Collaboration in Command and Control Environments: Exchanging Iconic Tags of Key Information

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Abstract

In network centric environments, team decision making and situation assessment are distributed in both time and space. Shared understanding among team members with regard to the impact, importance, and quality of relevant information items (e.g., sensor outputs, text documents, images, message traffic, web pages) is a critical element in the selection of an effective course of action. Here, we focus on the issues of (1) what is the minimum information that needs to be exchanged for shared understanding to occur, (2) how do we capture that information and (3) how should it best be displayed? Distributed teams that communicate asynchronously require a knowledge management plug-in tool that will convert, encapsulate, and tag a group member's subjective understanding of a complex information item into an iconic representation that represents various information parameters. Icons can be automatically generated from an abstraction template completed by a team member for each decision-relevant information item. These tags can then easily be electronically exchanged among the team, improving shared understanding, consensus building, and information fusion among group members and significantly reducing the valuable decision time typically consumed by conflict resolution.

1 Introduction

Command and control technology has created distributed military organizations, where the common operational picture and commander's intent can be operationally understood throughout the chain of command. Simultaneously, defence transformation has put a new emphasis on the use of quick-response, agile, coalition or joint force response teams. Team knowledge processing has not kept pace with the cognitive overload created by massive sensor and tactical information distribution. The Office of Naval Research, with assistance from the Space and Naval Warfare Systems Center, seeks innovative new human-centric knowledge processing tools to collect, fuse and analyze uncertain, and often subjective multi-source information. This innovation must be able to summarize, share and display multi-source information at the speed of command in a usable format. The objective is to improve decision time by reducing the time and effort devoted to conflict resolution and consensus building for tactical or strategic course of action selection. This paper reports on the development of a cognitive processing-based tool that may improve the ability of both individual and distributed group participants to evaluate, share, and integrate relevant information items in reaching an overall course of action decision.

2 Background

As military command and control operations become more global and more network centric, collaborative environments for military group decision making will become increasingly more distributed in both place and time. The traditional face-to-face meeting has been replaced by asynchronous collaboration where the group decision-makers are located in different regions and with differing time-availability considerations. A significant consequence of this is that much of the decision-relevant information is also distributed across the participants. Because of their location, previous experiences, and differing access to information and sources, each participant has uniquely held information items that can significantly impact the decision making process. Uniquely-held

information can only impact the group decision if it can be reviewed, evaluated and integrated by other team members.

The work of Stasser and his associates (Stasser & Titus, 1985; Wittenbaum & Stasser, 1996; Wittenbaum, 1998) have clearly shown two significant problems in dealing with uniquely held information. The first is that participants are very poor at sharing their uniquely held information, even though it may have a significant influence on the final decision. They do not intentionally hide the information, group discussions center on the commonly held shared information, and due to time constraints, the uniquely held information is not shared. Second, even if one can devise a way to share this uniquely held information, it is often discounted by the group and will not impact the final decision. This later phenomenon is discussed by Dennis (1996) in an article aptly entitled "You Can Lead a Group to Information but You Can't Make It Think." A more complete review of this literature has been reported by Fleming & Kaiwi (2002).

3 Approach

Shared understanding among team members with regard to the impact, importance, and quality of relevant information items (e.g., sensor outputs, text documents, images, message traffic, web pages) is necessary in the selection of an effective course of action. We hypothesize that uniquely held information is not shared because it increases the cognitive burden of the recipient. In a distributed group decision making environment, each team member must collect, analyze and integrate their own information. Processing information sent by another is an additional cognitive burden. It is likely to be ignored simply because the recipient does not have the time to analyze and integrate other's information. This is unfortunate, because this information has already been analyzed and evaluated by the sender.

3.1 A knowledge management tool

A knowledge management tool is needed that is sensitive to the cognitive burden of the recipients in the collaborative environment. The following questions must be considered: (1) What is the minimum information that needs to be exchanged for shared understanding to occur, (2) how do we capture that information, and (3) how should it best be displayed? Distributed teams that communicate asynchronously require a knowledge management plug-in tool that will convert, encapsulate, and tag a group member's subjective understanding of a complex information item into an iconic representation that represent various information parameters.

3.2 Information objects (IOBS)

These icons are referred to as Information Objects (IOBs) and are automatically generated from an abstraction template completed by a team member for each decision-relevant or key information item. These IOBs can then easily be electronically exchanged among the team, improving shared understanding, consensus building, and information fusion among group members and significantly reducing the valuable decision time typically consumed by conflict resolution.

The use of IOBs enhance both team and individual decision making. Individual military decision makers, both in an operational and intelligence environment, are required to fuse many information items that differ in quality, timeliness, impact and importance. The creation and display of IOBs from the initial examination of the information item leaves a permanent, accurate record that is not subject to the limitations of human memory. When a decision is required, this pool of icons becomes available for overall assessments, with each contributing information item still retaining and displaying its distinct information relevance. Just as tactical symbology encapsulates the complex output of remote sensors, IOBs encapsulate the content of complex documents, web pages, images, and reports. Preliminary evaluation of this display concept has shown improved accuracy and speed of situation assessment in decision-making (Fleming, 2003; Fleming & Cowen, 2004).

3.2.1 Identification of key information

Fleming (2003) provides steps to help determine which information should be retained and tagged:

1. Is the item relevant? Specifically, does it relate to one of the decision criterion?
2. It is a usable item? This addresses the quality of the information, such as the source credibility, the timeliness of the information and the confidence in the accuracy of the information.
3. What does the content imply? This addresses both the direction and degree of effect of the information content. Does it have a positive or negative effect (direction) on the criterion and how strong is this effect (degree)?
4. How important is this item? This factor addresses the relative importance of this item compared with other items that have been retained for this criterion. It is usually determined by a subjective composite of information quality and content.

The above subjective parameters are implicitly assigned to the retained information as part of our internal cognitive process. An IOB is created when these parameters are explicitly attached to the information. Using a knowledge elicitation template, we can quantitatively assign a score to each parameter. For example, a subjective perception that "this information has high source credibility" is tagged as "high" on the "high-low" source credibility continuum displayed to the decision maker. We define an IOB as tag that contains a quantitative assessment about a participant's subjective impression of a piece of information.

3.2.2 Iconic tagging of key information

If we are going to ask participants to create IOBs, it must exert a minimum burden so that its cognitive cost does not exceed any benefits it may bring to the decision process. The IOB template (see Figure 1) needs to be simple, easy to learn and user friendly.

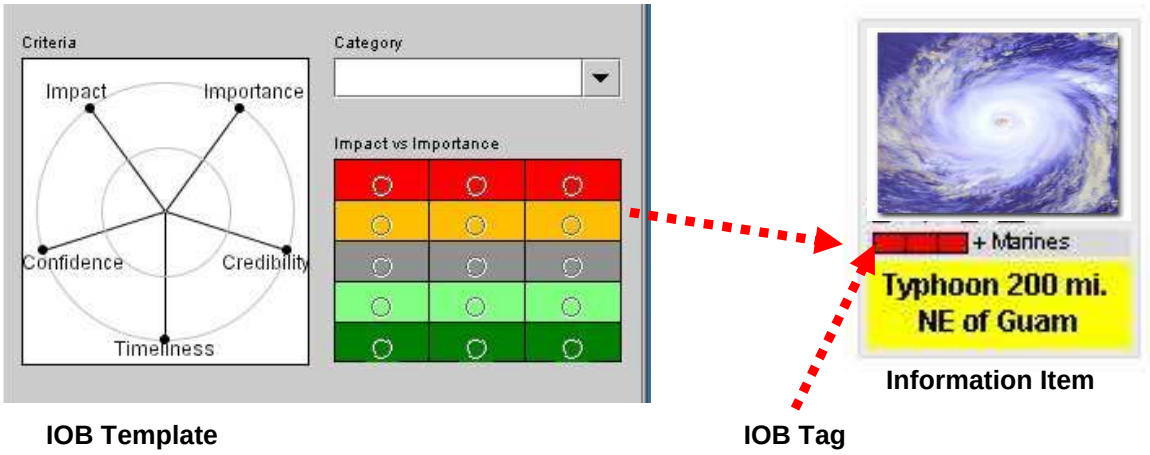

***Figure 1**: IOB Template and IOB Tag.*

In the above example, participants need to make a decision about using the Marines to rescue refugees off the coast of Guam. Current information was found on the National Weather Service's web site showing a photo of a typhoon 200 miles northeast of Guam. The wagon wheel section of the template is where the participant enters his marks for the various information parameters. The three spokes on the bottom indicate information quality: **Credibility** of source, **Timeliness** of the information, and **Confidence** in the accuracy or logic of the information. The participant evaluates the information by moving the dot on the spoke, where the outer ring represents high quality and the center of the wheel represents low quality. The two spokes on the top represent **Impact** and **Importance** of the information, relative to the decision category or option (in this case using the Marines): Does this information support using the Marines to rescue the refugees? Is this information relatively more important to other information items? Again, the participant evaluates impact and importance by moving the dot on the spoke, where the outer ring represents strong positive support or very high importance and the center of the wheel is for marks of low importance or information that is counter to using the option.

Since impact and importance are more critical parameters in making a decision, the template double codes those parameters in the 15 cell red-to-green table, next to the wagon wheel. This "Impact vs. Importance" display

represents impact using the "traffic light" metaphor and importance using the "power bar" metaphor as shown in Figure 2. After the participant completes the template, the information is tagged with a row from the "Impact vs. Importance" display (see Figure 1). A "+" sign after the row indicates that participant move the dots to the outer rings for **Credibility**, **Timeliness**, and **Confidence**. In other words, the quality of the information was high. Going back to our example, the typhoon information was tagged as highly important information of high quality against using the Marines to rescue refugees.

***Figure 2**: Levels of impact and importance parameters.*

4 Results and discussion

An experiment that evaluated the use of IOBs in an individual decision making environment was conducted at Colorado State University. It is important to first demonstrate that IOBs can improve individual decision making as a prerequisite for improved group decision making. Participants were tasked to rank companies as investment opportunities given reports about the financial health of each company. We addressed the following question: Do participants who tag information using our template make better decisions than those who do not tag the same information?

The participants were 36 students from Colorado State University (CSU). They were asked to participate as part of a classroom requirement. All the participants were trained on how to create and use IOBs to tag electronic information such as a web report or graph. The participants were tested individually in CSU's Computer Information Systems Laboratory. Each participant received the same stimuli (i.e., electronic reports). Once the participants logged-on, an instructional page appeared tasking them to rank three generic companies as the best, middle, or worst investment. Participants were provided electronic reports about each company's profits, workforce, leadership, and business markets. Participants had the option of using IOBs to help them deal with the electronic reports and the final rank ordering of the three companies. This rank ordering task is part of a known case study taught at the Colorado State University, College of Business and the companies, given the financial reports provided, were ranked a priori based on a previous factual study.

Unfortunately, most of the participants did not opt to use IOBs: Only 15 of the 36 students chose to use IOBs as part of their decision making process. However, when IOBs were utilized, better decisions were made. Those who used the IOBs were about 20 percent more likely to rank the best company (as determined a priori by experts) as their first choice. It is clear that tagging the reports was helpful. Our results lend support to the belief that IOBs can improve individual decision making performance for a relatively simple ranking task. Improved performance could also be attributed to increased attention on each electronic report afforded by the tagging process, and our future experimental designs will need to account for attention effects. Future studies will also increase the complexity of the scenario and will involve the sharing of the IOB tags among distributed participants.

5 Summary

A prototype decision support and knowledge sharing tool is being developed that can be plugged into existing off-the-shelf military asynchronous collaborative environments. This application provides the capability to easily create and exchange tags about a participant's subjective impression of information items. We described formalized process for abstracting, quantifying, displaying, and sharing these subjective assessments, which may be useful for simplified conflict resolution, consensus building and decision making. In the future we will test various tool design

features (e.g., sorting, tagging, icon sizes, shapes and colors) in an effort to improve decision making within distributed military teams.

6 References

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