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Personal Computer-Based Aviation Training Device (PCATD)

"According to a number of sources, consumer flight simulators have become a de facto part of Air Force flight training. 'It's almost like that's the first phase of training - you come here fully trained up on [Microsoft] Flight Simulator and we'll throw you into an Air Force simulator and see how you handle it.'" — Prensky, M. *Digital Game-Based Learning*

The first commercial video game, *Pong*, appeared in 1974. *Space Invaders*, the first wildly successful video game, appeared in 1978. The IBM PC was introduced in 1981 and the Apple Macintosh in 1984. The soldiers who choose the Army today have grown up in an interactive, digital, PC-based environment. Eighty-eight percent (88%) of the soldiers who arrive at Fort Rucker for primary flight training have access to a PC at their place of residence. Thirty-four percent (34%) of these introductory flight students have used a commercial flight simulator "game" in the previous year. The comparable figures presented in a recent survey of Navy beginning flight students were 72% and 53%, respectively. Computers have been as much a part of their

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Figure 1: CW2 Keith Miller evaluates a micro-simulator

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From the Director

As an applied science, training is technology driven. Soldiers in the future will face increased challenges from an expanding mission set and the increasing complexity of tasks they must perform. The challenge for training research is to provide new training methods to ensure that soldiers are trained and ready to operate on the battlefields of the future. Digitization is a critical aspect of meeting the challenges of training in the 21st Century: from exploiting commercial gaming and simulation technology for military training to increasing training realism of computer generated forces through simulating combat emotions and soldier traits. Digitization is not only driving the "revolution in military affairs", but as the articles in this issue of the ARI Newsletter demonstrate, it is at the core of the emerging revolution in training.

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world as books or television have been to earlier generations. It is the responsibility of the Army to train this computer-literate generation.

The U.S. military has been particularly active in seeking ways to use commercial gaming software for serious training. For example, the Army trains over 80,000 soldiers yearly on the team-building game *Saving Sergeant Pabletti*. The Marine Corps continuously evaluates war games and pays commercial companies to develop Marine variants. Marines are allowed to load and play such games as *Harpoon, Harpoon2, Tigers on the Prowl, Operation Crusader, Patriot, Doom, Marine Doom, Quake,* and *Battle Site Zero* during duty hours on government computers. The Air Force Air National Guard uses the F-16 simulator Falcon 4.0 to maintain aircraft currency in easily perishable skills for pilots who are deployed for long durations. The Air Force created games entitled *JVID* and *Finflash* to train target identification after pilots mistakenly shot down two U.S. Army helicopters over Iraq in 1994. The Navy commissioned a game called *Bottom Gun* to train submariners in an important but tedious periscope-based ship identification and ranging task.

In addition, it is widely known that both the power of PC processors and the capability of flight simulation software have grown dramatically at the same time that they have become less expensive. Microsoft Flight Simulator 2000 Professional Edition, for example, is a very capable PCATD that can be purchased for as little as $49.95 on the Internet. Both the private and the military aviation communities have noticed this trend and are seeking ways to supplement it in service to their own training needs.

Recently, the Chief of Naval Education and Training has undertaken the Micro-simulator Systems for Immersive Learning Environments

Figure 2: Screen view of a TH-67 training helicopter approaching the Eiffel Tower

project to identify and apply commercial PC gaming and simulation technology as a potential training tool. Scott Dunlap, an Operations Research Analyst with the Navy, and Ronald Tarr, a Senior Manager/Principal Investigator at the University of Central Florida's Institute for Simulation and Training, reported one recent outcome of this project. They configured 10 simulator workstations as Navy training aircraft. These workstations were purchased from Desk Top Simulators L.L.C. for a cost of approximately $10,000 each. Fifteen scenarios were developed including familiarization flights, basic instruments, and navigation instruments. The Microsoft Flight Simulator 98 software was augmented with an instructional framework that provided a demonstration of each scenario narrated to point out key visual and timing events. After the demonstration, student pilots were afforded the opportunity to practice the scenario. Participation in this training experience was entirely voluntary and performed at a time that would not interfere with the primary flight curriculum. Results from this initial test were positive. Participating students were significantly more likely to score highly during flight training and significantly less likely to "wash out" of flight training compared to their peers who did not participate.

MG Anthony R. Jones, Commanding General Fort Rucker and Army Aviation Center, heard

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about this Navy initiative and asked the ARI Rotary Wing Aviation Research Unit (RWARU) "What do we know about all this?" The question eventually resulted in the formation of the PCATD Joint Working Group of which ARI-RWARU is a charter member. ARI considers participation in this working group to be a technical advisory service to the Army Aviation Center and covered under the Science and Technology Objective (STO) AVATAR or Simulation-based Aviation Training. The mission of the working group is to research if and how best to employ PCATDs in Army Aviation training.

The working group has limited its scope to primary helicopter flight training, called Initial Entry Rotary Wing (IERW) flight training. Three avenues of approach, as well as small-scale concept tests, have been recommended. These are:

- Use PCATDs for self-study learning by flight students prior to IERW. This approach attempts to improve the baseline knowledge level of students by providing them study materials either via CD-ROM, the Internet, or both. Psychological research has shown that highly competent students will take advantage of these materials for independent self-study.

- Use PCATDs to enhance the richness of IERW ground school by providing instructors with a dynamic, interactive teaching tool. Instructors currently use a platform lecture technique with Microsoft PowerPoint slides for visual aids. While this time-honored instructional technique is efficient in terms of time and cost, it is limited in its ability to impart the dynamic, interactive, three-dimensional knowledge required for helicopter flight. The use of a PC-based flight simulator with the screen view projected onto the wide screen classroom display would allow an instructor to demonstrate key relationships between flight controls, instruments, and out-the-window view dynamically in real time.

- Use PCATDs to provide an easy-to-use and easily accessible practice simulator for IERW students. This avenue is similar to that demonstrated by Dunlap and Tarr for Navy fixed wing flight training.

Figure 3: Flying an approach pattern

The third avenue identified above is the one ARI has been asked to investigate first. The Fort Rucker Directorate of Training, Doctrine, and Simulation obtained a temporary loan of two micro-simulators from Desk Top Simulators. These micro-simulators are currently housed at the ARI building on Fort Rucker.

ARI has begun a three stage proof-of-concept evaluation. Stage 1 is a subject matter expert evaluation of which IERW flight tasks can be supported by the micro-simulator for training. Current findings suggest that the micro-simulator shows promise as an instru-

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ment procedures trainer for tasks involving primarily flight instruments and/or radio navigation instruments. Interestingly, the Navy researchers Dunlap and Tarr reported similar results from their task analysis of fixed wing primary flight tasks. Stage 2 requires creating a series of training scenarios from the supportable tasks. Stage 3 involves using the micro-simulator to provide pre-training in selected tasks to a sample of IERW students. ARI will measure performance during the micro-simulator pre-training phase as well as track the performance of the sampled students during formal IERW training.

Ultimately, lessons learned by the PCATD Joint Working Group will contribute to the Army Aviation Center's ongoing transformation of flight training in the Army called Flight School XXI.

For additional information, please contact Dr. David M. Johnson, ARI-Rotary Wing Aviation Research Unit, ARI_RWARU@ari.army.mil.

Previous Experience with the Military

"Did you know that…"

among officers (WO1/CW5, 2LT/COL) in the Active component, officers in 2000 (72.3%) were as likely as officers in 1996 (70.9%) to have reported previous experience with the military (other than currently being on active duty)?

warrant officers - W01/CW5 (63.4%) were less likely than company grade - 2LT/CPT (74.0%) and field grade - MAJ/COL (73.8%) officers to have reported in 2000 previous experience with the military?

among enlisted personnel - PV2/CSM in the Active component, soldiers in 2000 (56.4%) were less likely than soldiers in 1996 (59.4%) to have reported previous experience with the military?

junior enlisted personnel - PV2-CPL/SPC (53.2%) were less likely than Jr. NCOs - SGT/SSG (60.2%) and Sr. NCOs - SFC-CSM (59.0%) to have reported in 2000 previous experience with the military?

junior enlisted soldiers in the Active component in 2000 (53.2%) were less likely than in 1996 (60.4%) to have reported previous experience with the military?

for both company grade officers and junior enlisted soldiers, having a parent(s)/guardian on active duty was the most commonly reported previous military experience?

	Company Grade Officers	Jr. Enlisted Soldiers
Child or parent(s)/guardian who is/was on active duty with the U.S. Armed Forces	36.3%	26.5%
I served in the National Guard/Reserves	29.9%	10.4%
Brother/sister is/was on active duty in the U.S. Armed Forces	20.3%	15.2%
Other experience	12.8%	4.9%
Spouse was/is on active duty with the U.S. Armed Forces	12.7%	5.9%
Junior Reserve Officer Training Program (JROTC)	11.6%	9.4%
Military high school	1.4%	2.6%

User-Produced Training Support Packages

Tools of the Trade: Training Today's Army Personnel

Today's Army units are faced with training for varying contingencies involving a wide variety of missions. This training increasingly involves the use of resources other than traditional field or classroom environments, such as simulations and distance learning. The development and conduct of unit training is thus becoming more complex.

At the same time, the resources available to help units with their training are increasingly limited. With regard to collective training exercises, Training and Doctrine Command (TRADOC) proponent schools generally provide guidance and a few sample exercise outlines in Mission Training Plans and related documents. However, they do not have the resources to provide the comprehensive training support packages (TSPs) needed for effective conduct of exercises.

Unit leaders (and other trainers, such as institutional instructors) are often required to develop their own exercise TSPs for a growing variety of environments. Many of these trainers have limited experience and training in doing this, and they proceed by modifying available materials the best they can to meet their needs. Trainers need tools (i.e., software applications) to help them tailor and develop complete exercise TSPs to meet their units' needs while maintaining quality and standardization. Such tools are emerging; the primary example is the Commanders' Integrated Training Tool for the Close Combat Tactical Trainer.

Management Issues

The increasing production of TSPs by users (unit leaders and other trainers) leads to numerous training management issues of concern to TRADOC and other agencies. What are the essential components of TSPs? Are these the same for all environments? What exercises would comprise a core set (basic starter set for tailoring to meet units' needs) of TSPs for a given unit type? How should TSPs be distributed and sustained to keep them accessible and to meet the needs of all users?

The ARI Armored Forces Research Unit at Fort Knox, KY has recently completed a research and development project, entitled "Methods for Assessing and Managing User-Produced TSPs" to address these and related issues. The research team queried numerous Army training sources through interviews and other means to identify the components of TSPs and a process for specifying core sets of TSPs. The team also designed methods for assessing and managing user-produced TSPs, and identified prototype tools supporting these methods.

Research Findings

A primary result of the project was identification of the components and elements of a TSP for collective training exercises, to a level sufficient to develop database specifications for them. This activity led to the conclusion that the same TSP components and elements can serve all collective training exercises for live, virtual, constructive, and combined environments. This means that a standardized database format can be used in developing and maintaining all collective TSPs, although the contents of each element may change for different training environments. See Table 1 on folllowing page for a listing of the top level of common collective TSP components.

The project team developed a five-step process for identifying core sets of exercise TSPs, and they provided an example of applying this process to identify core TSPs for armor units. The team also identified a process for five levels of TSP assessment, addressing issues in the approval and maintenance of user-produced TSPs. Issues in the distribution of TSPs were

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User-Produced Training Support Packages

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Table 1. Primary Components of Collective Training Support Packages (TSPs)

- TSP Identification
- Exercise Overview
- Tactical Materials
- Exercise Control Materials
- Exercise Set-Up Materials
- Evaluation Plan
- Administrative Materials
- References

also addressed, resulting in design of a hybrid method in which core sets of TSPs are centrally managed while others are maintained in a widely distributed fashion. Finally, needed tools or applications were identified for six types of TSP users, including training developers, observer/controllers, and unit personnel.

The findings of this project have been provided to TRADOC training managers, and they should be useful to these personnel, as well as to unit leaders, who are developing their own collective training exercises. Ongoing and future efforts to develop the Army Training Information Architecture can build upon the work completed here.

For additional information or a project compact disk, please contact Dr. Billy L. Burnside, ARI - Armored Forces Research Unit, ARI_AFRU@ari.army.mil.

Predicting the Decay of Digital Skills: A Preliminary Look

Unique Aspects of Digital Tasks

The Problem

Efficient scheduling of refresher training requires prediction of Military Occupational Specialty (MOS) skill decay. Anecdotal evidence indicated that skill at performing digital tasks on computer-based systems decays faster than skill at performing traditional Army tasks. The Army has a method for predicting skill decay – developed by ARI researchers in the early 1980s – called the User's Decision Aid or UDA. But it is intended for use with those traditional procedural skills, such as disassembling a rifle, that involve execution of a set of steps by rote. There are reasons to suspect it might not succeed as well if applied to digital tasks. For example, the UDA assumes a situation in which soldiers have been trained to a criterion of one or a few correct performances on a task. In the training of digital tasks, however, soldiers often must complete certain enabling tasks (the most obvious is turning on the equipment) before they can perform other tasks. As a result, soldiers are likely to be over-trained on some tasks and barely trained on others. Although such over-training is known to affect skill retention, the UDA does not include a component to address the issue. Thus the UDA might be limited in its ability to predict the decay of skill at performing digital tasks, especially those that include decision-making or other cognitive elements.

Our Approach

We first developed measures that appeared to capture the unique aspects of digital tasks, including cognitive components and variable practice across tasks. We designed these measures to be administered, like the UDA, as a set of interview questions for subject matter experts, usually instructors at Army schools. The UDA uses questions such as: "Into how many steps has the task been divided?" and "Are the steps in the task required to be performed in a definite sequence?" Our new measures include questions such as: "To what extent is situational awareness a factor in successful completion of this task?" and "During the next year, how often is the equipment (hardware and software) expected to undergo modification?"

The rest of the research approach was to: 1) identify candidate MOSs at Army schools that teach digital tasks; 2) apply the UDA to those tasks (by interviewing instructors); 3) also apply our new measures of digital complexity, cognitive load, and task practice to the same tasks; 4) track down soldiers in the field who were trained at one of the selected schools but who had no opportunity to perform the digital tasks since graduation; and 5) measure their performance of the digital tasks on a test patterned after the school's end-of-course exam. We hoped thereby to see how well the UDA predicted the level of retention of the digital tasks and how much our new measures improved that prediction. We expected either to demonstrate that digital tasks are no different from traditional procedural tasks or to identify the factors needed to broaden the applicability of the UDA.

Some Difficulties

For our first chosen MOS, Intelligence Analyst (96B), the digital tasks taught to entry-level soldiers turned out to be highly procedural. Most of the 22 tasks we investigated yielded low scores on the scales we proposed for measuring complexity or cognitive aspects of digital tasks. They appeared to be examples of what the instructors call "knobology," tasks requiring execution of a set of steps involving knobs and buttons on the computer screen or keyboard. The UDA predicted that the tasks would be well retained, and we found that they were. In one sense this was successful prediction; on the other hand, it left within our selected set of 96B tasks, few complex or cognitive tasks with

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which to gauge the accuracy of our predictions across the range of possibilities.

For our other chosen MOS, Field Artillery (13D), our selection of 23 tasks spanned a wider range. Thus, they included tasks predicted to be easily remembered, easily forgotten, and some in between. They also included tasks that scored low, moderate, and high on our proposed measures of cognitive complexity. However, tracking 13D soldiers to measure retention in the field turned out to be a problem.

These soldiers use new computer equipment, for which software is revised frequently. As a result, we could track the graduates of only a few classes before the testing instruments we developed and the software needed for our retention test became obsolete. This was compounded by the problem of personnel turnover. Posts often reported that some requested personnel had been reassigned, sent abroad on TDY, were on leave, or -- in one case -- were detailed to fight forest fires. In the end, we identified useable data from seven Field Artillery soldiers, four with one retention interval (4 to 5 months) and three with another retention interval (7 to 8 months).

Tentative Results

There was not enough data to perform the statistical analyses originally planned. However, even for our small samples of soldiers, the measures of task difficulty were surprisingly stable, matching well across the two samples (correlation = .73). That is, both sets of 13D soldiers found roughly the same tasks to be easy to remember and the same tasks to be difficult to remember. At the same time, the expected effect of "retention interval" (length of time since the end of school training) was found: Those soldiers who were tested 4 to 5 months after completion of their school training remembered, on average, 59% of the tasks; those tested after 7 to 8 months remembered 44%. Neither the UDA nor our proposed new measures of cognitive complexity of digital tasks accounted directly for much of the variation among task retention.

By the statistical technique of discriminant analysis, we found that our data nevertheless possessed an encouraging regularity. Discriminant analysis allowed us to determine whether any combination of our measures could sort the tasks correctly on the basis of task difficulty. At both retention intervals, the analysis was able to sort those tasks soldiers found easy from those they found difficult by adding three measures (beginning with the strongest predictor) to the predictions generated by the UDA: 1) the size of the cognitive component in the tasks, 2) digital task complexity, and 3) the amount of practice given the various tasks during training. These results represent the first identification of special factors required to predict the retention of digital, as distinct from procedural, tasks.

For additional information, please contact Mark Sabol, ARI - Advanced Training Methods Research Unit at Alexandria, ARI_ATMRU@ari.army.mil.

Training Digital Skills in Army Environments

Training in the Digital Age

Overview

How to train digital skills in the U.S. Army poses new challenges with an old theme. Should system-operating procedures be trained after or along with system applications? If the U.S. Army is to maintain information dominance, it must improve training for system operators. This research, performed by scientists from ARI's Advanced Training Methods Research Unit (ATMRU), compares alternative training methods to determine how to optimize the ability of entry-level soldiers to be adaptable and flexible users of digital systems in solving unfamiliar problems.

Background

Currently, the U.S. Army digital training uses a 3-step process: (1) train the military topics or concepts without the use of digital systems (e.g., draw situations by hand on a map), (2) train procedures for digital system operation, and (3) integrate the training content with the digital system (e.g., produce electronic situation maps). There is research supporting the value of training the military subject matter and the manual task before transferring this knowledge to the digital version.

In contrast, there is also support for the value of an alternative method that emphasizes computers as job tools and integrates the content knowledge and digital system functions as a single training event through the use of a constructivist learning model. The constructivist model builds on existing knowledge by embedding training experiences in a real-world context. Learning is interactive among the trainees and the instructor, with the trainees assuming responsibility for learning. The instructor intervenes when the trainee is no longer making progress. This intervention takes the form of questioning, demonstrating, discussing, or providing instructions that encourage the trainee to think about the situation more deeply and adaptively. The question is whether this alternative method would be successful in enhancing the adaptability of entry-level, enlisted soldiers.

Method

Participants

Forty-eight enlisted soldiers, most with only basic training experience, were used for this experiment. These soldiers were receiving Advanced Individual Training (AIT) toward becoming Military Intelligence (MI) Analysts (MOS 96B). Several of the soldiers had prior military experience in other areas of specialization such as the motor pool and infantry. Experience in MI was meager and none of the soldiers had used digital equipment to perform the intelligence analyst job.

Course/Class Description

Traditional AIT for MI analysts requires 83 training days, with the first 65 days devoted to basic skills, including performing analyst tasks using non-digital equipment (e.g., paper maps and acetate overlays). Days 66-72 are dedicated to training on the Remote Workstation (RWS), a digital system component of the All Source Analysis System (ASAS). RWS is a communications center for inbound and outbound messages and for creating map overlays of the area of interest.

Three classes, each comprised of 15 or 16 soldiers with a primary instructor, participated in this experiment during the days 66-72 dedicated to digital RWS training. Each of three classrooms contained 15 "plug-and-play" computer systems and one instructor's module that projected the computer display on a large screen in the front of the classroom.

Description of Instructional Methods and Implementation

Control groups. Two of the classes served as a control group and received the traditional instruction by lecture, demonstration, and

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practice, with the emphasis placed on learning how the system operated (i.e., knobology). The last day of instruction included an application of the soldiers' knowledge of the system to develop a map product.

Experimental group. As an alternative to traditional instruction, one of the classes received a brief introduction to the digital equipment and an on-line manual followed by presentation of realistic practical exercises. Implementation of this constructivist training approach used a series of practical exercises (PEs) developed by Subject Matter Experts to stress problem solving.

The PEs built upon each other and prior learning in the course to accomplish the required tasks, including the most complex and difficult tasks. Soldiers were encouraged to work cooperatively in small teams to define the goal of an exercise and formulate a plan on how to resolve the problem. When one part of the practical exercise was completed, the team debriefed the instructor and then was allowed to move forward in their training. No training time was added to the program of instruction. The responsibility for the instructional material was shifted from being centered on the instructor to being centered on the student. The instructor's role changed from the traditional "sage on stage" to a "guide on the side."

Results

No differences were found on scores on the traditional end-of-course exercise. Irrespective of the training method, soldiers mastered the established learning objectives.

An unfamiliar exercise evaluated soldiers' ability to be adaptable and apply what they had learned to an unfamiliar set of problems. Figure 1 shows that the experimental group performed significantly better on this performance-based evaluation: a 39% performance advantage, which is statistically significant.

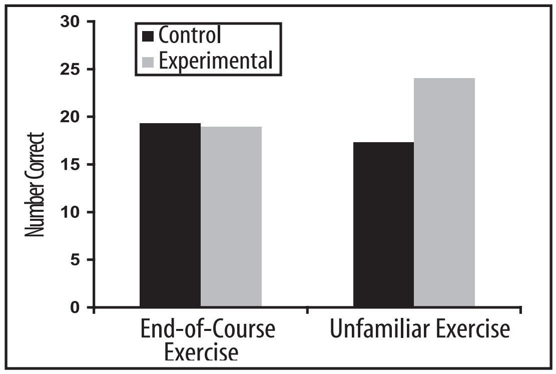

Figure 1. Mean number correct on traditional (n.s.) and novel examination as a function of method

Soldiers in the experimental group expressed very positive reactions to the training experience. Responses on a questionnaire indicated they felt challenged and were highly motivated to learn. Teaming with other soldiers to frame and solve problems was seen as beneficial to learning.

Conclusions

Results of this preliminary research suggest that training of digital-system operations should be embedded in realistic mission-related scenarios. This method improves transfer of training to novel situations for the entry-level soldier. Further benefits include increased motivation and the establishment of team coordination in problem definition and problem solving. Additionally, soldiers are taught to take responsibility for their own learning. This greater emphasis on self-learning is imperative in maintaining mission readiness since systems or software changes may occur frequently.

In today's Army, soldiers are asked to work as teams to define problems and develop solutions. Additionally, the Army is increasing its dependence on digital systems to maintain superior communication and information exchange to ensure information dominance. Training today's soldier to take full advantage of these digital systems is a challenge. Just as it sees the importance of upgrading its hardware and software, the Army can take a step to answering this

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Expert Leader Development Course for Brigade and Battalion Commanders

Intelligent Tutoring Machines: Coaches of the Future

The training of students by individual and small group mentoring is at least as old as the ancient Greeks. In more recent years, the United States Army has given formal recognition and emphasis to three pillars of soldier education. This broader educational emphasis has created a renewed interest in the quality and content of the mentorship given by commanders to their subordinates. One outcome of this emphasis is an interesting application of mentorship recently developed by ARI and the School for Command Preparation (SCP) at Fort Leavenworth.

This training program is called Think Like a Commander (TLAC). It is being applied in SCP's Tactical Commanders Development Course. This course provides pre-command training and orientation for battalion and brigade command designees. A major part of this training is the conduct of tactical exercises in the planning and execution of brigade-level operations. In these exercises, the newly designated commanders play the command roles of the type and level of unit they will soon command. The TLAC training program uses PowerPoint presentations of events that might have occurred during the execution of the trainees' plan. The intent is to exercise the trainees' ability to adapt their thinking and apply their knowledge to novel situations that might develop on the battlefield.

TLAC's design principle is the rather straightforward concept of deliberate practice. Deliberate practice is simply the exercising of important aspects of a skill or task to the point where they can be performed without conscious effort. It is a training principle used extensively in developing skills in sports and performing arts but being applied here to more strictly mental operations.

We say mental operations because the goal of TLAC training is not to memorize and apply a set of doctrinal rules, although doctrinal application is certainly involved in TLAC exercises. Nor is it to memorize a new procedure for battlefield thinking. The goal of TLAC is rather to develop the commander's skill in how to think on the battlefield. Over several research projects, ARI has identified a set of "themes of thought" that characterize expert battlefield decision-makers. These appear in Table 1 on the next page.

These themes are familiar in one form or another to virtually all Army officers. They look a lot like METT-TC with a few other familiar things thrown in. But ARI has found that although officers in general know them, they do not always apply them, especially in unique and time-dependent situations, such as presented in TLAC. The problem is that they are not frequently provided with enough oppor-

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challenge by providing its trainers with a wider variety of training methods and tools to promote improved digital training and to enhance performance in new situations.

For additional information, please contact Dr. Brooke Schaab, or Douglas Dressel, ARI - Advanced Training Mthods Research Unit ARI_ATMRU@ari.army.mil.

Expert Leader Development Course for Brigade and Battalion Commanders

Table 1: Expert Reasoning Themes

- Keep focus on **mission** and **higher Commander's intent.**
- Model a **thinking** enemy.
- Consider effects of **terrain**.
- Use all **assets** available.
- Consider **timing**.
- See the **bigger picture**.
- **Visualize** the battlefield.
- Consider **contingencies** and remain **Flexible.**

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tunities to practice their battlefield thought processes under learning conditions.

This is where expert mentoring becomes important. In the SCP application, TLAC vignettes are presented in the classroom and the trainees are asked to interpret the situation and describe how they would respond. A mentor then probes their thoughts with questions intended to raise their awareness of the eight themes shown above. Usually after the first vignette, the eight themes are described and discussed and a second vignette is presented with the mentor again probing for consideration of the themes. A maximum of three TLAC vignettes are presented in an hour-long session and most trainees go through two sessions during the course.

The mentor probes used in TLAC follow an approach to case-based teaching known as scaffolding. Here the mentor begins with an indirect question intended to stimulate the trainees to apply knowledge they already possess but may not have associated with the particular situation. For example, if the Brigade Commander had failed to ask for some asset from Division that would clearly assist him in the problem, the mentor might first ask something like, "Is there anything else you would do?" If this general thought stimulus does not provoke the desired response, then a more direct question is asked such as, "What could Division do for you?" If this does not work, then an even more direct question is asked, "What assets does Division have that could help you here?" Because these are senior officers, this approach does not insult their intelligence and provides maximum opportunity for them to make the association on their own. Research has shown this approach to be a very effective way of training job incumbents to apply knowledge that is rarely exercised during day-to-day job performance.

ARI is working with experts at these levels of command to develop such thematic probe sets

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Expert Leader Development Course for Brigade and Battalion Commanders

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for each TLAC vignette. The experts are tying the probes to the sections of the operations order they apply to and the doctrinal issues they involve. They are also developing facilitator's notes for each probe and a set of training aids that might be used to clarify how each theme applies in the particular vignette.

These systematic probe sets will be used in several ways. First, the SCP classroom mentors will use them as guides in their mentoring. Second, the SCP is producing a CD-ROM version of TLAC that will contain all completed vignettes along with the related exercise material. It will also contain the expert-mentoring probe set data along with a mentor's guide for using the program. This CD will be issued for each enrolled course to students to take to their new command. Then, they can study the material and use it to help train their staff and subordinates. The CD will be available in Summer 2001.

Another application of the probe sets is in an intelligent tutor system ARI is developing for TLAC. Intelligent tutor systems contain software programs designed to imitate the role of a human tutor. Individual officers will thus be able to receive TLAC training on their PCs without outside assistance. The intelligent tutor will react to the officer's responses to a vignette with probes similar to those used by the live mentors. The expert probe sets are being used as a source for these interactions. ARI is also evaluating performance measures that will be used in the intelligent tutor system to provide performance feedback to the users.

Efforts are now under way at the School for Command Preparation and at Fort Knox to expand TLAC coverage to include different levels of command and unit types. But regardless of where the future takes this program, expert mentoring will continue to be its primary focus.

For additional information, please contact Rex Michel, ARI-Leader Development Research Unit, ARI_LDRU@ari.army.mil.

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Mr. John S. Kay, *Communications*
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U.S. Army Research Institute for the Behavioral and Social Sciences
5001 Eisenhower Avenue 6E14 • Alexandria, Virginia 22333-5600
Web site: www.ari.army.mil • E-mail: news@ari.army.mil

Almost Human: Simulating Combat Emotions and Soldier Traits

Army leaders have often voiced the dictum that soldiers should train in the same manner as they will fight (i.e., train as you will fight). Unfortunately this is very difficult to achieve in practice. Even when weapon's effects are simulated in live exercises, the human and physical resources consumed by these exercises make them prohibitively expensive for satisfying all Army training needs. A less expensive alternative is to train against a computer-generated force (CGF) using simulation (see Figure 1). Current CGF models produce relatively predictable behavior tied closely to doctrine. CGF have not been designed to perform as human beings would. Among other things, they lack human emotions and personality traits that would produce believable variations in performance.

ARI's Human Behavioral Modeling Program

The U.S. Army Research Institute (ARI), with the help of some leaders in modeling and simulation, are exploring ways to make CGF behave more like humans, making them susceptible to combat fatigue, giving them rudimentary personality traits, and allowing them to react realistically to combat events. ARI's first effort it this area was a joint project with Science Applications International Corporation (SAIC). This project developed mathematical models that account for sleep deprivation effects, circadian rhythm, experience, and aggressiveness. These models have been tested in conjunction with two different simulations and shown to affect command decisions.

ARI is currently supporting three efforts to further humanize CGF by integrating human emotions and personality traits into human performance models. A brief synopsis describing each approach to this goal is presented below.

SOAR Technology Approach

Researchers at Soar Technologies are integrating their rule-based architecture with a connectionist model of emotions that assumes that emotions arise from a combination of pleasure/pain, arousal, attention and time components. The selected application incorporates emotions and individual differences into the behavior models of synthetic virtual helicopter pilots in a battlefield simulation. The pleasure/pain system interprets the level to which a stimulus represents a threat or enhancement to survival. In turn, pleasure and pain stimulate the arousal system. Different personality types may be more or less susceptible to events that generate arousal, pleasure, or pain. These personality differences lead to distinctive decision making profiles that can produce crucial performance differences in combat situations.

In the model, clarity and confusion are also important determinants of behavior. A person who is confused is less likely to respond in accord with his/her best interests in minimizing pain and maximizing pleasure. Emotional attributes combine with deliberate cognitive processes and background knowledge in working memory to generate strategies, reasoning, and external behavior. Simultaneously, the cognitive model evaluates the environment and status of internal goals (situational awareness). The connectionist model uses this information in computing new values for each emotional attribute.

Evolutionary Programming Approach

The approach adopted by Natural Selection Inc. (NSI) is to use Evolutionary Programming techniques to develop a realistic non-rule-based intelligently interactive combat simulation for training two or more combat teams of various skill and intelligence levels. Evolutionary Programming evolves combat plans and behaviors based on their ability to satisfy some stated goal or condition. To improve the fidelity of their approach, NSI

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A new goal: Developing realistic intelligently interactive CGF

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is also modeling personal traits of individual decision-makers, such as loyalty, risk taking propensity, motivation, and social ability. For demonstration purposes, NSI is interfacing the evolutionary programming modules with a version of JANUS (a constructive simulation). Four basic mission types will be used to demonstrate the effectiveness of evolutionary programming techniques in generating intelligent and realistic behaviors: (1) attack a predefined position, (2) attack the enemy (potentially temporally variable position), (3) defend a predefined position, and (4) defend from enemy attack (withdraw).

In phase 1 of this effort, NSI used a basic attack scenario as a proof-of-concept demonstration. In that scenario, six Red Force tanks were defending a strategically important landmark. The goal of the Evolutionary Programming controlled Blue Team was to attack the position defended by the Red Team and secure the objective, surviving at all costs. This technique successfully evolved plans that outmaneuvered the Red Team to reach the objective. The outcome of this effort will be an intelligent and interactive human performance model that is adaptable to virtually any simulation engine; it includes personal traits, and allows interaction or comparison with humans. Recent work has focused on including a higher meta-learning algorithm (with memory) in the model.

A Cognitive Architecture Approach

Psychometrix Associates, Inc. selects individual differences to model, based on empirical evidence indicating a high potential to affect soldier and commander performance. These differences are encoded as parameters of a cognitive architecture. A large number of individual differences and affective factors (e.g. ability factors, risk tolerance, anxiety/stress tolerance, aggressiveness, fear, mood) are being considered for inclusion in the model. The factors change the parameter values in the cognitive architecture which, in turn, change the computer-generated agents' behaviors. The cognitive architecture will also incorporate individual goals and expectations, working memory, and a model of attention. In the Psychometrix approach, goals are selected based on the current emotional state; they in turn trigger approaches that guide perceptual and cognitive activities and decision making. A simulation test bed environment is being designed to demonstrate and evaluate architecture's performance. The test bed will display the goals and expectations, emotional states, and decisions made by the intelligent agent being modeled. The test bed will map all of the possible situations and behaviors, as well as the agents' choices within its environment.

Our Goal

By incorporating basic emotions and personality factors into human performance models, the CGF will act more realistically. As a result, soldiers training with simulations will encounter a wider range of plausible situations allowing them to practice their combat skills against a realistic foe. Including these factors will make CGF less predictable because their reactions to combat events will vary as a function of emotions and personality as well as cognitive factors.

For additional information, please contact Stephen Goldberg, Chief, ARI-Simulator Systems Research Unit, ARI_SSRU@ari.army.mil.

Development of New Army Aptitude Composites for Classification

Improving classification composites to more precisely predict performance

Overview

The U.S. Army Research Institute (ARI) has been conducting research with the objective of improving the effectiveness of Army classification (the placement of recruits into their initial job training and MOS assignment). The Army currently employs nine Aptitude Area (AA) composites in its classification of new recruits. These composites are derived from the Armed Services Vocational Aptitude Battery (ASVAB), in a manner which makes them easy to calculate but relatively inefficient for classification. Plans are underway within the Office of the Secretary of Defense (OSD) to eliminate the two "speeded tests" in the ASVAB by December 2001. This is due to the extra expenses involved in administering and equating different forms of these tests in an automated environment. When this comes to pass, the classification efficiency of the Army composites will be further reduced and will necessitate measures to redefine them.

Applicants are offered initial training in MOS for which they are eligible and which meet the accession needs of the Army. Eligibility is based on meeting minimum AA composite score standards for the MOS in question. The Army's current set of nine composites goes back to 1976. They were formulated to represent measures of the aptitudes / skills required for training and assignment to the corresponding nine Army job families: clerical, combat, electronics repair, field artillery, general maintenance, mechanical maintenance, operators / food, surveillance / communications, and skilled technical. The training criteria used to validate the AA composites were the best available criteria at the time. Each composite is formulated as a combination of 3 or 4 unit-weighted subtests. This approach is a carry-over from the 1950s when calculations were kept as simple as possible. One consequence is that AA composites do not track performance as well as they might. In addition, classification efficiency requires the use of composites that can distinguish how well a recruit is likely to perform in different jobs. The existing composites and job families have limited ability to do this.

Two major recommendations have come out of the classification research conducted by ARI. The first recommendation is to improve the classification composites by replacing the 9 AA composites with measures of predicted performance. A set of 17 new composites and corresponding job families is recommended. The second recommendation is to improve the classification process. The existing training reservation system (known as *REQUEST*) should be enhanced so that recruits are assigned to those jobs that they are likely to perform best, while meeting the training management goals of the Army. The focus of this newsletter article is upon improving the classification composites.

Principles for Developing Classification-Efficient Composites and Job Families

ARI Project A research of the 1980's found a strong relationship between ASVAB and first-term soldier performance measures and validated the use of ASVAB as a selection tool. ARI subsequently began research in the early 1990's to develop classification-efficient composites for use in Army classification – that is, to develop better measures for distinguishing recruit capabilities to do different jobs and to test the efficacy of these measures for making better classification decisions. This research was founded upon differential assignment theory (DAT), proposed and developed by Dr. Joseph Zeidner and Mr. Cecil Johnson of George Washington University.

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The empirical implementation of DAT is based upon the following three principles:

- One: New composites should utilize defensible criterion data (i.e., soldier performance data) and all the informational power of the ASVAB battery.

- Two: Classification efficiency depends upon (a) how well the composites predict performance (predictive validity), (b) how distinctive the composites are from each other, and (c) how many distinct job families can be identified using available criterion data. In other words, predictive validity is only one term in the classification efficiency equation; thus, classification efficiency cannot be described adequately by predictive validity alone.

- Three: Classification efficiency should be evaluated by measuring soldier mean predicted performance (MPP) in job assignments made within classification optimization experiments.

In simulating the optimized assignment process, the predicted performance of each applicant in his/her assigned job family is determined, and the MPP of the group is computed. The existing AA composite / job family set yields an MPP equal to .023, not much different from the classification efficiency that would obtain with random assignment (MPP = 0). Predicted performance composites for the existing job families yield MPP of .123. And when 17 job families are identified, with the greater homogeneity of these families and greater overall distinction between them, the classification gains increase even more. Indeed, we estimate that the performance gains obtainable from predicted performance composites together with optimization methods would rival in size those obtained from the screening out of low Armed Forces Qualification Test (AFQT) applicants.

Recommended New Composites and Job Family Structure

Using the Skill Qualifications Test (SQT) database and a clustering algorithm designed to identify classification-efficient job families, ARI researchers identified two sets of classification-efficient job families - a detailed set of 150 and a summary set of 17 job families. The 17 predicted performance composites and corresponding job families would be used for administrative, counseling, and school proponent purposes just as the existing 9 operational job families are used. Minimum eligibility standards (cutoff scores) would be established against these new composites. The new job families would be consistent with the CMFs currently used by the Army in managing the entry-level job structure and with the current AA system. No pair of MOS that are together in the current AA system fails to be together in the 17 job family system. The new structure resembles the existing structure, in effect being a further shredding of certain existing families.

We can illustrate how the new (classification-efficient) composites differ from the existing AA composites by referring to the chart below. The chart compares the existing mechanical maintenance composite to two new composites, MM-1 and MM-2. Under the new structure, the mechanical maintenance job family has been shredded into land vehicle and aircraft vehicle maintenance job families. The existing AA composite is defined by AS, MC, EI, and NO (see legend). The predominant contributor to MM-1 (land vehicle mainte-

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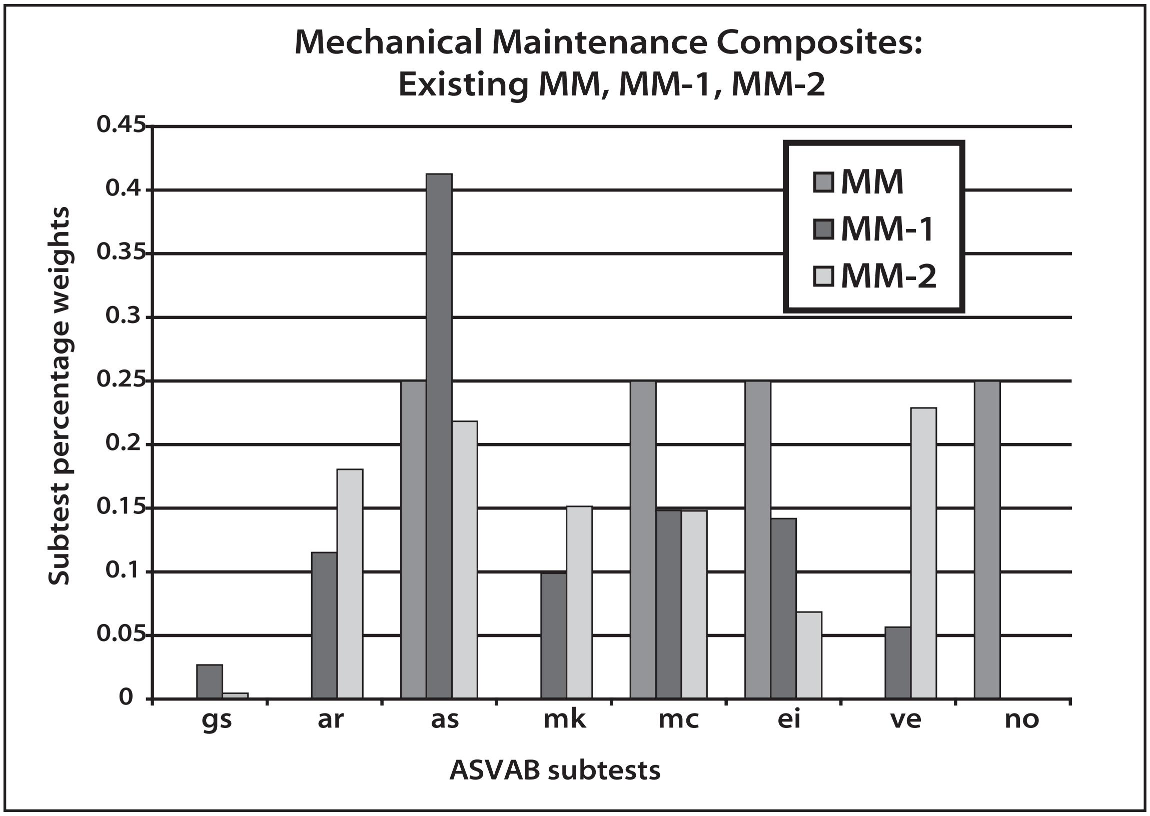

gs = general science
ar = arithmetic reasoning
as = auto & shop information
mk = math knowledge
mc = mechanical comprehension
ei = electronics information
ve = verbal
no = numerical operation

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nance) is AS, followed by MC, EI, and MK. The major contributors to MM-2 (aircraft maintenance) are VE, AS, AR, MK, and MC. The latter is more balanced in the aptitudes identified as necessary to perform in the job family.

Post-Script

Given time and resource constraints, Army management has elected to move toward predicted performance composites in two stages. Interim predicted performance composites have been estimated and will be put in place for the existing 9 job families by end of December 2001. As described, these are based on soldier performance criterion data and make use of all the informational power of the ASVAB. Implementation of the 17 composites and job families will take place in the 2005 period, coinciding with changes scheduled for major PERSCOM databases.

For additional information, please contact Peter Greenston, ARI, ARI_SARU@ari.army.mil.

U.S. Army Research Institute
5001 Eisenhower Avenue
Alexandria, VA 22333-5600

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