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Digital Skills Training for Net-Centric Operations

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Foreword

The U.S. Army Research Institute for the Behavioral and Social Sciences (ARI) performed multiple research activities to identify training methods that enhance operations with sophisticated digital equipment. ARI collected information from Soldiers over five years to understand how "going digital" changed their responsibilities. Soldiers told of training preferences and shared their frustrations and successes while their understanding and expertise in net-centric systems evolved. Based on this comprehensive investigation, which included experimentation and field surveys, researchers developed principles and recommendations for training Soldiers to maximize their use of evolving digital systems.

Zita M. Simutis

ZITA M. SIMUTIS
Director

Introduction

As U.S. Forces transition to future battlefields, young men and women will need information technology skills to cope with network centric operations (often shortened to net-centric operations). What can Soldiers today, who depend on digital systems and electronic networks to execute their mission, tell us about training needs for the future? This report summarizes five years of research illustrating the remarkable progress made in preparing Soldiers to meet the challenges of the information age and documenting lessons learned along the way.

What Soldiers Say...

1999

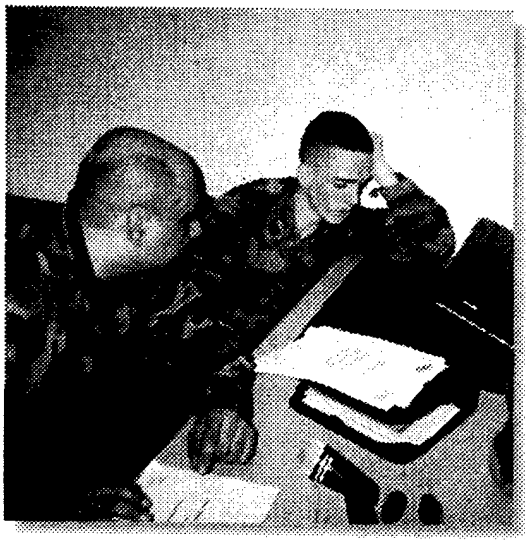
"These systems are too complex for Soldiers to learn to use."

"It's faster to do it by hand."

"We focus on the old way because the system may fail."

"We haven't changed the lesson plans because most instructors have never used the new technology."

"No one at our new unit knew the system so we had to learn by trial and error."



2003

"Communication and coordination between units is outstanding. For a refuel point, you just have to drive your symbol to the symbol of the unit you're trying to link up with."

"You can react to other platoon movements and get the best angle of attack without saying a word."

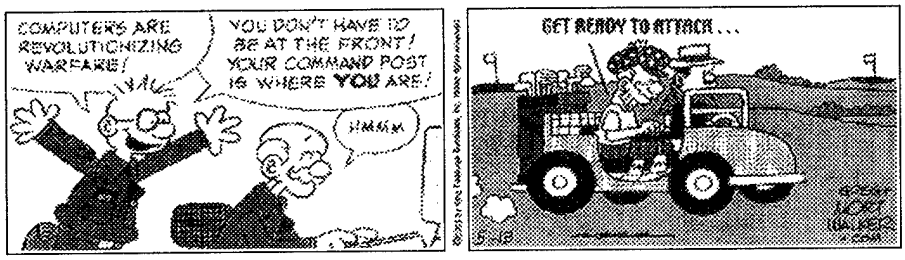
"Soldiers with more advanced field experience pass their knowledge onto people who don't know. That's how we get our best training, from our peers."

"Fratricide is reduced because we know where everyone is and they know where we are located."

"Every time that we go in the field we learn new ways to use our systems."

Soldiers in Net-Centric Operations

The concept of net-centric operations, where soldiers use digital systems that interact over an electronic network, is not new. Over 23 years ago, then Major General Paul Gorman demonstrated net-centric operations in the Command Post of the Future field exercise. His visionary commentary, *A Command Post is not a Place*, described that exercise where the commander "could call for staff briefings on demand, and from whence he could talk to key subordinates afield, or interact with his staff for estimates of the situation, or for the issuance of planning guidance or instructions."[1] General (Ret) Gorman's foresight is now reality as we saw when General Tommy Franks, Commander of U.S. Central Command,



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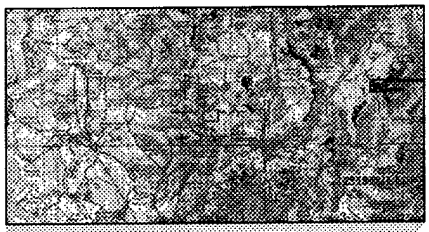
led Operation Enduring Freedom from his command center located on the other side of the world in Tampa, Florida.



Since their introduction, digital systems have undergone a dramatic evolution. Initially, developers tended to design systems that imitated the current job. For example, digital maps replaced paper maps and electronic drawing tools replaced grease pencils. As the Army learns and adapts, the new technology continues to improve. For example, electronic maps in 2003 can display additional details about a battalion (e.g., size, movement history, resources). Further, as Soldiers begin to understand the limitations and capabilities of digital systems, they use them in new and better ways. "For the potential of digital systems to be realized, leaders and Soldiers must, through trial and error, identify the best ways to operate and employ these systems."[2]

I contend that one of the differences between fighting on today's battlefield and a Force XXI battlefield is mental agility.

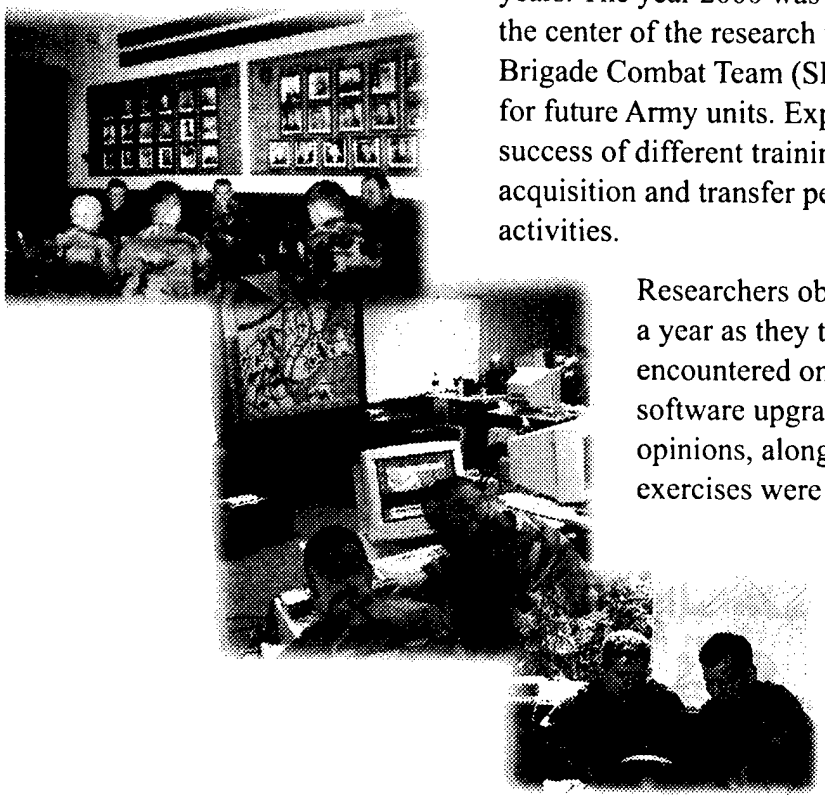
COL Rick Lynch
(Currently BG Lynch)[6]

At that point, "Soldiers have moved from trying to get the digital system into operation to trying to attain the benefits available from digitization."[3]

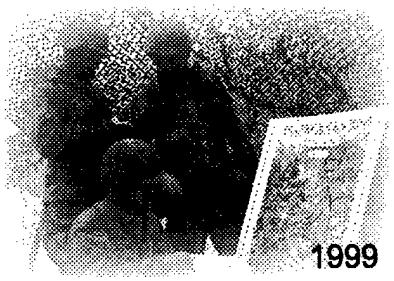
There is an evolving dependency on digital systems and the network that links forces horizontally and vertically. It fosters major changes in how quickly we can see and respond to events. "Net-centric warfare (NCW) translates information superiority into combat power by effectively linking knowledgeable entities in the battle space."[4] It changes how the Army can do its business. NCW also changes what gets trained and how. By summarizing lessons learned and best practices, this report will help future military units as they continue to transform into the information age.

Research Activities

ARI research focused on enlisted Soldiers whose military job required training and use of the Army Battle Command System (ABCS), the most advanced system currently being fielded. Research activities began in 1999 by surveying entry-level Soldiers and their instructors to gain a better understanding of the training challenges. ARI continued to survey this population over four more years. The year 2000 was of particular interest because the unit at the center of the research was becoming part of the first Stryker Brigade Combat Team (SBCT) at Fort Lewis, the prototype for future Army units. Experimental research documented the success of different training methods as measured by knowledge acquisition and transfer performance at the conclusion of training activities.



Researchers observed one group of Soldiers for almost a year as they trained on their digital system and then encountered one major hardware change and three software upgrades. Soldiers' observations and subjective opinions, along with objective data from practical exercises were documented in the research report, *Six Myths about Digital Skills Training.*[5] These myths address issues central to training complex digital systems.



Early Challenges

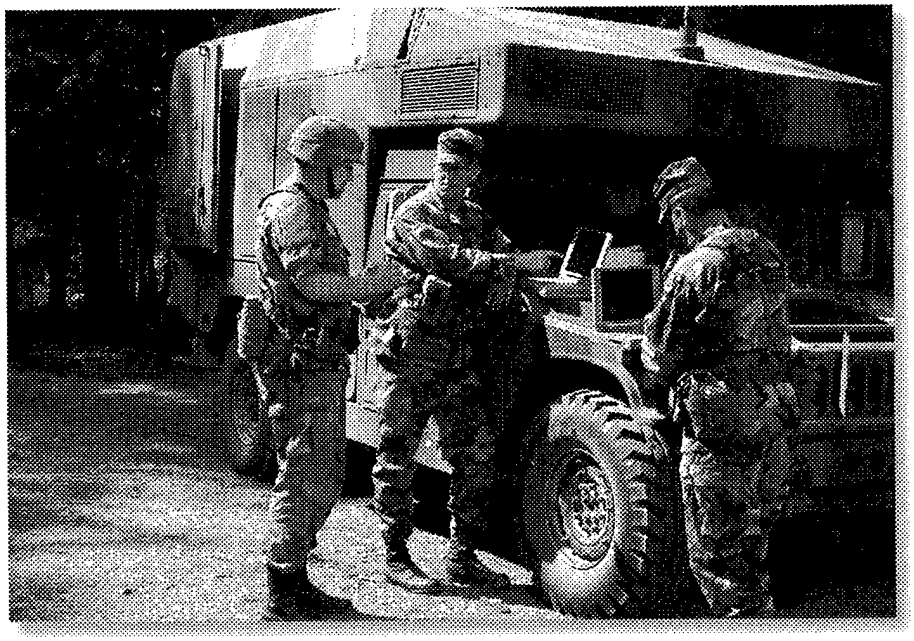
System Challenges

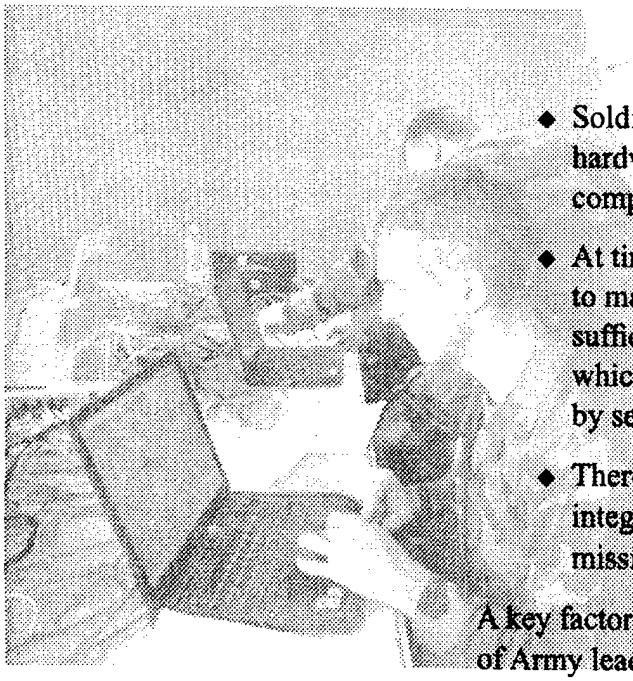
In 2001, Soldiers and leaders expressed great frustration with their digital systems. They had difficulty identifying the advantages digitization brought and were reluctant to depend on them. Computer bugs and system crashes were a given. At the same time, Soldiers were asked to prepare to use these 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 had similar doubts. They asked, "Why do I have to use the computer when it's quicker by hand?"[7]

The Challenge of Changing Attitudes

As is often the case with the introduction of new technologies and methods of operation, universal acceptance was hard to come by when digital systems were introduced into the Army.

- NCOs and officers spent years training the "old" way and were comfortable with it.
- Some commanders were unsupportive. They were suspicious of this "latest fad" and their subordinates quickly picked up on this.
- Systems that frequently failed or "crashed" added to the perception that the unit had to absorb an additional training burden that gave limited benefit.





- Soldiers did not understand that the system is more than hardware and software, but includes an essential human component.
- At times, junior-level enlisted personnel, who knew how to maneuver through the system, were viewed as having sufficient skills to fully leverage the digital advantage, which they did not. This compounded the problems created by senior NCOs and officers not wanting to change.
- There was a general lack of understanding of how to integrate the capabilities of the digital system into the Army mission.

A key factor in the gradual change in attitudes was the perspective of Army leaders. Observations and interviews conducted by retired Army personnel found differences in proficiency in operating digital systems and in taking advantage of the information provided based on the commander's perception of the contribution of technology. They concluded:

> *Unless the commander and his key assistants (executive officer, command sergeant major, staff leaders) believe and teach that a high-performing staff is a combat multiplier, the operator contribution will be neglected or underestimated. Whatever else he or she may contribute, one thing is certain—the leader's attitude will be reflected throughout the organization.*[8]

One important note is that negative attitudes toward the digital systems did not arise because Soldiers and officers were luddites with bad attitudes about technology. Surveys administered to Soldiers attending Infantry courses between 1999 and 2001 indicated increased computer use, ownership, and skills.[9] In 2001, 96% of Soldiers from three of the four Infantry courses (Advanced Noncommissioned Officer Course, Basic Noncommissioned Officer Course, and Infantry Officer Basic Course) used computers, as did 86% of those enrolled in the One Station Unit Training Course.

That finding was reinforced when, between 2001-2003, entry-level Soldiers in Army occupations requiring extensive computer use were asked to describe their experience with the technology. Over 90% of these Soldiers used the Internet and three-fourths engaged in instant messaging "some" or "a lot" at a constant level over the three years.[10] Military personnel at all levels have gained experience with computers, often doing it on their own time.[11]

However, familiarity with computers is not enough. Training challenges abound as the Army begins to understand the complexity of net-centric operations. Observations and interviews with trainers indicate that current practices "just scratch the surface" of what Soldiers need to know and understand about using their digital systems. Training challenges include, but are not limited to: Soldier, NCO, and officer training; training in Army schools; unit training; and practical application of the skills learned during training. While the Army keeps pace with technological advancements, the practical training that applies the tenets of net-centric operations is proving to be difficult.

Today's Soldiers want to assume greater responsibility for their own training. Regarding digital skills training:

- ***92% of Soldiers in Army digital units report that systems are available for training during work hours.***
- ***58% report that they have the time to train during their work day.***

Training Challenges in the Unit

In 1999, observations and interviews by ARI researchers at units recently introduced to digital systems provided a first look at the initial frustration Soldiers often encounter. It was common to hear:

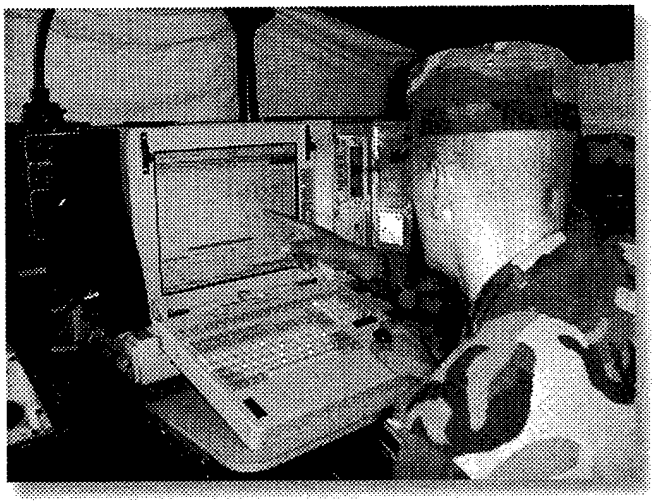
"The old way is better."

"We don't have time to train everything that Soldiers need to know AND the digital system."

"What if we lose power?"

"We call it our closet system because that's where we keep it."

"My system doesn't work."



Perishability of skills was a common complaint. Soldiers completed training, passed their end-of-course assessment, yet had difficulty operating the system when they reported to their units. Perishable implied that digital skills were acquired and then quickly decayed. However, research found that Soldiers in the observed brigade and Soldiers from three other Army posts could pass an alternative form of their final schoolhouse examination. They took the exam 3-to-4 months after completing training with no contact in the interim with the digital equipment. Skills acquired during classroom training remained intact during that time period. The belief that "digital skills are highly perishable" proved untrue.

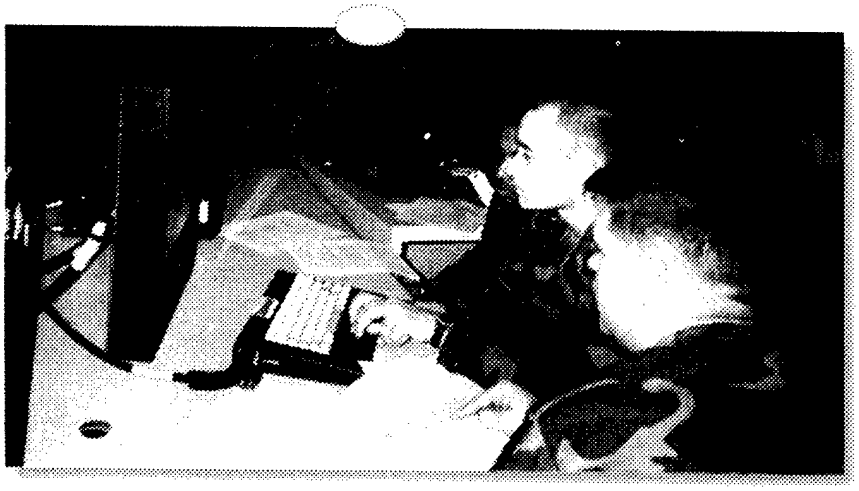
A Training Effectiveness Analysis found that many junior enlisted operators were "trained, motivated, and quite skillful" in manipulating the equipment but, "In many instances, operators needed more training on critical tasks to support operations...."[12] In addition, they found that some staff and leaders did not appreciate the capabilities of their systems and thus had difficulty understanding and using them.

PROBLEM:
The Brigade XO is focused on enemy units capable of defending, reinforcing the forward defenses, or supporting enemy offensive operations. Create an updated situational map to assist in his analysis and the briefing.

Training Challenges in the Classroom

ARI's research found that one obstruction to successful training is that classroom materials and methods tend to focus on single aspects of digital systems and do not incorporate the complexity or variety of situations that Soldiers would encounter when returning to their unit.

Trainers use lecture and demonstration to hurriedly cover huge amounts of material related to the system being trained, as if presenting information trains it. Trainers know that this is untrue, yet feel this is the only way to cover all pertinent material in the time allotted. For example, one trainer spent an entire morning lecturing, demonstrating, and describing the location and function of every item on a complex pull-down menu. One Soldier asked, "Do you have a



handout? You don't expect us to remember all of this do you?"

Trainers are proficient in operating the system but do not instruct Soldiers about how to integrate it into unit operations. Therefore, they are quite good at producing system operators, but not operators who know how to fit that system into the overall job functions. During interviews, trainers frequently indicated they saw their role as training about the equipment, claiming that they do not have the time or background to do more. Some diligent individuals, 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.[13]

Finally, some trainers view these new systems as an "add on" to their already overwhelming burden. They say they must choose between training on the digital systems and other equally essential material.

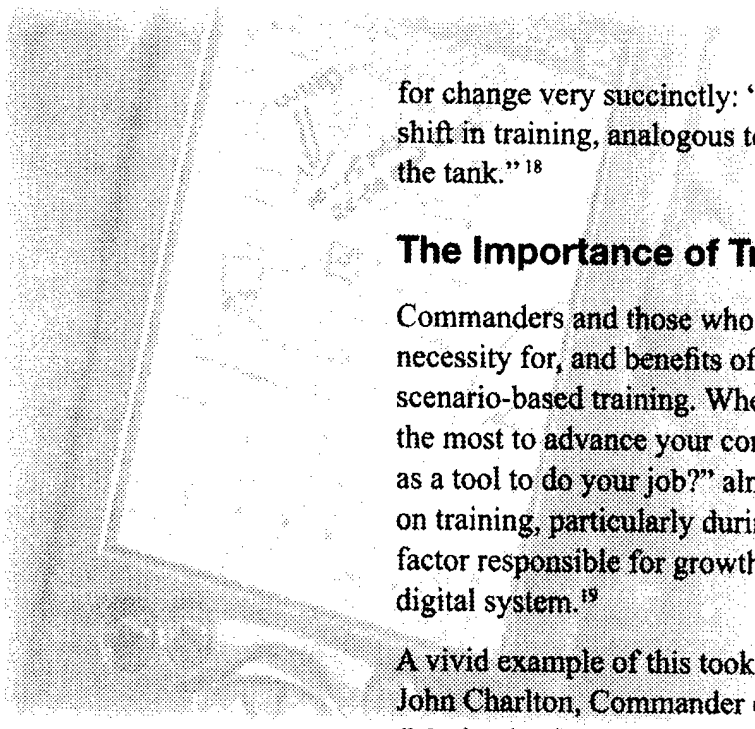
As a result of these problems, unit leaders complain that Soldiers come to them from training with limited understanding of the purposeful use of systems. As one commander stated, "Training should focus on how the machine can be used, not on the machine itself."

The Importance of Training

Everyone recognizes the importance of training to the acceptance and use of digital systems. A report on the 4th Infantry Division found that "Every Soldier interviewed expressed training as the number one priority of the digital environment."[14] An exercise with an Army Aviation Battalion Battle Staff had similar findings. "The digital equipment was used very little in the planning of Mission 1. However, all members of the battle staff were using the digital equipment much more extensively and much more effectively by the time they commenced planning Mission 3."[15] The number one comment from Soldiers: "Our biggest problem is that we need more training."[16]

Trainers recognize that changes are necessary to meet the substantial requirements needed to develop competent Soldiers for the technologically advanced Army. General Ellis stated the need

The U.S. Army is committed to leveraging technology to enhance combat power. Training soldiers to use these complex and evolving digital systems is fraught with challenges, both (a) in the systems themselves, such as dealing with frequent upgrades, system evolutions, and continuing software/ hardware problems[17] and (b) in understanding how to optimize mission success through the use of digital systems.



for change very succinctly: "Digital systems require a paradigm shift in training, analogous to transition from the horse cavalry to the tank."[18]

The Importance of Training in Context

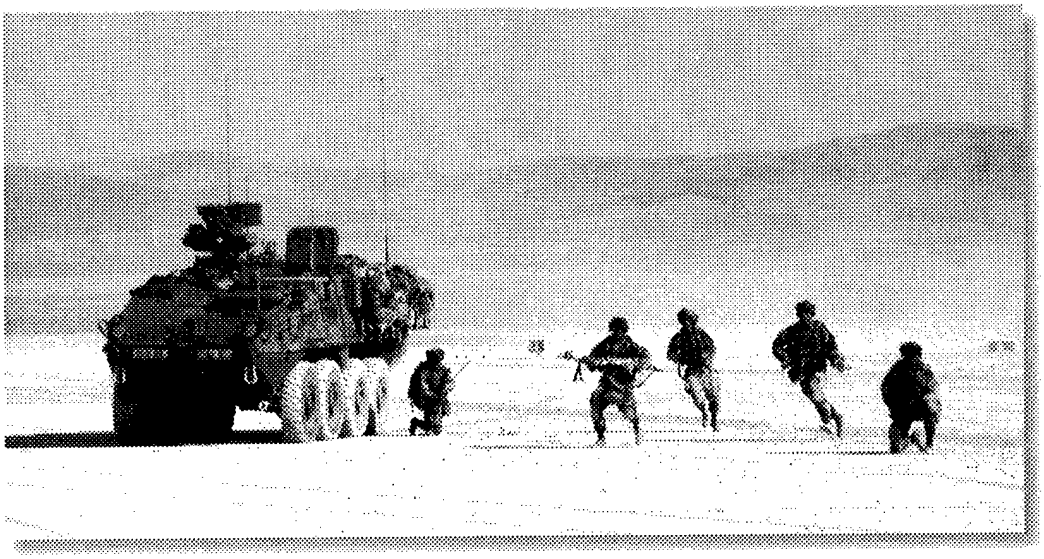
Commanders and those who serve under them recognize the necessity for, and benefits of *hands-on training*, particularly scenario-based training. When asked, "What one thing has done the most to advance your competence in using your digital system as a tool to do your job?" almost every Soldier attributed hands-on training, particularly during field exercises, as the number one factor responsible for growth in their competence to use their digital system.[19]

A vivid example of this took place in the 2003 Iraqi War. LTC John Charlton, Commander of 1-15 Infantry, 3rd Infantry Division (Mechanized), described his change of attitude toward digital systems.[20] LTC Charlton wrote of the dynamic and complex environment in which his unit operated. When the operations started, he had little experience or confidence in the FBCB2. "As a result, I fell back on my "Old School" battle command techniques of juggling maps in the turret of a Bradley. I didn't completely ignore the new system, I just didn't fight with it." LTC Charlton described how he became increasingly reliant upon FBCB2 until finally becoming a firm believer after operating in a sandstorm. As he put it, "The experience of being forced to use and rely on FBCB2 during a combat mission under impossible weather conditions completed my conversion to digital battle command. I never used another paper map product for the rest of the war and fought every fight thereafter using the FBCB2."

The importance of context in training is further underscored by how Soldiers themselves say they like to learn. As seen in Figure 1, when asked, the preponderance of Soldiers stated that field exercises are the most valuable training method for them. Gaining knowledge in an environment similar to that in which it will eventually be applied, provides a more complete picture of the function and importance of the skills being trained.

I am convinced that digital battle command is the key to success in current and future conflicts. As we look at lessons learned from Operation Iraqi Freedom, we need to embrace digital battle command and recognize its importance in twenty-first century warfighting.

LTC John Charlton[21]



Best Practices

- Personnel at the Mission Support Training Center at Fort Lewis, WA, modified their training methods to place greater focus on a handful of critical functions and trained Soldiers to perform these five or six functions adeptly. Soldiers returned to their units comfortable with their system and capable of supporting these essential functions. This level of understanding provided the confidence and knowledge for Soldiers to explore the system and collaborate with others to acquire additional proficiencies.

- Based on the findings from Army Experiment VI in 1999, and the support of General Dubik—former Deputy Commanding General for Transformation, I Corps—Fort Lewis developed a training program using vignettes as a low-cost way to teach adaptive problem solving. Soldiers were provided with a description of the current situation and were guided by their leader as they planned for evolving circumstances and considered the appropriateness and possible consequences of various courses of action. For example:

  Current Situation: The 1st BDE IBCT has been alerted for deployment to Bolivia to assist in reestablishing the Bolivian government back from the Drug Cartel's control…The Drug cartel has the ability

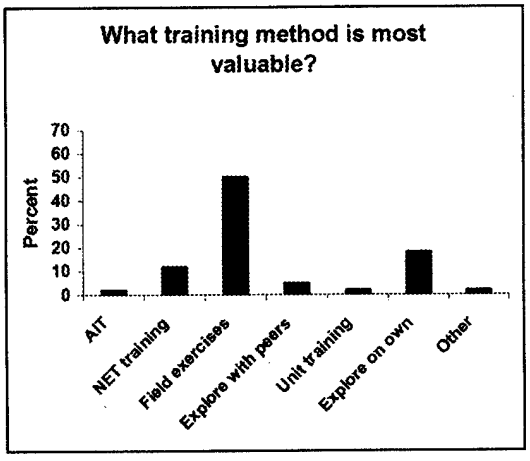


Figure 1. Soldier Preferences for Training Methods

> to restrict movement and will place anti-personnel and anti-tank mines in the sector that you are going to enter... It is currently during the wet season with constant down pour of rains.

Although this novel approach was developed for leadership training, one resourceful platoon sergeant saw the benefit in this technique and adapted it for his troops.

- Research by Ross and Yoder[22] at the US Army Command and General Staff College integrated the training of computer skills and tactical skills rather than training each in isolation. This approach was highly successful in that students mastered the objectives of tactical skills training and how to operate their digital system in the same time it had taken to train the tactical skills alone. In addition, retention of learning was reported to be high. Instructors, appreciating the success of this research, incorporated these training methods into other courses. Key features included:
  - Dramatically reduced instructor presentations with increased time in scenario-based problem solving;
  - Limited demonstration of the digital system to those tasks needed to solve the problem;
  - Instructors acting as mentors; and
  - After action reviews where students briefed and discussed their solutions.
- Schoolhouse training was transformed at Fort Huachuca. All instructors understood how to operate the Army's digital system. This allowed them to integrate multiple training methods into the program of instruction. For example, Soldiers learned to interpret information on both a paper map and from a map that can be manipulated simultaneously on a computer screen. This strengthened the interrelationship of old and new technologies and made learning more meaningful.

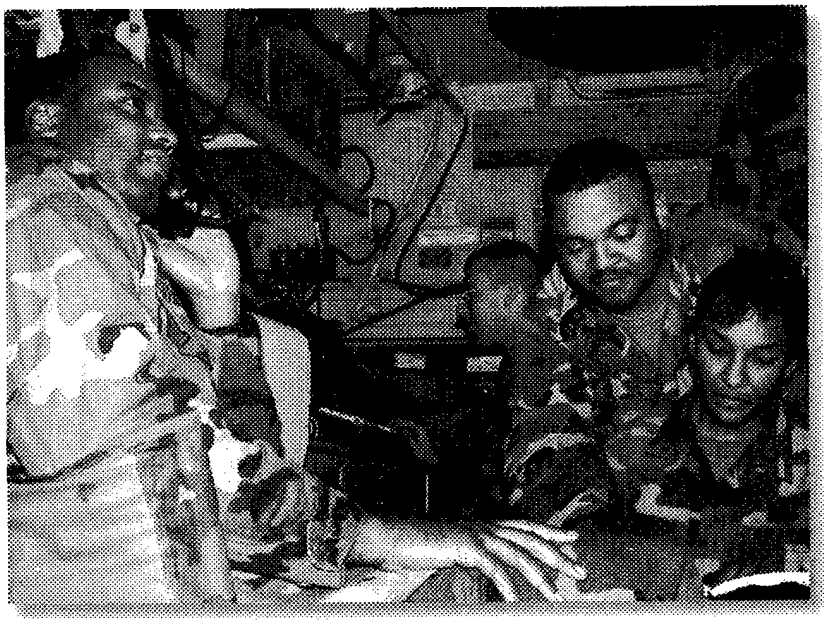
- Unit training at Fort Bragg, NC was enhanced when a platoon sergeant used a digital map of Kosovo, a potential deployment destination, as a training tool to query his Soldiers about possible missions. Soldiers eagerly discussed temperature, terrain, local culture, and likelihood of hostilities.

The Success of Training in Groups

In the classroom, Army trainers recognize the benefits of small-group instruction (SGI) and cooperative learning. SGI is defined as: A means of delivering training that places the responsibility for learning on the Soldier through participation in small groups led by leaders who serve as role models throughout the course. Learning is individualized, team building enhanced, and idea exchange maximized. A Small Group Leader (SGL) facilitates role modeling, counseling, coaching, learning, and team building.[23] The role of the trainer using SGI is more demanding than lecture, but not, as many expected, more time consuming. The reward is Soldiers who actively participate and create a better training experience.

Cooperative learning involves forming small groups that are composed of individuals with varying levels of ability. Team members know that they are not only responsible for learning the material being taught, but also helping those in their group learn. Cooperative learning works because trainees become cognitively engaged. The benefits of this approach, include:

- Feedback and debate motivates learners to find better solutions;
- Interactions refine cognitive processes such as verification and evaluation; and
- Collaboration encourages flexible thinking and generation of ideas.[24]



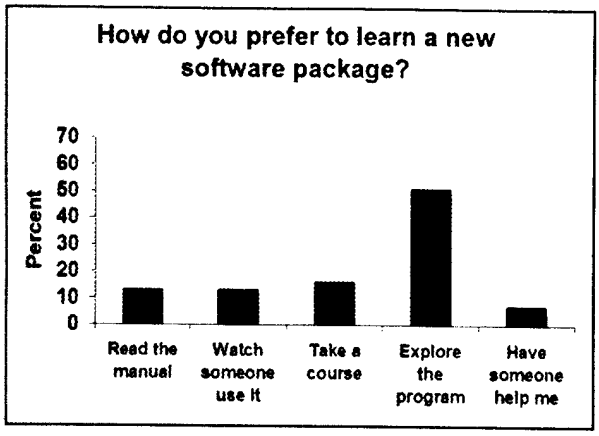


Figure 2. Soldier Preferences for Learning New Software

Another benefit of SGI and cooperative learning is that they allow Soldiers to learn through application and discovery. Knowledge and insights that are gained through "doing" are often better retained in the long run. In fact, as seen in Figure 2, Soldiers themselves apply this technique when learning new computer programs. Rather than reading the manual or taking a course, most report that they explore the program to learn its various functions and applications. Working cooperatively in small groups encourages this type of exploration and discovery.

Best Practices

- Research by Schaab and Dressel, using Soldiers enrolled in Advanced Individual Training at Fort Huachuca, demonstrated the success of a training method that used SGI.[25] Soldiers were required to work in small groups on a series of practical exercises that stressed using problem solving to accomplish all the required tasks, including the most complex and difficult tasks. Success hinged on instructors changing from lecturer to mentor. By combining subject-matter knowledge with positive coaching techniques, the instructor was able to shape and enhance performance dramatically as he/she facilitated the learning experience for the Soldiers. At the same time, Soldiers gain the experience needed to learn and solve problems on their own.
- Soldiers trained using this alternative method were significantly more successful in applying what they learned to a novel set of problems. The training method was as important as the training content. Working as a team, a basic Army concept, was an advantage.
- SGI in the Armor Captains' Career Course was compared to SGI in a virtual learning environment that included small group work in real-time with collaborative peer interaction, instructor facilitation, and practical application of knowledge. Well developed Web SGI was as effective as institutional SGI in maintaining group cohesiveness, learning effectiveness, and motivating Soldiers.[26]

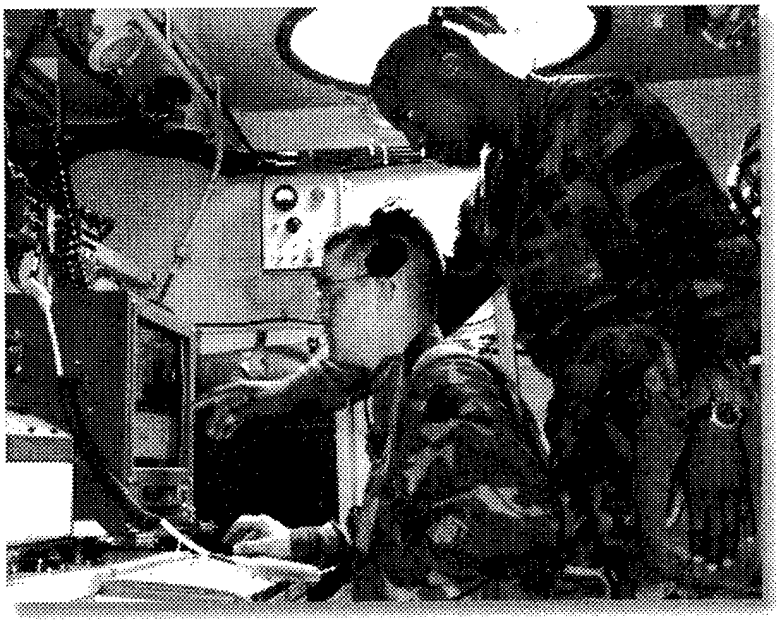
Lessons Learned

Training Soldiers simply to get their digital system into operation should not be the goal of training. The goal is for Soldiers to use the system to maximize information acquisition and exchange for a better understanding of the situation. Training Soldiers to "push the buttons" is the easy part. Soldiers repeatedly say that understanding how to apply that knowledge is much more difficult. There are, however, a variety of approaches to aid this competency.

- Provide leadership with an understanding and appreciation of the benefits of digital systems for mission success.
- 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 and do not know.
- Provide an appropriate context and guided support that allow Soldiers to construct their own knowledge and skills. This increases motivation and allows the Soldier to:
  - Improve transfer to unfamiliar situations;
  - Develop flexible and adaptive reasoning skills;
  - Establish team coordination of problem definition and problem solving; and
  - Accept responsibility for her or his learning.

In a digitally complex environment, Soldiers must be trained to think through problems and situations. There are several methods available to accomplish this.

- Present instruction in the context of realistic situations.



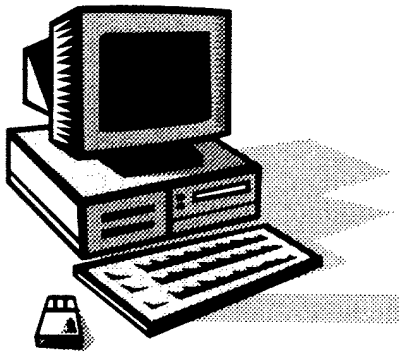
- Develop scenario-based problem solving to promote cooperative learning.
- Use the instructor as mentor/coach to provide guided practice.
- Carefully design the instruction and instructional material to keep the learner actively engaged.
- Incorporate complex training material that forces Soldiers to react and think about what they are doing and why.
- Build on what the Soldier already knows.
- Train self-development skills so Soldiers assume responsibility for continued development at the unit.

Emerging Issue: Building Digital Collaboration

Training Soldiers to competently exploit their own digital system in a variety of situations is not the final goal. Soldiers are part of a net-centric operation. They must interact with others and data from others for mission success. This interaction or transmission and distribution of products among members on the network means that teams must be built and skills practiced so that they can properly handle the digital information.

Soldiers trained solely on their own system have difficulty interacting with other Soldiers using different systems, and during field exercises did not perform at the highest levels.[27] For example:

- "We had all the information that we needed to act, but we didn't know that it was there. If we had accessed another menu we could have gotten the detailed report with the information we needed."
- "We were ready to fire but didn't get the intelligence in time to do so. We missed the opportunity to hit the enemy."



To confirm their observations, ARI researchers conducted an experiment using a Command and Control game.[28] Participants were trained either on (a) their own role or (b) both their role and their ally's role in the game. Training time was held constant for

both groups. Findings indicated that participants trained on both roles performed significantly better in the game than those trained only on their own.

A Command and Control Research Program workshop noted that "lack of shared knowledge/understanding" was a major barrier to effective collaboration and interoperability. To overcome this, workshop participants recommended expanding "knowledge of each others' mission, structure, processes, and practices."[29]

Unfortunately, interoperability continues to be a problem. In January 2003, only 34 percent of the Soldiers interviewed ever exchanged information with another Army digital system. However, even on those occasions where digital interoperability occurred, problems plagued the system. Researchers heard comments such as:

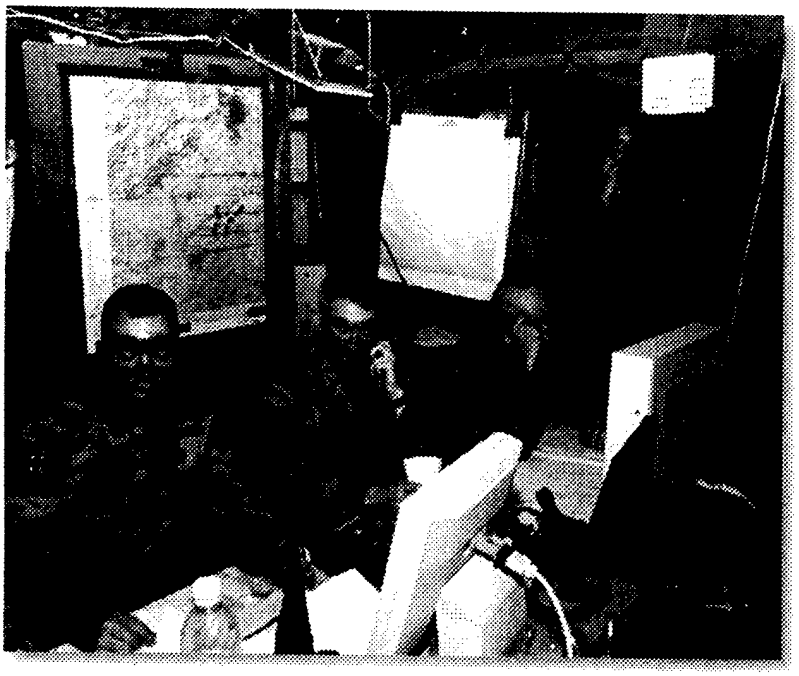
- "We have entire exercises on using and integrating systems. The push is *digital*. The problem with this is that if the digital isn't working, we go no further. None of our new Soldiers has the fundamentals of what really goes on in the [Tactical Operations Center] TOC. We have done no scenario-based training, only digital."
- "The problem we face is that when systems are working together and attempt to share data, systems fail. Answers are found by accident and experimentation."
- "Our units kept repeating steps and hoping that the networks would connect."
- "Our system will not receive sent messages from other systems if the system is turned off. The messages will not be stored and received after the system is turned on. The problem hasn't been solved yet."

The information gained from these field observations, experiments, and other research indicates optimal performance on tasks that require timely sharing of information will more likely occur only when participants are familiar with each other's roles.

Information technology is the only military weapon system that operates at the speed of light and while that rapid flow of information has helped reduce the "fog of war," much work remains to be done.

MG Franklin Hagenbeck[30]
(Currently LTG Hagenbeck)

Major General Paul Eaton, Chief of Infantry at Fort Benning, GA, likened the new capabilities in the TOC—specifically for the Stryker brigade—to the improvement in communications technology gained between World War I and today.



Best Practices

Army personnel, particularly those observing training exercises, recognize the need for Soldiers to gain some understanding of how their role influences others and vice versa.

- The Mission Support Training Facility at Fort Lewis required their instructors to complete courses on all of the Army Battle Command System (ABCS) systems in order to gain an understanding of the system interrelationships.
- The ABCS Training and Integration office at Fort Hood developed an electronic overview that described ABCS and how the capabilities worked together.
- Soldiers reconfigured the TOC so that systems that need to exchange information were located next to each other. Soldiers instructed each other on what information needed exchange. In one TOC, Soldiers became proficient in multiple digital systems through observation and peer cross training.
- An emerging tool that holds promise is the Sustainment Portal. This digital training support package links training publications, online interactive multimedia instruction, scenario-based simulations, and learning management systems using Army Knowledge Online. The goal is to achieve an efficient and cost-effective way to establish, integrate, and maintain "living" training products and globally distribute simulation-driven packages that individual Soldiers, unit commanders, and school commandants can adapt, modify, and reuse to satisfy their unique training needs.[31]

SBCTs are considerably more complex than existing brigade combat teams and require a different approach to individual, leader, and collective training to truly capitalize on their inherent capabilities.[23]

Lessons Learned

- Stovepipes blocked victory. A Soldier's job required more than understanding one system. The Soldier must know how his/her individual system interacts with rest of the network.
- Training must begin with an overview of the entire system and a Soldier's role within that system. Interacting with other systems must be introduced early in training and be an integral part of sustainment training.

Know What You Know

In this digital age, a Soldier must be able to accurately evaluate his or her readiness to carry out battlefield-type digital procedures in the field. Soldiers must understand where their expertise ends and when they should seek additional information. Self-knowledge will become even more critical in the future Army.

Research shows that Soldiers just acquiring expertise tend to overestimate their abilities.[32] Soldiers in a training course for digital skills were asked to rate how prepared they were on the Terminal Learning Objectives (TLOs) taught in that program of instruction. Self-ratings were gathered directly after instruction. Soldiers were then administered an exercise to determine how well they actually performed the tasks that they rated. In all cases, Soldiers saw themselves as more proficient than they actually were. Even more unsettling, instructors also rated trainees as "ready to go" on all tasks.

These findings are typical of persons just acquiring knowledge. Novices tend to think they understand how to solve a problem, yet often their solution is incorrect. Why does this occur? One group of researchers provides the following explanation:

> *The skills needed to produce correct responses are virtually identical to those needed to evaluate the accuracy of one's responses. The skills needed to produce logically sound arguments, for instance, are the same skills that are necessary to recognize when a logical sound argument has been made. Thus, if people lack the skills to produce correct*

Real knowledge is to know the extent of one's ignorance.

Confucius

answers, they are also cursed with an inability to know when their answers, or anyone else's, are right or wrong.[34]

Interestingly, these researchers found that skilled performers, while accurately assessing their own performance, tended to overestimate the performance of others. Overestimating the abilities of your colleagues can cause disaster in military environments. For instance, during a military exercise newly trained Soldiers enthusiastically received messages, processed the information, and sent it to their commander. Their commander accepted and acted upon this information as if it were "good." Only after the exercises, did they realize they were processing summary information and that critical details were at another location on their computer. One aggravated Soldier commented, "We had all of the information that we needed to win, but didn't know where it was."

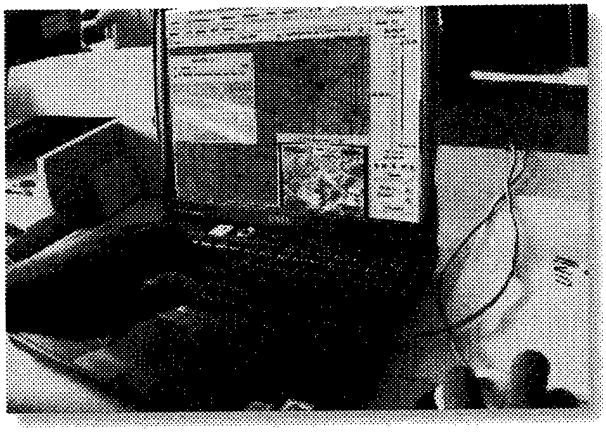
Fortunately this tendency of skilled performers to overestimate others' competence can be remedied by having a proficient individual critically observe the actual performance.

Best Practices

- Soldiers provided solutions to problems presented in short vignettes by working in small groups. These were then debriefed to the class. During debriefings, peers and instructors interacted to debunk misconceptions and consider alternative solutions. Soldiers developed better perceptions of their own expertise.

Lessons Learned

- Small group problem solving, with the instructor acting as mentor, leads to Soldiers who are better at evaluating their expertise.
- Soldiers need sufficient benchmarks for required performance during the training course. They need to see what good performance looks like so they can assess how they measure up.



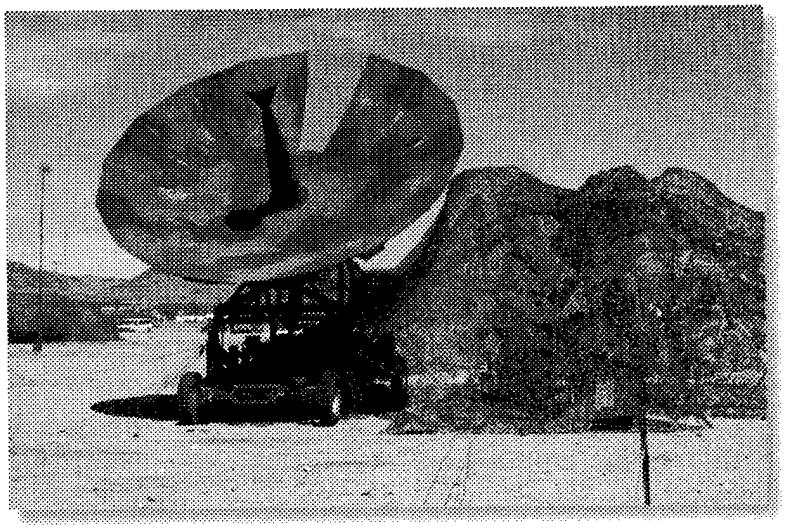
Summary and Conclusions

Transformation not only revolutionizes the way the Army operates, it necessitates reforming the way we train to prepare Soldiers for the future. The implications of transformation are numerous and yet sometimes not obvious. For example, operation of multifaceted digital technology systems and management of the critical information flow initially was seen as a low-level responsibility delegated to entry-level Soldiers. Soldiers received several weeks of training and were erroneously deemed "good to go."

Over several years, dramatic changes took place. Initially Soldiers and leaders were skeptical and ill prepared to meet the demands of a digital unit. Trainers focused on using lectures and demonstrations to instruct, when in fact the tasks required a great deal of hands-on interaction with the equipment. Leaders were resistant to change to a system in which they had little confidence or experience. They did not understand the capabilities and limitations of the technology, and therefore did not and could not maximize its potential. Consequently, they were unable to mentor subordinates on the best ways to use the digital systems.

In different ways, this report documents an overarching theme: *We underestimate the complexity of leveraging technology.*

Now, Soldiers and leaders who have worked with digital systems over the past few years support the powerful advantages that technology provides. Digital systems are no longer viewed as add-ons, but are as much a part of the landscape as the M-16. But three years is much too long for successful development of digital skills in units. Lessons learned can assist others in increasing the pace of transformation to digital systems. Trainers who work closely with units have been able to adapt and modify their methods to produce more powerful instruction. Soldiers at varying levels of ability are able to help each other advance. NCOs, frequently on their own time, mastered their digital system challenges. Leaders at all level are beginning to understand the leverage that digitization provides in situational awareness and decision making.



Soldiers, not technology, are the key to continued superiority.

BG(r) Huba Wass de Czege[35]

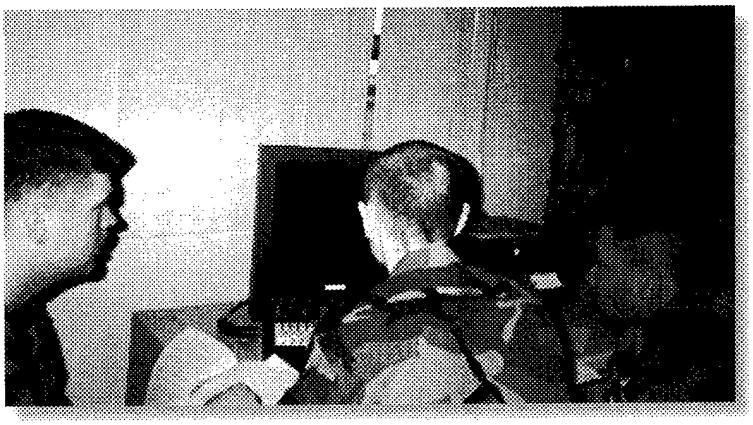
Are We There Yet?

> *"But to date we have been only scratching the surface of what is possible. A great deal of what has been done is "picking low-hanging fruit" by direct application of new technology with existing practice. Progress is also "hit and miss," in that progress has not been systematically achieved across the board. Hence we have only begun to take advantage of the opportunities afforded by rapidly advancing information technology."*[36]

No, clearly we are not there yet. However, this report indicates the progress made and presents a number of training recommendations. These recommendations can aid in training Soldiers to maximize their understanding and use of evolving digital systems thereby reducing the difficulty and increasing the speed of the continuing transformation to digital interoperability in the information age.

What Soldiers Learned

Soldiers told us what they found to be the most successful ways to master their digital systems plus additional insights. These include:

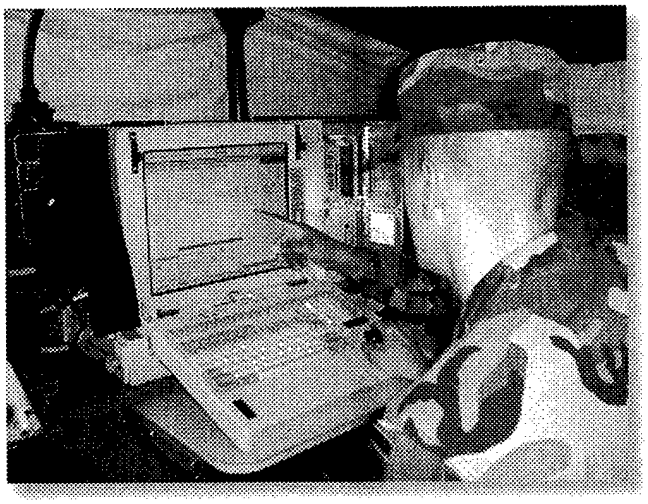


- Hands-on training, preferably during field exercises was the best way to learn.
- While in a field training exercise, Soldiers perform their jobs as a cooperative member of a team.
- Working with a knowledgeable peer was helpful.
- Soldiers seek more opportunities to advance their knowledge and expertise but training support material is limited.
- Technology helps them do their job.
- Soldiers must understand how to integrate digital information from the other digital systems and combat operations.

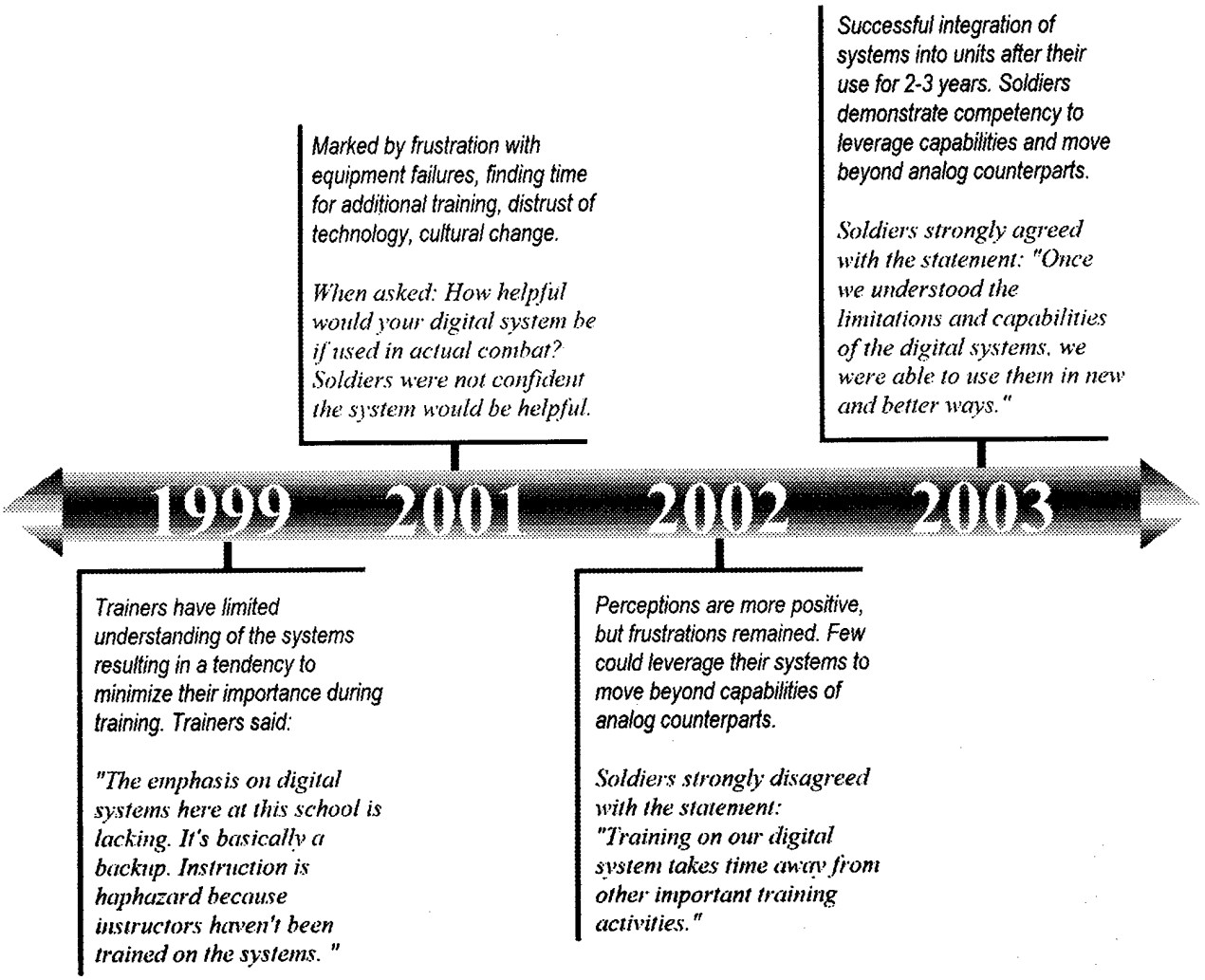
What Trainers Learned

Experienced motivated trainers developed more effective means to train. These include:

- Incorporating digital systems into every aspect of training making it a "routine" part of the job.
- Integrating knowledge of all systems and how they interrelate at the beginning of training and online.
- Developing training tools such as AFATDS and FBCB2 distance learning programs that provide both previews of the systems and refresher information.
- Utilizing complex scenarios at all levels of training to expand adaptable thinking.
- Using SGI that enables individualizing training to focus on deficient areas while providing relevant feedback.
- Promoting self-development by providing opportunities for peer training, web-based training, and good training support materials.



A Timeline...


1999
Trainers have limited understanding of the systems resulting in a tendency to minimize their importance during training. Trainers said:
"The emphasis on digital systems here at this school is lacking. It's basically a backup. Instruction is haphazard because instructors haven't been trained on the systems. "
2001
Marked by frustration with equipment failures, finding time for additional training, distrust of technology, cultural change.
When asked: How helpful would your digital system be if used in actual combat? Soldiers were not confident the system would be helpful.
2002
Perceptions are more positive, but frustrations remained. Few could leverage their systems to move beyond capabilities of analog counterparts.
Soldiers strongly disagreed with the statement: "Training on our digital system takes time away from other important training activities."
2003
Successful integration of systems into units after their use for 2-3 years. Soldiers demonstrate competency to leverage capabilities and move beyond analog counterparts.
Soldiers strongly agreed with the statement: "Once we understood the limitations and capabilities of the digital systems, we were able to use them in new and better ways."

End Notes

[1] Gorman, P. (1980). *A command post is not a place.* Retrieved from Institute for Defense Analysis Web site: http://www.ida.org/DIVISIONS/sctr/cpof/CPnotPlace.pdf, p. 9.

[2] Dudley, M. G., Johnston, J. C., Jones, W. S., Strauss, C. P., & Meliza, L. L. (2001). Making the transition from analog to digital warfighting: Changes in unit behavior and knowledge. (Research Report 1785). Alexandria, VA: U.S. Army Research Institute for the Behavioral and Social Sciences, p. 2.

[3] Ibid. p. 16.

[4] Alberts, D. S., Garstka, J. J., & Stein, F. P. (2000). *Network centric warfare: Developing and leveraging information superiority.* Washington, DC: C4ISR Cooperative Research Program, p. 2.

[5] Schaab, B. B., & Moses, F. L. (2001). *Six myths about digital skills training.* (Research Report 1774). Alexandria, VA: U.S. Army Research Institute for the Behavioral and Social Sciences.

[6] Summary of Interview following a training exercise, 21 April 1999

[7] Schaab, B. B., & Moses, F. L. (2001). Six myths about digital skills training. (Research Report 1774). Alexandria, VA: U.S. Army Research Institute for the Behavioral and Social Sciences. p. 9.

[8] Cox, J. A., Leibrecht, B. C., Holder, L D., & DeRoche, L. (2002). Training Digital System Operators for the Objective Force. (Research Note). Alexandria, VA, :U.S. Army Research Institute for the Behavioral and Social Sciences. p. 34.

[9] Dyer, J. (May, 2003). The computer backgrounds of soldiers. ARI Newsletter, Alexandria, VA: U.S. Army Research Institute for the Behavioral and Social Sciences.

[10] Schaab, B. B., & Dressel, J. D. (2003). Training the Troops: What today's soldiers tell us about training for Information-Age Digital Competency. (Research Report 1805)). Alexandria, VA: U.S. Army Research Institute for the Behavioral and Social Sciences.

[11] Felton, R. J., Schaab, B. B., & Dressel, J. D. (2003). Training requirements of Battle Staff NCOs in digital units. (Study Report 2003-01).). Alexandria, VA: U.S. Army Research Institute for the Behavioral and Social Sciences.

[12] Laferriere, R. R., Vargas, D. K., Barrett, R. D., Maj. Gen (2002). Division capstone exercise: training effectiveness analysis. Technical Report TRAC-WSMR-TREA-02-019, p.v.

[13] Schaab, B. B., & Moses, F. L. (2001). Six myths about digital skills training. (Research Report 1774). Alexandria, VA: U.S. Army Research Institute for the Behavioral and Social Sciences, p.11.

[14] Dudley, M. G., Johnston, J. C., Jones, W. S., Strauss, C. P., & Meliza, L. L. (2001). Making the transition form analog to digital warfighting: Changes in unit behavior and knowledge. (Research Report 1785). Alexandria, VA: U.S. Army Research Institute for the Behavioral and Social Sciences, p. 28.

[15] Howse, W. R., & Cross, K. D. (1999). Use and management of digital information by Army aviation battalion battle staff members. (Study Report 99-01). Alexandria, VA: U.S. Army Research Institute for the Behavioral and Social Sciences, p. 58.

[16] Schaab, B. B., & Dressel, J. D. (2003). Training the Troops: What today's soldiers tell us about training for Information-Age Digital Competency. (Research Report 1805). Alexandria, VA: U.S. Army Research Institute for the Behavioral and Social Sciences.

[17] Krygiel, A. (1999). Behind the Wizard's Curtain: An Integration Environment for a System of Systems. C4ISR Cooperative Research Program. Retrieved from the Command and Control Research Program Web site: http://www.dodccrp.org

[18] Memorandum for Deputy Chief of Staff, G8, 201 Army Pentagon, General Larry Ellis, Commanding, Department of the Army, Headquarters U.S. Army Forces Command. 24 March 2003.

[19] Schaab, B. B., & Dressel, J. D. (2003). Training the Troops: What today's soldiers tell us about training for information-age digital competency. (Research Report 1805)). Alexandria, VA: U.S. Army Research Institute for the Behavioral and Social Sciences.

[20] Charlton, J. W. (Jan 15 2003). Digital Battle Command Baptism by Fire: My Conversion to Digital Battle Command. Infantry Online. http:www.benning.army.mil/OLP/InfantryOnline/Issue_34/art_233.htm.

[21] Ibid.

[22] Ross, K. G., & Yoder, K. R. (1999). Producing computer literacy for digitized battlespace of the future. Proceedings of the 1999 Interservice/Industry Training, Simulation, and Educational Conference, Orlando, FL.

[23] United States Army. Training and Doctrine Command (1995). TRADOC Regulation 350-70: Training development management, processes, and products. Ft. Monroe, VA: Author.

[24] Slavin, R. E. (1996). Research on cooperative learning and achievement: What we know, what we need to know. Contemporary Educational Psychology, 21, 43-69.

[25] Schaab, B., & Dressel, J.D. (2001). Training for adaptability and transfer on digital systems (Research Report 1782). Alexandria, VA: U.S. Army Research Institute for the Behavioral and Social Sciences.

[26] Wardell, C. S. & Paschetto, G. (2001). Small group instruction in real-time over the web. Proceedings of the 2001, Interservice/Industry Training, Simulation, and Educational Conference, Orlando, FL.

[27] Schaab, B. B., & Moses, F. L. (2001). Six myths about digital skills training. (Research Report 1774). Alexandria, VA: U.S. Army Research Institute for the Behavioral and Social Sciences.

[28] Schaab, B. B., & Dressel, J. D. (2003). Training implications for shared situational awareness in net-collaborative environments. Paper presented at the 15th annual convention of the American Psychological Society, Atlanta, GA.

[29] Enabling Effective Collaboration in Military Organizations, (3-5 April 2001). Workshop summary {on-line}. Available: http://www.dodccrp.org/collaboration_ws/

[30] Defense IT leaders outline challenges, Federal Computer Week, 8 May 2003.

[31] Conway, P. W., CW5 (2003). The Sustainment Portal-Virtual Technology for Transformation. Army Logistician.Retrieved from U.S. Army Logisitcs Management College web site: http: //www.almc.army.mil/alog/July_Aug_InsCov.htm

[32] Rittman, A., & Schaab, B. (2000). Soldiers' self-assessment of performance in a digital training/learning environment. Paper presented at the annual midyear symposium of the American Psychological Association's Division of Applied Experimental & Engineering Psychology and Division of Military Psychology, Ft. Belvoir, VA.

[33] Key Transformation and Unit Set Fielding Lessons, Transformation Conference, Fort Lewis, WA, January 2003.

[34] Dunning, D., Johnson, K., Ehrlinger, J., & Kruger, J. (2003). Why people fail to recognize their own incompetence. Current Directions in Psychology, 12, p. 83-87.

[35] Wass de Czege, H., & Biever, J.D. (2001). Six compelling ideas on the road to a future Army. Army Magazine, 51(2), 43-48.

[36] Alberts, D. S., Garstka, J. J., Hayes, R. E., and Signori, D. A. (2001). Understanding information age warfare. Washington, DC: DoD Command and Control Research Program.

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14. ABSTRACT *(Maximum 200 words)*:

Multiple research activities identified training methods that enhance Army net-centric operations where Soldiers use sophisticated digital systems that interact over an electronic network. Researchers collected information from Soldiers over five years, from 1999 to 2003, to understand how "going digital" changes responsibilities and training needs. Soldiers documented training preferences and shared frustrations and successes as their understanding and expertise evolved over time. This special report presents principles and recommendations, including supporting evidence from extensive experimentation and field surveys, for training Soldiers to maximize their use of digital systems. Results should help Soldiers to increase the speed and the ease of transformation to net-centric operations.

15. SUBJECT TERMS

Training, Training Methods, Training Effectiveness, Computer Skills, Digital Skills, Net-centric Operations, Collaboration, Transformation, Situational Awareness

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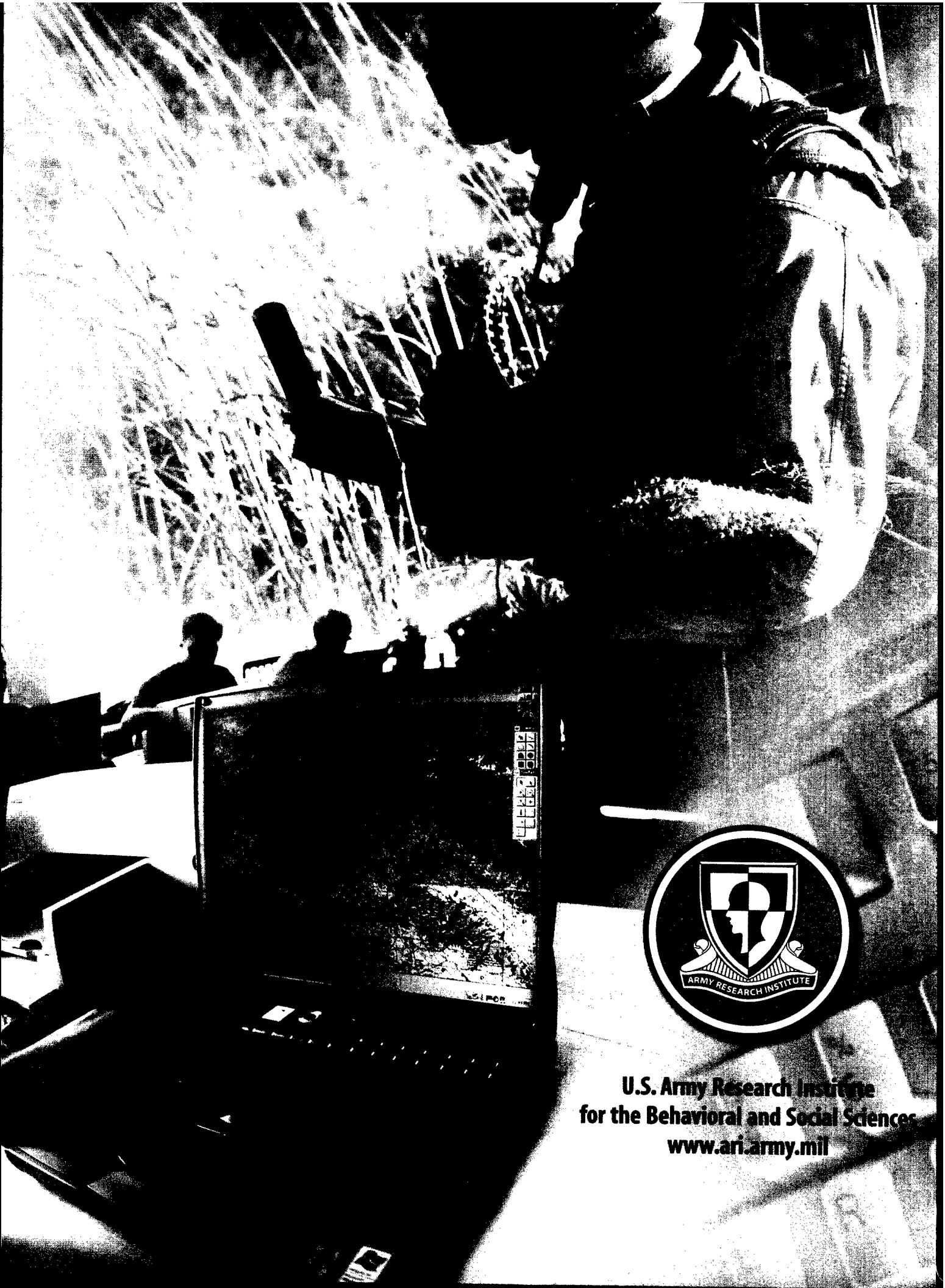

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