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Six Myths about Digital Skills Training

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U.S. Army Research Institute

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for the Behavioral and Social Sciences

A Directorate of the U.S. Total Army Personnel Command

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14. ABSTRACT *(Maximum 200 words)*:

Soldiers entering the U.S. Army today encounter an array of weapons, equipment, and technologies that require information-age, digital skills. As these unique digital systems evolve, trainers are challenged to prepare soldiers to leverage these systems to meet complex, and sometimes unanticipated, missions. In order to gain a better understanding of digital skill training, one group of soldiers was followed for almost a year as they experienced Advanced Individual Training, New Equipment Training, and unit training that covered one major hardware/software change and three software upgrades. Findings are based on observations, surveys, and performance on practical exercises. Results identify several misperceptions regarding the acquisition of digital skills and recommendations for modifying training to improve skill acquisition and transfer. For example, digital skills may not be highly perishable. Soldiers retain what they learned during Advanced Individual Training for at least three-to-four months, but many encounter difficulty in transferring what they have learned to a different problem setting. Training that engages the soldier by embedding the experience in a real-world context that requires active problem solving can enhance transfer.

15. SUBJECT TERMS

Training, digital skills, transfer of training, skill retention

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Six Myths about Digital Skills Training

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FOREWORD

Advanced technology means that the U.S. Army is asking more from its entry-level soldiers and from the trainers who must prepare these young warriors. Unanswered questions about how best to train soldiers to meet complex technological challenges led to this effort by the U.S. Army Research Institute for the Behavioral and Social Sciences (ARI), with assistance from the U.S. Army Intelligence Center (USAIC) and the 209th Military Intelligence (MI) Company.

The Advanced Training Methods Research Unit, as a part of ARI Work Package 209, "Principles for Training Digital Skills" focuses on identifying and documenting principles and methods to maximize training for operators of Army digital systems. Work is accomplished through literature reviews, observations of digital system training, and tracking soldiers' performance from the schoolhouse to the units through several iterations of digital hardware and software. From the results of these activities, researchers were able to draw the general conclusions summarized in this report.

Project plans were briefed to the Assistant Deputy Chief of Staff for Training, U.S. Army Training and Doctrine Command in June 2000. Results were presented during March-April 2001, to the Deputy Commander USAIC, the Brigade Command Cell at Fort Lewis, and the 209th MI Company at Fort Lewis.

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SIX MYTHS ABOUT DIGITAL SKILLS TRAINING

EXECUTIVE SUMMARY

Research Requirements:

As the Army moves its forces into the 21st Century, it will become increasingly dependent on soldiers who understand information age technologies, are well versed in digital skills, and can use their weapons and equipment to accomplish assigned missions. Current training is not meeting the expectations of developing soldiers who fully understand and exploit the capabilities of digital systems which can effectively manage massive, multiple sources of information.

Procedure:

One group of soldiers was followed for almost a year as they experienced Advanced Individual Training at the schoolhouse, New Equipment Training (NET), and unit training for the All Source Analysis System/Remote Workstation. Observations, subjective opinions from soldiers, and objective data from practical exercises provided the basis for this report.

Findings:

Several misconceptions are identified and recommendations for modifying training are suggested. They are:

- Digital skills may not be highly perishable, for soldiers successfully passed a retest of their schoolhouse final examination four months after leaving the school, with no subsequent exposure to the system. Recommendations include using constructivist-training methods that would challenge soldiers to solve a variety of real-world problems.

- Soldiers quickly adapted to software upgrades and system changes. Soldiers entering the Army today come equipped with well-developed computer skills. Training should focus on mission performance differences in upgrades rather than on details of operating the system.

- Systems will become easier to use, but training needs will grow as system capability increases. Digital systems should be accessible and used for work routines whenever possible to support adaptation to system changes.

- Soldiers are not confident that today's digital systems support mission performance. Soldiers need routine exposure to digital systems if they are to recognize when and how the system can leverage mission success.

- Soldiers understand the basic digital systems but require training on how to use their system to perform the job. Training should take place in context and adapt to different rates of knowledge acquisition through collaboration and mentoring.

- Sustainment training to maintain and develop expertise with digital systems requires additional support at the unit level. Infrequent refresher training on knobology or multi-day exercises does little to advance the soldier at skill level 10. Developmental training materials (e.g., training vignettes, computer-based training activities) are needed that support and expand emerging skills. Having a leader who knows the system offers countless opportunities for incidental learning of both the system and its military application.

Utilization of Findings:

These findings can influence decisions made regarding how digital skills can be better trained to increase the Army's capabilities.

SIX MYTHS ABOUT DIGITAL SKILLS TRAINING

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SIX MYTHS ABOUT DIGITAL SKILLS TRAINING

> Digitization applies information technologies to acquire, exchange, and employ timely data throughout the battlespace. It is a strategy to take advantage of information age advances by developing and fielding information technologies throughout the force.... This capability will allow all friendly forces to share a constantly updated and integrated view of the entire battlefield, no matter what the mission, to penetrate the enemy's decision loop, and act faster than he can react.
>
> *The Army Digitization Report (June 2000)*

The problem

Digitization can facilitate a smaller, lighter force's ability to strike quickly, before the enemy has a chance to retaliate. As the U.S. Army struggles to move its forces into the 21st Century, it will become increasingly dependent on soldiers who understand information age technologies, are well versed in the use of digital skills, and can use their weapons and equipment to accomplish assigned missions. As the Army goes forward in that direction, the training community faces unresolved challenges.

Current training is not meeting the expectations of developing soldiers who fully understand and exploit the capabilities of digital systems so that they can judiciously manage massive, multiple sources of information. The successful training and maintaining of digital skills are proving more illusive than that of traditional skills such as gunnery or vehicle maintenance. Colonel Robert Cone, Commander of the 2nd Brigade, 4th Infantry Division, states that only half of the potential of digitization has been realized (III Corps Digital Training Seminar Minutes, May 2001). This report will help the Army to get a better understanding of the problems associated with digital skills training, and it will provide recommendations of ways to improve digital skill training.

What did we do?

In an attempt to understand digital training better, researchers observed one group of soldiers (96B-military analysts) for almost a year as they experienced Advanced Individual Training (AIT) at the schoolhouse, New Equipment Training (NET), and unit training for the All Source Analysis System/ Remote Workstation (RWS). Observations, subjective opinions from soldiers, and objective data from practical exercises provided the basis for this report. During the time that this research was conducted, soldiers encountered one major hardware/software change and two additional software upgrades (see Table 1). Practical exercises and surveys were administered (1) after AIT, (2) before and after NET for one hardware/software upgrade and one software upgrade, and (3) before NET for a third upgrade.

The six myths about digital training discussed in this report are a beginning toward identifying and addressing issues central to our understanding of training complex digital systems. Some may disagree with these myths. Differences of opinion are expected, even encouraged, for this focuses thoughts and discussion on problems whose resolution can only contribute toward training that is more effective.

Table 1.
Longitudinal observations of training across three versions of the ASAS/RWS

DATE	March-April 00	June 00 Pretest	August 00 Posttest	October 00 Pretest	November 00 Posttest	March 01 Pretest
MEASURE - MENT	AIT* Schoolhouse Examination	AIT Retest before NET** Block II, Version 4	NET PE*** after NET training and unit exercises	Vignette based on AIT tasks before NET training Block II, version 6.1	NET exam after NET training on Block II Version 6.1	NET PE Readminister Vignette on Version 6.2
TRAINING LENGTH	8 Days in schoolhouse	None	4 day NET, 2 Months Unit: NET instructor available	None	3 Weeks NET	4 Months Unit: 2x month plus field exercise
SYSTEM	Block I	Block I	Block II, Version 4	Block II, Version 4	Block II, Version 6.1	Block II, Version 6.1

* Advanced Individual Training ** New Equipment Training *** NET Practical Exercise

What did we find out? What are the implications for training?

Myth I: Digital skills are highly perishable.

"Digital skills are highly perishable" is the mantra heard as soon as a soldier returns from training on operating a digital system. Perishable implies that digital skills are acquired, and then quickly decay. This was not so. All soldiers in the observed brigade and soldiers from three additional posts passed an alternative form of their final schoolhouse examination 3-to-4 months after completing training with no contact with the digital equipment in the interim (see Table 2). Two soldiers, who had not operated the RWS for about a year, also passed the exam. Skills acquired during classroom training remained intact when soldiers are asked to complete basic operational tasks **very similar** to those presented in the classroom (i.e., same maps, databases, terminal learning objectives).

Discussion.

Why are digital skills perceived as perishable? One major reason is soldiers have difficulty transferring their training to unfamiliar situations when training focuses on basic operating tasks (i.e., knobology) with little connection to their functional use. Previous research by the U.S. Army Research Institute for the Behavioral and Social Sciences (ARI) asked soldiers in AIT to complete a practical exercise (PE) after completing training and just prior to their end-of-course examination (Schaab & Dressel, 2001). Soldiers performed tasks with Terminal Learning Objectives (TLOs) identical to those on the end of course examination but using a different map, database, and operation order. Most soldiers were unable to transfer their knowledge to the PE, yet all soldiers passed the examination. This phenomenon, sometimes referred to as inert knowledge, is common with novices learning multifaceted skills, and

underscores the complexities involved in understanding how to take full advantage of the capabilities of a digital system.

Table 2.
Percent of items passed on reexamination from AIT

Condition	Number of Soldiers	Items Passed on AIT Reexamination
Completed AIT 3-4 months prior	21	90 percent
No RWS, Single Source	1	82 percent
AIT about 1 year previous	2	78 percent
No RWS training, occasional use in unit	1	78 percent
No RWS, but MI Background	1	78 percent
AIT about 2 years previous, no RWS	3	50 percent
MOS not 96B, no RWS training	2	25 percent 50 percent

ARI evaluated an alternative method of training using discovery learning, sometimes referred to as constructivism. Constructivism supports deeper understanding and better transfer of training by integrating the content knowledge and digital system functions as a single training event. Thus training builds on existing knowledge by using experiences embedded in a real-world context (Ross & Lussier, 1999; Ross & Yoder, 1999; Schaab & Dressel, 2001[1]). Learning is interactive with other trainees and the instructor, with the instructor intervening when the trainee no longer is making progress. This intervention or scaffolding can take the form of questioning, demonstrations, discussions, or providing instructions that encourage the trainee to think about the situation more deeply and adaptively. Soldiers trained using constructivism perform significantly better when asked to transfer their learning to unfamiliar situations than do traditionally trained classes (see Figure 1) with the same TLOs. (A sample PE that reviews the TLOs for AIT is located in Appendix A.)

Presenting instruction using realistic situations that require soldiers to solve increasingly complex problems enhances understanding and acquisition of new knowledge. Regrettably, adopting complex, real-world training vignettes will not eliminate a soldier's lack of proficiency on digital systems. Proficiency will develop over time with continued exposure to a variety of digital and military experiences. Soldiers trained using constructivist methods will be ahead of traditionally trained soldiers in their ability to use their training to adapt to various digital experiences and in possessing the self-learning skills needed for continued development.

Another reason for perceived perishablility of digital skills is an underestimation of the complexity involved. This causes confusion about the amount of time required for training digital systems, how this training should be delivered, and at what point in a soldier's career

[1] Contact the author for a copy of *the Leader's Guide to Exploratory/Discovery Learning.*

expertise should be developed. Instructors familiar with how these systems are used in the field say that several weeks of intense instruction "just scratch the surface" in terms of being able to use the system to perform the job. They agree that soldiers need to continue training to develop an integrated understanding of their military job skills and digital systems if the potential of the system is to be realized.

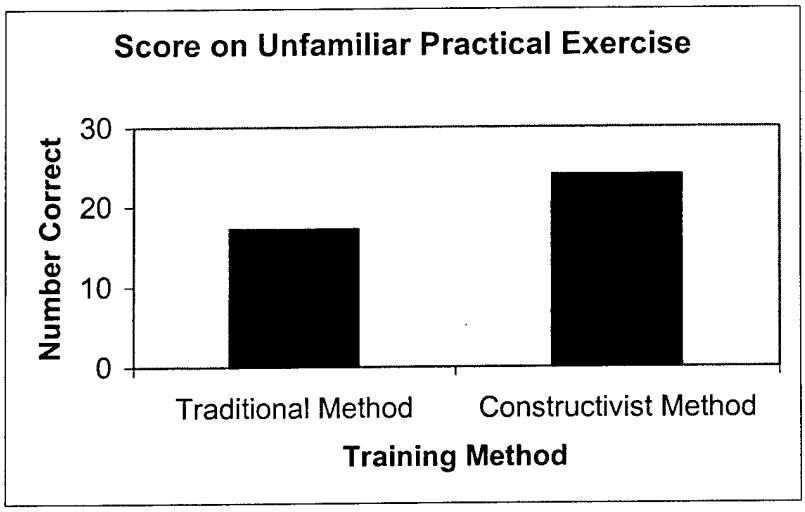


Figure 1. Comparison of the number of items correct attained by soldiers

An example of this complexity and need for integrating digital and military knowledge is illustrated in developing situational awareness (SA). Keep in mind that these soldiers, with scant time in service, have the responsibility of manipulating vast amounts of electronically received information used by their commander in making critical decisions. Greater SA is a primary driver for advanced technology, but increased SA is a complex skill that requires a soldier to comprehend and manipulate results that have been collated and analyzed by the digital system. SA consists of three hierarchical levels: 1) perceiving the appropriate elements or cues, 2) understanding how these elements are significant in relation to the particular goals, and 3) integrating the first two levels with experience and skills (Ensley, 1995). Advancing the entry-level soldiers shown on the left side of Figure 2 to expert level requires exposure to a wide variety of experiences at varying levels of complexity.

Current practices in Army training introduce the equipment at the entry level, usually in AIT. Once they leave the schoolhouse, these soldiers more often than not have limited opportunity to develop further competence. One commander refers to digital systems as closet systems, meaning too many units store their systems in the closet until exercise time. One reason this happens is the shortage of personnel at the unit level with the expertise to advance the soldiers' understanding. Another may be the lack of time that unit leaders have available to train. This translates into limited expertise in the unit and missed opportunities to develop entry-level soldiers.

Retraining occurs for the mid-level soldier. If these NCOs have lost the chance to develop a deeper understanding and comfort level with the digital system, they leave school as digital novices who are more comfortable doing their job the pre-digital or manual way.

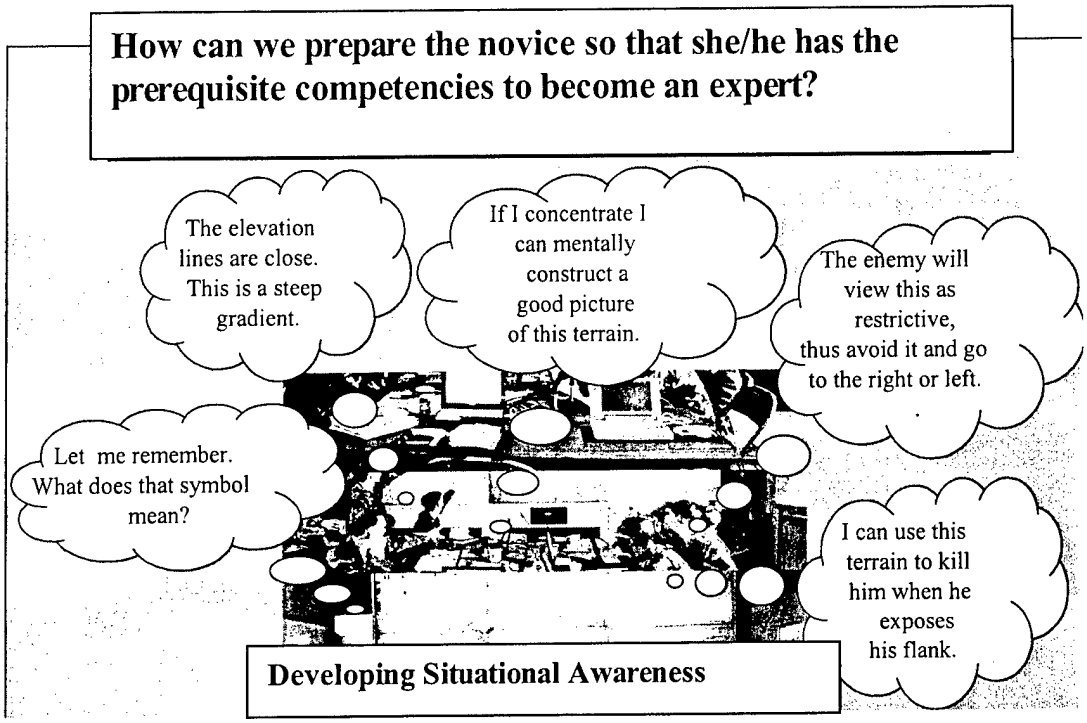


Figure 2. Developing situational awareness, from novice to expert

Training evaluations done via a questionnaire can contribute to the misperception that a soldier has "mastered" skills necessary to employ digital systems. Using questionnaires is a quick and logistically simple way to collect information, but how valid are the data?

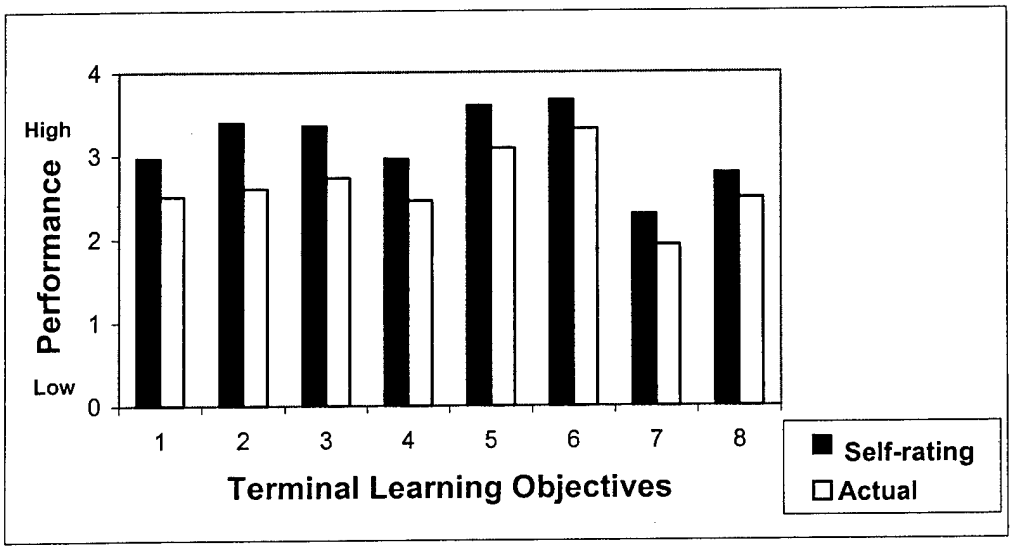


Figure 3. Self-rating of performance compared to actual performance

Soldiers observed during Time 3 (see Table 1) were asked to rate how prepared they were on the TLOs taught in a program of instruction. Self-ratings on training readiness were gathered directly after instruction. Following the self-ratings, soldiers were administered an exercise to

determine how well they actually could perform the tasks that they had rated. In all cases, soldiers rated themselves as more proficient than they actually were (see Figure 3). It is common for novices to overestimate what they know. The danger comes when these ratings are equated with mastery of training content.

Commanders must take time to develop soldiers by providing the support and resources necessary at the units. Soldiers will become more motivated because they understand that they play a vital role in successful mission accomplishment. The ultimate result will be digitally proficient young NCOs who are able to work flexibly and adaptively to positively influence mission success. These proficient NCOs can command respect from their subordinates, resolve day-to-day problems, provide impromptu insights that develop more competent soldiers, and demonstrate superior performance. In other words, foster better Army leaders while improving the skills of the young soldiers.

Recommendations

Pre-training

- Determine the job responsibilities of a soldier for the level of training that he or she is receiving to establish what should be trained.

In the institution

- Train the system (i.e., knobology) and operational functions together.
- Allow trainees to work together in teams to replicate on the job conditions, but ensure that all soldiers have an opportunity to perform all tasks.
- Present instruction in the context of realistic situations.
- Incorporate complex training material that forces soldiers to think.
- Build on what the soldier already knows.
- Train self-development skills so soldiers assume responsibility for continued development at the unit.
- Incorporate discovery (constructivist) training methods to deepen understanding and enhance transfer.

Myth II: Serious disruptions to training occur when a soldier must transfer learning from one version of software to another.

Anticipated disruptions in performance were minimal or nonexistent as soldiers advanced to new hardware or software upgrades. Soldiers tend to focus on performing functional operations using their systems, while trainers spotlight basic operational differences (e.g., interface changes, new menu items) between versions of the system.

Discussion.

Changes from Block I to Block II (Blocks designate key system changes) involved major hardware/interface differences as well as software modifications. About half of the soldiers reported that their knowledge of Block I interfered with their learning Block II, but all reported that this interference did not last beyond the first week. It appears that when soldiers focus on performing a function (e.g., determine the fastest route to the enemy's location), differences in

the interface were mastered quickly through exploration, asking a peer, or using the help function.

One platoon's introduction to a software upgrade serves to illustrate the speed of adjustment. At the platoon sergeant's instructions, soldiers loaded software upgrades on their systems and immediately began exploring. They were given several typical tasks to perform. After less than an hour exploring, soldiers were asked how different this software was from the previous version. They responded, "Oh, it's not really different. The maps are better, but it works about the same." They stated that they could probably learn the delta without NET training, especially if training aids were available.

Closer examination of today's soldier shows that they come to the classroom with a great deal of knowledge about computer usage, with more than 90 percent of the new soldiers being proficient in at least two software applications. They find answers by exploring system operations or, if all else fails, use the help function. Playing with the system and asking a friend are the two most common ways that users learn new software packages. Such exploratory training takes advantages of the natural way we learn. Army trainers need to take advantage of this existing knowledge and experience with computers. In the words of LTC John R. Brooks (U.S. Army, Retired), "get the technology in the hands of the soldiers and they will tell you how to use it (1997, p. 10)."

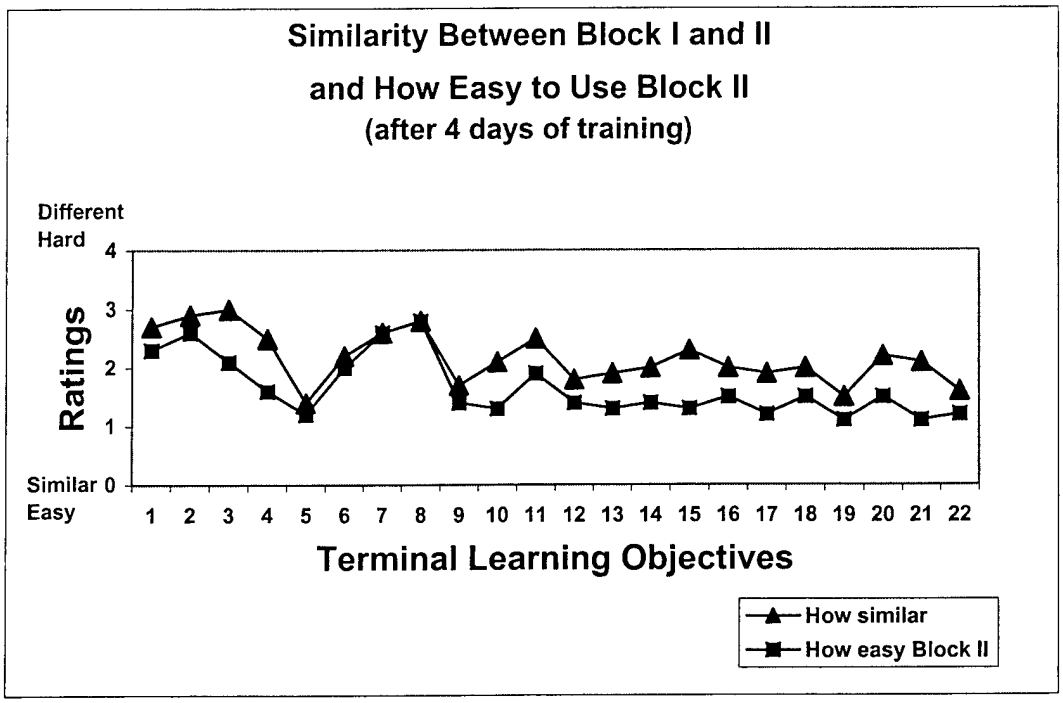
After four days of training on Block II, soldiers compared Block I and Block II for (1) similarity between the two and (2) ease of using Block II (see Figure 4). The ratings were performed for each of the 22 terminal learning objectives from 96B AIT. Predictably, tasks seen as more similar on the two Blocks were rated as easier to perform. In a related finding, trainers and trainees agreed only about 50 percent of the time on task difficulty level. This was because, as previously noted, trainers tend to focus on differences in operating the equipment, not how changes influence job responsibilities.

After using Block II for about two months, then followed by a month of non-use, soldiers again were asked to rate how different Block II was from Block I. Soldiers rated the two blocks as significantly more similar on 20 of the 22 tasks than they had after using Block II for only four days. Additionally, soldiers reported that tasks on Block II were easier than on Block I. This suggests that soldiers were comfortable with and had adapted to the upgrade.

COL (P) Lynch, former Commander, 1st Brigade Combat Team, 4th Infantry Divisions, makes similar comments in his report (2001) about lessons learned from his digital brigade.

> It is important to remember that today's soldier is extremely trainable on information technology... Remember-today's young soldiers were most likely taught computers in grade school...An amazing thing happened as we worked the individual training of our soldiers on the high-tech devices we were given. Routinely, our junior enlisted were given a basic block of instruction on how to use the technology, and then they discovered (by working through the issues) the power of technology. It was only a matter of time before the soldier knew more about the capabilities of the system than his chain of command, and his instructors, by purely experiential learning. They enjoyed the challenge of how to make the technology

work to its maximum potential. Routinely the young service members became the center of gravity on a particular piece of technology. (p. 6)



Note: Correlation between similarity rating and ease of use $r = .84$; n=14; $p < .05$.

Figure 4. Comparison of Block Block II RWS and I after 4 days of training

Recommendations

- Show soldiers how changes affect their job, rather than details about basic system operations.
- Don't teach what the soldiers already know.
- Focus on mission performance differences with short training vignettes that include the change.
- Teach soldiers to expect change and us it to their advantage.

Myth III: As systems become smarter, the job of the operator will become easier and require less training.

One justification for minimal digital training for entry-level soldiers is that future systems will be smarter and operations will become easier, and, therefore, require less training. To quote one commander, "We won't have to worry about training. We'll be using robots." If the past is any indication, systems will become easier to use, but this will be accompanied by added functions and complexity, resulting in fewer basic operations to train but additional cognitive workload. For example, the F-16 aircraft was conceived as a highly maneuverable, low-cost, austere dogfighter that was straightforward to train (Stinnett, 1989). When it finally was delivered, it had developed into a complex, suite of systems.

Discussion.

One comparison of human capability versus computer capability is chess. In chess, straightforward rules are easily programmable allowing the computer to consider millions of potential moves, their consequences, and possible countermoves. Yet, a very good human chess master can beat the digitized chess program at least some of the time. War is immensely more complex than chess. For the foreseeable future, people, with the aid of machines, will make the complex choices necessary during war.

Computer literacy has become synonymous with acquiring a "skill" such as being competent with a computer application. The Committee on Information Technology Literacy (1999) sees this as a gross underestimation of the type of expertise required for today's fast changing technology. They prefer the term "computer fluency." Computer fluency requires adapting to change by developing a firm foundation that allows independent acquisition of new skills. People who are computer fluent "are able to express themselves creatively, to reformulate knowledge, and to synthesize new information." Isn't this the goal for the objective force warrior if the Army is to realize the digital promise? Obviously this level of expertise cannot develop only during schoolhouse training, for it requires time, effort, support, and motivation over an extended period.

To quote COL (P) Rick Lynch, again:

> The critical point to remember in dealing with advanced technology, especially when it comes to warfighting, is the soldier imperative. It is all about the soldiers. We will never replace people on the battlefield. They are the folks who make the technology work, and we can never forget that. Always remember- high tech demands high touch. (p. 3)

Recommendations

- Provide the resources necessary to develop digitally fluent soldiers beginning at the entry level and continue throughout the soldiers' career.
- Integrate digital systems into everyday work routines whenever possible.
- Offer easy access to the digital systems, including training aids.
- Provide well-developed training support for the entry-level soldier to engage in self-development that sustains foundation skills while maturing digital skills necessary for job performance.

Myth IV. Soldiers see the advantages of digitization and depend on their digital systems to perform their job.

Soldiers train on evolving systems specifically designed for their unique job responsibilities. Computer bugs and system crashes are a given. At the same time, soldiers are asked to prepare to use these systems in life-and-death circumstances. One commander commented, "When I do IPB [Intelligence Preparation of the Battlefield], I take a piece of paper, draw the battlefield, and fax it to those who need it. In the time it takes me to get the information out the system hasn't even booted-up." System operators have similar doubts. They ask, "Why

do I have to use the computer when it's quicker by hand?" or "Are we going to take the contractors to war with us to keep the systems running?"

Discussion.

A group of beginner-level (step above novice) operators were asked how helpful their system would be if they had to use it in an actual conflict. None of the operators were confident that the system would be very helpful.

Interestingly, instructors reported more difficulty with system and software upgrades then did trainees. One sharp soldier was working diligently on a problem when the instructor told him that there was a bug in the new software that prevented performance. The soldier replied, "I already did it." By focusing on the problem, this soldier knew that it was important to display a piece of critical information on the map. He obtained the information he needed and drew the desired symbols freehand. Compare this behavior to the more novice soldiers who "stopped the war" while trying to decide how to plot a riot on the map because they had not been taught a symbol for "riot." Finally, they used the draw tool to write "riot" across the appropriate area.

One insightful major, observing his troops using the digital equipment to plan an operation, told them, "I depend on you to do my job, because the information that you produce is used for decisions up the line." Off-line, this commander asked why simple training aids were not available to sustain and grow these young soldiers. They don't need expensive simulation or multi-day exercises, but inexpensive, paper-based vignettes that can be completed in several hours. This leader recognized two critical training issues. First, the quality of the information produced at the lowest level significantly impacts decision making higher up. Second, developing competent digital soldiers requires well-developed training support that exposes soldiers to a variety of realistic, complex experiences over a period of time. It's like learning to play the piano. You can learn all of the keys in short order, but it takes practice with a variety of compositions to make music.

Lessons learned from the Joint Contingency Force Advanced Warfighting Experiment (Nelson, Downs, Kaniecki, & Faughan, 2000) corroborate this need for continued training to take advantage of digital systems. This report comments that: "The training units did not appear adequately trained on the ABCS systems and were not confident in their use...not adequately familiar on the ABCS systems and capabilities." (p.4) The report goes on to note that soldiers used the digital equipment more like Microsoft products that probably are more familiar to them. This should be a cue to system developers to match system functions to well-known standards (i.e., Windows) for ease of use within units and to minimize confusion across military units.

Exemplar training was observed at some units. Young soldiers would role play authentic or contrived military conflicts, working as teams to plan goals, act, and refine approaches. These mini-exercises took place in a single day or afternoon using nothing more than a battle order and a sharp unit leader/trainer. Motivation was so high that soldiers said that they willingly would use embedded training packages incorporating this type of realistic practice on their own time. Unfortunately, good training directed toward developing soldiers is not consistently supported due to factors such as limited training material, inadequate expertise, equipment unavailability, and time limitations of leaders.

Problems with trust in automation will decrease as systems become more stable and leadership more comfortable with their presence. Meanwhile, soldiers should become equally proficient in performing their job with and without digital systems. This will reinforce the power of the systems while providing the security of knowing there are fallback methods.

Recommendations

- Soldiers must do more than sustain the introductory knowledge gained in formal training if they are to leverage the system's potential to surpass manual operations.
- Leaders must support incorporating digital systems in training and exercises if soldiers are to understand when and how digitization is superior to performing manually.
- Material that supports digital skill training at the unit for beginning soldiers must be developed and distributed. Well-developed material (i.e., motivating, real-world, complex) promotes self-learning.
- Encourage system exploration so soldiers find ways to use it that were never intended.
- Leaders should support and guide impromptu discussions comparing digital and manual performance of tasks.
- Soldiers must learn immediate action drills to bring their computers back on line, just as they learn immediate action drills for their jammed weapons, disabled vehicles, and other pieces of equipment.

Myth V: Formal training (e.g., schoolhouse, NET) should focus on teaching basic operations of the equipment, not on its functional use.

Unit leaders complain that their soldiers come from training with limited understanding of the purposeful use of the system on which they were trained. As one commander stated, "Training should focus on how the machine can be used, not on the machine itself." Trainers interviewed frequently saw their role as training the equipment, claiming that they do not have time or background to do more. Some diligent trainers, often in the military or recently having left the military, attempt to interject operational knowledge at entry-level but generally, this is not part of the lesson plan.

Discussion.

Traditional Army training focuses on delivering a predetermined program of instruction primarily via instructor-led lecture and instructor-assisted practical exercises (PEs). Frequently, these PEs stress isolated aspects of performance without an operational context. Using this time-honored method, the instructor lectures about the tasks followed by soldiers practicing discrete aspects of the skills. The result is soldiers who understand the "knobology" but not how the digital system functions as a tool to enhance situational awareness and information transfer.

One illustration of what can happen when the focus is on the machine and not the job occurred at a unit short of operators. Their "solution" was to train soldiers from a different Military Occupational Specialty (MOS), where there was a surplus, to operate the equipment and produce a picture of the battlefield. Simple right? Soldiers quickly were producing great computer generated displays but with frequent errors. Uninformative displays were generated because soldiers did not comprehend the underlying task and its implications. For example, a

platoon plotted on the wrong size map caused it to appear to be spread over hundreds of miles; failure to plot certain units because operators were not specifically told to caused decisions to be made with critical data missing.

Army training is based on a "crawl, walk, run" method which assumes that soldiers must begin with very elementary tasks and progress through stages to more complex and advanced tasks. The ultimate goal is to "train as we fight" including realistic practical exercises. In practice, Army trainers have a hard time achieving that goal for digital systems. For example, some trainers in the schoolhouse interpret the "crawl stage" as including only basic operator (i.e., knobology) skills. The focus is on lectures where soldiers follow directions to make systems operate. Additionally, training on digital systems tends to be isolated from other training, thus further distancing the training from application. Focusing solely on the operational skills hinders the soldiers' understanding of how the digital system is used to achieve mission goals. When schoolhouse training concludes, the soldiers return to their unit where digital training resources often are limited in terms of expertise, self-training materials, and equipment availability. The Army by modifying its approach to digital system training can better support "train as we fight."

Figure 5 illustrates how to integrate the "train as we fight" and "crawl, walk, run" methods to improve training. As noted previously, providing short vignettes that deliver repeated crawl, walk, run exercises that are cumulative and grow in complexity can provide a more beneficial training experience.

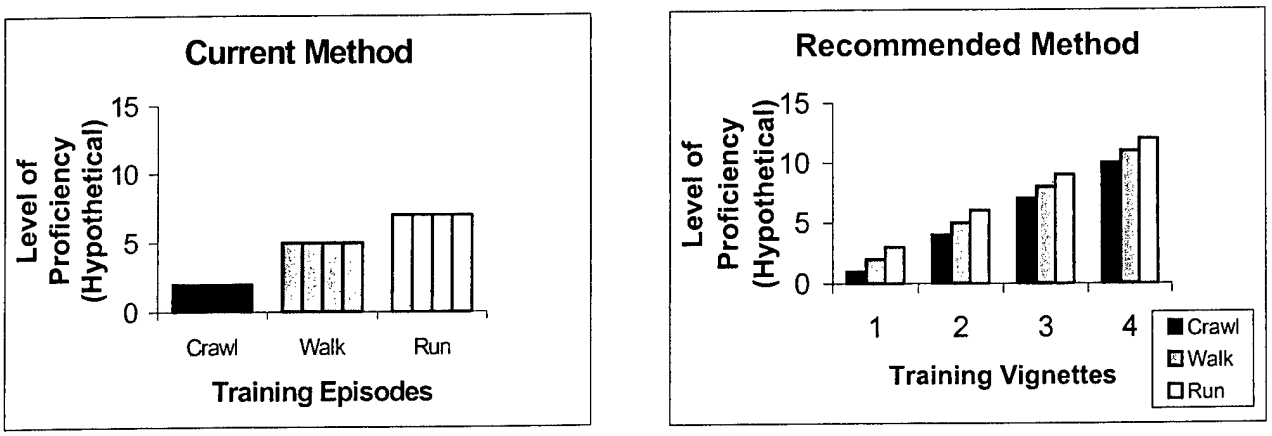


Figure 5. Current and recommended methods of "crawl, walk, run" training

Is there time to focus on both the equipment and operations in the short time allotted for training? ARI researchers developed training materials that embedded the TLOs into realistic vignettes (Schaab & Dressel, 2001). These vignettes placed the responsibility for learning on the soldier by presenting interesting problems to solve. Initially, soldiers were confused, with some wasted effort. But after the third day, these soldiers were six hours ahead of the traditionally taught classroom. In an After Action Review, soldiers commented: "This is the hardest thing we have done since coming to Huachuca." "Good PEs, they helped me to understand." "Overwhelming up front, I like it." "I liked being able to work on my own and ahead."

How could these soldiers be learning more in the same amount of time or less? There are several reasons. First, soldiers worked at their own pace. Each soldier needed to complete the

task on his or her own machine, but soldiers were able to work together and help each other. This allowed the instructor to focus his or her attention where it was needed or to challenge soldiers to consider multiple alternatives.

Second, soldiers were motivated by the realistic problems presented. For example, "Your unit is equipped with laser target designation equipment that is capable of assisting in the destruction of point targets. Assuming a 14-kilometer range for these systems, provide the S3 (Operations Officer) and FSE (Fire Support Element) with a plot of the area that your unit can observe and influence." By contrast, one traditional training program spent an entire day describing every item on the menu bar including drop down items. This prompted one soldier to ask, "Do you have a handout or something? You don't expect us to remember all of this do you?" It is difficult to remember isolated pieces of information presented out of context.

Training that incorporates both learning the machine and how to use the machine to perform the job results in better-trained soldiers who retain and transfer learning at a higher rate. One school is addressing this problem by rewriting lesson plans to incorporate both knobology and operational use. The school's innovative commander puts it exceedingly well:

> I got here and the same teaching methods were being used that I received back in '79 as a PFC 96B. I was astonished. ... We completely revamped the course. We are almost eliminating the lecture methods and going to vignettes. This is a bold move to start teaching these young warriors to think rather than memorize facts and spit them out for an exam. We also have more PEs to work these kids and put them through their paces. ... We will integrate RWS/ASAS into all of the course. Now we just teach RWS the last two weeks. We want the soldiers to use the tool more for all the tasks. Task/standards are the same, we have just changed the conditions. And it's going to be more than just buttonology- we want these kids to understand what the tools are and how they can best be used to support the intel mission (LTC Tommy Kelley, 309th MI BN Cdr).

A further need is to avoid training the same thing at the same time to all soldiers. In classroom A soldiers are forbidden to touch the keyboard until given the okay by the instructor, and then they are guided keystroke by keystroke. Bold letters on the wall in classroom B state, "DO NOT WORK AHEAD." Current practices require soldiers to move lockstep with each other, even chastising soldiers who attempt to move forward or explore a system's capabilities. This means that the slowest student sets the pace. Instructors may be responding to system unreliability that results in frequent "crashes" and long reboot times. However, soldiers need the opportunity for self-learning to prepare for the self-motivated training that becomes essential at the unit level.

Why should soldiers be encouraged to explore and learn the equipment independently? Soldiers with no previous experience on a military digital system were able to master 25 percent or more of the training objectives **before** receiving training (see Table 2). This gives the Army an opportunity to take advantage of soldiers' well-developed computer skills and strategies for understanding unfamiliar software.

NET delta training is one area where instruction that is more independent could be particularly productive. Classes often contain varying ability levels, from the complete novice to the soldier there to learn about minor software changes. Trainees comment: "We didn't need a whole week." Or, "We spent a lot of time just sitting around." Remember the wise platoon sergeant that was discussed earlier? He had his soldiers load a new software update and then let them use it to perform their job prior to NET training. This limited the amount of confusion when the new system was trained. Figure 6 shows these highly motivated soldiers as they solve a practical problem using new software for the first time. When the soldiers go to training, they plan to ask questions relevant to their needs or point out glitches, which they diligently documented. They anticipated finishing the class early.

Figure 6. Soldiers exploring software upgrade.

An example from a public high school illustrates how lockstep-instruction influences learning (Schaab, 1997). Two methods of teaching mathematics were compared. No differences were found based on instructional method. But findings did show that low ability students made less than a years' progress, average students made about a years' progress, and high ability students made about six months progress. The highest ability students made the smallest gain! These students were well ahead academically before receiving instruction and did not progress as rapidly as other students because the challenge they needed was not available. Had these students been able to move ahead, it is likely that they would have mastered the material in a shorter time period or learned more in the same amount of time.

Training activities should encourage soldiers to work independently and explore the system on their own. Research demonstrates that soldiers learn more and are more motivated when they accept responsibility for their learning (Ross & Yoder, 1999; Schaab & Dressel, 2001). In the research cited in Myth I, trainers were able to challenge soldiers who progress rapidly through the program of instruction. When a team completed a vignette and debriefed the instructor, they were asked to revisit the problem with slightly different data. For example, the

most likely course of action (COA) becomes the least likely when the adversary's reconnaissance sees U.S. Army strength gathering at the point where they planned to advance. An added advantage is that these modifications reinforce the reality that hostilities are not static. It also underscores the need to plan ahead with multiple tentative COAs.

Another benefit for the Army is a means to identify highly skilled soldiers. Currently almost all soldiers "pass" their schoolhouse examination in digital training courses. Providing means for soldiers to maximize their learning could identify those who acquire and apply their digital skills more readily than others. In the constructivist-learning environment, the skilled performer becomes obvious.

Recommendations

- Focus training on how to use the system as a tool to perform the job by embedding understanding of the mechanics of the system in realistic job experiences.
- Develop lesson plans that are flexible enough to address multiple training needs based on what soldiers do not know.
- Allow soldiers to construct their own knowledge by providing an appropriate context and guided support; this allows the soldier to:
    - Improve transfer to unfamiliar situations,
    - Develop flexible and adaptive reasoning skills,
    - Establish team coordination of problem definition and problem solving,.
    - Accept responsibility for her or his learning, and
    - Increase motivation.

Myth VI: Soldiers must train on digital systems 4-20 hours a week to sustain readiness.

If readiness means being prepared to take full advantage of digital systems should hostilities occur, the amount of training needed is the delta between where the soldier is and where he or she needs to be. Training time depends on this delta, coupled with the complexity of the system, including interactions with other systems, the capabilities of the trainee, and the type of training available.

Discussion.

Over the year that soldiers were observed, their proficiency level remained static for about seven months while they trained on two versions of the system and three software upgrades. Once soldiers settled in at their duty station, their proficiency level began to strengthen and grow. This can be attributed to having a platoon sergeant who was proficient on the digital system and saw the importance of developing soldiers to produce accurate information when needed. Soldiers trained for about four hours every two weeks, but incidental learning took place continuously as the platoon leader asked questions and promoted thinking and reasoning about military issues and their application on the digital system. Systems were accessible to soldiers, and experts were readily available to answer questions. After four months, these soldiers were able to concentrate on problem solving and really using the system as a tool rather than focusing on how to make the system work. They worked quickly and with confidence. Are these soldiers ready to perform in an actual conflict? Not yet, but they are progressing.

Having digitally proficient NCOs who are able to evaluate and grow their subordinates through formal and incidental knowledge exchanges is extremely effective. Individualized instruction (i.e., not one-to-one instruction, but instruction that focuses training at a soldier's ability level and deficit areas) by a knowledgeable leader directs training where it is needed. This often is not the case during NET training due to the wide variation in skill levels or during training provided by instructors who do not know the soldiers' strengths and weaknesses. Individualized training can be up to **five times** more influential than group instruction. Units whose NCOs are not digitally proficient, who do not have ready access to equipment, or who do not have time to train, need to look toward alternative training support. Fortunately, we have seen that young soldiers are adept at acquiring digital knowledge on their own and through peer interaction. This suggests that self-learning would be successful if soldiers were provided with motivating training support materials.

Integrated systems (e.g., Army Battle Command System) are a critical goal for the future Army. Training for this integration will create as yet unidentified turbulence. For example, the Digital Production System, developed by the Defense Mapping Agency, found that people understood their own system but had limited knowledge of other systems and how they interacted. Operators had difficulty understanding the what, why, and how of functionality beyond their own system. This resulted in unanticipated ripple effects in operator effectiveness.

Recommendations

- Developmental training materials are needed that support and expand emerging skills.
- Competent use of digital systems requires experience using the system to solve a wide variety of complex problems set in a military context.
- Successful unit training is more likely when the trainer is part of the unit and competent on the system. This allows:
    - Individualized training.
    - Spontaneous training when opportunities arise.
    - Team training that addresses potential missions.
- Be alert for unforeseen problems when systems are integrated horizontally.

Conclusions

Advanced technology increases the Army's capabilities while placing higher demands and responsibilities on our soldiers to use information wisely. Technology, under the control of knowledgeable and skilled soldiers, enables the Army to "see first, understand first, act first, and finish decisively" (COL (P) Combest, 2001).

As more and more digital systems are trained and fielded, the Army is questioning current training practices and asking, "How can digital skills be best trained to ensure maximum benefits from advanced technology?" The Defense Science Board Task Force (2000) reinforces this query by noting, "The risk exists that training failure will negate hardware promise."

Training and sustaining the digital force must be given emphasis if the U.S. Army is to realize its transformation vision. Research presented here highlights the need for training support

for newly acquired digital skills that can develop the digitally proficient soldier. Recommendations made can improve training, but more must be done to achieve the Army's vision. Distributed learning, embedded training, and web-delivered training hold promise as delivery mechanisms. Equally important are training content and user support (e.g., tailor training to individual or group needs, keep records, accommodate learning style).

Training is evolving to meet the Army's technology challenge. Like the digital systems themselves, training will crash, have bugs, and be reconfigured. This paper is an effort to shine light on the path to successful training practices and operational outcomes. Some parts of the path are well lit, others hidden by darkness and shadow, and some are yet to be recognized.

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Appendix A

Sample Practical Exercise that reviews Terminal Learning Objectives from Advanced Initial Training.

GENERAL SITUATION

I Corps has been deployed as JTF 409 to the desert nation of ARIZONEV (east of the Arizona and Nevada border). The primary mission of JTF 409 is to protect the sovereignty of ARIZONEV from the aggression by the lawless regime currently ruling CALFORN.

Over the past two (2) years thousands of ethnic Arizonevites have been killed, imprisoned, or driven from CALFORN. In the past three (3) months CALFORN forces have, without apparent provocation, conducted ground and artillery raids into ARIZONEV under the pretense of retaliation for alleged persecution of ethnic Calforns or in "hot pursuit" of fleeing criminal bands. Casualties have been high in the ARIZONEV border villages, and the deliberate destruction of homes, local industries, schools, and crops has been significant. ARIZONEV has called up reserve units, but it can only equip a force of eight (8) light infantry battalions and two (2) police security battalions with modern weapons.

Though the CALFORN National Guard (CNG) currently occupies the border with two (2) light infantry divisions (14 battalions), the 84th Mojave Ground Hussars and the 121st Granite Guards, raiding subsided upon the deployment of the US Joint Task Force. Two (2) artillery exchanges have occurred between CNG units and US artillery units resulting in the significant damage and heavy casualties to CNG units.

However, just hours ago, without warning, CALFORN deployed a heavy regiment (24th Tank Regiment, 1st Tank Division) by rail and road through the military supply depot of Yermo (11SNU155618). This deployment was a clear violation of the Armor Vehicle Exclusion Zone established by the Tiefort Agreement.

The 24th Tank Regiment is currently in a tactical assembly area East of the railhead (11SNU 270650). The regiment is capable of moving rapidly along either Highway 15 or Highway 40 reinforce or attack along the border.

SPECIAL SITUATION

You are an analyst in the Brigade S2 and have been assigned the task of supporting the brigade planning effort.

Your brigade is assigned to I Corps as an independent motorized infantry brigade. To support the planning effort a small cell of planers from the Corps G2, G3, G4, and Fire Support Element

has arrived. Augmenting the cell is an Aviation Liaison Officer from the 111th Aviation Brigade who will coordinate helicopter attack and lift resources.

Your Brigade's mission is conduct a deep attack and destroy the 24th Tank Regiment and the CALFORN logistics complex in the vicinity of Yermo. For this mission the Brigade has been allocated ATACAMS fires, OPCON of an attack helicopter battalion, as well as, Army helicopter assault and transport assets. Air Force tactical lift assets also are available.

Initial planning has outlined an operation that will be conducted in four phased:

- Phase I is an attack by fire conducted by long range missiles and attack helicopters to destroy the most western elements of the Regiment, neutralize air defenses, and disrupt command and control.

- Phase II is the securing of a blocking position and fire base vic. Elephant Mountain (11SNU097602).

- Phase III is the destruction of Yermo Supply Center (11SNU118609), Yermo Rail Yard (11SNU150615), and the Nebo Supply Depot (11SNU045590) and continued attack by long range missile, attack helicopter, and artillery of the 24th Tank Regiment.

- Phase IV is the extraction and recovery of all forces to ARIZONEV.

The objectives of the attack are:
1. Destroy or damage beyond field repair 50% of the tanks, IFVs, and artillery of the 24th Tank Regiment.
2. Reduce throughput and material handling capability of the Yermo/ Nebo rail and logistics complex by 75%.

Using the information available through the ASAS-RWS provide information and intelligence products to support the planning process and tactical decision-making.

ASAS – REMOTE WORKSTATION

REQUIREMENTS:

1. The initial Air Force strike in the target area occurred at EECT local time (101920). The Air Force Liaison Officer (ALO) has reported that a flight of 8 x F-16s have performed their egress on Air Corridor ALICE. Flight Lead reported destruction of 3 x ZIL Type Command Vans, 1 x T72 Tank, 1 x BTR-80, 2 x 2S6 30mm AA Systems and a number of utility trucks in the vicinity of 11SNU260705. Secondary explosions were reported with a number of fuel fires in the target area. Additionally, 10 confirmed 2S3 152mm SP Howitzers, 1 x 2S6 30mm AA System, and 16 x ZIL trucks were struck with Rockeye at 11SNU 230645. Good target coverage was reported with numerous secondary explosions with an estimate of heavy enemy casualties and all guns and trucks out of action.

A. What enemy units were degraded by the F-16's attack?

(1). _____

(2). _____

(3). _____

B. Determine the combat effectiveness of these units, update the database, and record your data below.

(1). _____ at _____ %

(2). _____ at _____ %

(3). _____ at _____ %

2. Three (3) Special Operations Teams have been inserted and currently occupy observation and laser designating points on the high ground around the target area. **Plot their locations** and **provide the elevation** for each point so that NO FIRE AREAS can be established.

Elevations

Team 1 – 11SNU28185259 _____ meters

Team 2 – 11SNU17176523 _____ meters

Team 3 – 11SNU38986554 _____ meters

Each team is equipped with laser target designation equipment capable of assisting in the destruction of point targets. Assuming a **14-Kilometer range** for these systems, provide the S3 and FSE with a **plot of the area** that these teams can observe and influence. Save this plot as an overlay for future reference labeled as **"SF_OBS_(your last name)"**

3. The initial company team of the ground element will seize Elephant Mountain by air assault. To assist with the timing of the assault and coordination of preparatory fires on the objective, the helicopters will hold South of Su Casa (Hill 1291) 11SNU115488. The LZ will be along the road at 11SNU089598. The start point **(SP)** for the last leg of the flight is the road and dry creek bed junction at **11SNU12304602**. The **air route** will follow the dry creek bed down **Daggett Wash** with a release point **(RP)** at the drain under Highway 40, at **11SNU08705710.**

What is the distance of this leg of the flight? _____.___ kilometers

With a planned speed of 81 knots (150 km/h) along the route, how long will the flight take from the SP to the RP?

_____ minutes _____seconds

4. Reporting on the 24th MRL battery had indicated their presence on the North side of the 24th Regiments tactical assembly area. Corps assumes that no improved munitions are in the CALFORN's inventory. At the standard range of 20,380 meters, could the unit strike the initial air assault LZ (11SNU089598) or the Elephant Mountain blocking position?

_____

Plot the range arc of the BM-21 from the last known location with a plot of the LZ at 1:250,000 scale. Save this graphic as **BM-21 Threat_ (your last name)**.

5. An extract of an agent report, dated 3 days earlier, has been faxed to the Brigade from Corps G2. The report provides details of the security at Yermo Supply Center. The text of the report follows:
"The on-site security force is a 36 man security platoon from the CALFORN Home Guard. The command center and billets for this platoon is in the wood two-story building West of the Main Gate entrance (11SNU115617). The force is equipped with small arms, 3 x AT rocket launchers, and 3 x GAZ-66 type light utility trucks mounting PKM 7.62mm machine guns. Training is poor and most soldiers have not fired their weapons in 6 months. The platoon has no night vision or thermal systems. There is a 3-man post in a wooden guardhouse at the East side of the Main Gate. A ground observation post is maintained in the South. 3 persons normally man the bunker at 11SNU115598. A single anti-personnel minefield exists from 11SNU116593 to 11SNU125596."

Plot this data and prepare it as an overlay for transmission. Name the overlay **YSC_Scty_(your last name)**.

Notify your instructor when you complete the evaluation.