KNOWLEDGE MANAGEMENT FOR COMMAND AND CONTROL

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Topics of the symposium to which this paper pertains are as follows:

1. C2 Decision Making and Cognitive Analysis
2. C2 Assessment Tools and Metrics
3. Network Centric Operations Transformation
Abstract

This paper highlights some major trends and developments in knowledge management with particular emphasis on the software that resulted from the DARPA Rapid Knowledge Formation (RKF) program, and how this technology can be combined with intelligent agents to produce advanced capabilities for command and control systems. Past trends, present accomplishments and future work in knowledge management systems are covered. We also describe an in-house effort to accumulate, validate, and integrate the results of this program with a view toward the recommendation of specific technologies for transition to operational command centers. The objective of the RKF effort was to enable distributed teams of subject matter experts (SMEs) to enter and modify knowledge directly and easily, without the need for specialized training in knowledge representation, acquisition, or manipulation. The resulting knowledge bases (KBs) and the tools that manage them are recommended for transition into operational command centers and can be made available to provide specific answers to questions and could be applied in many different command- and intelligence-related problem-solving situations. This technology will permit scientific, technical, and military experts, such as command-center and intelligence-center personnel to encode massive amounts of knowledge into reusable knowledge bases for application in many different tasks. Further research is planned in the area of ontologies, expert systems, knowledge management, intelligent agents and user-interfaces for SMEs under this program.

The paper is organized as follows. Section I introduces some facts and observations about knowledge management and its benefit to command and control. Section II summarizes some of the most successful technologies of the RKF program. Section III describes the SSC-SD in-house RKF integration effort. Section IV describes intelligent agent technology to manage knowledge in a command-and-control environment. Section V describes directions for future research.

Knowledge has been defined as “an evolving mix of framed experience, values, contextual information and expert insight that provides a framework for evaluating and incorporating new ideas and information.” Knowledge management is the process or creating value through the organizational integration of the knowledge in the organization. Knowledge management concerns knowledge bases (KBs) and much more. One type of a knowledge base is a state of information that consists of a collection of rules, axioms or assertions structured according to an ontology and a knowledge representation that allows knowledge to be stored explicitly, and from which conclusions can be drawn using an inference engine. Another type of knowledge base is a structured acyclic graph, such as a Bayesian network that stores knowledge in its structure and in its associated conditional probability table. The discussion on knowledge bases in this paper is limited to the first type of knowledge base. During the 1970s there was a certain advantage to having a computer. Today it is a necessity. During the 1980s, it was advantageous to have a database management system. Nowadays, it is a necessity. Today, the advantages of knowledge-based systems grow with each new application. In the future, knowledge management systems (KMSs) and knowledge-based systems such as RKF will become necessities. Many facts that apply to database systems also apply to knowledge-based systems. In terms of theoretical understanding and technological maturity, knowledge management is today where database management was 25 years ago. Given that this is the case, we can exploit some of the trends in knowledge management to enhance the single integrated picture.
sometimes called the common-operating picture) in command and intelligence centers. The ultimate goal is to improve the performance of command and intelligence center personnel at multiple levels.

Specific technologies that will be useful to improve command-and-control capabilities include but are not limited to:

• enhancement of a knowledge-authoring system that includes integrated technologies,
• novel knowledge-base access such as sketching and mapping techniques,
• knowledge-base analysis and structure improvement using knowledge clustering techniques,
• use of partitioning methods to improve query response time and error detection,
• automation of logical explanations of query results,
• intelligent agents for knowledge management,
• use-case development for testing the technology,
• distributed knowledge-base connectivity for group collaboration

RKF technologies are recommended for transition into operational C2 systems for the following reasons: • Manuals, software licenses, and a video are available.
• SHAKEN Knowledge-Authoring System, by SRI International. SHAKEN has multiple knowledge acquisition and reasoning paradigms.
• Natural-language sketch and graphical knowledge entry with logic, simulation, pattern analogy, and spatial reasoning capabilities are among the diverse features of SHAKEN.
• Integrated knowledge-base diagnostics are used for trust analysis and knowledge-base improvement.
• Technology provides pedigree information and explanation of the reasoning process behind the system’s answers and pattern features.

Future research in the area of intelligent agents needs to concentrate on reducing the workload and improving the performance efficiency of command-center personnel.

Operational military transition efforts for SHAKEN have taken the form of a proposal to JFCOM to provide tools for interoperable, collaborative knowledge support. Experts in an intelligence center have identified training as their most significant problem. SHAKEN has direct applications in command and intelligence centers as a training tool. Military experts can capture their knowledge in the knowledge base before they rotate. New personnel can use learned skills quickly and reduce errors with SHAKEN. Future work on various aspects of SHAKEN is required to fit the software to command-center environments. For example, in the area of sketching tools for SHAKEN, future improvements include the following enhancements.

1. More battlespace reasoning needs to be built into the sketching tools. This includes improved pathfinding, combat-power calculations, integrating our detailed trafficability domain theory, etc. This will provide the knowledge infrastructure for additional support tools that our military uses have requested.

2. Integration with sources of real-time data feeds, such as simulations, and the ability to communicate with wargames.

3. The current enemy-intent hypothesis system must be improved in several ways. For example, more battlespace reasoning is needed to construct better explanations about why actions in a precedent worked, and hence improve the accuracy of the hypothesized actions.