Information Overload in the Digital Army: Simulator-based Training for Prevention, Detection & Cure

Jared T. Freeman, Ph.D.*, Marvin S. Cohen, Ph.D.* & Daniel Serfaty** [1]
* Cognitive Technologies, Inc.
4200 Lorcom Lane, Arlington, VA 22207
(703-524-4331) **cti@access.digex.net**
** Aptima
25 Burlington Mall Road, Suite 300, Burlington, MA 01803
(617-270-0613) **serfaty@aptima.com**

Abstract

Recent field studies and training experiments suggest that military teams can learn to operate effectively when the volume of data is quite high. We describe STIM (Staff Trainer for Information Management), a networked, simulator-based team training system that will help Army staff officers to prevent, detect and cure information overload. STIM will train officers 1) to make and interpret periodic situation updates, 2) to think critically about specific aspects of assessments and plans, 3) to detect symptoms of information overload, and 4) to adapt their methods of decision-making and communication as information load increases. The empirical basis for the training is presented, as is a description of the interface and real-time, automated functions for assessing a staff's ability to filter, interpret and communicate information under varied information loads.

1. Introduction

The digitization of the battlefield is promoted with the vision that soldiers will become messengers of opportunity, reporting quickly and precisely the events they perceive. The resulting data stream will make commanders and their staff knowledge rich, allowing them to achieve dominant battlefield awareness and to project force at a rapid tempo wherever and whenever it is needed.

Increased information flow may be necessary to ensure victory in future battles, but it is not sufficient, nor is it risk-free. As information flow increases, staff may drown in data while their commanders thirst for information; decisions may be made poorly, late or not at all. One analyst put the problem in this way:

> *While up-to-date technical means of communication and data processing are absolutely vital to the conduct of modern war in all its forms, they will not in themselves suffice for the creation of a functioning command system, and they may, if understanding and proper usage are not achieved, constitute part of the disease they are supposed to cure. [van Creveld, 1985]*

Conditions in Desert Storm were ripe for the spread of this malady. Consider the reported case (possibly apocryphal) of the Joint Forces commander who received 1.3 million messages within 24 hours. The campaign was a success, but perhaps in spite of the volume of information exchanged, not because of it. Recent exercises by the Army's

[1] This research was performed under contract to U.S. Army Research Institute for the Behavioral and Social Sciences (ARI) Armored Forces Research Unit at Ft. Knox, KY., contract Number: #DASW01-97-C-0015. The opinions expressed in this paper are solely those of the authors and do not necessarily reflect the views of the Department of the Army.

Experimental Forces testing Force XXI equipment and procedures also have highlighted the burden that larger data streams place on command staff.

Good software tools (such as automated filters, data fusion systems and decision aids) can help alleviate the problem, but they are not enough, particularly given the current state of technology. It is necessary also to train staff officers to manage massive data streams.

2. Theoretical & empirical foundations

Recent field studies and training experiments suggest that military teams can learn to operate effectively when the volume of data is quite high.

Having observed that commanders of outstanding Navy staff issued periodic briefs concerning their tactical priorities [Serfaty, et al., 1994], Serfaty and colleagues tested training that consisted of lessons on the use of such briefs, as well as instruction concerning the symptoms of information overload and various supportive communications and time-management skills. Performance on a range of outcome and process measures improved by an average of 21% with training, and was better after training under high stress than before training under low stress [Entin, et al., 1994].

Cohen and colleagues have conducted studies of how officers formulate and critique assessments and plans given data that are plentiful but nonetheless conflicted and incomplete. They found that experienced officers often go beyond pattern recognition to develop nuanced, well-critiqued causal models of events [Cohen, et al., 1996]. The researchers applied this finding to train Army and Navy staffs in specific critical thinking skills [Freeman and Cohen, 1994 & 1996; Cohen, et al., in press]. The training reliably improved the accuracy of officers' assessment of complex tactical situations, increased contingency planning, and boosted confidence in decisions. It also improved indicators of decision-making skill, including the variety of issues addressed, the number of arguments generated to defend and refute assessments, and the number of alternative assessments considered. Current studies by Cohen and Freeman integrate situation updates and critical thinking skills into a single training regimen. The initial results are positive.

Why is this training beneficial? The principle challenges in data-rich environments are to search efficiently (a top-down, goal-driven process) while still recognizing unexpected but interesting events (a bottom-up, data-driven process). Situation updates convey explicit search criteria, and critical thinking skills help officers to infer additional search goals. The combination of the two may facilitate goal-driven filtering of large data streams. In addition, situation updates that explicitly present predictions (e.g., about enemy movement) and critical thinking skills that help officers to make those predictions should both prime recognition. Events that violate those predictions should be highly salient. That is, this training should help officers detect unexpected events earlier and more accurately.

3. The STIM training simulator

We predict that staff will be better able to prevent, detect and cure information overload by learning 1) to make and interpret periodic situation updates, 2) to think critically about specific aspects of assessments and plans, 3) to detect symptoms of information overload, and 4) to adapt their methods of decision-making and communication as information load increases. These are the core training concepts in a scenario-based, networked training simulator we are developing to aid U.S. Army battalion staff[2]. The device that presents this

[2] As of the submission date of this paper, a demonstration version of the system was being completed to be tested with battalion staff in spring of 1997.

training and tests staff skills is called STIM (Staff Trainer for Information Management).

STIM will present each lesson in four multimedia segments: explicit instruction, demonstration (typically in annotated storyboard form on the simulator's multi-media interface), practice on short but complex scenarios and feedback modeled after the U.S. Army's after-action-reviews (including team self-critiques, automated assessment by the system and recommendations for improving performance).

Like other staff training systems, such as BDM's sophisticated Staff Group Trainer, STIM will present a large and rich stream of messages[3] to key members of a battalion staff (the S1, S2, S3, S4 and CO). The incoming message stream is entirely textual. Staff will be expected to interpret messages and to communicate critical information up the chain of command, out to the field and between themselves. Staff will interact with the system and each other entirely by creating structured and unstructured (free-text) messages. The tool for creating structured messages is essentially a CAD system for representing arguments plus email facilities for distributing officers' messages.

Officers construct node-link graphs using a simple template of components. (These components are adapted from Toulmin's [Toulmin 1958; Toulmin, et al, 1984] studies of argument across disciplines). In their messages, officers will specify evidence supporting and refuting a conclusion. Evidence nodes in the message graph can contain free text or material dragged from the incoming message stream or a database of briefing and reference materials. Each evidence node must be linked to a conclusion with arcs that indicate a supporting or refuting relationship. Refuting evidence can be neutralized by linking it to other evidence or assumptions that describes exception conditions, that is conditions that explain away the refuting evidence. The information needed to test assumptions can also be specified, as can contingency plans that protect against assumptions that cannot be tested. Evidence nodes are linked to a node that specifies the issue at hand (an element of a tactical plan, part of the C.O.'s assessment or a message requesting information) and the officer's conclusion concerning it. The conclusion can be entered as free text or as a selection among multiple choices.

Graphical message construction serves two purposes. First, it supports instruction concerning finding and handling conflicting evidence, incomplete information and unreliable assumptions. Second, it facilitates automated, real-time assessment of the staff's ability to apply these skills. Each of these three sources of uncertainty (conflict, gaps and unreliable assumptions) has a distinct structural form (a specific pattern of nodes and links) that the system can detect, and upon which it can base feedback, remedial training and scenario adaptation.

The assessment functions of STIM will also leverage real-time analysis of communications patterns. For example, Serfaty and colleagues found that training enabled officers to more frequently send appropriate information upward on their own initiative, rather than to await requests for information from above. STIM will be capable of detecting whether officers exhibit this and other patterns of communications.

STIM's assessment capabilities will also hinge on principled manipulations of the scenario message stream. To support testing and assessment of officers' critical thinking skills, the message stream will be intentionally incomplete, conflicted and designed to evoke

[3] We are indebted and to the BDM Federal, the U.S. Army Force XXI Training Program (funders) and the Army Research Institute (research directors and contract monitors) for providing us with scenarios with which to test STIM.

unreliable assumptions. To aid testing and assessment of communications patterns, the message stream will be seeded with explicit and implicit requests for information and actions, responses to some (but not all) of these requests, and instances of unrequested, unexpected informational messages and action reports from field officers.

In sum, the reliance on structured, graphical message construction, monitoring of communications patterns and strategically composed scenarios will enable STIM to assess critical thinking and communications skills among staff. In particular, the system will be capable of real-time, automated measurement of:

- the accuracy and timing of staff recommendations concerning implementation of commanders' plans and revisions to commanders' assessments;
- the quality of the evidence staff offer in support of their recommendations;
- the accuracy with which staff critique assessments and plans;
- the degree of consensus within staff concerning the accuracy of key aspects of the commanders' assessments;
- the ability of staff to adapt communications patterns under stress (for example, by initiating information push); and
- the ability of staff to coordinate their activities under stress (for example, by offloading work from other overburdened staff).

These and other real-time measures will drive algorithms that adapt the difficulty of the scenario to the individual and the team, and that generate formative and summary feedback similar in part to an after-action-review.

4. Conclusion

In sum, STIM represents several advances in training and assessment for military staff in the information age. First, it will extend successful training research that improves the ability of staff to filter and interpret information while under stress. Second, it will capitalize on the digital information environment by using the structure inherent a graphical message format to measure individual and team decision-making processes, as well as bottom-line accuracy in situation assessment and plan implementation. Third, STIM will support on-demand training for physically distributed staff, a valuable attribute in an era of rapid response and international staffing.

References

[Cohen, et al., 1996] Cohen, M.S., Freeman, J.T. and Wolf, S. (1996). Meta-recognition in time-stressed decision making: Recognizing, critiquing, and correcting. *Journal of the Human Factors and Ergonomics Society*.

[Cohen, et al., in press] Cohen, M.S., Freeman, J.T. and Thompson, B.T. (in press). Critical Thinking Skills in Tactical Decision Making: A Model and A Training Method. (Canon-Bowers, J. and E. Salas, eds.), *Decision-Making Under Stress: Implications for Training & Simulation*. Washington, DC: American Psychological Association Publications.

[Entin, et al., 1994] Entin, E., Serfaty, D, and Deckert, J.C. (1994). Team Adaptation and Coordination Training. (Technical report to U.S. Navy NAWC/TSD, Orlando, FL, Contract #N61339-91-C-0142). Burlington, MA: Alphatech.

[Freeman and Cohen, 1994] Freeman, J.T., and Cohen, M.S. (1994). Training metacognitive skills for situation assessment. *Proceedings of the 1994 Symposium on Command and Control Research and Decision Aids*, Monterey, California.

[Freeman and Cohen, 1996] Freeman, J.T., and Cohen, M.S. (1996). Training for complex decision-making: A test of

instruction based on the recognition/metacognition model. *Proceedings of the 1996 Command and Control Research and Technology Symposium*, Monterey, California.

[Serfaty, et al., 1994] Serfaty, D., Entin, E., Sovereign, M., Kemple, B. and Green, L. (1994). Team adaptation and coordination training. *Proceedings of the 1994 Symposium on Command and Control Research and Decision Aids*, Monterey, California.

[Toulmin, 1958] Toulmin, S. (1958). *The uses of argument*. Cambridge, UK: Cambridge University Press.

[Toulmin, et al., 1984] Toulmin, S., Rieke, and Janik. (1984). *An introduction to reasoning*. NY: MacMillan.

[van Creveld, 1985] van Creveld, M. (1985). *Command in War*. Cambridge, MA: Harvard University Press.