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Title: An Approach to Collaborative Sensemaking Process

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Abstract

This paper outlines a principled approach to collaborative sensemaking process. It is recognized that there are aspects of sensemaking knowledge that are difficult to capture and represent analytically. However, by relying on the existing axioms and principles we have developed a methodology for collaborative sensemaking process. We work from theoretical foundations, assumptions and methodologies to establish some design principles that will serve as a reference when laying out a framework for a sensemaking support system development

INTRODUCTION

Today we are ever more cognizant of the complexity and dynamism of coalition formations and their use in responding to business, government, and military affairs. In situations demanding coalition of disparate and heterogeneous group of people or organizations, collaboration has consistently emerged as a theme to be recognized. Examples of collaborations include inter-governmental alliances, economic and commerce collaboration between nations, and different business entities, such as banks that collaborate through mergers to provide financial services. In the artificial systems, software systems collaborate to solve complex problems through agencies (Clark, 2000; Ring & Rands, 1998).

Modern military environment represents a complex command and control (C2) sociotechnical system where not only technology and humans interact, but where a culture of different nationalities interfaces. Within this system is a myriad of factors that affect how the interacting agents perform their tasks. For example, changes and differences in organizational structures and political constraints, changes of military missions, asymmetric and littoral battle scenarios. In addition to this is the continuous military operation involving coalition members and their requirements to consider multivariate factors, such as, Political, Military, Economic, Social, Information, and Infrastructure (PMESII) (Leedom, 2005).

Coalition is more than just a team. It represents a group of friendly people (usually nations) with different philosophies, political orientations, or different doctrinal backgrounds coming together to fight another group who may be posing an international threat. An example is the Joint Task Force or Coalition Force Command in Iraq. Here, the coalition members are tasked to develop and use collective intelligence for the purpose of achieving effect-based operations. In the coalition settings, “knowledge” is emphasized (Rogers & Ellis, 1994) to reflect (a) how diverse expertise from the coalition members is used to affect the understanding of the problem context; and (b) how diversity from coalition knowledge is shared and integrated into a common problem space.

Coalition formulation has been cited in both military and business as a way to deal with adversaries—especially those adversaries characterized to operate in wicked dimensions (Leedom, 2004; Kurtz & Snowden, 2003). In this kind of setting,

the formulation and integration of a coalition knowledge base requires a new method for knowledge management, including the aspects of framing, contextualization, and reduction of equivocality arising from the complex and interacting information models. This method of knowledge management that can deal with the wicked domain and its information uncertainty is known as sensemaking (Arnseth & Ivars, 2004; Davenport & Prusak, 1998).

Sensemaking can be viewed as a paradigm, a tool, a process, or a theory of how people reduce uncertainty or ambiguity; socially negotiate meaning during decision making events. Weick (1995) states that sensemaking refers to how meaning is constructed at both the individual and the group levels. Through the accurate construction of meaning, clarity increases and confusion decreases. For example, Leedom (2002) indicates that battle rhythms can best be understood through the sensemaking process. A poor sensemaking process often leads to poorly understood objectives, missions, and visions. This in turn can lead to poor framing of plans, and consequently, poor decisions.

This paper is organized as follows: In Section I, we introduce the general concept of collaboration and their definitions with respect to group problem solving and decision making; Section II presents an anecdotal views on sensemaking; Section III presents the differences between sensemaking and decision making and show that in the traditional decision making theory, risk management is often analyzed as a consequence of action, while in the sensemaking process, risk is recognized and distributed through various channels of potential actions and human activities; In Section IV, the concept of collaborative sensemaking is presented; It is argued that collaborative sensemaking provides the core center of gravity for collective analysis of information in a domain of interest; Section V presents the framework required for collaborative sensemaking modeling.

I. COLLABORATION

Modern organizations, including the military establishments, are designed around coalitions, where two or more organizations with mutual goals, collaborate to pursue common goals. Typically, collaboration involves a situation where the collaborating entities share the same information space; the same interests; share the same mutual and consensus strategies. Depending on the composition of the collaborating organizations, managing the evolving collaborative behaviors can be complex. The complexities from the coalition organization can be attributed to many factors that may include, for example, differences in culture (Cramton, 2000; Gioia & Sims, 1986), differences in goals and aspirations (Klein, 1998; Smircich & Morgan, 1982; Stahl, 2000), differences in strategies, methods and tools (Blackler, 1995), differences in advancement of interest and trust, and the overall understanding of the uncertain information from the new stakeholders (Nonaka, 1994; Suthers, 2005). The last characteristic, understanding the uncertain information in an organization is the center of gravity for sensemaking, a theme of our discussion in this paper.

Along with the problem of defining collaboration in a systematic way, we must also recognize the complexity and interdependence of multiple cultures, tools, techniques, and methods that members of a coalition system bring to the situation. For example, action processes, decision-making styles, and beliefs systems that are anchored on the individual and the organizational practices (Ambrosini, 2003; Davenport & Prusak, 1998). The central theme, then, is how to frame shared understanding of contextual information using shared and common cultural lens, while taking into consideration, the coalition member beliefs, different mental models, and different perspectives of assigning meaning information.

The process of a collaborative sensemaking, then, should mitigate the creation of a common framework for shared and mutually developed common information sharing and processing whereby conflicts are minimized and the outcome of the shared information space leads to timely decision making by the decision makers. Because communication is needed to enact the sensemaking process, a successful collaborative sensemaking must sustain a quality discourse, including constructive discussion of ideas, and collaborative arguments by following some interaction guidelines that emphasize listening, questioning, clarification, feedback, modeling and collective meaning making through framing and reframing (Daniels, et. al., 1996).

A significant body of literature exists on team decision making and collaboration that supports collaborative sensemaking framework. Horvitz (1999) characterizes the types of collaboration as follows:

Mixed initiative. The parties to collaboration have a mixed initiative relationship. Any of the collaborating parties can propose information, interpretations and solutions to the problem being addressed.

Shared purpose. The collaborating parties have a shared sense of purpose. There may be other goals of the parties that are not shared, or even openly contested, but the parties agree on the purpose of their collaboration.

Shared situation. The collaborating parties must interpret the conditions of the

environment in the same way. If the assessment of the situation is not the same at the start of collaboration, the parties must resolve the relevant differences.

Shared planning. The collaborating parties have a common set of expectations about the availability and applicability of methods to resolve the problem. A resolution to the problem requires consensus of the collaborating parties.

Communications. A communications mechanism must exist to enable the collaborating parties to exchange information about the exercise of initiative (“rules of order”), joint purpose, situation and candidate problem resolutions.

The characteristics of collaboration above are relevant to coalition organizations involved in managing multivariate information. These kinds of information usually will interact to breed uncertain, complex, and chaotic structures (Kurtz & Snowden, 2003). Although these characteristics have been exploited to support team decision making (Cannon-Bowers, Salas, & Converse, 1993; Cook, Salas, Canon-Bowers, & Stout, 2000) and the associated software designs (Salvin, 1999; Shum & Selvin, 2000), their applications to collaborative sensemaking processes remain at the infant stage.

Finally, collaborative sensemaking involves a fusion of team information processing using team mental models. Rentsch, Hefner, & Duffy (1994) note that team knowledge is an example of a team schema or team mental model (Klimoski & Mohammed, 1994). In general, a team working collaboratively, needs a common operating picture made possible through graphical displays (Tversky, Zacks, Lee, & Heiser, 2004) and a common situation awareness developed from the individual mental models (Endsley, 1995). Although team members may have teamwork knowledge within a specific domain, a collaboration in sensemaking requires that the individual core or tacit knowledge be fused based on a common trait or goal to be achieved. Core teamwork knowledge provides individuals with a seamless understanding of a problem structure.

II. SENSEMAKING

Sensemaking (SM) involves the collective application of individual “intuition”—experience-based, sub-consciously processed judgment and imagination—to identify changes in existing patterns or the emergence of new patterns (Weick, 1995). A peruse of literature on sensemaking can be summarized as follows: *How are meanings and understanding of situations, events, objects of discourse, or contextual information produced and represented in a collective context?*

In this paper, we define sensemaking as the process of being aware of a situation by using information in context to predict the consequences of the individual and team actions relative to the interpretation and assignment of meaning to that context, while doing so through progressive enactment of knowledge management process. SM is an embodiment of practical use of individual or team experience on the available information to construct relevant meaningful knowledge of a context of interest, both in time and space for the purpose of supporting actionable knowledge in that context; that is, knowledge used to perform activities.

Sensemaking is also an aspect of organizational information management that has evolved from many interrelated constructs such as cultural cognition, knowledge management, and quasi-analytic modeling to support diverse intelligent communities concerned with harvesting core knowledge from disparate information sources. The evolutionary process has not been simple. In general, sensemaking targets “Wicked” problem domains which were recognized by Rittel (1973) as constraints in planning of complex-adaptive organizations. Conlin (2003) expounded on Rittel’s concept by developing methods for supporting the sensemaking process. According to Conklin, the four defining characteristics of wicked problems are:

1. The problem is not understood until after formulation of a solution
2. Stakeholders have radically different world views and different frames for understanding the problem.
3. Constraints and resources to solve the problem change over time.
4. The problem is never solved since symptoms recur with completely new behaviors

For the an information context with “wicked “ characteristics, ccomplexity and chaos theories can create system boundaries which have implications for discerning interactions at various levels of abstractions, as well as, permitting multiple hypotheses to emerge as a group discourse is enacted (Kurtz & Snowden, 2003). In the context of organizational information management, sensemaking deals with open-source information which are characterized to be uncertain, ambiguous, conflicting, and incomplete with reference to what we know (tacit knowledge) and how we communicate what we know (focal knowledge).

Leedom (2004) notes that sensemaking is a multidimensional process of developing an operational understanding and awareness within a complex and evolving task domain. Cognitively, it can be seen as a process of collecting, filtering,

interpreting, framing, and organizing available information into actionable knowledge for decision-making. Within the operational context, it is an active and dynamic process in which the operator attempts to construct and impose a specific intent or reality on an object in the given task domain. Socially, it can be seen as a process of reconciling and integrating multiple stakeholder perspectives into a common operational vision that is driven by a specific goal. Organizationally it can be seen as the process of building up appropriate bodies of staff expertise, equipping those bodies with effective information systems and collaboration technology, and efficiently structuring the knowledge management and decision making capabilities of those bodies.

The concept of sensemaking is well named because it literally involves the making of sense. Active agents construct sensible events (Huber & Daft, 1987, p.154). Sensemaking also involves putting stimuli into some kind of framework (Starbuck & Milliken, 1988, p.51). When people put stimuli into frameworks, this enables them to “comprehend, understand, explain, attribute, extrapolate and predict.” Sensemaking is also viewed as a thinking process that uses retrospective accounts to explain surprises (Louis, 1980, p.241). Thomas, Clark & Gioia (1993) describe sensemaking as the “reciprocal interaction of information seeking, meaning ascription and action (p.240).” Sackman (1991) talks about sensemaking as the mechanisms that organizational members use to attribute meaning to events, such mechanisms include the standards and rules for perceiving, interpreting, believing and acting that are typically used in a given cultural setting (p.33). Feldman (1989) views sensemaking as an interpretive process that is necessary for “organizational members to understand and to share understandings about such features of the organization as what it is about, what it does well and poorly, what the problems it faces are and how it should resolve them.” Some researchers view sensemaking as more individualistic singular activity. For example, Ring and Rands (1989, p.342) define sensemaking as a “process in which individuals develop cognitive maps of their environments”. Sensemaking differs from interpretation in various ways. Sensemaking is about an activity or process, whereas interpretation can be a process but is just as likely to describe a product (Ring & Rands, 1999; p.13).

III SENSEMAKING AND DECISION MAKING

We recognize the fuzzy boundary between sensemaking and decision making. Notably, this confusion arises from the disciplinary viewpoints. For example, in the management science literature, there are no differences between these sensemaking and decision making. On the other hand, organizational theorists and cognitive psychologists have attempted to show some differences, but usually with subtle and weak arguments and associations. In this section, we shall first attempt to show the differences and similarities between sensemaking and decision making because it is important to discern the characteristics of both, while seeking to preserve their integrative relationships.

In solving a problem or making a decision, any intelligent system must start with a critical mass of core knowledge. One of the critical challenges of the decision maker (DM) is the ability to reflect on the core knowledge and use this core knowledge (own experience) while performing meta-reasoning with the available information on the problem situation (Ntuen, Burnette, Shattuck, and Leedom, 2005). For example, how does the DM determine what is not known in a novel situation? The DM’s reflection on core knowledge means that the DM has core concepts about the domain of interest stored in a schema of interrelated information. In this case, sensemaking is the process of discovering this core knowledge in order to provide a priori information to the DM.

Argyris and Schon’s (1996) espoused theory sheds further light on the differences between SM and decision-making. In Argyris and Schon’s model, humans make meaning in two distinct contexts: abstracted thought and embedded action. A belief or understanding that is held in thought (espoused) may or may not hold true in experience (theory in use). The espoused dimension represents the SM process, while the theory in use dimension represents the decision-making process.

Sensemaking process involves the understanding of many different and interdependent factors that must be reconciled with the realities and rhythms of the problem context. For example, in the battle space, the commanders’ levels of knowledge, skill, and experience vary greatly among individuals and among battle staffs. Compressed timeframes and the need for synchronized operations lead to high-pressure situations in which sensemaking processes must be enacted before decision making occurs. On the other hand, decision-making is the art of selecting among alternatives, for example, courses of action (COA) based on some defined metrics used to calibrate “how much more sense” one alternative makes than another alternative.

In the initial foray of the unknown, the SM process starts with some knowledge—experiential knowledge and some familiarity or awareness of the situation, and muddles through the problem space by a series of iterations. The aim is to discover patterns that will help the DM make comparisons when choosing from many COAs.

define collaborative sensemaking as “the process toward creating mutually intelligible representations.

Our concept of collaborative sensemaking is that of a social construction of knowledge. “Construction” is used here to denote the structure or the epistemology of team semantic knowledge, and, the process or the ontology of team syntactic knowledge. Epistemology deals with the science of meaning, understanding, and interpretation of knowledge (Baets, 1998). This includes such things as “knowing what” and “knowing which.” On the other hand, ontology knowledge deals with the process that leads to knowing, including “knowing how” (Blackler, 1995).

In a collaborative sensemaking environment, both epistemology and ontology are relevant to how the collaborating entities develop a common and shared meaning through communication; interpretation through logic and reasoning; and understanding through the comprehension of a contextual knowledge or situation awareness which allows the members of the collaborating team to see the same thing-- both inside (personal awareness) and outside-- through explicit graphical display of situated information (Erikson & Kelley, 2000).

Because collaborative sensemaking involves the interaction of multi-stakeholders, knowledge that is relevant in sensemaking settings is inherently multidimensional, including elements of theory (know-why), practice (know-how), transfer (tools and methods) and knowledge of results (reflective knowledge). The four formative elements of sensemaking—meaning, interpretation, comprehension, and understanding have been generically viewed in two dimensions of conceptual and actionable knowledge (Leedom, 2004). The actionable knowledge, sometimes referred to as "tacit" knowledge, is the know-how for effective action; meaning that there is an ability to produce actions that are effective in attaining desired outcomes.

In view of the collective behaviors of the multiple sensemakers involved in collaborative sensemaking, everyone is engaged in their own SM effort. For this reason, Shum and Selvin (2004, p.7) note that, “there are not only gaps in the languages, frames of reference, and belief systems that people in the different communities of practice have, but gaps between their respective SM efforts—their concepts in the representational situation are different. In many cases, different communities have mutually unintelligible SM efforts, leading to mutually unintelligible representational effort.”

Collaborative sensemaking systems are designed to explicitly decouple the innate tacit knowledge of the individuals within the collaboration setting. That means that a close cooperation between all entities involved in the sensemaking process must be maintained. Most importantly, since collaborative sensemakers are tasked with the processing and interpretation of diverse information, they must be comfortable with interactions, communication and sharing “what they know”, and, be able to analyze a situation as a team. The products of such a collective analysis are, most importantly, to isolate and detect potential conflicts and resolve potential errors using the available information.

In terms of cognitive processes and information processing, collaborative sensemaking is a result of cumulative years of diverse, but shared expertise. According to Blaikie (1993), people in the group are “constantly involved in interpretations of their world.” This observation supports the idea that collaborative sensemaking is socially constructed knowledge and a way to improve group information management based on specific organization. First, the organizational interest in collective social understanding carries some defined and agreed shared vision, values, and beliefs. Second, the collaborative sensemaking knowledge requires cohesive and articulated goals. Suthers (2005) observes that collaborative knowledge construction takes place when multiple participants contribute to the accretion of interpretations by building, commenting, transforming, and integrating a shared information base. For this reason, Conklin (2002) posit that shared knowledge is fundamental to an effective team and collaboration.

In general, Weick’s (1995) views collaborative sensemaking as a socio-cognitive process of creating actionable knowledge within an environment where each expert and stakeholders holds a different perspective. Here, Weick emphasis on how collective understanding of a situation can lead to shared execution of action required to attain an organizational goal. Since the process of collaborative sensemaking involves many stake holder’s expertise, integrating and reconciling different perspectives and behaviors have been cited as the core constraints (Gioia & Poole, 1984). Cohesiveness can be achieved through articulation and reconciliation process based on an established common understanding of a situation (Barsalou, Yeh, Luka, Olseth, & Wu, 1993). This leads to a collective understanding of the relevant entities and “cause-effect relationships that influence different types or classes of effect-based action (Leedom, 2005)”.

Before we discuss the framework to collaborative sensemaking, it is necessary to understand the general elemental activities that are crucial to the sensemaking process. These elements are:

- a) The communication process
- b) The knowledge management process
- c) Developing shared situation awareness and understanding process.

d) The process for developing collaborative knowledge

Communication Process

Sensemaking aggregates and refines intuitive judgment through conversations within an organization in which members construct interpretations of reality and develop explanations or stories to account for perceived anomalies. In a collaborative sensemaking environment, the collective tacit knowledge of its members must be made explicit in order to realize an effective transfer of knowledge. Without being able to communicate understanding in such a way so that it can be exercised effectively by others, the value of any claim of knowledge is limited. Chomsky has held that in communication, knowledge of grammar involves propositional knowledge and belief (1986, p. 265; 1980, p. 93), as does ordinary knowledge. In addition, Chomsky observes that a speaker's tacit knowledge of grammar is inferentially available to carry some meaning about the individual knowledge and belief (1980, p. 92), as speakers' decisions to use their tacit knowledge are influenced by their "goals, beliefs, expectations, and so forth" (1986, p. 261).

Knowledge Management

As shown in Figure 2 knowledge management is the process of making sense of information in context. The processing of data into information, and information into knowledge are woven into every fabric of the sensemaking process. In the sensemaking practice, knowledge management is synonymous to the process of converting tacit knowledge to explicit, formalized knowledge that is easy to understand and use for the intended actions. Peter Drucker (1997), one of the best management theorists has observed that "knowledge constantly makes itself obsolete, with the result that today's advanced knowledge is tomorrow's ignorance." As knowledge becomes more explicit, the more it approaches a high equivocality, and the more it can be used for instantaneous communications.

In the collaborative sensemaking domain, knowledge management takes on two dimensions: managing tacit knowledge and managing social knowledge. Tacit knowledge is the most difficult because it is embedded in the expert's mental model and can be observed through practice. Thus, tacit knowledge management is more dependent on observations and experience. Many techniques such as Kelly's Personal construct theory (Kelly, 1955) are useful in managing tacit knowledge. The second knowledge is social. Social knowledge, according to Nonaka and Prusak (1998) can be shared, and is also distributive through communication and language. The convergence of tacit-to-explicit knowledge is important in developing software tools to support collaborative sensemaking process

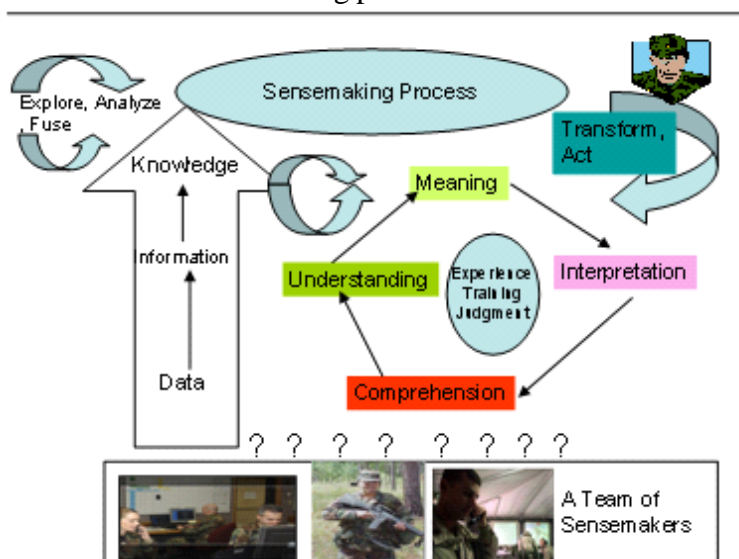


Figure 2: The collaborative sensemaking process that includes information management and action

Shared situational awareness and understanding

A team interaction mental model and situation awareness (SA) have also been investigated, and results show that both hold information concerning the roles, responsibilities, communication patterns, and interactions among team members (Converse, Cannon-Boers, and Salas, 1991; Endsley and Pearce, 2001). Testimonies to their effectiveness reflect on many axiomatic definitions. For example, Lt. Gen. Paul J. Kern, Military Deputy to the Assistant Secretary of the Army for

Research, Development, and Acquisition, and Lt. Gen. John N. Abrams, Deputy Commanding General of Army Training and Doctrine Command, provided one such definition of shared situational awareness as part of their testimony before the Senate Armed Services Committee in 1998, when stated that “shared situational awareness . . . translates to a clear and accurate, common, relevant picture of the battlespace for leaders at all levels and a reduction in the potential for fratricide. *Situational awareness answers three fundamental battlefield questions: Where am I? Where are my friends? Where is the enemy?* The sharing of timely information enabled by digitalization improves significantly the ability of commanders and leaders to quickly make decisions, synchronize forces and fires, and increase the operational tempo.”

In team collaboration, team situation awareness is established through the development of a team shared mental model. A shared mental model is defined as organized knowledge that members have in common regarding the task. Johnson-Laird (1980) made a strong case for mental models as a method for collecting information and using it in individual cognition for the distribution of information for action via cognition. Wilkes (1997) builds a case for mental models referring to literature, including, a cognitive framework that people use when interacting with other people. Intons-Peterson and Fournier (1986) indicated that mental models exist somewhere between cognition and perception. The apparent ubiquity of the mental model in the human activities makes it prime for use as a means of conveying cognition between members of a team. This model is probably best conveyed graphically (Tversky et al).

Wellens (1993) and Endley (2000) have distinguished between individual and team SA, with team SA referring to the sharing of an SA regarding system events (current and future status). Group SA is defined as “the sharing of a common perspective between two or more individuals regarding current environmental events, their meaning and projected future status” (Wellens, 1989, p. 6). The accuracy of group SA depends not only on the shared information, but also on the shared “mental model”. According to Wellens (1993), the shared mental model includes: 1) a shared idea of how the group operates the system, and 2) a shared understanding of the system problem the group encounters.

V. THE FRAMEWORK

Nosek (2001) indicates that all members of a team must be on the look out for relevant information to ensure the team mental model is shared effectively. There are again a myriad of social issues bound up in generating this shared mental model, which must have individual cognitive components that require study.

Stahl’s (2000) approach uses personal beliefs from individual perspectives to generate group understanding of a shared mental model. Her knowledge building environments act as a tool which attempts to integrate and mimic various models of tacit and focal knowledge hypotheses. Figure 3 shows this relationship between tacit and focal knowledge dimensions discussed earlier. The embedded circles contain the sub elements of the sensemaking process; and they are the epicenter of the framework to be discussed next. Figure 2 that was presented before can be used here for further clarification since it contains information on the sensemaking process and the outcomes, both at the individual and group settings.

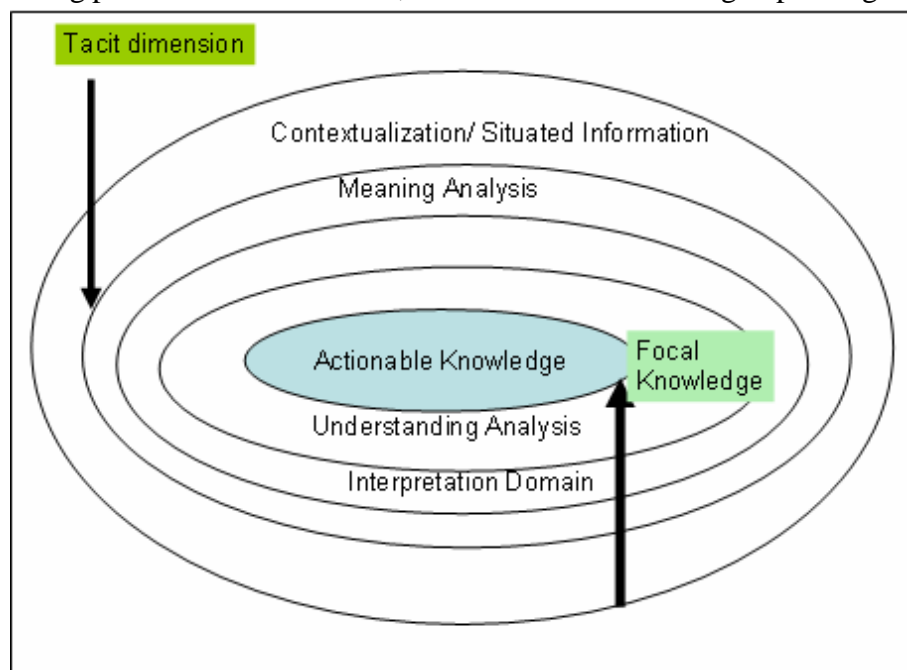


Figure 2. The evolving dimensions of the sensemaking process

We shall describe the elements of the proposed framework in five levels of abstraction:

- Identification and definition of the contextual information setting.
- Identification of the processes involved in ascribing meanings to contextual information.
- Identification of the processes involved in interpreting contextual information.
- Identification of the processes involved in understanding contextual information.
- Identification of the processes involved in tacit knowledge transfer.

1. Identify and Define the Contextual Information

The sensemaking process is driven significantly by the context and information available in that context. Thus, contextual information is situated, being in part a product of the activity of the sensemaking process. Situated information and situated action go hand in hand, and dominates action making practice. The term situated actions emphasizes the interrelationship between an action and its context of performance (Suchman, 1987). A sensemaking context is dynamic and changes from one situation to another based on the events happening in time and space. Since environment is subject to changes, context information undergoes some biological evolutions—some may mutate, while others may be relevant in a new situation, often through the invocation of reflective knowledge of the sensemakers. Consider the fictitious example without any reference to reality. *At 1400, CNN announced in its daytime news that Bin Laden has been found taking refuge in Syria.* This sort of announcement could potentially define a context of surprise and uncertainty (doubt that the news is true) for the sensemakers. Here, the PMESII attributes defined earlier is the paramount factor in the sensemaking process. For example, the political implication of the situation to Syria, economic embargo can be an option; military strike can be enacted, and so on. This sensemaking process driven entirely by the CNN news drives that necessary action for enacting the DIME actions on Syria. One salient problem is that the CNN news may or may not be true leading to a phase-based sensemaking process with varying contexts and “what if-” and “what next-“ situations. It is believed that this kind of contextual information for sensemaking can best be modeled with cognitive task analysis and work domain analysis (Leedom, 2004).

2. Identify the Processes Involved in Ascribing Meaning to Context Information

Meaning is tied to a specific context and dependent on the sequential order of interaction between all the experts involved in the sensemaking (Arnseth and Solheim, 2002). As an epistemological construct, meaning is a subtle, loose, and diverse assignment of definition to a knowledge token, object, or artifact. In this respect, Berkeley (1710) notes that meaning exists in one’s mind, and is often difficult to explain it—an observation that leads to the paradigm that “we know more than we can tell (Polanyi, 1666). Polanyi describes the semantic aspect of tacit knowing, how meaning tends to be displaced away from ourselves, and toward the external. This is observed in the perception of using a tool, in which the meaning of the use of the tool becomes evidenced in the external impact of the tool, not in its immediacy in our hands while using it.

Meaning is also realized through the process of how we describe things, objects, events, and so forth. Since meanings are embedded on language through description (Macdonald, 1995), meaning then becomes a function of language and grammar. While people construct their world they can nevertheless experience it as something more than a human construction; implying that “meaning cannot not be objective in the positivist sense (Ambrosini, 1998; pp. 40).” For a collaborative sensemaking, meaning is a crucial construct in understanding how different people convert information to action (Malhotra, 2001), and we do so through language.

3. Identify the Processes Involved in Interpreting Context Information

Interpretation reflects an approximation of individual awareness of the situation in a collective sensemaking setting while ignoring some elements and only partially ascribing meaning to the subset of external knowledge (Leedom, 2005). Interpretation leads the sensemakers to more focused knowledge required for the formalisms required for intended actions. Leedom (2005) observed that “Given the difficulty in externalizing tacit knowledge, these articulations, by nature, reflect only an approximation of each individual’s activated knowledge-ignoring some elements and only partially describing the remainder “.

The process of interpretation is not in isolation. It is affected by individual and group psycho-sociological characteristics such as bias, emotion, affection, thoughts, and actions (Duval and Wicklund, 19972), and interactions between individuals and

group (Ntuen and Winchester, 2005). The act of interpretation may take the form of explicit sensemaking through communication; it may also take place through the transformation and integration of representation of selected information base within the defined context (Suthers, 2005). The key challenge is, however, minimizing the variance in a diversity of meanings accorded the object of interest with its different interpretative viewpoints (Malhorta, 2001).

Nosek (2001) suggests that members of groups have to “face the existence of multiple and conflicting interpretations” which requires that individuals: scan for and filter relevant information to create and maintain a sufficiently shared mental model to act effectively as possible”. Shared mental models have the problem of knowledge or truth maintenance in that the information that was true for yesterday (or even an hour ago) may have decayed, have subtle changes, or may have demonstrably changed (Drucker, 1997). These changes occurring over the entire decision space can play havoc with meaning, interpretations, and choice of actions, and highlight the need for conflict resolution, multi-source sensemaking, and the social construction of knowledge.

In general, all our interpretations given to contextual information is subject to change and may be based on our experience or encounter with similar contexts. “Each of us lives in what is ultimately a unique world, because it is uniquely interpreted and thereby uniquely experienced (Bannister and Fransella, 1986; pp. 10).”

4. Identify the Processes Involved in Understanding Context Information

Knowledge is useful only if it can be understood in terms of the implications for action. As complexity, dynamics, or uncertainty increase, the use of the knowledge can become a burdensome and labor intensive process. The principal resource available to the DM for perceiving the situation and understanding it is his or her experience and judgment. If a certain pattern of information has been encountered previously and always represented a clearly defined situation, the DM will likely recognize that pattern and make the connection quickly.

Numerous authors have considered communication as it relates to shared understanding. These include Brock (2002), Arnseth and Solheim (2002), Sternberg (2001), Yufik and Georgopolous (2002), and Stahl (2000). These references supports the fact that sensemaking by itself, involve a collaborative (social) search for understanding of phenomena through shared mental models of all members of collaborating entity. For team members to achieve individual understanding and accumulation of facts there is a transformation process that takes place between team members. This process is that individual team members talk to one another about the common task, which builds individual understanding along with the team, as a whole, accumulating facts.

Devlin (2001) introduces the notion that “a common ground” of describing and understanding the situation is necessary to collective understanding of organizational knowledge-action interaction. Accordingly, Polanyi’s (1958) definition of focal knowledge can be used to infer how individuals in an organization assign meanings to what they see and feel. As echoed by Malhorta (2001), by understanding a situation, we can form the conceptual link between information available and the expected result or anticipation of task outcomes. It could also help us to understand the gap between performance expectations based on information in context (Malhorta, 2001; pp. 120).

5. Identify the Processes Involved in Tacit Knowledge Transfer

Knowledge transfer is a result of implementing actionable knowledge by enacting framed or scripted focal knowledge on task requirements. Crothy (1988) note that it is contended that “all knowledge and therefore all meaningful reality as such, is contingent upon human practices, being constructed in account of interaction between human being and their world (pp.42).” In the military domain, e.g., the actions may include the removal of a head of state by enacting one or the entire strategic dimensions embedded in the sensemaking process—political, military, economic, social, information, and infrastructures (PMESII). A combination of at least two of the PMESII elements may contribute to different COA facets; knowing where and how to use these dimensions to disable the adversary depend in part on the sensemaking knowledge transfer used in the command and control stage to support decision making.

The magnitude to which different adversary domains can affect sensemaking invalidates any attempt to construct any universal declarative knowledge to encode general sensemaking applications. More appropriately, constructing sensemaking with actionable knowledge in mind should be considered the embellishment of individual skillful knowledge (Hodgkins, 1992; Reber, 1993), formalized team knowledge (Nonaka, 1991), and knowing in action (Schon, 1994). Knowing in action is embedded in the socially and institutionally structured context; it goes beyond available rules, facts, theories, and operations.

The distinction between tacit knowledge and explicit knowledge has sometimes been expressed in terms of knowing-how and knowing-that, respectively, which is essentially, the application of what we know to solve problems (Ryle 1984, pp. 25-61). Knowing-how or embodied knowledge is characteristic of the expert, who acts, makes judgments, and so forth without explicitly reflecting on the principles or rules involved. As Dretske has pointed out (Dretske 1988, p. 116), knowing-how involves more than just a certain technical or physical "know-how"; it also involves knowing how to obtain desired end-states, knowing what to do in order to obtain them, and knowing when to do it.

The focal knowledge posited by Polanyi (1966) forms the theoretical basis for describing the enactment of sensemaking process into an actionable knowledge. According to Polanyi focal knowledge is a form of articulated knowledge made explicit through implementation of actions—therefore, resulting in some observable behaviors. In terms of the sensemaking process, we can describe knowledge transfer in one or all of the following ways:

- 1) knowledge that provides an understanding of the task domain;
- 2) framing strategies based on common recognizable information cues;
- 3) providing a plausible cause-effect explanations to executed actions;
- 4) recognizing the specificity of knowledge, that is, some knowledge is specialized based on consensus agreement on the way standards are enforced during task performance. In other words, there is no body of consensus knowledge specific to all tasks. This is echoed by Nonaka (1994), that “what makes sense in one context can change or even lose its meaning when communicated to people in a different context”;
- 5) although some knowledge resources could be transferred from one task domain to another, their efficiency or effectiveness would not be as great as it was before because the context as a whole would be different (Ambrosini, 1988);
- 6) emphasis on actions enables us to view knowledge as task-driven; this results in the so-called matter dualism that characterize empiricism and rationalism explanations of the sensemaking process (Leedom, 2005);
- 7) shared and collaborative knowledge is derived for a purpose based on task; the sensemaking should ask, “what is the relevant of the information in this activity?”

Davenport and Prusak (1998) distinguish between formal and informal knowledge transfer, and point out that formal knowledge transfer occurs in real work situation, through roles, activities, and actions. Informal knowledge transfer occurs in informal settings such as in conversations, open forums and talk rooms. Davenport and Prusak (1998) identify seven barriers that can hinder the informal knowledge transfer. They include, lack of trust; different cultures, vocabularies, and frames of reference; lack of time and meeting places; status and rewards going to knowledge owners; lack of absorptive capacity in recipients; belief that knowledge is the prerogative of particular groups; the “not-invented-here” syndrome; and intolerance for mistakes or need for help. In general, Brockman and Anthony (2002) observe that knowledge transfer is “intimately related to action such that it reflects knowing how as contrasted with knowing what (p.436).”

VI. SUMMARY AND CONCLUSION

At its innermost core, sensemaking is the process of information management to aid in decision making. Collaborative sensemaking constitutes a paradigm for mapping the expertise of an organization from its many stakeholders. The collaborative sensemaking approach has many valuable attributes to offer in the domain of planning and decision making. First, collaborative sensemaking supports easy access to a map of many individual experts within the organization and how they can connect people in terms of what they know (tacit knowledge); Second, collaborative sensemaking increases the space for constructing multiple meanings and interpretation about a problem context. This helps in common understanding of the relevant goals; Third, collaborative sensemaking provide a diversity of spatio-temporal reasoning about information by considering skills, expertise, experience, and location of the stakeholders. Lastly, where the process of collaborative sensemaking works, it can provide information and insights that are unique in reducing the uncertainty faced by the decision makers.

There are some challenges in modeling collaborative sensemaking systems in order to realize the above advantages. A first set of challenges is that multilevel sensemaking models described above must account for different communication strategies and modalities. Second, many people often wonder why others see things differently than they do or appear to be impervious to what is obvious; this is a challenge in achieving consensus in a collaborative sensemaking process. Third, the execution of many tasks in a distributed and /or collaborative environment requires the ability to synchronize actions performed by many stakeholders of the system.

In order to achieve the goal of developing a collaborative sensemaking support system, our review of existing literature

points to three fundamental problems to be resolved:

- (a) The collaboration framework must provide mechanisms that enable storage and retrieval of the results of the collaborative work.
- (b) Collaborative situation awareness is a state of resources used in collaboration—this provides the common picture metaphor to all participants in the sensemaking process.
- (c) A facility of procedure for modeling the individual tacit knowledge must be embedded in all the levels of the modeling process.
- (d) Different applications need different collaboration policies. The sensemakers must be chosen to reflect their domain of expertise

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