

How to Train Deployed Soldiers: New Advances in Interactive Multimedia Instruction

Lussier, James W., Shadrick, Scott B

U.S. Army Research Institute

Fort Knox, KY

james.lussier@knox.army.mil; scott.shadrick@knox.army.mil

ABSTRACT

A major goal of the Future Combat System of Systems (FCS) embedded-training strategy is to develop a training capability that provides accurate, timely, relevant, and affordable training in support of operational needs. Embedded training will lay the foundation for Unit of Action training. Four training modes have been identified for FCS embedded-training, including: simulation-supported live, virtual, and constructive training and computer-supported interactive courseware. The training modes will be employed at varying frequency depending upon whether a unit is deployed, at a combat training center, or at its homestation. The resource requirements of simulation-based training make it very difficult to employ during deployment. As a result only interactive courseware is expected to have a high level of usage during deployment.

The U.S. Army Research Institute for the Behavior and Social Sciences developed the Think Like a Commander (TLAC) training program to improve battlefield thinking skills in Army officers. The training uses a multimedia, vignette-based approach that can be easily adapted and updated to provide training on the most current tools, techniques, procedures, and lessons learned. The TLAC training has been successfully implemented in the Armor Captains Career Course and the resident phase of the Armor Captains Career Course for the Reserve Component at Fort Knox, KY. Recent advancements to the method have resulted in a version capable of supporting distributed training. An examination of the distributed methods with 36 captains revealed significant performance gains. An ongoing effort is developing a set of vignettes to allow small groups and teams to train multinational operations. The TLAC training method is presented as a model for the interactive courseware embedded training system and an efficient alternative to full-scale simulation-based training.

ABOUT THE AUTHORS

Dr. James Lussier has worked as a psychologist at the U.S. Army Research Institute since 1984, and currently works at the Fort Knox Field Unit. Research interests include command and control training, group planning and problem solving, and battlefield thinking skills. He received an A.B. degree in Psychology from Columbia University and a Ph.D. in Experimental Psychology at Fordham University. Dr. Lussier served with the U.S. Army as an interrogator with the XVIII Airborne Corps.

Mr. Scott Shadrick is a Research Psychologist at the U.S. Army Research Institute for the Behavior and Social Sciences, Fort Knox Field Unit. He has conducted research on computer-based learning, instructional design, learning systems design and evaluation, and leader development.

How to Train Deployed Soldiers: New Advances in Interactive Multimedia Instruction

Lussier, James W. & Shadrick, Scott B

U.S. Army Research Institute

Fort Knox, KY

james.lussier@knox.army.mil; scott.shadrick@knox.army.mil

The training deployed Soldiers receive – both pre-deployment and post-deployment – will certainly differ from that of Soldiers not facing a specific deployment. This paper considers two factors that will undoubtedly have significant effects on training activities – the capabilities available for deployed units as well as their more focused training needs. Future training capabilities, in particular the embedded simulation capability intended in the U.S. Army's Future Combat Systems (FCS) acquisition program, are considered with respect to the training of deployed units. We assess the role of a method of vignette-based training exemplified by the ARI-developed Think Like a Commander training, which has been successful in an institutional setting, to see how it transitions to deployed training conditions. The training method – which in the Think Like a Commander setting is focused on training adaptive thinking for tactical leaders – may provide a flexible tool to meet some key deployed training requirements. We also identify some key research challenges that will be important to insure deployed Soldiers receive quality training that is relevant and timely.

TRAINING AND PRACTICE

Whether one is concerned with the development of skilled behavior (e.g., aircraft piloting, gunnery) or with the development of expertise in a cognitive domain (e.g., command and staff decision making) the terms training and practice represent two distinct but often confused activities. Perhaps people confuse them so frequently because both usually involve task performance under real or simulated conditions and because both are significant components in gaining proficiency. Training activities are specifically intended to accomplish some significant change in the way a person performs a task – a change in the actual behaviors performed – to make the performance more effective or more in conformance with an expert's way of doing the task. Whether a cognitive or motor task, with good training the learners come to understand the steps of task performance and the manner, order, reason, purpose, etc. of the process of task performance. In performance-based training, they

perform the task, often under observation of a coach, while consciously attending to the elements of task performance to verify that they are performing them correctly. Performance measurement is focused on the process (Are the learners performing the task correctly?) rather than outcome (e.g., Are they performing it effectively?). With practice activities, however, the task is performed in the manner already known by the learners – they perform it in their usual way – but through repetition intend to ingrain the task, to make performance smoother and more automatic, to perform it under a variety of conditions, and to develop an ability to perform the task with little or no conscious attention. Coaching and instruction are less significant during practice activities, and performance measurement focuses on task outcome (speed, error rate, tactical success) rather than form or process.

Practice without training (probably not very different from what has been termed discovery learning) is not a very efficacious method, neither efficient nor ultimately effective. In most complex fields, for example, the relationship between performance levels and amount of experience is only reliably strong when considering the novice phase of skill development. In many fields, novices rise rapidly in skill and may, after a few days, a few months, or a few years, depending upon the nature of the domain, surpass very experienced 'old hands.' For example, in chess where there is a reliable performance-based measurement system, most amateur tournament players do not ever rise above the average United States Chess Federation rating of C player despite a lifetime of playing experience which provides extensive practice with clear outcome feedback, while many higher-rated players (A, B, Expert, and Master ratings) can be very young and comparatively less experienced. Typically, quality training and strong coaching can raise the performance even of highly experienced performers, although presumably the more ingrained behaviors are, the more resistant to training is performance. While we emphasize the importance of training we do not intend to slight the significance of practice. In the development of expertise in almost every field, training without sufficient practice produces as poor a result as practice without sufficient training.

SIMULATION-BASED TRAINING

The U.S. Army makes extensive use of tactical simulation in training activities, as do all the other military services, a necessity when wars are infrequent and dangerous. A familiar expression, ‘all but war is simulation,’ reflects the wide range of variation encompassed by the concept of simulation. At the most basic level, simulators can be classified into three general areas, constructive, virtual, and live. The distinction we made in the previous section between training and practice becomes especially clear when one considers war or other actual military operations. A war environment furnishes an excellent and effective (though unforgiving) practice ground but by its design is a rather poor place to train. Simulation technology – especially that intended for training – has made tremendous advances, offering unprecedented levels of realism, immersion, and fidelity. Unfortunately, the ability to use simulations for training in addition to practice has not kept pace. To insure quality training, the simulator must incorporate “specific key components based upon sound instructional principles” (Black, 1996, p 1). The significant components are: a.) identification of tasks, b.) presentation of enabling knowledge, c.) demonstration of how the task should be performed, d.) the opportunity for the trainee to perform the task, e.) provision for feedback to the trainee concerning task performance, and f.) the opportunity to practice task to mastery under increasingly difficult, but realistic conditions (Black & Quinkert, 1994; Black, 1996; Holding, 1965 as cited in Black, 1996). Other components of effective training that we would add to the list are an explicit description of elements that constitute correct performance of the task, performance measurement to assess whether the task is performed correctly, active and effective coaching, the opportunity for immediate repetition of poorly performed tasks, and a focus on tasks which are difficult, critical, or constitute areas of individual or collective weakness.

For many tasks the Army has had great success in developing simulation-based training approaches, two of many possible examples being aviation and tank gunnery. In part the reason for the success of such simulators as the Unit Conduct of Fire Trainer (UCOFT) is the adherence to the instructional principles listed above. Command and staff tactical training and the training of battle command skills have also made use of tactical engagement simulations in live (e.g., Combat Training Centers), virtual (e.g., Close Combat Tactical Trainer), and constructive (e.g., institutional JANUS exercises) modes but with less clear results. The difficulty no longer lies in the capability of the simulation to present a realistic

performance environment; rather the problem is insuring that the components of sound instruction identified above are present. Of the components of effective training listed in the preceding paragraph, tactical engagement simulations by themselves only truly enable the opportunity to perform and the opportunity to practice. Much additional exercise design work must be done to add the other components. Furthermore, the pace and complexity of exercises driven by tactical engagement simulations may often interfere with many key training components such as demonstration, measurement, feedback, immediate repetition, isolation of complex tasks, and focus on key tasks that occur infrequently.

EMBEDDED TRAINING CONCEPT

The training strategy for FCS relies heavily on the concept of embedded training. Indeed, it is one of the key performance parameters of the acquisition effort. Army planning documents describe embedded training (ET) as “a function hosted in hardware and/or software and integrated into the overall equipment configuration. ET supports training, assessment, and control of exercises on the operational equipment with auxiliary equipment and data sources as necessary. When activated, ET starts a training session or overlays the system’s normal operational mode to enter a training and assessment mode” (U.S. Army TRADOC, 2002a). The capability to support deployed Soldiers is inherent in the embedded training concept; because the training support devices are embedded in the systems they deploy with the unit rather than remaining in fixed sites at home station. In the words of Army planners, “Current virtual simulators do a great job of full-task training of the heavy force, but they are not readily deployable and do not address light, maneuver support, or maneuver sustainment soldiers and leaders” (U.S. Army TRADOC, 2002b, p. F-6). While we would amend the first part of the statement to “do a great job of full-task *practice* for the heavy force” we would agree that that merely adding an embedded simulation capability to tactical vehicles does not solve the training problems for major components of the deployed force. We would further assert that it does not meet the training requirement even for the heavy force and may in fact add new and significant impediments to using simulators for training. As noted by Graves et al. (2004) effective and timely coaching as well as performance measurement and feedback become critical issues when training participants and coaches are distributed and separated by great distances. In current fixed simulators, much of the training that occurs happens when players and trainers meet afterward in after-action reviews. An important

research issue involves finding methods for supporting distributed coaching and feedback, for example, ways to allow coaches to adequately observe and diagnose the causes of errors at a distance.

In addition to the limitations inherent in simulations for providing training as opposed to practice, current constructive tactical simulations are largely force-on-force engagement events and have difficulty representing tactical entities that are important in the current operating environment. How well does simulation represent caves, urban environments, civilians on the battlefield, bombs in the trunks of cars, and asymmetric threats that are constantly adapting to changing situations? How well would current simulation-based training products replicate the events that took place in Baghdad? Afghanistan? Bosnia?

A common belief regarding ET is that because the training event occurs on the actual equipment that there is not a problem with transfer of training – “the training is done on the real equipment, so there are no transfer problems!” Well, if there is a simulation – if the enemy behaves any differently in simulation than in real life – if commanding a robotic vehicle in simulation is somehow different from commanding a robotic vehicle in real life (and it certainly is in terms workload and manpower as can be seen in Lickteig, et al., 2004) – if the behavior of the robotic vehicle itself differs: Does it get stuck in the mud? Does it get lost? (and there certainly is a difference in characteristics of prototype robotic ground vehicles and their current simulated versions) – then there will be significant transfer problems despite the use of actual equipment for training. Training transfer may be a greater problem when the objective is to train how to employ systems (battle command and related command and control tasks) than when the objective is to train how to operate systems. From an engineering standpoint, however, ET will more likely support the former tasks than the latter because embedding devices onto operational systems is more feasible for digital components than mechanical.

While engineering decisions must tradeoff cost and vehicle performance to achieve various ET alternatives, conducting simulation-based exercises using ET support devices has two clear advantages. First the devices will deploy with the unit, increasing the possibility of anywhere-anytime training, and second there is a reduced time to switch from training to operational mode and back again. Still, an analysis by Gossman, et al. (2002) found that even with embedded simulation capabilities, units conducting force-on-force exercises would need additional mobile support vehicles to provide necessary exercise control

functions or would need to be able to reach to dedicated support sites at a distance. Furthermore, availability of simulation-based training may not be the key concern it is often thought to be. Consider, for example, the trend of underutilization many virtual combat simulators currently show. When they are used, it is often as a firing (gunnery) simulator rather than as a command and staff tactical trainer (Mastaglio, Peterson, & Williams, 2004). Using the same vehicles for training and operations may in fact exacerbate availability issues, for example training must compete with operational and maintenance time and will add to wear and tear on systems. There are many situations in which on-vehicle training is inconvenient and ineffective. We are reminded of the comical scene in which ARI researchers were trained in operation of the Force XXI Battle Command, Brigade and Below (FBCB2) system. They were suspended upside down, heads hanging down in the turret of an Abrams tank, trying to peer over the shoulder of a burly sergeant who pointed to the screen and had to shout to be heard over the noise of the vehicle (Sanders, 2001).

TRAINING SUPPORT PACKAGES

The Future Combat Systems Embedded Training White Paper (TRADOC, 2002b) states: “Once a mission materializes, there will be no time to prepare and program scenarios. Thus, a large library of rapidly tailorable exercise scenarios that can be ‘instantly’ overlaid onto a METT-T situation is urgently needed, along with the terrain databases and tools for making a generic library exercise specific” (p. 2). The requirement described above was also recognized in 1997 when Wilkinson discussed the need to develop a tool for the Close Combat Tactical Trainer (CCTT), one of the Army’s fixed site virtual combat vehicle simulation systems. The tool was envisioned “to be a system that serves as a repository for the development of structured training scenarios.” Further, Wilkinson stated that “such a system must have real-time access to information on the appropriate Mission Training Plans (MTPs), the training system, task trainability codes, and any previously developed structured scenarios. This system must support the modification of existing scenarios as well as the development of new scenarios.” In partnership with the Project Manager for the Combined Arms Tactical Trainer (PM CATT) and the TRADOC Systems Manager for the Combined Arms Tactical Training (TSM CATT), ARI developed the prototype Commanders’ Integrated Training Tool (CITT) to meet the requirement for a tool that would allow of the development of new training support packages and exercise scenarios and rapid modification of existing ones within a structured training

framework. The term structured training indicates that “the exercises are deliberately designed to assure that specific situations and events occur providing appropriate conditions for performance of particular tasks, subtasks, or actions” (Bessemmer & Myers, 1998). Structured training is implemented through the use of training support packages that provide all the necessary materials to conduct training and provide focused performance feedback (Campbell, Quinkert, & Burnside, 2000). Results from the large-scale CITT research project suggest that “full exploitation that provides for customization of exercises could lead to a potential conflict between structured training and customized training. Modifications to a structured training exercise could easily lead to non-structured training. This is particularly true if the modifications occur ‘on the fly’ ” (Gossman et al., 1999, p. 6). By that, the authors mean in effect that modifying the exercise causes the carefully constructed simulation-based training package to become simply an exercise, i.e., practice, not training. Further, the developers realized that even minor changes to an exercise required a significant number of additional changes throughout the exercise to ensure quality training. Consistent with this finding, the researchers determined that a solid understanding of structured training concepts and principles was needed to adequately modify exercises. Some changes (e.g., changing terrain databases, echelon, or mission) were so significant that it required the development of a wholly new exercise (Gossman et al., 2000). Similar findings were noted at various CCTT sites; when exercise scenarios are modified, the supporting materials are rarely adjusted. Thus, the important characteristics of the training support packages that help ensure effective training are all but removed. Again, the result was an exercise suitable for practice, but not effective training.

Rather than develop “a large library” of exercise scenarios, perhaps, what is actually needed is a way to rapidly develop exercises based on ground truth – taking information directly from the operational command and control system to allow creation of structured exercises based on current or anticipated mission situations. Following the lead of CITT, research is needed to determine how to take information from the operational environment (e.g., the METT-T situation) and develop mission related scenarios that units will need while deployed, to determine whether such exercises can provide effective training, and to find the best methods to include structured training and performance measurement requirements in rapidly created or modified scenarios. Apart from training, a solution to this difficult problem might allow embedded simulation capability to support the mission rehearsal function that is part of FCS

requirement. An automated capability to display mission events might enable a distributed command and staff mission rehearsal. Research is required to determine what functions of an embedded simulation would support a rehearsal capability.

FCS TRAINING MODES

Although the ET concept is the centerpiece of FCS training, in the previous sections we have attempted to convey that, while simulation-based exercises bring an excellent practice capability and embedded simulation makes that capability deployable, it does not necessarily represent a robust or complete training solution for deployed Soldiers. Key training developers for FCS seem to agree to some extent with that assessment as can be seen in Figure 1, a chart taken from Shiflett, Pennypacker, & Brookins (2002) which provides an initial overview of the vision for and use of ET for the FCS.

		Training Modes			
		Simulation-Supported			Computer-Supported
		Live	Constructive	Virtual	Interactive Courseware (ICW)
		Synthetic Training Environment (STE)			
Training Domains	Deployed	L *	L	L	H
	CTC	H	M	L	L
	Homestation	M	H	H	L
	Institution (No FCS Platforms)	-	H **	H **	-

H – High Usage
M – Medium Usage
L – Low Usage

* Threat-level dependent
** Linked Desk-Top Simulation ; Reused ET software

Figure 1. Embedded Training Usage Profile.

Clearly it is anticipated that when units are deployed, live, virtual, and constructive simulation will have a low level of usage. The assessment may more reflect a belief that live, virtual, and constructive simulations are too hard to do while deployed or will interfere too much with ongoing missions and therefore interactive courseware “will have to do.” Because simulation-supported training is the predominant method for training non-deployed units, we infer that the chart does not necessarily reflect an acknowledgement of the limitations of the effectiveness and efficiency of training supported by embedded tactical engagement simulation. In any event it is clear that there are diverse views on the issue including the following remarkably optimistic assessment. “The UA systems will allow the soldier and unit to train before, during, and after deployment into the operational area. For the

soldier and unit, training in the deployed domain will be much like training at home-station or at a CTC. The deployed training environment is seamless, training products are readily available, and simulation/stimulation provides for robust training for each UA soldier and unit. This allows them to both enhance their theater specific skills and sustain operation readiness while responding to mission requirements” (US Army TRADOC, 2002c).

TRAINING NEEDS OF DEPLOYED SOLDIERS

Future U.S. Army training planners aspire to a model termed “train-alert-deploy.” The intent of this admirable model is that Soldiers must be proficient in a wide range of basic skills prior to the requirement to deploy. If that is achievable – and that will largely depend on quality Army-wide training combined with extensive simulation-based practice as well as a method to control the extensiveness of the full-spectrum warfighting requirement – what then are the primary training needs of Soldiers once they deploy? Let us consider the experience of a battalion in 3rd Infantry Division in early 2003 after it arrived in Kuwait prior to the invasion of Iraq. The Soldiers moved to a bare spot in the desert about 20 km from Iraq and “spent three austere months in hard training with daily force-on-force exercises, live fires, urban combat training, and operating in a chemically contaminated environment. The task force took advantage of the extensive live-fire ranges at the Udairi Range complex as well as the numerous mock-up villages and trench complexes. Additionally the soldiers learned how to use the bevy of new equipment that the Army accelerated through the procurement process to bring to the field” (Charlton, J., 2003 as cited in Fontenot, G., Degen, E. J. & Tohn, D., 2004). Of course, these Soldiers did not have access to advanced training devices once they moved to Kuwait, but it is unclear to what extent they would have traded their live drills for virtual or constructive simulation. In an analysis of home-station training, Mastaglio et al. (2004) wrote: “Users do not rate the importance of training in CCTT [a virtual tactical simulator] as highly as field training and are not willing to tradeoff any resources that support live training for access to CCTT” (p. viii). For the most part the drills of the task force in Kuwait represent practice activities and rehearsals of basic skills that would likely be needed in the upcoming operation. Once operations began the Soldiers would presumably be performing these skills on a regular basis.

As for training, deployed Soldiers must focus on key activities that are requirements of the operation, for

example operating in a chemically contaminated environment and using the newly fielded equipment. Additional needs are individual and collective training relevant to the environment and to the mission with which the unit is being deployed (language, culture, terrain, weather). Significant training will be directed to mission-specific tactics, techniques, and procedures and to responding appropriately to enemy tactics, (e.g., improvised explosive devices) and in particular to emerging threat tactics that cannot be fully anticipated and that evolve as operations continue.

A more subtle training requirement can be seen from our experience with Think Like a Commander (TLAC) vignettes at the U.S. Army Armor Captains Career Course (the TLAC training will be described shortly). We, as well as the staff group instructors at the armor captains’ course noticed a clear difference in the nature of the responses to vignettes of captains who served in Bosnia compared to those who served in Iraq. Each deployment entailed a different set of behavioral responses, a different mindset that was perhaps expressed most clearly in how the rules of engagement were applied. This observation was borne-out by comments of Soldiers who had served in both deployments. Certainly, the Army capitalizes on the flexibility of the individual Soldier. It is that flexibility that allows the force to adapt itself so greatly to specific mission requirements that would be very difficult to explicitly codify. The observation points to a specific training need to behaviorally prepare Soldiers for specific deployment environments.

Additionally Soldiers may sometimes need practice on skills that are not being applied during a specific deployment, e.g., Soldiers engaged in stability operations have a need to maintain warfighting skills. Given operational requirements, it is not clear how feasible it is to devote resources that might otherwise be focused on actual mission requirements to such practice activities. Perhaps exercising conditions of potential transitions to higher (or lower) levels of conflict would be sufficient. Finally, deployed Soldiers need to training, practice, and rehearsal specifically directed at upcoming missions.

In this section, we have described some likely training requirements for deployed Soldiers that can be clearly distinguished from the training and practice that must occur prior to a deployment in a train-alert-deploy model. In all cases, it is clear that the addition of an embedded tactical engagement simulation capability does not provide a complete answer, and it is arguable whether it has much of a role to play at all. Even in the case of mission rehearsal, research is required to describe the characteristics of efficient and effective

automated support tools. Thus, in reference to figure 1, we conclude that the predominance of interactive courseware is appropriate not simply because simulation-based training is difficult to do when deployed but because of the specific training requirements of deployed forces. On the other hand, much of the training requirement described in this section will not be satisfied by training that only accomplishes knowledge acquisition; it must instead train behaviors. Typical examples of interactive courseware will not suffice. What is needed is a flexible form of interactive multimedia instruction (IMI) that can focus on very specific training needs, be readily tailorable, update quickly, and is effective in turning knowledge into action via training. We believe the TLAC method used to train adaptive thinking, a difficult training challenge, is a promising candidate.

THINK LIKE A COMMANDER: A NEW APPROACH

The TLAC methodology applies deliberate practice training concepts to train tactical thinking skills and allows students to model their thinking, understanding, plans, visualizations, and decisions after expert thinking patterns. The training method involves the presentation of cognitive drills – multimedia scenario-based situations – and structured questioning to elicit and assess an individual’s mental models and thought habits. The method was originally used to train tactical thinking skills in brigade, battalion, and company commanders and assists in converting knowledge into actual behaviors that can be observed, measured, and coached. For a more detailed description of the TLAC methodology, see Lussier, Shadrick & Prevou, 2003.

A critical component in the construction of the TLAC training is the explicit development of a set of expert tactical behaviors. In TLAC training, designed to train U.S. Army officers to think like tactical experts, the key thinking behaviors are: (1) keep a focus on the mission and higher intent, (2) model a thinking enemy, (3) consider effects of terrain, (4) use all assets available, (5) consider timing, (6) see the big picture, (7) visualize the battlefield, and (8) consider contingencies and remain flexible. We term these eight behaviors themes of TLAC training. The themes represent the elements of expert form that the coaches observe and the students model. While well known to most officers and understood at a conceptual level, these behaviors are often not exhibited by the officers during simulated tactical exercises. They have not become automatic and thus, when the officers’ attention is focused, as it should be, on the specific

situation confronting them, the behaviors are omitted. Once the behaviors to be trained were clearly specified,

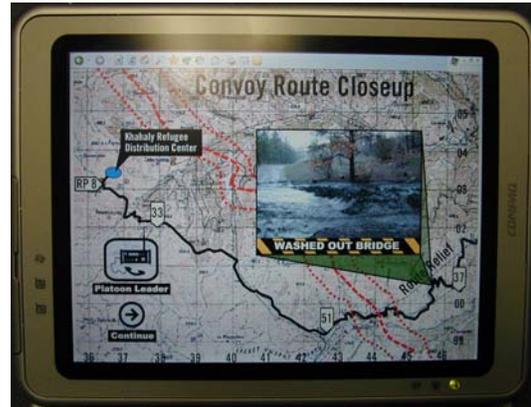


Figure 2. TLAC Multimedia Vignette-Based Training.

a prototype system was developed. The central component of the system is a set of vignettes based on tactical situations drawn from a single overarching scenario. Each vignette begins with a short – typically two to four minutes in duration – audio-video file that presents the student with a challenging tactical problem. After the vignette is presented, the system prompts the students to identify critical features that need to be considered before a decision is made. As training progresses, the instructor decreases the amount of time students are allowed for this step, forcing them to adapt to increased time pressure. After the students have completed their analysis, the instructor leads a class discussion. The training system provides tools to structure the discussion and support the instructors as they discuss considerations relevant to the vignette. Such coaching by a subject-matter expert is a key part of the learning process, enabling the student to develop expert habits. While each vignette has no officially sanctioned solution, a panel of expert battlefield commanders identified a unique set of “indicators.” These are the elements of the situation – the key features – that an expert commander should consider in the specific situation before making a decision. While the themes are consistent across all vignettes, each vignette has a unique set of about 16 indicators. In the final phase of each vignette, the students see the list of expert indicators and score themselves by comparing it to the list they generated. The system evaluates their performance and provides feedback in terms of the expert themes. This individual feedback complements the feedback given by the instructor. The students are then able to focus their future thinking during subsequent vignettes and place additional attention on themes for which they scored low. The training method allows students to perform repeatedly in a series of focused exercises to train key skills involved

in rapidly identifying critical features of novel military situations.

Shadrick & Lussier (2004) showed that use of the Think Like a Commander training program produced several dramatic findings. An examination of student self-scores revealed significant performance gains in key components of tactical thinking. Student self-scores were verified by an independent rater to insure scores were not systematically increased. Significant performance gains were found even though time constraints were made increasingly more stringent as shown in Figure 3 ($F(1, 23) = 34.21, p < .05$).

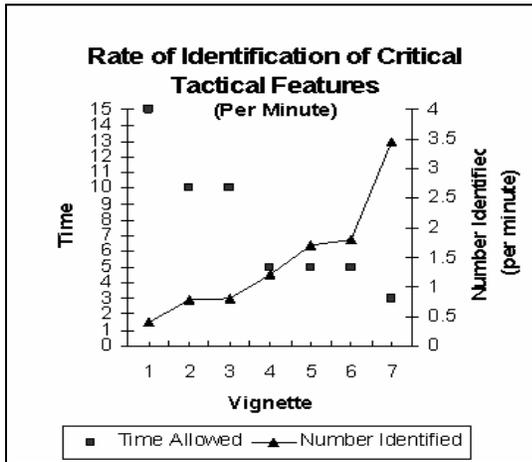


Figure 3. Rate of Identification of Indicators

Interpretation of the value of results such as these is always subjective. We feel in this case the increase is impressive particularly because each vignette presents a new tactical situation and the target considerations – the critical features that the students must identify – are also different each time. The results indicate a substantial rise in the students' ability to rapidly perceive and identify the critical features of tactical situations. In the TLAC example a method of vignette-based training was employed to train a skill that is difficult to teach and difficult to measure. The TLAC method, which works well in the classroom for training command thinking skills, may provide a useful method to meet a variety of deployed Soldiers' training needs. It is a flexible form of IMI that can be focused on very specific training needs, is readily tailorable, updates quickly, and is effective in turning knowledge into action. If it is to be used with deployed Soldiers, it would need to be readily deliverable at a distance via deployed unit reach capability. To that purpose, our research findings in developing a distance version of TLAC are relevant.

TLAC-DL

The original TLAC training application was designed and developed as a stand-alone program that runs on individual computers. All necessary software for presenting vignettes and collecting student data was contained on each student's computer. During the training, individual student responses collected during the execution of a TLAC vignette were saved to a network where they were combined for analysis. While this methodology works reasonably well in a schoolhouse environment, it is impractical for a large number of students or when they are geographically dispersed. *Think Like a Commander – Distance Learning* (TLAC-DL) was designed for students who will most likely not be co-located and will require remote presentation of vignette materials, remote interaction, data collection, coaching, and feedback. Therefore, the TLAC-DL method is analogous to an IMI approach implemented in an ET system. Just as in the stand-alone version, students view a vignette after which they respond to the vignette by listing key tactical considerations of the vignette. Then there is coaching/mentoring by an instructor, after which, the students score their performance and receive feedback based on the themes. The two key differences between TLAC in the classroom and TLAC-DL are that presentation of the TLAC-DL materials (i.e., vignettes, feedback, expert responses) occurred over the Internet, and the coaching must be presented in a distributed manner.

In TLAC-DL the students accessed the materials using a standard web browser. The approach has several benefits. Since the instructional materials reside on a server rather than on individual students' computers, they are easy to update to reflect current training needs or new lessons learned and tools, techniques, and procedures. It is also relatively easy to add new materials specific to the current environment or operation. In addition, student responses are sent directly to the host server (the institution) allowing for more efficient analysis and feedback.

Training in an embedded environment while deployed will require that coaching occur in the context of distributed training – it will be conducted at a distance without the benefit of face-to-face interactions. This represents a potential weakness because coaching is often such a critical component of training. Coaching increases the rate at which participants can improve their performance and reduces the possibility of negative training, where participants become efficient at performing tasks the wrong way. Further, quality coaching assists in bringing performance to standard during the exercise, rather than simply identifying what

the audience needs to improve during future training events. Thus, a key component of effective training is the consistent and timely feedback an active coach provides to the individuals during training. Coaching and feedback present a way for the training participants to focus on correct performance and on areas of difficulty and weakness.

Current technology allows for a variety of coaching techniques in ET/distance learning environments varying from no coaching at all to close simulation of a classroom environment. During the evaluation of the TLAC-DL methodology, three methods of distributed coaching were assessed and compared to standard face-to-face coaching (Gossman et al., In Preparation). The three methods were: an instructorless method, an asynchronous method, and a synchronous method.

The instructorless condition was the equivalent of using a multi-media self-help book. It used stand-alone or local area network resources to allow viewing of the presentation of vignette materials. The student generated their list of responses and then viewed model feedback materials. In the TLAC-DL Instructorless condition students read a doctrinally-based solution using written text. Although the Instructorless condition lacked an active interchange of ideas, it had the advantage that feedback was presented immediately.

The asynchronous method represents an approach that is more tailored to the individual student responses. Specifically, after the students viewed the vignette presentation and provided their responses, their output was electronically sent to an expert coach who provided feedback remotely via email. The feedback process required several hours or even overnight, but it was tailored to the individual student.

The third method, the synchronous method, attempted to provide a close simulation to a classroom environment. At a scheduled time after viewing a vignette and submitting responses, students engaged in a mentored discussion of the vignette using the Virtual Tactical Operations Center, an on-line collaborative software package providing functions such as chat, whiteboard, and voice over internet. All students viewed/listened to other students' comments as well as the comments of the expert coach, allowing feedback that was both tailored and timely.

The results indicated that selection of a coaching method has an effect on performance. The synchronous coaching and feedback method was the best choice for distance learning applications. The synchronous method provided the students with a

knowledgeable instructor and timely feedback. It is important to note that the method was the best even though there were technical issues involved with the specific collaborative software used during the study. While the synchronous form of coaching was almost as effective as face-to-face coaching, it required a live coach. Deployed units would require a reach capability, perhaps to the institution or to a Home Station Operations Center.

At times during a deployment, it may not be possible to obtain feedback from a live coach. Therefore, there may be times when feedback will have to be provided by instructorless means. While not ideal, results from our study indicate that instructorless training can be an effective and viable option. Our first attempt at providing instructorless feedback consisted of written text that the student was required to read. Such feedback was easy to prepare but not ideal. A better way to present feedback in instructorless training would be to use a video presentation – perhaps using a modeled classroom discussion so that the student would observe a typical classroom discussion without however being able to participate. Feedback formatted in a multimedia presentation could be tailored to the student's response by using branching techniques. Additional research efforts are needed to determine the most effective and efficient ways to provide instructorless feedback and performance coaching. A significant point must be made regarding the use of instructorless feedback. The successful use of instructorless feedback, or any feedback, was a direct result of the focus on expert behaviors and key characteristics of the training. By clearly identifying the expected performance behaviors and outcomes measures feedback was developed to model student performance. It is the focus on behaviors and performance measurement that separates training from practice.

Several recent ARI research efforts investigated the possibility of using intelligent tutor technologies to support this phase of the training (Domeshek, 2002; Lochbaum & Streeter, 2002; Domeshek, 2004; Ryder et al., 2004). Despite considerable effort, results were disappointing. In general, we conclude that for procedural tasks intelligent tutor technology may be a practicable solution in the future, but for more complex tasks as in TLAC it will not be a feasible solution for FCS. We believe the impact of artificial intelligence in supporting FCS training is often greatly overestimated.

In the asynchronous condition, the coach will need time consider the individual student responses in order to provide meaningful feedback. For our initial evaluation it was estimated to require about 30 minutes

for the coach to respond to each student response. This introduces a feedback delay that might involve several hours, or even days, if an instructor is coaching a number of students simultaneously. The combination of the feedback delay and the fact that the student should receive feedback prior to completing additional exercises may limit the effectiveness of the asynchronous feedback. Due to delay and the significant resources required, the asynchronous method we used did not appear to be a suitable method for providing timely performance feedback and coaching.

CONCLUSION

A recent article titled *A Solution Searching for Support* quoted an Army training expert: "Despite many attempts (including some notable successes) by Army officials to tap the full potential of embedded training, the concept remains splintered and its promise largely unrealized" (Roos, 2004). Since 1987, Army policy has mandated a thorough evaluation and consideration of ET for materiel acquisition programs, but "effective implementation of this policy has been hampered by the lack of specific procedures for determining what training should be embedded" (Witmer & Knerr, 1996). The assessment is true today when ET is not only a mandated consideration for FCS but is a key performance parameter of the acquisition program.

In this paper we have focused on the training needs of deployed Soldiers and attempted to show that the oft cited solution of ET – a solution that is sometimes represented as no more than two words on a briefing chart – in particular ET based on an embedded constructive tactical engagement simulation, is no panacea. We have advanced the idea that a TLAC–like method of training will be more efficient than full tactical simulation exercises and more effective than typical interactive courseware, and may have a major role in the training of deployed Soldiers.

Further definition, analysis, and research are required. Ongoing ARI research is exploring how a TLAC methodology can be applied to team training, in particular to distributed teams, and attempting to find improved forms of instructorless training, as well as effective methods of distance coaching. Other key research issues we have raised in this article include the need to find ways to use operational databases to create training scenarios, to insure that effective training components are included in those exercises, and to investigate key functional requirements for automated support of mission rehearsal.

REFERENCES

- Bessemer, D. W., & Myers, W. E. (1998). *Sustaining and improving structured simulator-based training* (ARI Research Report 1722). Alexandria, VA: U.S. Army Research Institute for the Behavioral and Social Sciences.
- Black, B. A. & Quinkert, K. A. (1994). The current status and future trends for simulation-based training in armored forces from crew to battalion level. *Proceedings of the 35th NATO-DRG Symposium on Improving Military Performance Through Ergonomics* at Mannheim, Germany.
- Black, B. A., (1996). *How will simulation enhance training?* [NATO RSG 26] Manuscript submitted for publication.
- Campbell, C. H, Quinkert K. A., & Burnside, B. L. (2000). *Training for performance: The structured training approach* (ARI Special Report 45). Alexandria, VA: U.S. Army Research Institute for the Behavior and Social Sciences.
- Domeshek, E. A. (2002). *Intelligent tutoring system for teaching battlefield command reasoning skills* (ARI Technical Report 1124). Alexandria, VA: U.S. Army Research Institute for the Behavioral and Social Sciences.
- Domeshek, E. A. (2004). *Phase II final report on an intelligent tutoring system for teaching battlefield command reasoning skills* (ARI Technical Report 1143). Alexandria, VA: U.S. Army Research Institute for the Behavioral and Social Sciences.
- Fontenot, G., Degen, E. J. & Tohn, D. (2004). *On Point: United States Army in Operation Iraqi Freedom*. Fort Leavenworth, KS: Combat Studies Institute Press.
- Gossman, J. R., Beebe, M. E., Bonnett, Michael, Forrest, D., Shadrick, S. B., Dannemiller, B., Mauzy, R., Bonnet, Mitch. (1998). *The commanders' integrated training tool for the close combat tactical trainer: Design, prototype development, and lessons learned* (ARI Research Report 1739) Alexandria, VA: U.S. Army Research Institute for the Behavioral and Social Sciences.
- Gossman, J. R., Bonnett, Michael, Forrest, D., Shadrick, S. B., Dannemiller, B., Flynn, M. R., Mauzy, R. P., & Bonnett, Mitch. (2000). *The commanders' integrated training tool for the close*

- combat tactical trainer - 2: Second generation design and prototype development.* (ARI Research Report 1759) Alexandria, VA: U.S. Army Research Institute for the Behavioral and Social Sciences.
- Gossman, J. R., Burnside, B. L., Flynn, M. R., Dannemiller, B., & Mauzy, R. P. (2002). *Command group training in the Objective Force* (ARI Research Report 1793). Alexandria, VA: U.S. Army Research Institute for the Behavioral and Social Sciences.
- Gossman, J. R., Heiden, C. G., Flynn, M. R., Smith, P. G., Shadrick, S. B. (In Preparation). *Think like a commander – distance learning* (ARI Research Product). Alexandria, VA: U.S. Army Research Institute for the Behavior and Social Sciences.
- Graves C. R., Heiden, Jenkins, S. N, Flynn, M. R., Smith, P. G., Brown, S. H., & Shadrick, S. B. (2004). *Multi-echelon distributed army leader information processing training: Prototype development and recommendations for future research* (ARI Research Report 1818). Alexandria, VA: U.S. Army Research Institute for the Behavior and Social Sciences.
- Lickteig, C. W., Sanders, W. R., Durlach, P. J., & Carnahan, T. J. (2004). *Future combat systems command and control (FCS C2) human functions assessment: Interim report – experiment 3* (ARI Research Report 1819). Alexandria, VA: U.S. Army Research Institute for the Behavioral and Social Sciences.
- Lochbaum, K. E., & Streeter, L. A. (2002). *Carnegie Hall: An intelligent tutor for command-reasoning practice based on latent semantic analysis* (ARI RN-2002-18). Alexandria, VA: U.S. Army Research Institute for the Behavioral and Social Sciences.
- Lussier, J. W., Shadrick, S. B., & Prevou, M. I. (2003). *Think like a commander prototype: Instructor's guide to adaptive thinking* (ARI Research Product 2003-02). Alexandria, VA: U.S. Army Research Institute for the Behavioral and Social Sciences.
- Mastaglio, T. W., Peterson, P., & Williams, S. (2004). *Assessing the effectiveness of the close combat tactical trainer* (ARI Research Report 1820). Alexandria, VA: U.S. Army Research Institute for the Behavioral and Social Sciences.
- Roos, J. G (2004) A Solution Searching For Support, *The MSIAC's M&S Journal Online, Winter issue 2004, Vol 5, No 2*, reprinted from *Armed Forces Journal, T&S 2002* from the February/March 2002.
- Ryder, J. M, Graesser, A. C., LeMentec, J. C., Louwerse, M. M., Karnavat, A., Popp E. A., & Hu, X. *A dialog-based intelligent tutoring system for practicing battle command reasoning* (ARI Technical Report, 2004) Alexandria, VA: U.S. Army Research Institute for the Behavioral and Social Sciences.
- Shadrick, S. B. & Lussier, J. W. (in press). *Assessment of the think like a commander training program* (ARI Research Report). Alexandria, VA: U.S. Army Research Institute for the Behavioral and Social Sciences.
- Shadrick, S. B., & Lussier, J. W. (2002). *Think like a commander: Captain's edition – prototype 1.0.* (Available from the U.S. Army Research Institute for the Behavioral and Social Sciences, 2423 Morande Street, Fort Knox, KY 40121).
- Shiflett, J., Pennypacker, W., & Brookins, K. (2002, November). FCS Training. Briefing provided by the FCS Training IPT (27 November 2002). Author.
- U.S. Army Training and Doctrine Command (2002a). *Statement of required capabilities future combat system of systems (FCS)*. Fort Monroe, VA: Author.
- U.S. Army Training and Doctrine Command (2002b). White Paper: *Future combat system embedded training* (Draft 24 April 2002). Fort Monroe, VA: Author.
- U.S. Army Training and Doctrine Command (2002c). *Objective Force: Operational and organizational plan for maneuver Unit of Action* (Draft, July 2002). Fort Monroe, VA: Author.
- Wilkinson, J. (1997). *Training support packages for the Close Combat Tactical Trainer – A concept for all training systems*. Unpublished Manuscript.
- Witmer, B. G. & Knerr, B. W. (1996). *A guide for early embedded training Decisions* (Second Edition) (ARI Research Product 96-06). Alexandria, VA: U.S. Army Research Institute for the Behavioral and Social Sciences.