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ADAPTING C2 to the 21st Century

Title: Sensemaking Training Requirements for the Adaptive Battlestaff
Topic: Cognitive and Social Issues

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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, and are required to deal with processing equivocal information, or sometimes, paucity of information; all leading to different interpretations, which in turn affects the team understanding of the situational (dynamic) information. The existing training doctrines that address the deliberate military decision making process is not adequate, or perhaps not even relevant to the training of the military sensemakers and intelligent analysts. We need a new training strategy, paradigms, and methods for this purpose. The sensemaking trainability factors o must be identified.

1. INTRODUCTION

Military commanders in most recent and continuing conflicts of fighting war against terrorism are overburdened with conflicting command and control functions that include operations other than war—such as emergency relief, civil duties, and managing ethnic conflicts. These are functions that are not the primarily military functions. In the civilian business and commerce, chief executives are facing competitions that can equally be described as asymmetric with multiple conflicting competitive goals—as evidenced in supply chain management and logistics occasioned by off-shore operation concepts. Thus, modern organizations, whether military or civilian, can be described and characterized by evolving behaviors with juxtapositions of social forces—a complex of network of information systems with people, technology, and domains of adversaries (tasks) that have been described to be "wicked", "complex", and "chaotic" (Leedom, 2005). The problem, of course, is that leaders of these nascent dynamic organizations must be trained differently to cope with the requirements for effective C2. We need a new training strategy, paradigms, and methods that are significantly different from the so called transformational leadership. We need to train leaders to acquire adaptive "mind sets" rather than transformational thinking.

Sensemaking is the ongoing process of finding out how to act in order to reach one's goal(s). Sensemaking is a phenomenon that spreads across the spectrum of the organizational hierarchy: strategic, operational, and tactical. An example of the strategic level is the CIA briefings to the President of United State on daily intelligent activities across the world. At the operational level, the military organization, for example, conducts sensemaking exercises to develop concepts of war, exploring information about the enemies, including their capabilities and plans. The sensemaking process is then used to support courses of action development. At the

tactical level, sensemaking provides the basis for enacting actionable knowledge, utilizing, e.g., tacit knowledge versus explicit knowledge; linear predictive processes versus nonlinear processes; and simple task versus wicked (unstructured) tasks. The knowledge derivatives from the interacting dimensions provide the basis for sensemaking in complex organizations.

The idea of training framework discussed here emphasizes the fact that sensemaking activities occur at the cognitive level of human actions. Cognitive training emphasizes situated learning of context-dependent task. A task is said to be situated if it relevance to a defined system of interest. For this reason, skill and knowledge acquisition are crucial to understanding what relevance attributes to be trained. The situated learning approach emphasizes context, realism, and inclusive of the ecological factors reminiscence of the task.

From rational philosophy, there is reason for training—and that is, to provide competency skill and knowledge to the person trained. In addition, the concepts and beliefs held by rationalists emphasize that knowledge can be constructed based on information about the task and the person performing the task. In other words, we can say that training is based on context; hence we can construct training objectives based on the contextual demand of the tasks and the contextual skill and knowledge deficiencies of the trainee. The ideology holds to the doctrine that knowledge can be constructed from an already held experience; and that learning is an active process incrementally derived from experience. These assumptions are important to designing training contents. Another concept that constructionists may held that is positive to training design is that the learners have various and different experience along the task continuum. It is necessary therefore to evaluate and rearrange this experience in order to determine a trainable knowledge base.

2. SENSEMAKING STRUCTURE AND THEORITICAL BACKGROUND FOR SENSEMAKING TRAINING

2.1 Background

The concept of sensemaking contains two main logical moments: the retrospective process of interpretation (sense) and prospective one of enacting a new configuration of the environment (making). We shall elaborate on the requirements to train core sensemaking tasks which is recognized to originate from the individual tacit knowledge. The requirements germane for training consist of how individuals and teams recognize and make use of their “sightful” knowledge, such as, insight, hindsight, foresight, oversight, and short-sight, respectively. Sensemaking relevant tasks identified by commanders during a recent interview at the SAMS (Fort Leavenworth) will be used for the requirement analysis.

This proposition is anchored on our interviews of commanders who have completed tours of duty in Iraq and Afaghistan. These commanders see the current leadership training for organizations with known goals and fixed missions is inadequate for organizations which are pragmatically dynamic—goals are not fixed—are developed based on contexts of adversary posture, and the main enemy (or competitor) is not known—leading to a latency forcing function not describable by the existing training doctrines and their performance metrics.

2.2 The Structure

The Army doctrines have recognized this situation through its three-tier hierarchy of physical, informational, and cognitive taxonomy of the battlespace (Medby and Glenn, 2002). This is shown in Figure 1. At the highest level of abstraction is the cognitive representations of scenarios, conscious instantiations of meta-knowledge, intuition, and instincts through various enactments of all the human experiences. At the informational or symbol level, the soldiers and commanders seek to understand different types of intelligence. Lastly, at the root level, the physical domain is represented by the “terrain”, landmarks, and a geospatial map of the battlefield—including stationary and dynamically moving targets.

Similar to the abstraction in Figure 1, we see sensemaking at three levels of abstraction that replicates the structure of modern battlefield (Leedom, 2004). These are, at the individual (cognitive state), organizational (social) state, and ecological (similar to physical) state, respectively. Figure 2 is used to illustrate these levels or states. The cognitive level represents an individual operator or a dismounted soldier, a decision maker (commander), or a staff member.

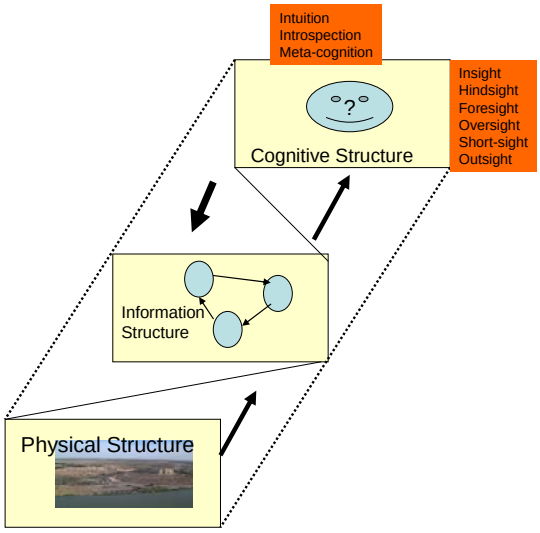

Figure 1. Levels of battlefield information processing abstraction

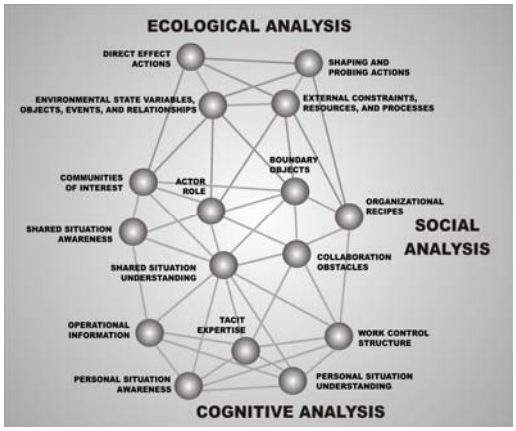

Figure 2. Cognitive, social, and ecological levels of sensemaking analysis

For example, in the battlefield context, staff member actors are seen to carry out knowledge creation tasks that (1) assemble, interpret, and shape available information from the environment into a state of situation awareness for the decision makers; (2) articulate and refine a decision maker's vision or work strategy into practical detail; and (3) reconcile those details with situation awareness to produce a working understanding of how the work system will move from its current state to some desired end state reflected in its overall purpose. At this level, we are concerned with training design that will take opportunity of the individual tacit knowledge. Tacit expertise is organized around the mental activities of pattern recognition and hypothesis testing. Pattern recognition reflects the ability of an actor to (1) "recognize" a set of cues—or situational features—from his available information environment and (2) use these cues to activate a specific mental framework for interpreting some aspect of the situation. In short, pattern recognition involves a mental process of "fitting" available information and experience-based mental models together into a cohesive structure.

While a cognitive level of analysis addresses the states of situation awareness and understanding of the individual actors within a complex battlefield system, it is the social level of analysis that explores how these actors collaborate with one another to achieve unity of purpose. Social analysis becomes necessary because a work system rarely—if ever—involves only a single actor or decision maker. Here, we see the battlestaff members in teams or groups (like platoons or units) in formation that may be called community of interest. A *community of interest* generally refers to a group of people with different backgrounds, different areas of expertise, and in some cases different objectives that come together to address a common problem. The group must recognize their individual roles and relationships with other roles, the common interest defined by shared goal, and their ability to reduce frictions in communication through common lens of shared mental models, situation awareness, and common operating picture.

At the ecological level, training is of interest especially with respect to how the soldiers interact with and/or recognize adversary environments that co-exist in an urban setting—an

interaction that occurs in a larger social and physical settings. Training should recognize ecological niches—things that make the soldiers to cope with evolving and dynamic situations; stressing the knowable knowledge to other dimensions of complexity and chaos (Kurtz & Snowben, 2003). For example, a military force exists to achieve specific geopolitical objectives for a nation or coalition of nations, a consequence management or disaster relief system exists to mitigate the effects of some manmade or natural catastrophe, and a community or public health system exists to maintain the general health of a population and to respond to specific disease epidemics.

Recognizing the impact of ecological factors in training goes beyond the simple physical strength or either the individual soldier of a unit. The field theory which is an information description of ecological niches, as observed by Deaux and Writhtsman (1988) is the *"proposition that human behavior is the function of both the person and the environment."* This means that one's behavior is related both to one's personal characteristics and to the social situation in which one finds oneself. Hesse (1970, p. 181) and Rummel (1975, p. 26) suggest that field theory may be said to have the following characteristics which we consider relevant for sensemaking training:
1) It purports to explain changes in the states of some elements (e.g. a static field induces motion in a charged particle) but need not appeal to changes in states of other elements (that is, "causes"). *In the battlefield equivalent, the commander's judgment and decision is time dependent since information about the adversary is not static*.
2) These changes in state involve an interaction between the field and the existing states of the elements (e.g. a particle of positive charge moves one way and one of negative charge another). *In the battlefield equivalent, the commander's interaction with the battlefield elements is the abattoir of experience that controls and mediates decision making.*
3) The elements have particular attributes which make them susceptible to the field effect (particles differ in the degree and direction of charge). *In the battlefield equivalent, the commander makes judgment based the level of effect desired relative to the field information; e.g., directions of the risk vector*.
4) The field without the elements is only a potential for the creation of force, without any existent force (Hesse 1970, p. 196). *In the battlefield equivalent, a commander will recreate battle scenarios and substitute combat genres to* control potential areas of agitation—a sort of anticipated plan.
5) The field itself is organized and differential (Koffka, 1935, p. 117). In other words, at any position the field is a vector of potential force and these vectors are neither identical nor randomly distributed. *In the battlefield equivalent, the commander views every sector of battlefield differently, applying different control elements designed to deliver the necessary effect.*

2.3 Sensemaking Process and Abstraction Model for Training

A generalized model capturing the key processes of sensemaking is recognized to occur in four generic cognitive levels. These are, meaning assignment, interpretation, comprehension, and understanding, respectively. This is shown in Figure 3. As a continuous process, there are recurrent feed-forward and feedback loops along the continuum of meaning—understanding axis. Let's look at these dimensions separately.

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 (Polyani, 1966). Polanyi describes the semantic aspect of tacit knowing, how meaning tends to be displaced away from ourselves, and toward the external. For example, in the perception of using a tool, 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.

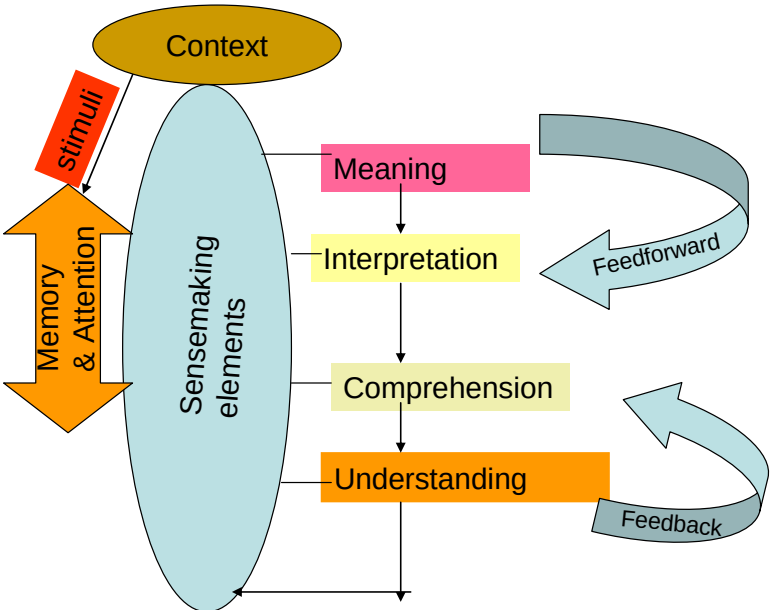

Figure 3. Cognitive Abstraction Model for Sensemaking Structure

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.

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, 1972), 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 require 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 truths 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)."*

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 sensemaker 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 sensemaker will likely recognize that pattern and make the connection quickly.

Numerous authors have considered communication as it relates to shared understanding. These include, e.g., Arnseth and Solhein (2002). 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 for 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 the 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.

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 the 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, for example, the actions may include the removal of a head of state by enacting one or the entire strategic dimensions embedded in the senemaking 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.

More appropriately, constructing sensemaking with actionable knowledge in mine should consider the embellishment of individual skillful knowledge (Hodgkins, 1992), formalized team knowledge (Nonaka, 1991), and knowing in action (Schon, 1994). Knowing in action is

embedded in a socially and institutionally structured context; it goes beyond the normal available rules, facts, theories, and operations, used in the existing training systems.

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 training, 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 Nonanka (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?"

With respect to sensemaking training design, 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)."*

3. TRAINING SENSEMAKING TASKS

3.1 Sensemaking Trainability factors

Training as a method of instruction, helps learners to: (a) acquire new information, techniques, and skills; (b) increase knowledge; (c) clarify attitudes, beliefs, and/or behaviors; (d) practice skills; (e) improve existing skills and; (f) implement any learning achieved.

Training is a particular form of education or teaching that encompasses the transfer of knowledge and the performance of skill at a later date. In the process of training the trainer has a variety of responsibilities. Typically the trainer creates specific objectives known as trainability factors to be accomplished within a given time period. Trainability factors represent variables, topics, or a body of knowledge that the learner must attain a pre-defined competency level. For sensemaking, the structure of Figure 3 gives the elements of trainability factors—meaning, interpretation, comprehension, and understanding. Since these factors occur at the abstract level, the trainer must then define a set of skills required at the concrete or action level.

Literature on personnel training is abundant; especially in the military domain where training are discussed as the foundation for the transformation force: the Army (and other branches of the military) is constantly evolving to improve current capabilities to response to

unknown adversaries in modern non-traditional warfare. This is concurred by major General Scales when he notes,

> "*While wars have become more complex, responsibility for those who fight them Has increasingly slipped down the chain of command to junior personnel. Yet these young, inexperienced leaders have little time to prepare themselves to make Strategic decisions" (2006, pp.8).*

Training soldiers for force-on-force warfare is relatively straight forward. Here the mind-body (physical-psychological) connection was the norm and emphasis was to prepare the mine to absorb the direct physical contact with the enemy. In modern warfare, the enemy is rarely known, direct one-on-one contact is relatively absent, and the battlefield is more in the urban corridor rather than known terrains.

The shift to prepare men and women of uniform to deal with dynamic, evolving, and unpredictable states of asymmetric battlefield begs for sensemaking training. Sensemaking, as alluded to before, is purely cognitive, and aims to prepare the soldiers for dynamic decision making—one that can recognize patterns and footprints of enemy deceptions and strategies that equally change in time and place. In training for sensemaking, there are no formal theories and recognized methods when compared to decision making and leadership training. Equally so, there is no formal recipes for sensemaking trainability factors (STF). STF are those attributes where the learner is weak and if properly trained may enhance performance (Ntuen & Chestnut, 1995).

In a generalized training theory, Campbell (1971) categorizes trainability factors (TF) under four psychological levels: attitude, motivation, behavior, and personality differences. In a study by Machala (1981), TF are identified as aptitude, achievement, competence, socio-economic factors, effectiveness, and communication. In another study, Peterson and Bones (1982) developed a TF inventory that has four macro units: level of information processing requirements, mental processes, workload, and relationships with other persons. The Peterson-Bownas inventory recognizes the individual and social levels of training.

3.2 Sample Trainability Factors By Sensemaking Levels

Based on our descriptions above, Tables 1-3 are used to portray some sample skill sets that can be trained for sensemaking tasks.

Table 1. Sensemaking Trainability Factors at the Individual (Cognitive Level)

Attribute	Attribute Description	Sample Cognitive Trainability Factors
Meaning	* First level situation conveyance * intent registration	* Situation framing and contextualization * Situational features recall * Mental model probing
Interpretation	* Conception of object or event significant in a situation	* Recognizing salient cues * Performing link analysis * Conducting pattern recognition * Offering explanation to meaning assignment
Comprehension	* Associating contextual features to goals or end-states * Exhibiting the acquisition of larger latitude of knowledge in context	* Using of information in context of goal * Meta-cognition with ordered mental map association to changing situations * Pattern discovery/ recognition * Case-based reasoning

Understanding	* Thorough grasp of situation * Latitude of judgment * Expandable lens in looking at situation Knowledge in use	* Deriving the significant of situation * Explaining the effect of action enactment * Reacting to evolving situation with information changes
Mind Sets	* Adaptivity * Agility * Flexibility	* Ambidexterity in executing tasks * Fitting contexts to multiple lens * Changing viewpoints to new situation * Applying reflexive knowledge * Opening to “global” cultural viewpoints
Awareness	Self awareness	* Understanding of what is important to you * Understanding how you experience things * Knowing what you want * Knowing how you feel and * Knowing how you come across to others
Sightful knowledge	* Insight * Hindsight * Foresight * Short-sight * Oversight * Outsight	* Using experiential knowledge * Anticipating and projecting “senses” into the future * Knowing more than you can tell (tacit knowledge) and tell others what you know (explicit knowledge) * Identifying discernment or long-range proactive plans * Identifying unintentional omissions, mistakes (overestimation or underestimation of opportunities) Thinking outside the box—respond to evolving and novel situations.

Table 2. Sensemaking Trainability Factors at the Organizational (Social Level)

Attribute	Attribute Description	Sample Cognitive Trainability Factors
Shared understanding	* Common picture * Context alignment or shared goal * Degree of shared knowledge	* The content (what they work on) * The process (how they work together) * Role (who they work with)
Sense giving	* Influence on each other * Shared sense and perception	* Common sensemaking patterns over a long time period * Common frame of reference * Interpersonal connections * Interpretive roles
Trust	* Familiarity of team members * Belief differences	* Viewpoint compression * Common negotiation metric * Bias minimization

	* Viewpoint differences *Differences in aspiration levels * Integrity of team members	* Reliability of team members with respect to information sharing
Communication	* Information sharing * Idea sharing	* Making tacit knowledge explicit * Frequency of communication * Willingness to share information
Organizational Factors	* Organizational design (e.g. hierarchy versus distributive) * Influence * Power structure * Culture.	* Status quo versus change * Group value optimization * Ambidexterity * Interpersonal sensitivity.

Table 3. Sensemaking Trainability Factors at the Ecological Level

Attribute	Attribute Description	Sample Cognitive Trainability Factors
Awareness	* Situation awareness * Self awareness * Organizational awareness	* Recognizing what is around you * Seeing things in individual, cultural and group lenses * Influence of organizational rules, doctrines, standard operating procedures
Spatio-temporal Factor	* Location of information (objects, events, activities) * Time * Field effects or ecological niches	* Recognizing changes and dynamicity * Synchronous versus asynchronous behaviors and actions * Synchronizing time and events based on changing goals
System edge, boundary, and constraints	* Complexity of problem representation (scales and dimensions) * Agitation in system structure and functionality * Chaos—evolutionary changes from states of order to disorders * Entropy—friction during mass-energy exchanges at different levels of system structure or information abstraction * Control structure to avoid traps of instability.	* Understanding problem environment (situation, context) * Terrain objects (e.g., topographical features in an urban environment) * Interaction modalities with multi-heterogeneous entities /agents * Cause-effect analysis: effect-based operations (determining causes, resources to deliver deterrent, and analysis of effects)—in the form of means-end analysis * Recognizing speed of change (direction, location, time) in system so as to enable rapid constructability * Differentiating between order and periodic change * Recognizing “things” that evolve versus simple disorder caused by changes * Transferring knowledge about known situations to knowable, complex, and chaotic situations

		(Kurtz & Snowben , 2003) * Recognizing general and/or specific emergent properties * Recognizing uncertainty versus ambiguity * Recognizing randomness versus agitation that has predictable sequence.

4. ELOBORATION ON KEY SENSEMAKING TRAINABILITY FACTORS

Given the sample STF in Tables 1-3, let us give a anecdotal summary of the important factors relevant to designing experimental training system for sensemakers.

4.1 Critical thinking

Critical thinking is defined as a structured process involving reasonable and reflective thinking about ideas, concepts and beliefs focused on finding the truth; critical thinking usually occur at the personal or individual level, although, team-based trainings today emphasize team critical thinking—thus, the evolution from the cognitively personalized tacit knowledge level to social level of building knowledge from a group of people who may have different frames of mind about how they think. Critical thinking (CT) is also described as "thinking about thinking" or "thinking out of the box." CT requires the thinker to reason, conceptualize, analyze, and conduct mental simulation based on tacitly held knowledge. Sometimes, thinking is usually attributed to expertise—in which case, the thinker reflects upon the matter in question based on retrospective knowledge. *"To think of a thing is just to be conscious of it in any way whatsoever" (Dewey,1939).*In critical thinking, the main object of knowledge is to recognize possibilities, alternatives, and decision making when the incumbent situation is no more relevant, or, when the problem to be solved has no "real quantifiable definition." In the military environment, officers receive critical thinking skill training so as to improve their decisions making abilities in asymmetric battlefields—coping with unexpected events and dealing with situations that need real-time adaptation. For this purpose, the military officer must be trained to recognize critical issues in a battle scenario—analyzing situational information and cues, interpreting events, and forming an understanding of the situation that will lead to action; the entire process leads to sensemaking. The trainability factors and the recipes for conceptual model of critical thinking are well discussed in the Army Research Institute project by Sharon Riedel (www.ari.army.mil)

4.2. Situation Understanding

Situation handling of the battlefield information requires a sensemaking process that can capture the dynamic, complex, and sometimes chaotic information properties of the battle system. This can be obtained through judicious combination of intuitive and analytical models to filter and fuse critical information from a variety of sources in near real-time. In this sense, Thomas, Clark and Gioia describe sensemaking as *"the reciprocal interaction of information seeking, meaning ascription, and action"* (1993). According Wiig (2002), sensemaking is summarizing ambiguous information in complex situations so as to provide multiple lenses of viewing the same problem in different contexts. For example, the battlespace visualization process consists of understanding the battlespace in terms of different levels of thinking. *Commander's visualization is the mental process of developing situational understanding, determining a desired end state, and envisioning how to move the force from its current state to that end state.(FM3-0 Full Spectrum Operations (Draft Jun 06).* As alluded to by Delvin (2001)

people move from order to chaos and back in making their worlds, and consequently *"… it may be more powerful to conceptualize human beings not as information seeking and finding, but as information designing" (p. 7).*

4.3 Situation Awareness

Endsley (1995) defines situation awareness (SA) as the perception of the elements in the environment within a volume of time and space, the comprehension of their meaning, and the projection of their status in the near future. SA is identified to occur at three levels:

- *Level 1 Situation Awareness*: perception of the status, attributes, and dynamics of the individual task-relevant elements in the environment;
- *Level 2 Situation Awareness*: holistic comprehension of the current situation, based on a synthesis and understanding of these elements in light of one's goals; and
- *Level 3 Situation Awareness*: projection of the future actions of these elements in the environment, at least in the very near term.

Each of the levels identified above needs specific training requirements ((Ntuen, et al., 2004).

Sensemaking can be viewed as a sequence of situated acts supported by each of the levels of sensemaking above. Situatedness (Clancey, 1997; Suchman, 1987) holds that ***"where you are, when you do, what you do matters"***. Thus, situatedness is concerned with locating everything in a context so that the decisions that are taken are a function of both the situation and the way the situation in constructed or interpreted. Because situations may change over time, the cognitive processes required to adapt to such changes must be dynamic. This change is dependence on the constructive memory which holds that memory is not a static imprint of a sensory experience, but is subject to continuous changes due to new information stimuli (Dietrich and Markman, 2000). Situation recognition models as used for sensemaking can provide the characterizations of memorized events and are can be tested for memory recall when comparable situations are perceived. People possess large libraries in the form of schemas with tens of thousands of situation recognition models that incorporate encoded information of situations they have encountered in their life. These are essential training attributes used by the sensemakers at any levels—individual, social, and ecological.

4.4 Case-based Reasoning

In the sensemaking process, CBR is relevant from the point that, when confronted with a new novel situation, we look for the most similar features of the problem that has been encountered in the past. However, caution must be exercised. First, unless the past situation was judged to produce optimum effect, and unless the problem similarity between the past and the current have a high similarity metric, then it is likely that the past case may have little to offer. Second, new and novel problems may have features that lack specific solutions because of changes in information. Thus, the application of old and existing solutions remain speculative, and can be experimented through trial and error. In the CBR approach, we look back at reflexive knowledge, compare the decisions made in the past to the features of the present problem; we can also use the results from the past decisions to envision the possibilities of the future. As Hume (1748) succinctly observed:

> *"In reality, all arguments from experience are founded on the similarity which we discover among natural objects, and by which we are induced to expect effects similar to those which we have found to follow from such objects…From causes which appear similar we expect similar effects. This is the sum of all our experimental conclusions."*

In general, then, case-based sensemakers may tend to behave as if they know certain rules for the problem. Note that the cases are known by the decision makers and make sense if he or

she was involved in the previous decision making that led to the case-based knowledge base. On the other hand, similarity functions are rarely known before hand. Similarity function can be determined descriptively of normatively. People can be trained to be proficient in determining similarity functions in a web of information or database.

4.5 Knowledge Discovery

Extracting information and knowledge contained in heterogeneous data is a difficult problem, especially when the systems that generate the data are dynamic. Knowledge discovery (KD) is the process of identifying valid and potentially useful information and knowledge through understandable patterns. Data mining is one possible tool for KD. Thus, sensemakers will improve the KD ability in dynamic situations if they receive some training—framing from the first principle, that every person is an intuitive statistician (Peterson, 1967). Here, computer-based training with embedded sensemaking support system can be useful. As noted by Wong and Wang (2003),

> *"The speed of the pattern and rule extraction process is often crucial to a decision making process. This is true, not only because of the imminent response often required for a quick decision , but also that interactive processes are often needed in the incremental information and knowledge extraction process for a comprehensive decision…. In many situations, based on what they learn or discover from the explicit patterns displayed on the screen, they could make a judicial decision or they may like to look further into the data to discover more supporting evidences (pp.115)"*.

KD can take place in many ways. Our interview with commanders returning from Afaghistan and Iraq conflicts in the summer of 2006 made it clear that pattern recognition (or pattern discovery) and link analysis are very important in adaptive sensemaking situations. Both pattern recognition and link analysis, although representing individual (cognitive) heuristics, are able to discover, in an unbiased and exhaustive manner, statistically significant events or data associations (known as high order patterns) automatically, and can be used to generate from them decision rules, classificatory modules for categorization, classification, prediction, and forecasting. It can also discover multiple explicit patterns using unique features. Both techniques can be trained to enable the sensemakers to make use of their cognitive maps—an individual (or group) representation of a situation in terms of a set of assumptions and beliefs that resides deep within either the individual or the organization (through memetic footprints defined by its culture and influences)

4.6 Adaptive Mind Sets and Ambidexterity

Leadership training model in complex adaptive organizations must adopt ambidexterity stance where agility, adaptation, and flexibility are norms rather than exceptions. These leaders adapt to changes in day-to-day activities orchestrated by the dynamics of the system. The ambidextrous individuals are multi-taskers with the capability to response to uneventful conditions taking place at various locations of the organization—including external noise. Ambidexterity is also defined by the ability of the leader to envision multiple opportunities and prioritize the ones relevant to problem contexts. The case of Hurricane Katrina revealed the characteristics of FEMA leaders who obviously were not ambidextrous, at the same time, lacked what it takes to manage organizational chaos. The leader is flexible in using judgment while making important policy decisions while maintaining a balance between human side and business side—a distinctive, yet many embedded elements of command and control (C2) bounded by organizational rules and procedures. Again, the Hurricane Katrina case revealed a complete lack of common characteristics of ambidextrous individuals---in this case, lacked of initiatives and independent judgment, did not seek for opportunities, could not build consensus and linkages

among all the C2 players, and could not perform designated task without directives. Thinking out of box, is then, one way to describe the ambidextrous leader.

Training mind sets for dynamically changing organizations are important. In this respect, Gosling and Mintzberg (2003) suggest five "mind-sets" relevant to leadership training for sensemaking tasks. These are:

- The reflexive mind-set: This imparts to the leaders the recognition for, and development of rules based on experience, lessons-learned, and the understanding of the implications of past events. Gosling and Mintzberg quipped that *"Unless the [this] meaning is understood, managing is mindless (pp 57)."*
- The analytic mind-set: This is to equip the leaders with the tools to deal with complexity by using the characteristics of organization structure to provide a shared understanding of a larger system goal through a common language or lexicon which itself is simple to describe organizational goals vertically and horizontally.
- The worldly mind-set: This is to teach leadership with recognizing the world of knowing stratification according to Popper (1972). Popper identified three classes of knowledge: World One is defined as the world of physics –the world of physical objects and forces that can be objectively measured and defined. This corresponds to the physical structure of terrain and geospatial maps. World Two refers to the psychological world of the individual –the personal world of feelings, dispositions to act, and all kinds of subjective experiences. This corresponds to the symbolic information processing—signals, signs, and symbols. Finally, World Three refers to the conceptual products of the human minds. This corresponds to the cognitive information processing.
- The collaborative mind-set: Leaders work with people—a constellation of many diverse communities—stakeholders, subordinates, and so on. The core of C2 is working with people and technology. This is the level of organizational or social sensemaking.
- The action mind-set: Actions in today's competitive business environment have to be agile and resilient to achieve the desired effect. That means that time is the arbiter of the success, and planning and action must co-exist—a paradigm of Plan-as-you-execute (PAYE)" developed by Ntuen (2006).The sensemakers must recognize changes in a spatio-temporal environment and develop appropriate actions for those changes.

4.7. Event Anticipation

One way to train sensemaking tasks is according to their degree of event novelty or complexity Three broad areas along a continuum of familiar to complex can be identified (Vincente & Rasmussen, 1992; pp. 589):

1) Familiar events are routine in that operators experience them frequently. As a result of considerable amount of experience and training, operators have acquired the skills required to deal with these events.
2) Unfamiliar, but anticipated events occur infrequently and thus operators will not have a great deal of experience to rely on. However, the events can be anticipated the operators.
3) Unfamiliar and unanticipated are also unfamiliar to operators because they rarely occur.

Other system typologies that support different training design is given in the Cynefin model (Kurtz & Snowben, 2003) which classify events in four dimensions of known, knowable, complex, and chaos. Chaos is the superset of other dimensions since we can reduce chaos to any of the other levels through dynamic training designs. Chaos can encompass that which is unplanned or does not conform to plan, plans that go wildly astray, tight deadlines, understaffed environments, runaway costs, critical system failures, and similar situations generally considered negative. Chaos, in one simple definition, is the opposite of order—or, at least, it doesn't show any obvious order or structure.

4.8. Training Social and Team Sensemaking

Shared understanding of team members facilitates working and interacting effectively and efficiently. Interacting effectively and efficiently is possible when the group members use the same symbols and assign the same meanings to those symbols in their interaction processes. Communal sensemaking creates alignment and generic understanding. Alignment suggests a more varied set of inputs than sharing. As Weick notes, (1995), incongruity in organizations is the basis for sensemaking occasions. Training should be developed to create visions to each person's understanding of the strategic choices in the organization. The process of communal sensemaking is therefore one of co-determination, free of direct attempts at influencing, and creating alignment out of conflicting and competing actions and cognitions. Some of the performance metrics include, e.g., social climate and strength of relationship, and degree of shared knowledge. For example, the creation and interpretation of knowledge is inherently a social process.

4.9 Training for Sensegiving

The military commanders are responsible for generating and shaping the military decision making process (MDMP) as well as executing and enacting actions in a dynamic manner. This process occurs at three primary phases: strategic, tactical, and operational. Thus, both senior and middle management of battle planning personnel are engaged in sensegiving and sensemaking activities that influence and shape innovations in strategy, operation, and tactics of the warfare (Floyd and Wooldridge 1992). A commander and his staff have to use whatever information is available to arrive at an understanding of the situation that can serve as a basis for action, hence sensemaking has a central role in the C2 process—especially the aspect of sensegiving , which is otherwise known as imparting presence (Shattuck, 1992). The purpose of training may consist of: (a) an attempt to influence the battlestaff perceptions of a new planning process; (b) understand a change or innovation in strategy, operation, or tactics; (c) decode, integrate, and understand multi-sources of information located in distributed network-centric C2 centers.

5. DISCUSSION AND CONCLUSION

This paper has presented theories, methods, and sensemaking trainability factors that are useful for developing training tools to support sensemaking tasks. We present a three-tier level of sensemaking hierarchy—individual, social, and ecological, respectively. At each level, we show some of the fundamental knowledge attributes, their constituent descriptions, and the sample cognitive trainability factors associated to them. It is hypothesized that sensemaking training factors are at the cognitive level, even though sensemaking process may occur concurrently or separately at the individual, social, and ecological levels. The requirements germane for training consist of how individuals and teams recognize and make use of their "sightful" knowledge, such as, insight, hindsight, foresight, oversight, and short-sight, respectively. Sample trainability factors germane to training sensemaking tasks have been identified. These include, e.g., link analysis, pattern recognition, case-based reasoning, knowledge discovery, knowledge reuse, situation awareness, and knowledge sharing. These are most mentioned deficit in the sensemaking needs identified by commanders during interviews with commanders returning from Iraq in Fort Leavenworth, Kansas, during the summer of 2006.

Relevance to the Army

Sensemaking training is important in the net-centric battlefield C2 which is characterized by real-time, complex, and adaptive information. The issues of common operating picture, shared knowledge, and self-awareness (individual tacit knowledge) must be reconciled through training. This framework will support training individual soldiers, teams (platoons, units), and leadership (commanders) to acquire agility, adaptively, and flexibility in both sensemaking and decision making in battlefield situations that are subject to agitations and chaos.

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