active learning*, which involves solving real-world problems; *social learning*, which provides opportunities for cognitive apprenticeship, reciprocity and cooperation among learners; *contextual learning*, which builds on existing knowledge and is integrated into the learner's world; *engaged learning*, which addresses intrinsic motivation and natural curiosity; and *ownership* of the learner who has control of the learning process and may reflect on it and choose learning strategies. Somewhat in accordance with deeper learning principles, Smith and O'Neil discussed *action learning,* which implies learning by doing, as the task environment is the classroom, and the task is the vehicle (Smith & O'Neil, 2003). Action learning is promoted as opposed to *learning gained from accepted authorities*.

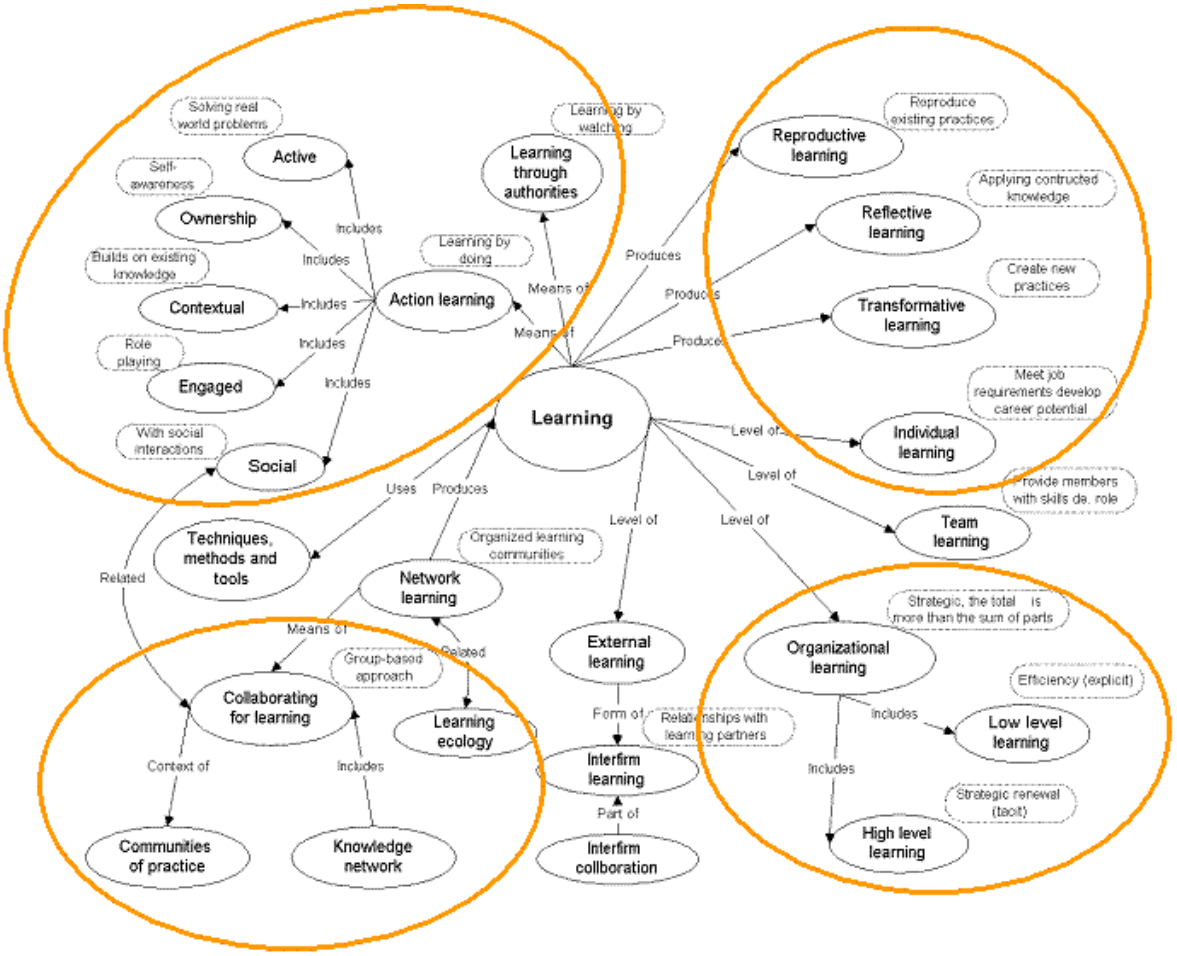

Figure 5. Learning Ontology Built from the Literature Review

Team learning would be collaboration among members who share learning objectives, interact to reach them, and mutually control the means to achieve both their individual and social learning. Also related to social learning are *Collaborative Approaches to Management Learning* (CAML) (Florén, 2003). It is argued that learning incorporates both a cognitive and a socially situated dimension and takes the *community of practice* as point of departure and reference. In the same vein, a *learning ecology* has been used to describe an environment that fosters and supports the creation of communities (Siemens, 2003).

Organizational learning, as with individual learning, can be viewed either as a change in belief systems (cognitive), or on changes in routines, rules and aspirations (behavioral) (Hwang, 2003; Polito & Watson, 2002). The knowledge-based view of organizational learning is the process of creating, acquiring and transferring knowledge (Teare & Rayner, 2002). It is similar to the definition of knowledge development stated earlier. Fiol and Lyles described two levels of organizational learning: the *lower level* is concerned with fostering efficiency and improving existing strategies and can be codified, whereas *higher level learning* fosters strategic renewal and transformation (Fiol & Lyles, 1985). The higher level tends to be more intuitive and tacit (Hwang, 2003).

Malhotra noted the importance of Information Systems for organizational learning, mentioning a series of *techniques, methods*

and tools that can foster organizational learning at many steps of the process: *knowledge acquisition*, *creation* and *distribution* (Malhotra, 1996), which correspond to Teare and Rayner's typology mentioned above (Teare & Rayner, 2002). On-going experimentations with new technological devices have not yet proved to give effects on learning and understanding that would be consistently different of traditional means. The point is more the learning style of each person than the ability to use specific techniques. The organizational behavior theory considers four main experiential learning styles that are related in a cycle of active or passive attitudes regarding to perception and comprehension. Those learning styles are dominant clusters of personal as well as social competencies to analyze, understand, make decision, and behave. Different terms may be employed to describe them, as: adaptive, receptive (divergent), reflective, deductive (convergent) (Kolb, 1984; Kolb et al, 1995).

Interorganizational learning is taken to be learning that takes place in the interorganizational setting: the learning actor can be an individual, a group, an organization or an interorganizational network (Knight & Pye, 2002). *Inter-firm learning* comes from the exchange of information, but can also include learning about partners or how to partner (Mohr & Sengupta, 2002).

4. Findings and Discussion

4.1. Scope of the Present Analysis

After conducting the interviews, a preliminary analysis of findings was performed to extract generalities and to trace a global portrait of the military setting. We produced the consolidated cards similar to the one provided in figure 9. In the following sections, we will present the analysis of these preliminary findings. Further work is underway to compare responses between sample groups and to perform a more detailed analysis of the military ontology vs. the literature one. Because of the small sample size and the qualitative nature of our collected data, we discuss the content of responses rather than the number of occurrences in the respondents' discourse.

4.2. Knowledge Creation

4.2.1. General Observations

Knowledge creation is often defined as gathering, analyzing, interpreting and adapting information to new environment and is compared with "situational awareness" development. "*In our case, our responsibility is to provide situational knowledge, by collecting and synthesizing information, putting it in context in relation to our objectives*". Some respondents associate the concept with knowledge capture, describing knowledge as what is recorded in the information systems. "*In the military context, we are now moving to adapt to the technology age, magical process to turn information into knowledge, use quantities of data and turn it into something useful*." "*Capturing knowledge and making it available in a useful context… is important because there is a lot of turn over and we lose people*".

Collaboration is a strong component of the military culture as it is described in the next section. It was therefore not surprising to observe that knowledge was described as most often created in social and collaborative settings. "*Collaboration is essential for knowledge creation so that decisions made are grounded". "Sharing your findings and insights is essential and can trigger more knowledge creation*".

A fertile environment with opportunities to respond to new challenges fosters the creation of knowledge, generation of ideas, creativity and innovation. "*Stressful situation can energize the creation from people*". "*To organize people setting to allow them to develop their knowledge including structural elements, resources, competencies, training, time…*" "*It is fostered by the ability to understand the global picture, the ability to perceive the future, the ability to conceptualize or visualize".*

The eternal dilemma of "sustaining vs. plan for the future" is exacerbated by the scarcity of resources and time pressures, which are often stated as strong limitations to knowledge creation. "*There is not a lot of place for creativity in the forces, no time to create from scratch*". The people that are most often identified as potential contributors to think tanks are also highly in demand for operations, which are of higher priority. "*Day to day operations hinder knowledge creation… I lose people that go on missions*." There is also very little time devoted to "internalization" activities. For instance some subjects stated that the lack of time, or the physical environment, hinder the thinking process. "*Before cuts in personnel, we always had two people doing the work and one had time to create things for the organization. Now, things are so varied that the level of knowledge is sufficient to react, but not to create*". "*This is not a very good environment to create knowledge, we share cubicles and we find it very difficult to concentrate. But the cubicle setting provides you with non-official communications, so that it provides knowledge*."

Security issues also have a significant impact on the difficulty to acquire new knowledge, both through other people and technology. "*Information available on the Internet, Defence Wide Area Network have, are limited by security issues… it is difficult to find all the latest reports on the Theatre…*"

While the value of knowledge is recognized to reside in people, there is very little structured ways of leveraging it in a systematic way. "*We stop at information management... The knowledge resides only in people, but we don't know who to talk to when one individual is gone*". "*We have to rebalance how we share information, up to now it relies on the individual willingness. We need to keep track…of the evolution of components, its history*". In many cases, information technology systems contribute to information overload. "*More information is available but we also have an overload of information…specifically with e-mails*."

The creative process is sometimes seemed to be hindered by the organizational structure and culture based on the chain of command, risk aversion and high level of control. "*Too much pressure, stress, autocratic environment that does not tolerate*

risk; cut actually errors are a good way to create knowledge". "*A too structured environment, being slave to a hierarchical chain of command, hinders knowledge creation*".

4.2.2. Mapping Military Findings to the Ontology built from the Literature Review

Figure 6 provides a global representation of the military environment in the context of the knowledge creation ontology built from the literature review. The shaded concepts are the ones that are predominantly found in the military environment. Overall, in the military environment, we observed that the process of knowledge creation is mostly considered at the level of the individual. There does not appear to exist any articulated organizational efforts to manage the process of knowledge distribution, review and revision.

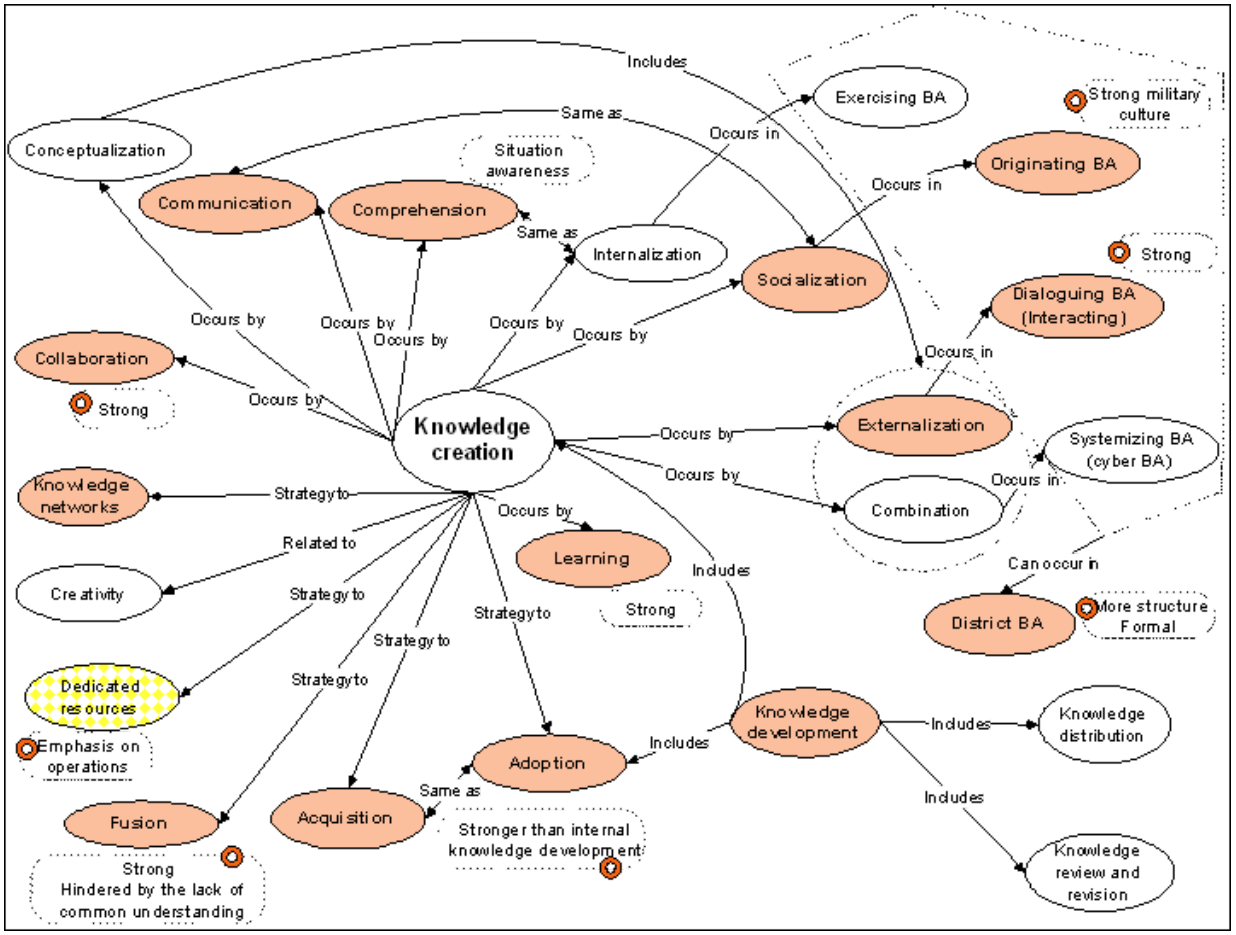

Figure 6. Mapping Military Findings to the Literature Ontology on Knowledge Creation

Along with the findings on collaboration and learning, the team culture is strong. Consequently, *interacting with others* impacts significantly on knowledge creation. We therefore highlight "socialization" and "externalization" in the model, as we understand them to be well developed in the military context. The two other forms of knowledge creation (and their respective "*ba*"), *internalization* (e.g. the time to reflect) and *combination* (e.g. the use of information technology), are underused and lacking according to the descriptions given by the respondents. The *district ba*, or context of interaction between organizations, is important but is more formal and structured because of the communication difficulties.

It appears that most of the knowledge creation process is characterized by the acquisition and adoption of external knowledge. The creation of new ideas from scratch is rare, mostly because of the lack of time to perform daily duties. R&D efforts, even informal, are limited by not having enough resources assigned to these, the priorities being put on operational work. The process of sharing knowledge with external organizations (such as consulting firms, universities and allies) is considered critical to compensate for the limitations of internal resources and could be markedly improved with the use of knowledge management strategies and tools such as forums, collaboration support systems, federated search engine, customized enterprise portals and expert locator systems.

4.3. Collaboration

4.3.1. General Observations

Collaboration is most often described as "working together towards a common goal with a common understanding". "*Collaboration is a way of meeting an objective, it is not an end in itself*". This definition centers collaboration on task related issues, as opposed to a knowledge sharing community, as described by Wenger et al (2002). Although knowledge sharing communities are mentioned, they are more of the "communities of interest" type, where acquaintances are called upon for specific information requests. "*My groups of close friends... used to back up*". Trust is also a factor in establishing solid and lasting relationships. "*Building relationship, trust, equal exchange… foster collaboration*".

As well known, the military environment is characterized by its high rotation rate. The career development plans encourage personnel to be exposed to a variety of positions in the organization. "*Every 2-3 years we move and change jobs, it helps people understand the whole picture and be more flexible*". This has been identified as carrying two opposite effects on collaboration. On one hand, it enlarges communities for information sharing because the multiple relationships formed in the different working environments. On the other hand, it reduces the time and the motivation for building internal networks of people, either with colleagues, counterparts, collocated social communities, etc. "*The initial investment in collaboration will benefit in the medium and long term… because of the rotation rate, people don't see the benefit for themselves*".

Another paradox in the military culture revolves around teamwork. The large majority of respondents describe collaboration as being constant in their work and central to learning and knowledge creation. "*The strongest enabler for collaboration is the military culture: the team approach and the high level of dedication to the organization.*" "*Team is fundamental; we have a culture that supports team activity*". However, some describe this cultural feature's effect on collaboration like a double-edged sword, which in many cases, hinder collaboration between groups. "*People are quicker to draw boundaries and it becomes "us" and "them*". Also, while working in cubicles increases more "informal" collaboration, some respondents mentioned that there might be too many meetings and less time to achieve their task.

While internal collaboration is very important and frequent, external collaboration with other DND/CF players presents more difficulties and challenges. The organizational structure revolves around different environments (air force, navy, army, joint) and functional units, often described as being "stove piped" and competing for the same resources. The geographically scattered locations of organizational functions and units also impede collaboration. "*The organization is based on a stovepipe structure, which makes contacts between organizations inside DND more difficult. I would like to share information with my equivalents in other sectors but different geographical locations, color of uniform, or the competition for resources, make things harder*." "*Half of collaboration problems are due to the matrix structure. You have to rebuild teams constantly and the time is never there*". Many high-level senior management officers mention that improvements should be made to clarify objectives and to better communicate the vision in order to develop common understandings between people within the organization. "*There is too much competition in the priorities of work. If we all had a common understanding of where we were heading, we would be better able to contribute*". "*The frequent changes in management bring about changes in directions, while people are not well informed; coordination is difficult*".

Despite their availability in some cases, tools supporting collaboration, apart from e-mail, are still not routinely used. E-mail is considered as an important medium and often described as complementary to face-to-face meetings. Other available vehicles in certain areas such as document sharing and lessons learned seem to remain difficult to use because of information validation and structure. "*We haven't standardized the way to store information; people look for information in other people*". Virtual Teleconferencing tools are in some cases very effectively used to compensate for geographically dispersion but are still considered by the majority as being technically difficult to put in place.

External collaboration is critical for the Canadian Forces, both between environments and with other organizations or nations. However, there are important barriers, such as culture, geographical dispersion, competition, security, and history, which make this type of collaboration harder. Most often, external relationships are more structured and formal. "*In an ideal environment, you have no structure, but it would not work with other nations because of different values, language, understanding*". "*We need a lot of data, which we can't produce ourselves... with allies, we collaborate through memorandums, procedures and manuals. The process is well documented. We are very structured, which may not be the best way to do that".*

4.3.2. Mapping Military Findings to the Ontology built from the Literature Review

Figure 7 provides a global representation of the military environment in the context of the collaboration ontology built from the literature review. As we noted, collaboration, in the form of teamwork, is strongly imbedded in the culture and work settings. The majority of team communication supporting collaboration is done face-to-face, although e-mail is used extensively, most often as a complement for face-to-face to share information or confirm, validate and render official the collaboration outputs. Internal networks of relationships are highly developed, especially among collocated individuals from the same military organization.

There appears to be little use of technological tools for collaboration. Very rarely were mentioned the use of tools such as forums, collaborative software, document management systems, electronic libraries, solicitation applications or portals. A few organizations use virtual teleconferencing systems successfully and others are experimenting the use of collaborative suit tools to exchange with other nations.

Collaboration in external networks, both between environments and with other organizations, are considered strategically critical, but a great number of factors hinder external collaboration. Based in these general observations, it seems that technological advancements may offer some promise to support internal and external team work activities and compensate for many problems such as geographical dispersion, stovepipe structures or the time it takes to form teams. Even more, the strong (face-to-face) team culture might offer some resistance to the use of these technologies (this may be one reason why the tools are not used now).

Communities of practice informally exist in the military setting but they are not structured in a way that the organization can efficiently leverage them and support them by technological means. This might be due to the rigid organizational structure, culture or security constraints. However, it has been mentioned as a future avenue, which may offer great promises for knowledge sharing by facilitating contacts between domain experts among different geographical locations, environments, organizations and even nations.

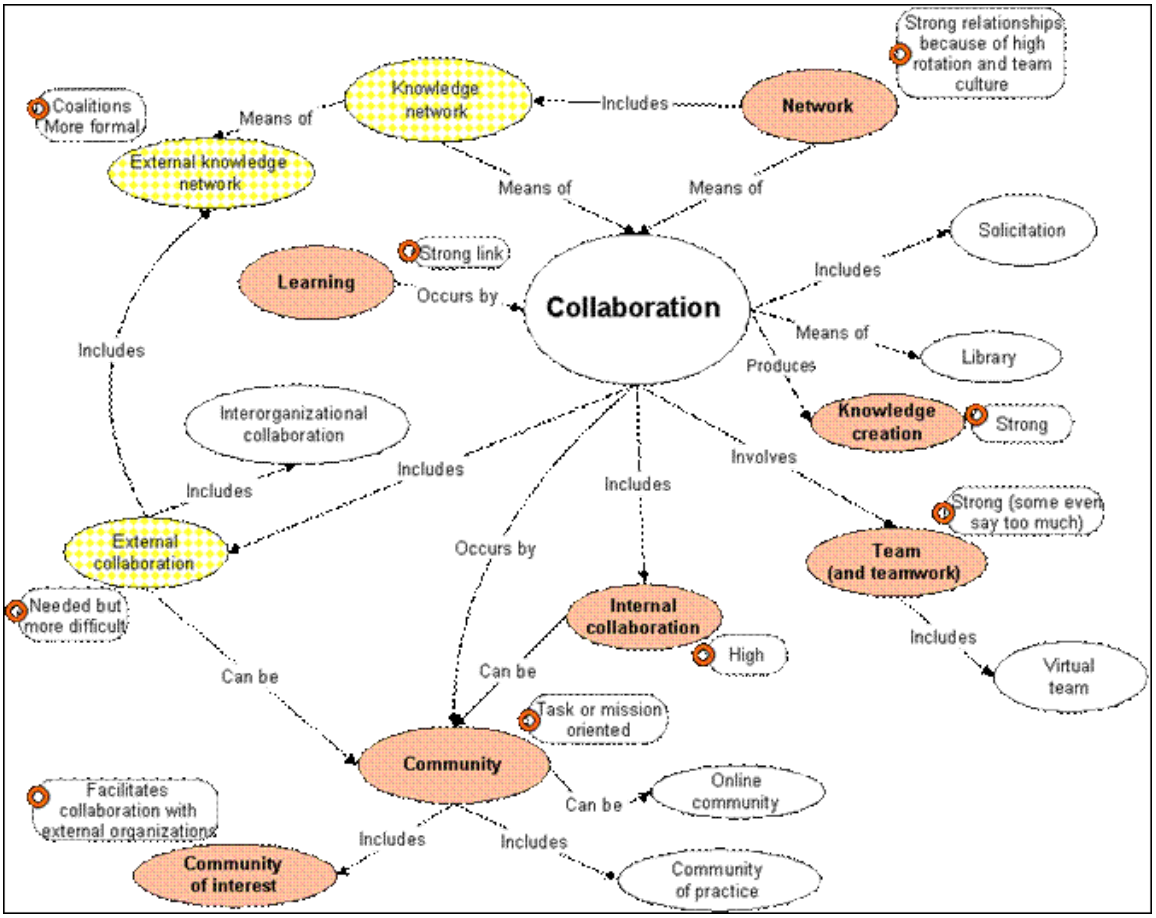

Figure 7. Mapping Military Findings to the Literature Ontology on Collaboration

4.4. Learning

4.4.1. General Observations

Learning is viewed as either gaining knowledge or acquiring new competencies and skills. This reflects both the cognitive and behavioral aspects of learning that were noted in the literature review. Also learning refers to understanding from past experience and expanding on individual's experience. "*The biggest point (to improve learning) would be to have techniques to share learning, best practices… We are good at identifying our weaknesses, but not what we do well*".

Respondents often described the military environment as being more unpredictable and changing than before (during the cold war, for instance, the opposite Forces were well understood and procedures were sufficient to guide people in their responsibilities and tasks). The actual chaotic environment necessitates new ways of learning that are more adaptive. "*The pace of change pushes the need for active learning, where actually most of the military people are used to more passive learning… Past military were told what to do; now the average soldier is asked to do and to comprehend… We need people that can absorb complexity and the new high pace of change*". "*We can not afford to reproduce anymore*". In the same vein, improvements in the Defense are mainly focused on reproducing and adapting external practices. "*We take new developments from the outside and adapt them for our needs, existing technologies are modified and combined…*"

The high level of rotation in the military requires constant learning for individuals, forming generalists and a variety of skill sets. People mainly learn their new roles when performing their work activities. Active learning is therefore a frequent way for people to acquire their competencies and new knowledge. "*No one ever explained what my work or my tools were. After a year, I am still learning about things that may help me*". "*There should be a mentor assigned to you for longer than two weeks for knowledge transfer, and whose responsibility would be to answer your questions*".

This level of rotation, however, hinders organizational learning at the unit level, because the organizational memory, residing mostly in people, changes constantly. Handover time is too short, as resources are scarce. "*The learning curve for a job is about six (6) months; when you change positions after two years, you have not exploited your acquired knowledge very much*." Also, access to knowledgeable people for knowledge transfer is difficult either because they are difficult to locate or because they are in high demand in operations. "*In many ways, our organization could be less knowledgeable next year because we will not be able to go back to our history and find the solution that solved the issue four years ago due to people changing and turning around*". Capturing knowledge in a more permanent form (through lessons learned, documents, etc.) may offer some compensation, and are in development. On the other hand, the organizational memory at the global level for the CF grows as newcomers bring new perspectives at every position in the organization. "*Learning offers you options*".

Learning through traditional venues (i.e. education) is highly encouraged and valued in the military, even though most interviewees describe active learning (and sharing of experience and knowledge) as equally important to acquire task

competencies. "*There is no formula to learn*". Some subjects state that the organization should differentiate "education" from "training". "*Education is a higher level cognitive function as opposed to training that is more oriented toward pragmatic functions.*" In the same realm, the department is seen as having the need of moving forward and embracing learning as a way of doing: "*We are still a continuous training organization; we need to become a continuous learning organization".*

Reflection is identified as key to learning, but lack of time, just like in the case of knowledge creation from scratch, is very often mentioned as hindering this process and leads to a superficial learning. "*Priorities should be modified to put people in a context to learn: read, listen, and reflect*". "*We have extraordinarily little time to frankly learn. In terms of having an actual situation where you are doing pure learning, it practically never occurs*". "*When there is less time, demands are less articulated and you become more of a day to day generalist instead of becoming an expert in a field*".

Teamwork and collaboration are perceived as very important sources of learning. As we mentioned when discussing collaboration, there is a strong team culture and many interactions between people in their day-to-day activities. "*The best way to learn is by physical interaction*". "*Team learning is very important to me*".

4.4.2. Mapping Military Findings to the Ontology built from the Literature Review

Figure 8 provides a global representation of learning in the military environment in relation to the literature ontology.

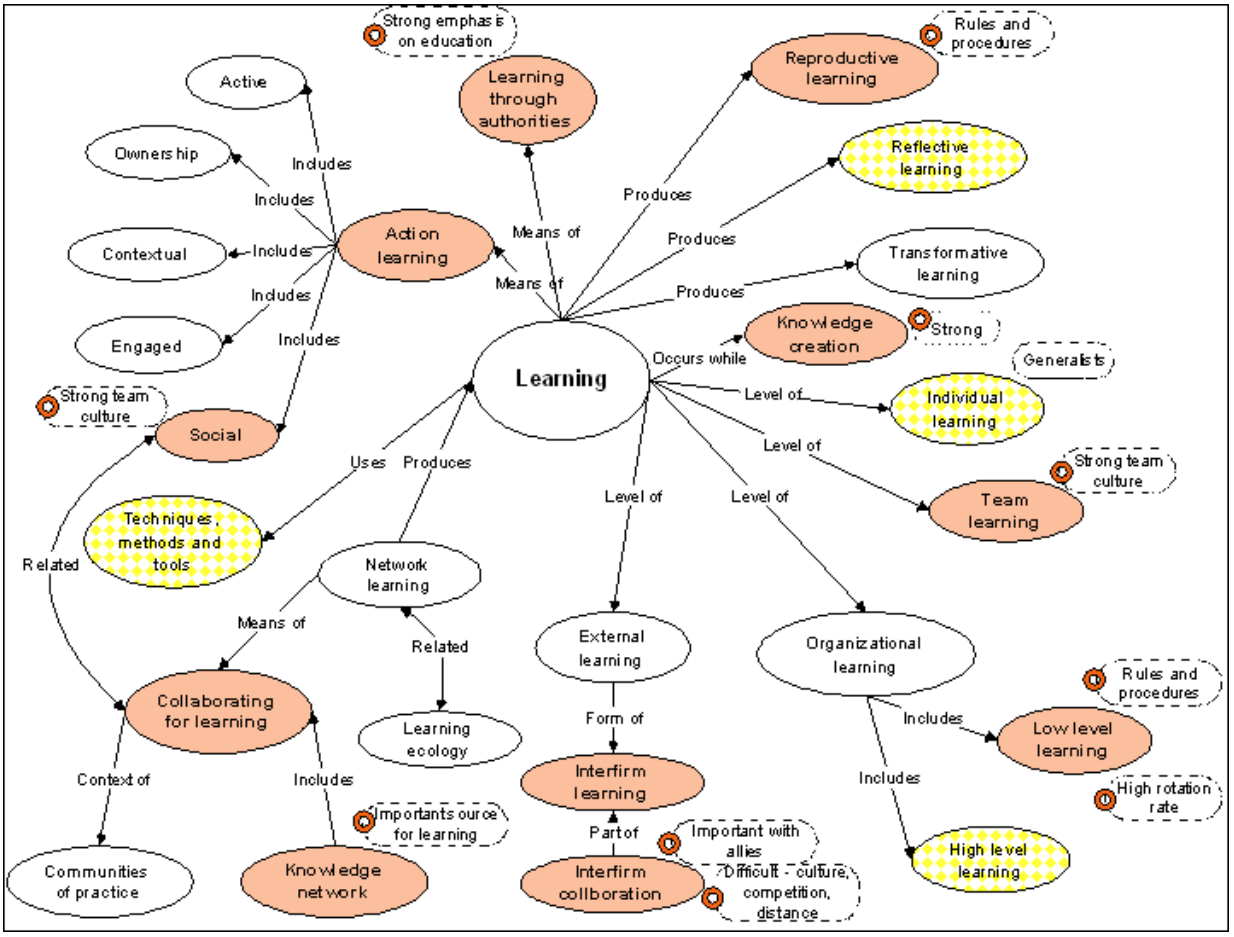

Figure 8. Mapping Military Findings to the Literature Ontology on Learning

First, we observed that the learning process is very important for most respondents and emphasized in the military's organizational strategies. On one hand, the military organization puts strong emphasis on formal education and offers financial incentives for studies and career advancement with advanced degrees. On the other hand, high rotation rates encourage continuous "on the job learning", which suggests that many competencies are acquired through "action learning". The social dimension of action learning appears to be the most developed, because of the strong team culture in the military.

In terms of the learning products, there appears to be a high level of reproductive learning, and a certain amount of reflective learning, since most respondents describe their tasks as being largely defined by rules and procedures, in a structured, hierarchical setting. It was also often mentioned that more reflective, adaptive and transformative learning would be needed to cope with the present military operational context, which is much, more complex than ever.

At the organizational level, we observed that a great deal of explicit rules and procedures are developed in order to capture learning and guide action, such as the lessons learned process. However, more flexibility is required to ensure that tacit knowledge and experiential information are freely captured, made readily available and to make sure that both good strategies and errors are learned. This could help maintain and even increase the organizational knowledge assets through time.

4.5. Commonalities between the three main concepts

Even though the respondents were questioned on issues related to three different concepts, we found that they had strong links between them and many commonalities emerged as depicted in Figure 9. The three concepts were all strongly related to the pursuit of the same objectives and to be of critical importance to people's jobs. Common enablers include leadership and cultural issues, whereas barriers often come down to resource constraints (time, people, and cost) and culture (such as resistance to change and organizational structure). We also observed very little use of technology to support all of the processes.

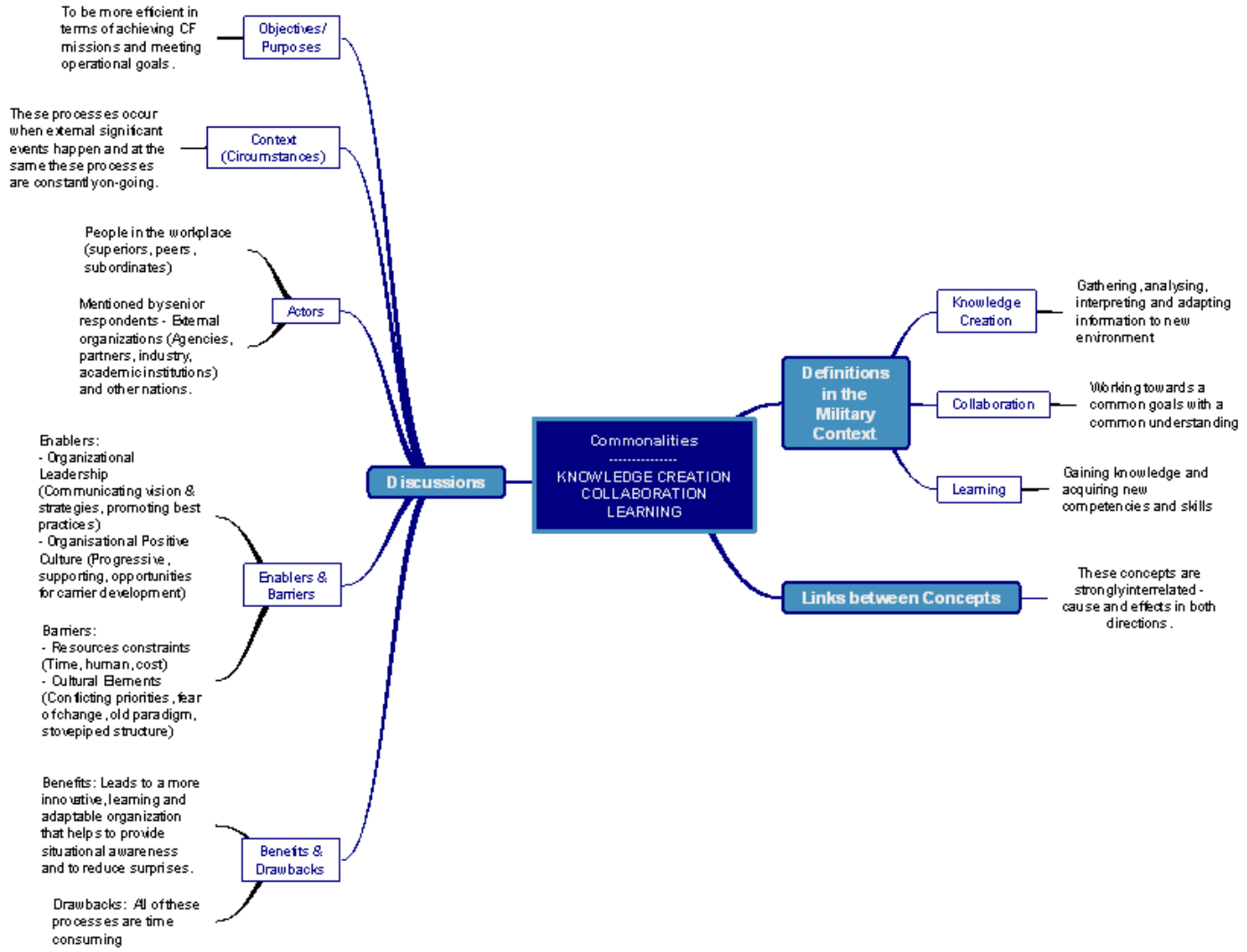

Figure 9. Commonalities between *Knowledge Creation*, *Collaboration* and *Learning* in the military context

5. Conclusion

In this study, we used an ontology-based approach in order to better understand the knowledge management context in the military environment. With a literature review based on three related key concepts, *knowledge creation*, *collaboration*, and *learning*, we defined the related concepts and their relationships. Then we ran semi-structured interviews with distributed samples of military personnel to define the meaning and the characteristics of these concepts in their specific work environments.

Although the results presented here are preliminary, they offer many interesting insights in the military environment and the personnel's perspectives on the concepts related to knowledge management.

It would be important to note that the majority of respondents were quite knowledgeable and articulate about the discussed topics. We did not find major differences between people's discourse and the definitions found in the literature review. The findings permitted to highlight some specific notions or areas important in the military context. We also found that these concepts were related to the essence of military personnel's work, which provides a strong indication that appropriate knowledge management strategies and corresponding initiatives will have a significant impact in the military environment. Also, respondents from the group of senior level management often indicated that strategies are already being put in place to institutionalize some better practices of knowledge management.

In a few instances, knowledge seemed to be equated to the information inside systems. This may originate from the fact that most often, knowledge management is discussed by people that are responsible for implementing technological solutions. We found that even though the respondents were questioned on issues related to three different concepts, many commonalities emerged. This implies that, in all probabilities, some targeted initiatives could impact on all three concepts.

The observations derived from this study should provide important insights onto fruitful directions for knowledge management

strategies. Preliminary results indicate that organizational knowledge (at the unit level) may lack in stability and evolution because of the high rotation rates. Strategies to capture knowledge and provide a more stable organizational history may help people to acquire the knowledge to perform their jobs more effectively. They may also improve the sharing of information, inside and outside of organizational boundaries. Also, even though collaboration is constant and pervasive in the military environment, few technological tools are used to support the collaboration process. These tools may also help nurture external collaboration, which appears to be more difficult at the present time. Many initiatives are underway to develop and implement collaborative support tools; there will probably be more and more users of these tools in future years.

6. Future Research Work

The data collected in this study is very rich and, as we mentioned previously, will necessitate further analysis to provide more detailed indicators on the military environment. Future work will therefore encompass the following:

- A more detailed analysis will be performed to study the differences between the hierarchical levels of respondents and the military environments (air, navy, land and joint forces).
- Responses will be categorized and compared to the literature ontology in a more detailed way. For instance, how different or similar are the aims, enablers, barriers and other properties mentioned by the respondents to those found in the literature? This analysis will help us understand how general prescriptions about knowledge management may or may not apply to the specifics of the military setting.
- Learning styles were also measured in the data collection process. An analysis of this data will help to typify learning styles in the military and eventually relate them to the respondents' perspectives on learning and knowledge creation.

7. Acknowledgments

An earlier version of this paper was presented at the 9th International Command and Control Research and Technology Symposium, September 2004 – Copenhagen, Denmark

We wish to acknowledge the excellent contribution of the respondents who agreed to participate in this survey and deliver their work experience with openness and trust. We are also thankful to Michel Quirion and Marie-Elaine Lemieux from CGI, who enthusiastically joined the interviewer teams. We also wish to express our thanks to the various collaborators and facilitators to this study, namely LCol Ralph Giffin, Dr. Alain Auger, Dr. Michel Gagnon, Dr. Jack P. Landolt and Maj Mark MacDonald.

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