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MAY - JUNE 1995

Soldier Selection • Role of Flight Simulation • Training Strategies • Battle Command Concept

ARMY RESEARCH INSTITUTE AND FORCE XXI

ALSO IN THIS ISSUE:

SOLDIER PROGRAMS

- New Soldier Systems Command
- Combat Identification
- Force Provider
- Sleep Deprivation Studies

From The Army Acquisition Executive

The Growing Importance of the Army Science Board

I am delighted to have this opportunity to commend the Army Research Institute's (ARI) behavioral and social scientists and staff on the excellent work they're doing to maximize the combat effectiveness of of the soldier. This issue includes a number of articles on ARI's current focus on Force XXI. ARI is the "people" side of research and development, and its work has had a great impact on America's Army.

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I recently had the pleasure of attending the Army Science Board's (ASB) 1995 Spring General Membership Meeting in Huntsville, AL. I served as the board chairman from 1987 to 1989, and I am intensely interested in the work undertaken and the challenges faced by this distinguished panel of experts. More than ever before, the board is a vital resource for our soldiers and our overall modernization program.

As background, the ASB is the Department of the Army's senior scientific advisory body. Its mission is to provide independent scientific, technological and managerial advice and recommendations to senior Army leadership on scientific and technological matters of concern to the Army. The board has been in service since 1977 when it was chartered to replace the Army Scientific Advisory Panel, and its impact has never been greater than today.

We find today that our smaller Army must be more versatile, deployable to more locations, sustainable in a variety of environments, and just as mission-capable as in the past. In short, we are asked to do more with less—less money, less people, and less time. In this complex and ever-changing world, there is a growing need for the Army to employ groups of experts like the ASB to provide advice and recommendations on how the Army should cope with this changing environment. Readiness is our number one priority, but we must not overlook the fact that a stable focus on modernization will ensure the long-term readiness of the force. Today's modernization program is tomorrow's readiness. Our actions now will influence the readiness of the force for the next decade and beyond.

Through a careful membership screening and selection process, the ASB has brought onto the board the kinds of experts needed to support the Army in today's environment, experts from industry, academia, government agencies, and the private sector. Membership focus has been broadened to include members with contemporary areas of expertise to deal with today's problems, i.e., the environment, information warfare, acquisition reform, organizational re-engineering, and infrastructure issues.

The ASB performs most of its advisory functions through subgroup panels and studies. Two Summer Studies are conducted each year which address major Army issues. They are one year in length, highlighted by an August brief-out to the secretary of the Army and the Army chief of staff. Ad hoc studies and independent assessments are conducted throughout the year to address Army issues narrower in scope. They generally last three to nine months and culminate in briefings and reports to the study sponsors. The ASB maintains 10 standing issue groups. These panels are functionally organized and provide advice throughout the year to their functional area sponsors.

The 1994 Summer Studies were entitled the "Technical Information Architecture for Command, Control, Communications, Computers and Intelligence (C4I)" and the "Capabilities Needed to Counter Current and Evolving Threats." The C4I information infrastructure is a critical component of the Army's operations, and it is vital with the increasing emphasis on joint and combined operations. A coherent and enforceable technical architecture is the key to ensuring interoperability among all Department of Defense C4I systems. The ASB's other Summer Study looked at the capabilities required in the zero to seven year timeframe and the eight to 20 year timeframe in order to allow senior Army leaders to prioritize resources to meet new and unforeseen threats. This study was briefed beyond the Army to the chairman of the joint chiefs, at General Sullivan's request.

This summer the board is focusing on "Army Logistical Support to Military Operations Other Than War" and the "Transition of Technology from the Technology Base to the Customer." The ASB's workload is heavy. It has been involved this fiscal year in more than 20 Summer Studies, ad hoc studies, and independent assessments.

The board's operating methodology is to work closely with the Army study sponsors to ensure that all aspects of a study are investigated and that the board provides advice and recommendations that are actionable by the Army within the constraints of today's environment, including budgetary and joint aspects. In addition, in a number of studies, the board is tasked to continue working with the Army to support its implementation of a study panel's recommendations.

In closing, let me thank the illustrious members of the Army Science Board and the ASB staff for the many significant and lasting contributions to our national security. A very high percentage of board recommendations will be implemented because they really focus on the things we need to do. Keep up the good work!

Gilbert F. Decker

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Acting Administrative Assistant to the Secretary of the Army
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Research Development Acquisition ARMY RD&A

Professional Publication of the RD&A Community

FEATURES

DEPARTMENTS

COVER

Army Research Institute R&D efforts in support of Force XXI cover a broad range of areas, including training programs, leadership development, and the concept of soldier quality.

THE ARMY RESEARCH INSTITUTE AND FORCE XXI

By Dr. Scott E. Graham

Introduction

The Army continues to change. It recently changed from a forward deployed Army to a force projection Army. Now Force XXI is going to require even deeper change—change in the way Army leaders view their roles and responsibilities, and change in the way the Army plans to do business. Force XXI will also require change from an "Industrial Age," where preparedness was defined by the number of well-honed weapons ready for well-defined missions, to the "Information Age," where preparedness is defined by flexibility, responsiveness, and the ability to exploit near-instantaneous knowledge of the battlefield. Force XXI will not, however, change the fundamental tenet that quality, well-trained soldiers and leaders are the key to battlefield success.

Manpower, Personnel and Training R&D Needs

If the Army is to meet the goals of Force XXI, there must be significant advancement in manpower, personnel and training (MPT) technologies to complement advances in hardware and digital technologies. This article presents an overview of research and development (R&D) being conducted by the U.S. Army Research Institute for the Behavioral and Social Sciences (ARI) in support of Force XXI. ARI's research represents the Army's primary R&D efforts supporting three of the Army chief of staff's six imperatives for a trained and ready Army: Leader Development, Quality People and Training.

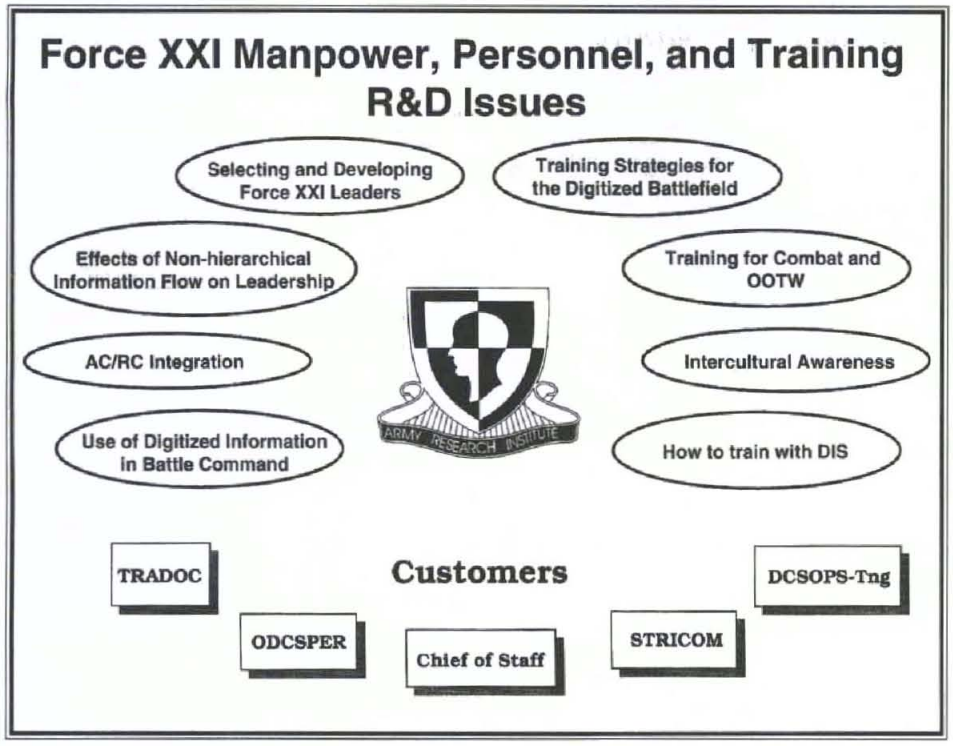
With fewer than 250 people, the majority of whom are research psychologists, ARI has research units collocated at three Battle Labs, the Mounted Battlespace Battle Lab (Fort Knox), the Dismounted Battlespace Battle Lab (Fort Benning) and the Battle Command Battle Lab (Fort Leavenworth). We also have research units at the U.S. Army Aviation Center (Fort Rucker), the U.S. Military Academy (West Point), the Special Warfare Center (Fort Bragg) and with the Simulation, Training and Instrumentation Command (STRICOM).

Why an ARI? That is, why is behavioral and social science research important to the Army and Force XXI? Behavioral research is important because it is seeking ways to better understand, measure, predict, and change performance. And the bottom line for the Army is performance, be it in high intensity conflict or in operations other than war (OOTW). Much of ARI's R&D leads to new methods for improving individual, unit, and leader performance, often through the cost-effective use of emerging simulation technologies. Other ARI research seeks to understand the underlying skills, knowledge and experiences that are important for effective planning, decision-making and leadership.

Behavioral science researchers are trained to avoid many of the pitfalls of research involving soldier and unit performance. This is particularly important in the evaluation of Force XXI technologies in that hardware-oriented scientists and engineers tend to underestimate the contribution of soldier-related variables, e.g., the effects of adequate training or cohesion. As has been demonstrated at the National Training Center, the added value of Force XXI technologies can be obscured by the effects of soldier-related variables. In addition to their R&D mission, ARI researchers serve as honest-brokers for senior Army decision-makers in the analysis of policies and programs.

A Force XXI Scenario

Consider the following hypothetical Force XXI scenario. A Force XXI division is given



short notice to mobilize for a multinational offensive operation. The division includes reserve component civil affairs, psychological operations, and military police units as well as some active duty fillers. The intact division has time for six days of pre-deployment training.

The division and battalion commanders and their staffs have digitized, real-time, two-dimensional images of the battlefield which represent all friendly and enemy forces. Portions of the digitized information are internetted to company, platoon, and individual tanks, as well as to adjoining units. The battalions have tacit consent to engage any targets of opportunity on the extremely fluid battlefield which is near international boundaries and civilian populations.

Now add the *new fog of war.* Corps and battalion headquarters have access to a near-infinite amount of digitized intelligence and communications data from forces on the ground, as well as from aircraft, satellites, and friendly nations. While largely accurate and nearly in real-time, there are constant information mismatches and disconnects.

At platoon level, a tank commander's two-dimensional display shows coalition forces 10 kilometers to the east and enemy forces 30 kilometers to the north. Upon hearing "incoming" on the platoon voice net, he executes a react to indirect fire battle drill. His display now shows a unit five kilometers to the northeast represented by "Unknown" IFF symbols. His battalion completed a peacekeeping operation in southwest Africa nine months earlier.

Research Issues

The scenario is presented as a platform for considering some of the Force XXI MPT research issues. As stated in the Training and Doctrine Command Pamphlet 525-5, *Force XXI Operations,* Force XXI leaders, regardless of rank or experience, will be required to make rapid, doctrinally sound decisions as they plan and execute missions in diverse, complex, high pressure operational environments. Future leaders also must be able to fully exploit the opportunities and capabilities of new digitized command systems. They must show vision, adaptability, creativity and the ability to reduce ambiguities–all while operating under stress and the scrutiny of international media. The basic MPT research questions are relatively straightforward.

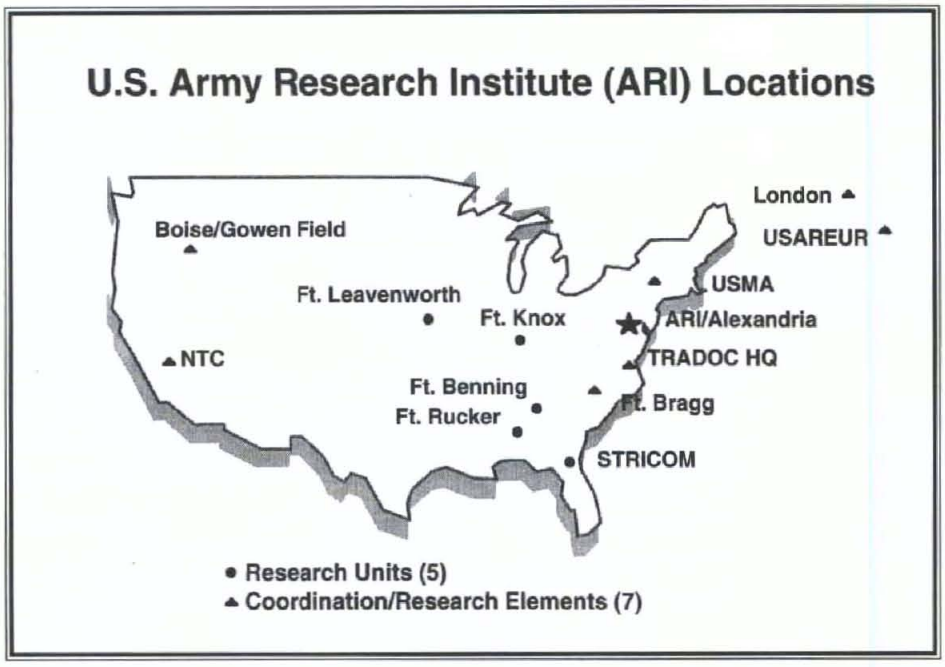
First, how do we determine what knowledge, skills, and abilities are required for successful performance and leadership in Force XXI? Second, what methods and career experiences can be used to develop officers and enlisted personnel? And, third, how do we train the increasing number of individual, unit, and leadership tasks in an era of increasingly limited training resources? The number of tasks to be trained will increase because the Force XXI modular Army will have both a greater variety of missions and fewer individualized officer and enlisted specialties.

More specifically, how are Force XXI leaders at all echelons supposed to make use of all the digitized information? Much of the digitization R&D is working to get more information, more quickly to the decision-maker. While this is important, it is also important to determine what information and how much information battle commanders need to increase their units' performance, be it on the battlefield or in OOTW. More information is not necessarily better, as there will certainly be instances of information overload. The question then becomes: How do we train leaders at all echelons to make effective use of the Force XXI digital technology and doctrine?

Other MPT research issues that can be drawn from the scenario include:

- The effects of internetted, non-hierarchical information flow on leadership and command relationships;
- Selecting and assigning active and reserve component officers and noncommissioned officers with the abilities and skills for effective decision-making and leadership;
- Training rapid, sound decision-making when confronted with conflicting digital information;

If the Army is to meet the goals of Force XXI, there must be significant advancement in manpower, personnel and training technologies to complement advances in hardware and digital technologies.



• Training intercultural sensitivities to all echelons;

• Understanding skill acquisition and decay as soldiers and units shift between traditional combat missions and OOTW;

• Ensuring basic combat tasks are fully trained, e.g., executing battle drills, along with Force XXI technology-based tasks.

ARI Research Supporting Force XXI

Much of ARI's training systems research involves enhancing the effectiveness of new training simulation technologies with the focus largely being on how to use distributed interactive simulation (DIS). Virtual training simulations, no matter how elaborate or lifelike, are merely tools to be used to improve soldier and unit performance. Simply stated, ARI's training simulation research is looking for better ways to use these new tools. Listed below are brief descriptions of selected ARI research projects that support Force XXI. Other articles in this issue present more complete descriptions of these and other ARI Force XXI-related projects.

Force XXI Training Strategies for the Digitized Battlefield. This research is developing new training technologies that will help prepare operators and commanders to incorporate new doctrine and take maximum advantage of the capabilities of evolving digitized command, control and communications systems. The project will use developmental simulation and the Advanced Warfighting Experiments to demonstrate and evaluate prototype training techniques. The work will be done in conjunction with the Mounted Battlespace Battle Lab.

Multi-Service Distributed Training Technologies. This project is developing guidelines for the use of DIS in the training of joint missions with the initial focus on close air support. A recent demonstration linked together simulated armored forces, attack aircraft, forward air controllers, and ground spotters in four states. The project will also develop performance measures for interrelated brigade-level tasks, e.g., synchronization, as the basis for brigade-level performance assessment and feedback methods.

Human Dimensions of Battle Command. This project is determining the key factors in commander and staff effectiveness. It will then validate recommended organizational designs, procedural changes, and training strategies for effective battle command. Issues include situational assessments, effective utilization of all combat power, and communication of commander's intent. The research will include the analysis of data from the Battle Command Training Program and the Louisiana Maneuvers Data Base.

Simulation-Based Training for Army National Guard Units. This project is developing and evaluating a structured multiechelon training program using DIS and constructive simulations. The work includes the development and validation of new methods of performance feedback and after action review capabilities.

Force XXI Leader Effectiveness and Development. This project is developing methods for improved leader assessment and development from pre-commissioning through company-grade officers. The research will develop measures of effective leadership across organizational levels and new approaches for progressive leader development.

Volunteer Reservists in Peacekeeping Operations. This project is evaluating the use of composite active and reserve component units. The focus is on the first unit of this type which is currently performing a peacekeeping mission in the Sinai as part of a multinational force and observers. The research addresses various MPT technologies, including selection, small-unit cohesion, commitment, training, economic and family impact.

Other ARI research projects addressing the full spectrum of Force XXI issues involve: intercultural communication requirements for Special Forces teams, training methods to sustain foreign language skills, training technologies to improve night operations, and the development of OOTW training strategies.

Force XXI Research Priorities

In an era of reduced budgets, the Army needs to be particularly prudent in its prioritization of programs, including those R&D programs that are helping the Army to realize the full potential of Force XXI. To a great extent, the Army's MPT R&D is guided by two documents, the Army Modernization Plan and the Army Science and Technology Master Plan which well represent MPT concerns. Considering that greater than 60 percent of the Army's budget goes to personnel and training, it makes good sense for the Army to continue to place emphasis on the development of new MPT technologies.

Force XXI is about a leap-ahead, digitized capability that will leverage the latest advances in electronics. These include the effective integration of electronic intelligence, computer processing, advanced software, and "window to the battlefield" displays. But it is also about well-trained units comprised of quality soldiers. And it is about leaders with vision who can translate the digitized information into effective battle command. Only when the digitized, electronic technologies are merged with appropriate manpower, personnel and training technologies will we fully realize the information-based potential of Force XXI.

DR. SCOTT E. GRAHAM is a research psychologist in ARI's Plans, Programs and Operations Office in Alexandria, VA. He has a B.A. from Indiana University and a Ph.D. from the University of Maryland in cognitive psychology. He worked for eight years at ARI's Fort Knox Field Unit and has conducted research on simulation-based training, reserve component and Special Forces training.

SOLDIER SELECTION FOR FORCE XXI

By Dr. Michael G. Rumsey

Soldier Quality

As the Army approaches the 21st century, it is faced simultaneously with declining resources and monumental challenges. Even as it downsizes, its missions are increasing both in numbers and variety. Now, besides preparing for conventional, large-scale warfare, it must also be prepared for the full range of operations other than war. The Army's response to these challenges, Force XXI, is both proactive and innovative. It accepts the reality of downsizing and focuses on leveraging those resources that will still be available.

Much of the discussion of Force XXI has emphasized the importance of new technology, particularly with respect to the digitized battlefield and associated communication issues. Technology is in fact a critical element of the Army's strategy. However, no less important is the concept of soldier quality. The Army's Training and Doctrine Command Pamphlet 525, *Force XXI Operations,* notes: "Quality soldiers, trained and led by competent and caring leaders, will remain a key to success on future battlefields." This article discusses current and planned work by the U.S. Army Research Institute (ARI) to improve soldier quality through selection.

Historical Perspective

The focus of ARI's selection research is to determine what constitutes quality, develop the techniques to measure it, and determine how to apply these techniques in the most effective and cost-effective manner possible. Army research on the problem of defining quality is not new. It began in 1917 with the development of the Army Alpha and Beta tests to select and classify recruits for World War I on the basis of cognitive aptitude. The Army then developed the Army Classification Battery for differential assignment, a forerunner to the Armed Services Vocational Aptitude Battery (AVSAB), which has been used for joint service enlisted selection and classification since 1976.

Recently, ARI has been conducting research which suggests the need for a more comprehensive assessment of applicant characteristics. The research has identified multiple facets of job performance and indicates that multiple measures are needed to best predict these facets. New tests of temperament, spatial ability, and psychomotor ability have been developed which represent a major step toward improved prediction of enlisted performance. We are currently working on refinements to ensure that these measures work as well in an operational environment as they do in a research environment.

New Requirements

While the general problem of defining quality is not new, it takes on new urgency and direction as we try to develop a definition of quality which will meet the requirements of the 21st century battlefield. This definition must take into account the need to deal

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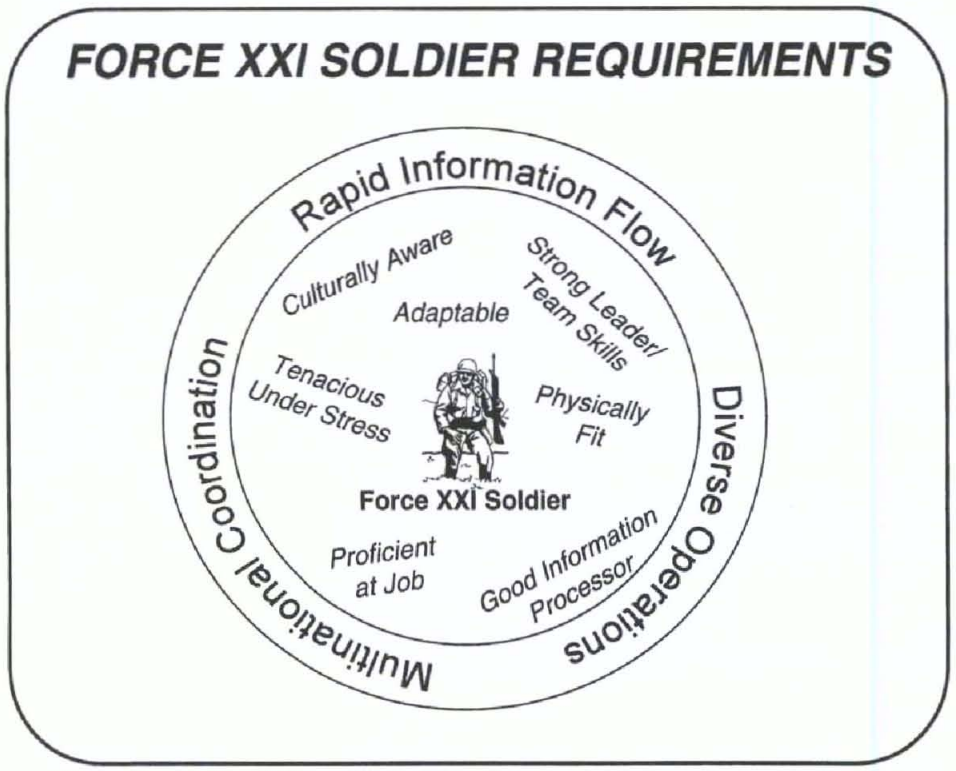

effectively with a rapid flow of information in a high-stress environment. It must encompass the ability to quickly determine the relevance and importance of the information received and to use effective judgment and time management so that the individual can respond effectively to the situation rather than being overwhelmed by information overload.

Our interviews with Desert Storm veterans identified some performance requirements which may well forecast some aspects of what will be required in a Force XXI environment. These included adaptability, tenacity under stress, capacity to learn spontaneously from experience, sustained performance, resourcefulness and working well with others. The definition of quality for the Force XXI soldier must also take into account requirements associated with peacekeeping and operations other than war, such as cultural awareness and tolerance for boredom.

This new, evolving definition of requirements for the 21st century soldier suggests the need to develop appropriate new predictor measures. Such requirements as adaptability and tenacity under stress have non-cognitive components which can be assessed to some extent by measures of temperament and personal history. These types of measures are being developed and tested, with encouraging results. Future research will focus on improving such measures and increasing their coverage of characteristics associated with Force XXI requirements.

Person-to-Job Match

To maximize the efficacy of our force in the 21st century, we must ensure that individuals and jobs are properly matched. One generic definition of quality will not apply equally to all jobs. We must differentiate those characteristics which are important for combat jobs from those which are important for combat support and combat service support jobs, then make further distinctions to the extent possible. The current ASVAB provides separate selection criteria for separate collections of jobs. These criteria will be refined and expanded to enhance overall effectiveness. We will look at the person-to-job match from the job side as well. We expect that jobs will need to be re-defined to fit the requirements of Force XXI. We will conduct research to develop improved job definition procedures so that the new job structures can be rationally aligned with the Army's needs and individual aptitudes.

Quality Leaders

We also need to look at how the definition of quality regarding Force XXI requirements changes as one moves up the organizational ladder. We believe we can do a better job of predicting how a soldier will perform in his or her first or second tour than we can at predicting how he or she will perform as a mid-level or senior non-commissioned officer. Considerable research is also needed to enable us to better predict officer performance. We need to look at the job requirements at all organizational levels, not just the enlisted entry level, and we need to develop procedures which will ensure we are placing individuals in each case for the maximum benefit of the Army.

Conclusion

Today, Force XXI is a concept. Bringing this concept to reality will require doctrine, technology and equipment. But above all, it will require people who can perform effectively in the 21st century environment. The Army must be able to attract these people; then it must be able to recognize and properly place them. Through the efforts outlined here, ARI is attempting to develop the tools that will be most helpful in the recognition and placement process. These tools will help ensure that we do not waste manpower, the most precious resource we have, as we move toward century 21.

DR. MICHAEL G. RUMSEY has been chief of the Selection and Assignment Research Unit in the Manpower and Personnel Research Division, U.S. Army Research Institute since 1989. He holds an A.B. degree in political science from Whitman College and M.S. and Ph.D. degrees in social psychology from Purdue University. Since 1975, he has participated in and directed numerous research projects dealing with enlisted and officer selection, classification, and assessment. He is the senior editor of Personnel Selection and Classification, a book published in 1994 by Lawrence Erlbaum Associates.

DEVELOPING FORCE XXI BATTLE COMMANDERS

By Dr. Stanley M. Halpin

Introduction

The battle command concept incorporates both battle decision making and leading and motivating soldiers and their organizations into action to accomplish missions (FM 100-5, June, 1993). Building on a long tradition of behavioral science research on tactical planning and decision making and a parallel tradition of research on Army leadership from pre-commissioning to strategic levels, the U.S. Army Research Institute (ARI) is conducting a research and development program to support the development of battle commanders for Force XXI. This article will briefly examine the changing requirements for battle commanders under Force XXI, highlight some recent research findings and technology insertions, and provide an overview of longer-range research goals.

Questions being addressed center around two major issues:

- What are the performance requirements for the Force XXI battle commander?
- How does the Army develop competent, confident and tactically proficient battle commanders for Force XXI?

Force XXI Battle Command

In many ways, the job of a Force XXI tactical or operational commander will not be very different than it is today. Battle commanders will need to understand the mission passed down from higher headquarters; identify, evaluate and select options for accomplishing the mission; and guide their organization to successful mission accomplishment. This will not be done in isolation, but with a supporting staff system, and a continuing need to train the supporting staff to perform their assigned tasks. But, under Force XXI, battle command will be performed within a radically new information environment and within a new organizational structure. Force XXI conditions will change the nature of the battle commander's task, and in order to maximize the commander's battlefield effectiveness, these changes need to be understood.

Impacts of Battlefield Digitization

The vision for Force XXI includes battlefield information technologies which will allow digitization of the battlefield; information will flow in an internetted fashion among all echelons, across all battlefield operating systems. When these information concepts are combined with plans to physically isolate the commander and principal staff in battle command vehicles, we can see that the commander will have a distributed, virtual staff group; there will seldom be a cluster of staff personnel around a common map sheet providing situation updates or assessments, as in the past.

Digitization is expected to result in a net gain in situation awareness and understanding for senior personnel, a net gain in the extent to which different elements share a common vision of the current situation, and a net reduction in the number of staff personnel required. It will also certainly result in a change in the working relationships between battle commanders and their staffs. The Army needs to develop battle commanders who can adapt to and, more importantly, take advantage of this new way of working.

Force XXI conditions will change the nature of the battle commander's task, and in order to maximize the commander's battlefield effectiveness, these changes need to be understood.

Impacts of Modular Units

If information-age technology is the most frequently used term to describe the materiel underpinnings of the Force XXI vision, then modularity is the most often used organizational-design concept. In a smaller Army, we cannot afford the luxury of maintaining division-sized units which are designed and trained to accomplish a single mission. The alternative which has been proposed is to assemble brigade–or division–size forces from among force modules as needed for a given mission. A situation where ad hoc forces are assembled under strong time pressures for rapid deployment could create spinoff consequences for battle commanders.

First, ARI research has shown that the effective span of control of commanders depends to a great extent on their establishment of strong working relationships with their subordinate commanders. It is difficult to invest total trust in an unknown subordinate, no matter how competent he or she is reputed to be; an ad hoc unit with many unfamiliar

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subordinates could severely tax even the most expert commander's leadership skills.

Second, subordinate commands are not independent actors, but rather, elements of the larger unit. Force XXI battle commanders, working with unfamiliar subordinates, may also be faced with the difficult task of coordinating with unfamiliar adjacent and supporting modular units to a greater extent than in the past.

Battle Commanders

Developing Expertise

Battlefield digitization and ad hoc modular units will put increasing demands on the battle commander's personal knowledge and skills. ARI scientists participated with the Battle Command Battle Laboratory (BCBL) in conducting focused rotations at the National Training Center and the Joint Readiness Training Center in 1994; observations made there confirmed for Army leaders what is known about other professions: experts must possess high levels of well-integrated domain knowledge in order to operate effectively. In the context of battle command, expertise demands a thorough understanding of relevant tactics, techniques and procedures. Expertise is gained over a long period of time, with considerable practice. An issue, then, is how to develop expert Force XXI battle commanders and develop the necessary leadership, decision making, and broad technical skills required to command ad hoc modular units commanded by unfamiliar subordinates.

Battle Commander Development

An Army division commander takes 25 years to develop. Force XXI battle commanders now are in various stages in the developmental pipeline. The major generals who will assume command, in 2010, of division-sized elements of Force XXI entered the Army in 1983-1985, are in their early 30s, have participated in Operation Just Cause and/or Operation Desert Storm, and will graduate from the Command and General Staff Officer's Course in 1994-1996. Under their command will be commanders of brigade-sized elements who are currently senior captains who probably also have Operation Just Cause and/or Operation Desert Storm experience.

The lieutenant colonels who will command battalion-sized Force XXI elements in 2010 entered the Army in 1991-1993 and probably did not participate in Operation Desert Storm, but may have experience in Somalia, Rwanda, and/or Haiti. The commanders of Force XXI company-sized elements have not yet entered high school. How these future battle commanders and command staff will develop and practice the skills needed for the Force XXI digitized battlefield is a major consideration of our research.

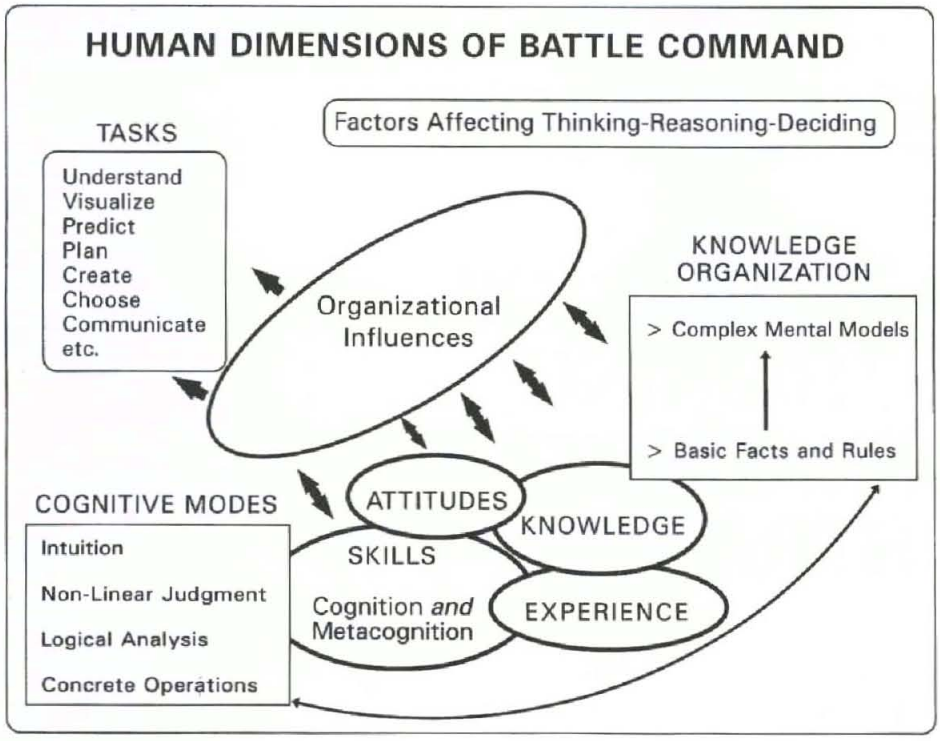
The Army leader development model is based on the relationship among the three pillars of officer development: institutional training and education, operational assignments, and self development. The Officer Personnel Management System, built around this model, balances the institutional and operational opportunities in an officer's career, with each successive experience allowing growth and development. The goal is to provide an orderly, predictable career path which will maximize an officer's capability to accomplish each new assignment. We believe the fundamental concepts of this leader development model fit the requirements for battle command development for Force XXI, but the specific details of the information, knowledge, skills, and expertise, and the timing of critical experiences need to be better understood.

ARI Research on Battle Command

Past ARI research relevant to developing Force XXI battle commanders draws from two parallel tracks: an emphasis on tactical decision making processes and an equal emphasis on senior leadership competencies. The insights gained from these research programs were brought together in a presentation to GEN Frederick Franks, then commander, U.S. Army Training and Doctrine Command (TRADOC) and formed the basis for a joint ARI and BCBL Workshop on Force XXI Battle Command held at Fort Leavenworth, KS, in November 1994. This application of prior research findings to the concept of battle command and the workshop discussions provide the foundation for exploration of new approaches to the development of battle commanders.

A Preliminary Cognitive Model

A cognitive model was developed to describe the interplay among factors which affect an individual's effectiveness in performing complex mental tasks. Based on their experiences, individuals develop knowledge, skills, and attitudes which affect their performance. A second component of the model recognizes that knowledge alone is relatively useless; true expertise comes as individuals organize their knowledge. Expertise implies extensive domain knowledge organized in a complex, adaptable fashion. The knowledgeable commander can recognize points of similarity between the current



battlefield situation and famous battles, but the expert battle commander can recognize opportunities and risks in the current situation, building only in part on historical analogies. Effective organization of one's knowledge can come about only with practice and experience.

Complex cognitive skills are required for battle command—some we can identify, others we need more research to articulate; moreover, battle commanders may need to be capable of thinking in a number of modes, such as intuitively or logically, depending upon the task demands. We believe that, at a minimum, components of these skills can be taught. We also believe that, to a large extent, modes of thought also can be taught.

Finally, task performance depends to some extent on organizational dynamics. For example, a battle commander with zero tolerance for failure will hear fewer speculative tactical assessments than a battle commander who encourages open discussion.

Insights

Based on this cognitive model and the military and civilian research which underlies it, we have derived a number of general insights into the cognitive aspects of battle command. Some of these are:

- Even the most intuitive battle commander must have a sound base of experience and knowledge to draw upon when making decisions. There is no magical process whereby someone can solve a complex problem in an area about which they know little or nothing.
- At a minimum, components of critical battle command skills such as planning, problem solving, decision making, communicating, and leading can be taught.
- Expertise cannot be taught; it must be developed over time.
- Expert battle commanders operate on the knowledge they bring to the situation as modified and refined by information about the current situation. The massive internetted flow of information seen as the hallmark of Force XXI will be critically important for the control function, but may contribute relatively little to battle command.

Continuing Research

ARI will continue to collect data during focussed rotations at combat training centers and during advanced warfighting experiments to assist the Army in the articulation of skills required of Force XXI battle commanders. Our future research program will continue to be oriented on our two central questions on battle command:

- What are the performance requirements for the Force XXI battle commander?
- How does the Army develop competent, confident and tactically proficient battle commanders for Force XXI?

Several research efforts are directed at developing cognitive and metacognitive skills. For example, researchers at the ARI Fort Leavenworth Research Unit are currently teaching a 17-hour block of instruction on practical thinking skills within the Battle Command Elective (A308) of the Command and General Staff Officer's Course. Pending evaluation results on this pilot effort, we expect to refine and export the instruction to other TRADOC schools.

We are laying the groundwork for an understanding of the growth of Army leaders' knowledge, skills, and abilities over time as a function of educational and assignment experience. Much of this research is developing performance and skill measures targeted at the battle commander as a leader and a decision maker. One project is attempting to measure the growth of cognitive and metacognitive skills at different times in officers' careers. Valid measures could be used to provide feedback to developing battle commanders on their cognitive and metacognitive skills. The ARI Leader Development Research Unit at the U.S. Military Academy, West Point, is conducting longitudinal research on officer development using a variety of aptitude, cognitive, and leadership measures. Critical to this and other related research looking at the nature of expertise is the development of meaningful performance measures of battle command.

Battle commanders with strong leader and decision-making skills are critical to the success of Force XXI. The human dimensions of battle command will continue to be a major focal point for ARI behavioral and social science research on selection and assessment, performance measurement, leadership, and decision making.

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DEVELOPMENT OF A FORCE XXI TRAINING MANAGEMENT STRATEGY

By Dr. Jack H. Hiller,
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Introduction

The Army chief of staff has said that the critical challenge for the Army as we create Force XXI is to remain trained and ready, while growing more capable. Essential to training readiness are the resources required for conducting the training; the spares, fuels, ranges, maneuver areas, and the training aids, devices, simulators, and simulations (TADSS) necessary to accomplish the mission. To maximize the value of these resources, there is a need to develop current and relevant unit training strategies. In addition, there is also a need for management tools to: analyze changes in training needs caused by revised mission assignments and personnel turbulence/turnover; coordinate the acquisition of resources (e.g., firing ranges, fuel and bullets); and construct schedules for individual, leader, and collective training that adjust to outside taskings and post support chores. Finally, there is a need to create a simplified, yet accurate means for routinely reporting training results to enable monitoring of readiness and detection of needs for training system changes, including funding requirements.

The Training Directorate (DAMO-TR), in the Office of the Deputy Chief of Staff for Operations and Plans, is leading the organization of efforts by the Army Training and Doctrine Command (TRADOC), the Army Forces Command (FORSCOM), U.S. Army, Europe (USAREUR), National Guard, and Army Research Institute (ARI) to estimate and justify the necessary training resources and to develop the management tools necessary for maintaining readiness during the transition to Force XXI and beyond.

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Operational Tempo Rationalization and Validation

How much operational tempo (OPTEMPO) does an armored or aviation unit require to achieve and maintain combat readiness? Don't unit Mission Essential Task Lists (METL), and basing differences (e.g., Fort Hood or USAREUR) affect access to training areas, training strategies, and OPTEMPO requirements? Field commanders generate and forward their analyses of training resource requirements, but how good are their training strategies and how accurate are their analyses of resource requirements? The Office of the Secretary of Defense and the General Accounting Office have continued to ask these questions year after year.

Back in the mid-80s, DAMO-TR attempted to answer these questions with the direct assistance of TRADOC and major command representatives by formulating training strategies for each type of battalion, at each readiness level. Panels of experienced trainers led by TRADOC proponents distilled their experi-

ence to estimate how often units needed to train in the field with the aid of TADSS, to sustain each readiness level. Based on average Army cost factors, each battalion training "strategy" was costed and entered in the DAMO-TR data base as a Battalion Level Training Model (BLTM).

Today, the Army is once again facing the need to accurately determine and then defend its analyses of the resources required to maintain training readiness. Today, this challenge will be met by capitalizing on the experience of Army leaders, both in-Service and recently retired, to form the training strategies–but with significant changes in procedure from the original effort. When the BLTMs were originally defined, there was an intent to have each MACOM collect data that would form more accurate BLTMs than the single models or strategies, but that intent was never realized.

Recognition of Basing Differences

Accuracy demands that significant variations in availability of training areas and training devices to units be incorporated in the units' training strategies. To accommodate this requirement, FORSCOM has provided selected armored units from III Corps as a test bed and USAREUR has likewise provided an armored unit from V Corps. The current availability of the simulation network (SIMNET) in USAREUR and severe maneuver area limitations will be reflected in training strategies custom tailored for USAREUR. Likewise, training strategies will be custom tailored for Fort Hood. To focus the effort, only the 10 highest cost battalions will be worked initially. The basic procedure will be to draft the training strategies with the aid of detailed TADSS inventories and recent unit training programs. TRADOC proponents will be critical evaluators of these draft strategies.

Field Testing

Once the training strategies have been approved by TRADOC proponents, they will be applied to craft complete two-year training plans. The two-year plans will provide a detailed basis for conducting costing and effectiveness analyses. This two-year period was selected to permit inclusion of rotations to the combat training centers that typically occur within every 24 months, and to provide a firm basis for costing analyses.

After the training strategies and two-year plans have been drafted, they will be subjected to "murder boards" at Fort Hood and USAREUR hosted by the test-bed units. After scrubbing, the test-bed units will use the strategies and two-year plans as training management aids. The test units will be free to vary their schedules to accommodate mission requirements, actual availability of resources, and emerging new and better ideas. DAMO-TR will monitor unit execution with the assistance of ARI to determine if the training strategies correspond to actual practice, and, if not, how to modify them to reflect actual resource requirements.

Flexible Training Strategies

The training strategies will be drafted to identify the alternative live, constructive, and virtual simulations that units may choose, or, because of shortages, be forced to use. However, to ensure that training readiness is accurately monitored by the units, each of the alternative TADSS will be rated in one of four categories for its ability to train specific tasks. The four ratings are: (A) Combat Training Center (CTC) rotation: realism sufficient to permit appraisal of unit training readiness for the Unit Status Report (USR); (B) CTC quality training: realism also sufficient to permit appraisal of unit training readiness for the USR; (C) training Gate quality, but not adequate for USR; (D) good enough only for refresher or basic training.

Training Management

Unit training management is exceedingly complex. Units are responsible for achieving and maintaining readiness for multiple combat missions and military operations other than war. The mission tasks to be trained within a battalion number in the hundreds, for both collective and individual soldier training. Personnel turbulence/turnover and skill degradation complicate determination of unit capability and thus complicate precise scheduling of the most important tasks to be trained or refreshed. Coordinating the resources for training events requires continuous attention and effort. Collecting the results of training and analyzing them to adjust training schedules and to assess training readiness are tasks so difficult that a great deal of subjective estimation must be relied upon by training staffs and commanders.

To provide units with computer-based training management tools, ARI developed an integrated training management system (training, personnel, supply and maintenance were included together) and tested it in one battalion (the 1/11FA) of the High Technology Test Bed, Fort Lewis, WA, in the mid-80s. The test results validated the utility of a computer-based training management system (the Advanced Technology Unit Training Management System).

Standard Army Training System

Based on the success of ARI's experimental system, and further development by the High Technology Test Bed as the Integrated

Collecting the results of training and analyzing them to adjust training schedules and to assess training readiness are tasks so difficult that a great deal of subjective estimation must be relied upon by training staffs and commanders.

Training Management System, TRADOC assumed proponency and fielded a personal computer-based Standard Army Training System (SATS). During this fiscal year, with funding and policy guidance provided by ODCSOPS, the Army Training Support Center will advance the capabilities and user friendliness of the SATS by entirely reprogramming it to feature objective oriented programming within a Windows, or Windows-like, environment. This software, called SATS 4.0, will "pull the user" into the process of managing training.

Training Management Tools

The new SATS (4.0) will incorporate the experimental training strategies as upgraded versions of Combined Arms Training Strategies and the two-year training plans as example implementations. The Training Mix Model developed by the Training Analysis Center will be incorporated to assist training managers to modify the strategies as a function of shifting training resources. An automated scheduling program, developed by ARI, will be included. The program is based on the concept of "simulated annealing," i.e., the program constructs a schedule based on rated training priorities and availability of resources until it hits an impasse, at which point the program backs up a few steps and resumes its scheduling task (see *An Application of Simulated Annealing to Scheduling Army Unit Training*, ARI TR 727, Hart and Goehring, 1986).

Of major importance, the SATS will incorporate the Combined Arms Tactical Trainer - Training Exercise Development System data base which comprehensively lists all missions and tasks and provides a training quality rating for all TADSS, including the Close Combat Tactical Trainer.

Another management tool to be incorporated in the SATS data base is the set of Critical Combat Functions (CCFs) recently defined by ARI research (see chapter, "A Conceptual Framework for Measuring Unit Performance," by Lewman, Mullen, and Root in *Determinants of Effective Unit Performance*, Edited by Holz, Hiller, and McFann, ARI, July 1994). The CCFs were developed in response to a major management problem found by the determinants research. The management problem's genesis comes from a gap between management doctrine and the tools needed for implementation.

FM 25-100, *Training The Force*, guides units at every echelon in analyzing their missions to identify the unit's METL, and to communicate this METL down the chain of command to assist units in developing their training programs. Although units have routinely defined and communicated their METLs, the tasks necessary for focusing training, e.g., Mission Training Plan (MTP) tasks, have not been systematically listed. Missions and activities that were too general or abstract were generally listed as additional METL tasks. The problem as analyzed by ARI appeared to stem from a reluctance to create the long list of MTP tasks that were associated with each METL item.

The CCFs were created and designed to provide a functional basis for naturally organizing task clusters by decomposing the seven Battlefield Operating Systems. Thirty-nine CCFs have been identified for combined arms operations and are organized within the battlefield operating systems, e.g., maneuver: conduct tactical movement, and engage enemy with direct fire; command and control: plan for combat operations; direct and lead preparation; direct and lead execution of the battle.

Training Readiness and Resources Linkage

An important feature of the SATS data base will allow training managers to key in the results of their training. An automated software routine will then track the status of training against the unit METL to enable a running assessment of unit training readiness. Diagnostic pointers for remedial training will be provided for consideration. Furthermore, training readiness will be linked by SATS software to training resource expenditures and shortfalls. Thus, training resources and training readiness will be linked and simultaneously monitored by units. This SATS capability will greatly enhance the unit's ability to monitor and report training readiness. It will also give the Department of Army the ability to estimate and justify training readiness resources. This module will allow the unit commander to communicate training readiness with DA in similar fashion to the Personnel, Equipment on Hand, and Equipment Readiness systems.

Force XXI Transition Training Management

In the past, an already complicated unit training management environment was always stressed by the fielding of new equipment, changes in tactical doctrine, and typically late arrival of individual training, maintenance, and collective training programs. Force XXI development planning should sharply reduce these historical training problems. The Army, by committing to an experimentation methodology for developing Force XXI, has adopted a strategy that requires training to be developed in parallel with equipment and doctrine–so that the equipment and doctrine can be tested without obscuration of results caused by untrained and unprepared experimental units. The work on training resources rationalization, management, and readiness reporting described in this paper will provide an efficient and effective basis for units to maintain their training readiness as they transition to Force XXI.

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DESIGN OF MOUNTED WARFARE TRAINING FOR FORCE XXI

By Dr. Billy L. Burnside, Dr. Kathleen A. Quinkert, Dr. Barbara A. Black, and BG Lon E. Maggart

Introduction

Training has been critical to the successful conduct of mounted warfare in the past, and it will continue to be so in the future. Training for the 21st century promises to be increasingly challenging as smaller forces use highly sophisticated equipment in widely varying environments. Force XXI, the digitization of battlefield systems through application of information technology, will result in major changes in the conduct of mounted warfare on future battlefields. Combat tactics, techniques, and procedures are likely to change significantly. How must the design of training change to accommodate new training requirements and technologies?

In some aspects, training for Force XXI will remain much as it is today. At the delivery level, training will still be conducted largely through the provision of opportunities for practice with performance feedback, although the feedback will be provided increasingly through means other than human instructors. At the management level, the systems approach to training will still provide the appropriate framework for training, although parts of the process will be increasingly abbreviated and automated.

The training process involves analysis, design, development, implementation, and evaluation phases. Major outputs of training design, the focus of this article, include the identification and sequencing of training objectives and the development of evaluation approaches. The remainder of this article briefly examines ways in which the design of training for Force XXI will differ from traditional training design. Following a brief discussion of future training requirements, the structuring of training objectives and evaluation opportunities is addressed in terms of an example simulation-based training program and its implications for Force XXI training.

Training Requirements

Training for Force XXI must continue to apply the basic principles that guide Army training today. Among these are requirements to train as combined arms teams, to use performance-oriented training in a functional context (train as you fight), to challenge and excite soldiers and leaders (immerse them into training), and to use multi-echelon techniques to train organizational echelons simultaneously.

The requirement for mounted warfare training to be increasingly simulation-based will continue to emerge as we approach the 21st century. More specifically, the use of constructive and virtual simulations will increase as traditional training resources and locations (ranges and maneuver areas) become more constrained. These simulation capabilities must be used efficiently as well as effectively.

Reserve units have long faced the requirement to train efficiently, due to constraints on training time. Active units are increasingly faced with the same need, due to similar time constraints, resource constraints, and the need to train rapidly for a variety of contingencies. Training efficiency will be a prime consideration for Force XXI.

Force XXI will also face an increasing need for staff training, particularly in information processing and command and control skills to support combined arms, joint, and multinational operations. Finally, training requirements themselves will change more rapidly in the future, due to the dynamic nature of world affairs and the development of automated databases (e.g., the Standard Army Training System) to support rapid updating of task analysis. Training for Force XXI must, thus, be rapidly reconfigurable.

Consideration of existing and emerging training requirements such as those outlined above leads to recognition of the need for structured training. As defined by LTG (Ret.) Frederic J. Brown, structured training involves the deliberate design of training events to meet specific objectives in an organized sequence of performance and evaluation activities. Such design is necessary for efficient delivery and reconfiguring of training.

Structured training is not new to the Army. Established examples include "lanes" training during field exercises and the matrix for the Conduct of Fire Trainer. What is new is recognition that structured training is appropriate for training complex tactical and staff skills, for making best use of limited training time and resources available, and for taking full advantage of the capabilities of simulation. A recent example of the design of structured training is described briefly below, followed by examination of issues relating to structured training for Force XXI.

Example of Structured Training

The Army Research Institute's (ARI's) Armored Forces Research Unit at Fort Knox recently completed a project (entitled "Simulation-Based Multi-echelon Training Program for Armor Units"), providing training research and development support for the Reserve Component Virtual Training Program (RCVTP). This program was established at Fort Knox with congressional funding to provide simulation-based training focused initially on Army National Guard (ARNG) armor units. The training is designed to be "turn-key," so that ARNG units can maximize their time in training execution while at Fort Knox. The program includes complete training support packages and a dedicated team of military observer/controllers (O/Cs) to assist in training implementation.

The RCVTP design provides for a highly structured training program with multi-echelon or nested training exercises. The program includes a library or menu of over 100 structured training exercises, all within the context of two typical battalion-level missions (one offensive and one defensive) conducted at the National Training Center. Platoon, company, and battalion exercises are available for execution on the Simulation Network (SIMNET), battalion staff exercises are available on the Janus simulation, and one battalion staff exercise is available on SIMNET with the addition of automated message generation capabilities.

The program design focuses on critical combat skills; each exercise addresses a small number of specific training objectives or critical subtasks. The sequencing of exercises

provides for a structured progression of difficulty, often described as "crawl-walk-run." Once the unit leader and O/C select a starting point in the library, the training unit completes exercises based upon its performance and training needs (performance-oriented training).

Exercises are designed to focus learning and use simulation time efficiently. Each platoon and company exercise or table is organized into a short preparation period of 30 minutes or less, an execution period of approximately one hour, and an after action review (AAR) lasting about 30 minutes. The training objectives are stated explicitly at the beginning of each exercise and are addressed during the AAR. Battalion exercises have a similar organization over longer time periods.

The training design emphasizes frequent provision of feedback. Each AAR is facilitated by an O/C who encourages group discussion and discovery learning. The O/C has various tools available to support the AAR. In SIMNET, these include capabilities for replaying exercises (including communications) from unlimited perspectives, for focusing on or "freezing" key exercise events, and for extracting and displaying descriptive data (Unit Performance Assessment System developed by the Army Research Institute).

The design focuses the program on maneuver execution. The provision of complete training support packages and assistance from O/Cs allows units to move quickly into a tactical situation in order to train in a functional context. Units can move rapidly back into the situation or context following guided analysis of their previous performance during an AAR. This approach is designed to maximize learning through challenging interactive use of simulation that immerses the unit into training. Formative evaluation indicates that the program has achieved this design goal.

Research Issues for Force XXI

Structured simulation-based training programs such as the RCVTP provide a starting point for the development of Force XXI training. This section addresses lessons learned and research and development issues or requirements for the structure of Force XXI training. How can we get from structured training of today to the training required for the 21st century?

One of the goals of structured training is to provide efficient training delivery. That is, overhead is minimized for the receivers of training. Doing this has many implications for the design, development, and management of training.

Future simulation systems need built-in capabilities to support generation of structured training exercises. Imagine a video game that creates new versions as the player defeats existing ones. The design and development of structured training is hard work and resource-intensive. Much effort is required to check routes, positions, and the timing of events to ensure that performance during training exercises is cued properly for addressing specific training objectives. Methods for increasing the efficiency of training delivery have been tried and documented. Methods for increasing the efficiency of training design and development for Force XXI are now needed.

Research is needed to reduce the personnel overhead of implementing structured training by automating O/C functions through intelligence built into simulations. Force XXI training programs are not likely to have dedicated military O/C teams available. Commanders must serve as trainers as well as active participants in the training. They will need training in the operation of simulation workstations, as well as in techniques of conducting structured training. This is a special concern for the AAR process.

Trainers (O/Cs or commanders) will find it increasingly difficult to use all available feedback tools that simulation can provide (such as instant replays and statistical data summaries) in the short time they have available to prepare AARs. Feedback may continue to be based largely on trainers' quick observations and judgments. One aspect of addressing this situation is the development of methods for integrating and rapidly displaying objective measures of performance tailored for users' needs, using automated intelligent feedback systems. Another aspect is recognition that it will become more difficult for trainers to observe performance as command and control becomes increasingly automated or digitized. Training observation and feedback tools need to be built directly into simulations of digitized systems.

As structured training is developed and implemented, procedures and resources must be put in place to sustain it. Software updates and other enhancements will need to be incorporated into the programs, and good ideas from trainers and others will need to be considered and applied as appropriate. Configuration management and sustainment will be required for structured training programs, much as it is for weapons systems.

Structured training is effective and efficient, at least for basic levels of training. LTG (Ret.) Brown has argued that training should become less prescriptive and more descriptive at advanced levels. Many questions remain about how and when units should transition from highly structured tables to exercise variations tailored for unique capabilities and requirements. This issue is especially critical for information processing skills of prime interest for Force XXI.

A final issue related to the last one raised above is the required flexibility that must be provided with future structured training. Units must be increasingly prepared to operate in a variety of contingencies and locations. They will operate over wider terrain and more varieties of terrain. Their training will require larger terrain databases, and must be rapidly tailorable to terrain and other conditions. Just as simulators are becoming reconfigurable to represent different weapons systems capabilities, the training programs in which these simulators are used must be reconfigurable for different conditions and requirements.

Conclusion

To make efficient use of simulation capabilities, training for Force XXI needs to be structured yet flexible. Current structured training programs provide a starting point for Force XXI training, but many research and development issues remain.

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THE ROLE OF FLIGHT SIMULATION IN THE FORCE XXI ARMY

By Dr. Dennis Wightman, MG Ronald E. Adams, and Charles A. Gainer

In his vision for the Force XXI: Digitized Battlefield (*Army RD&A Bulletin*, November-December 1994), Army Chief of Staff GEN Gordon R. Sullivan defined six points which outline the axis of advance for the Army to follow in order to achieve the enhanced effectiveness which is the promise of Force XXI. The sixth point, "take a holistic approach to the problem," highlights a significant requirement. Over the course of history, down to the present, the aviation training community has been concerned with the training of aviators as individuals and not as members of a crew or as unit leaders.

Advancing technology has influenced the design of aircraft. Engines, structures, flight controls, and avionics systems have all improved radically, while little effort has been expended to advance the technology, programs, and tools used to train aircrews. In sum, initial training has, in the past, focused upon developing the individual aviator's skills, while neglecting the roles aviators play in a total force context.

When simulation is applied to the process, it has more often than not been done in a piecemeal and unsystematic fashion. A conventional wisdom approach has evolved which has a guiding philosophy that the flight environment is the best one in which to learn piloting skills. Anything short of real flight is considered a compromise, since all important learning is thought to take place in the aircraft. As a consequence, simulators have been designed based upon what the latest technology provides in the way of a ground-based, pseudo-flight environment.

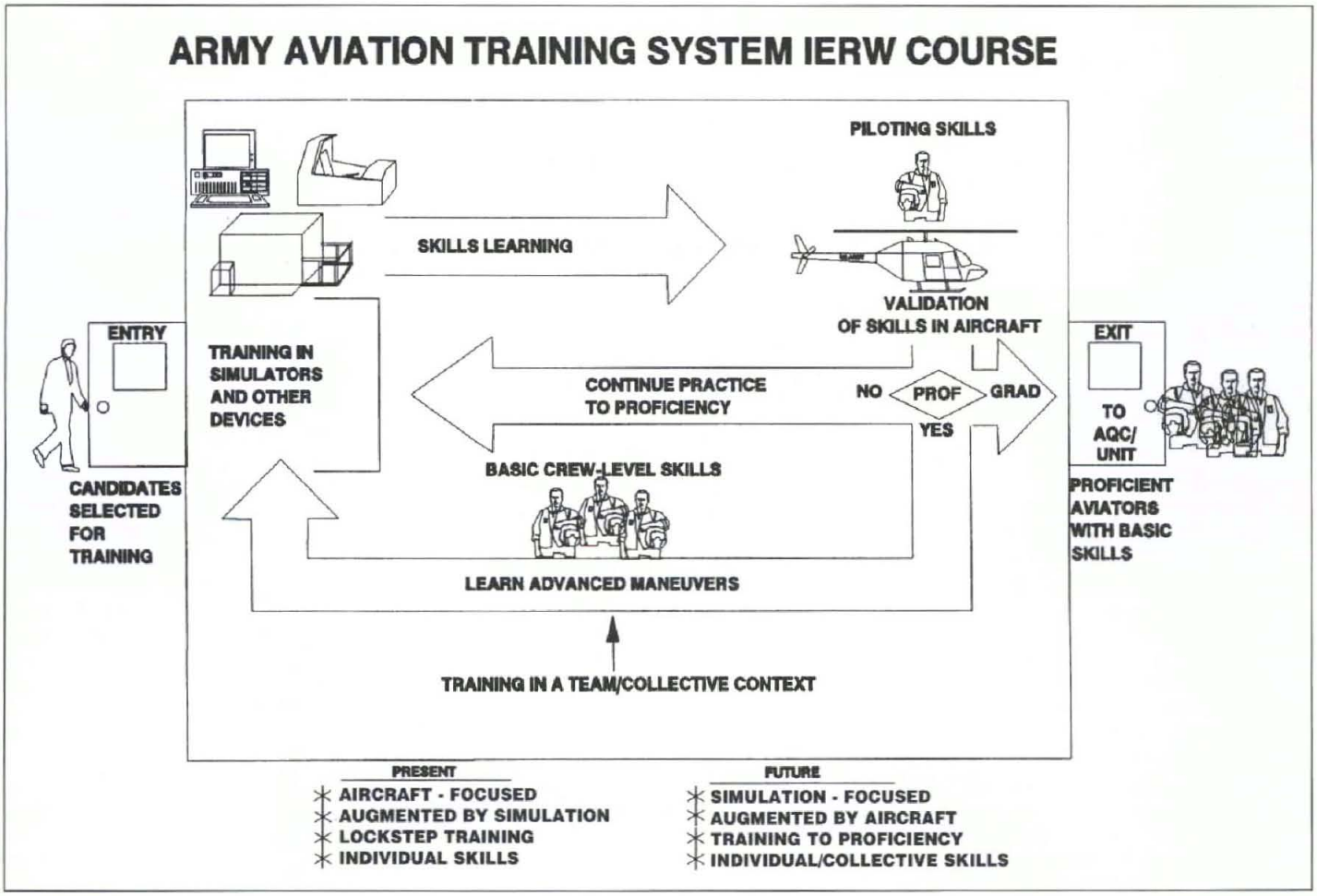

Figure 1.
Initial entry rotary wing Army Aviation Training System.

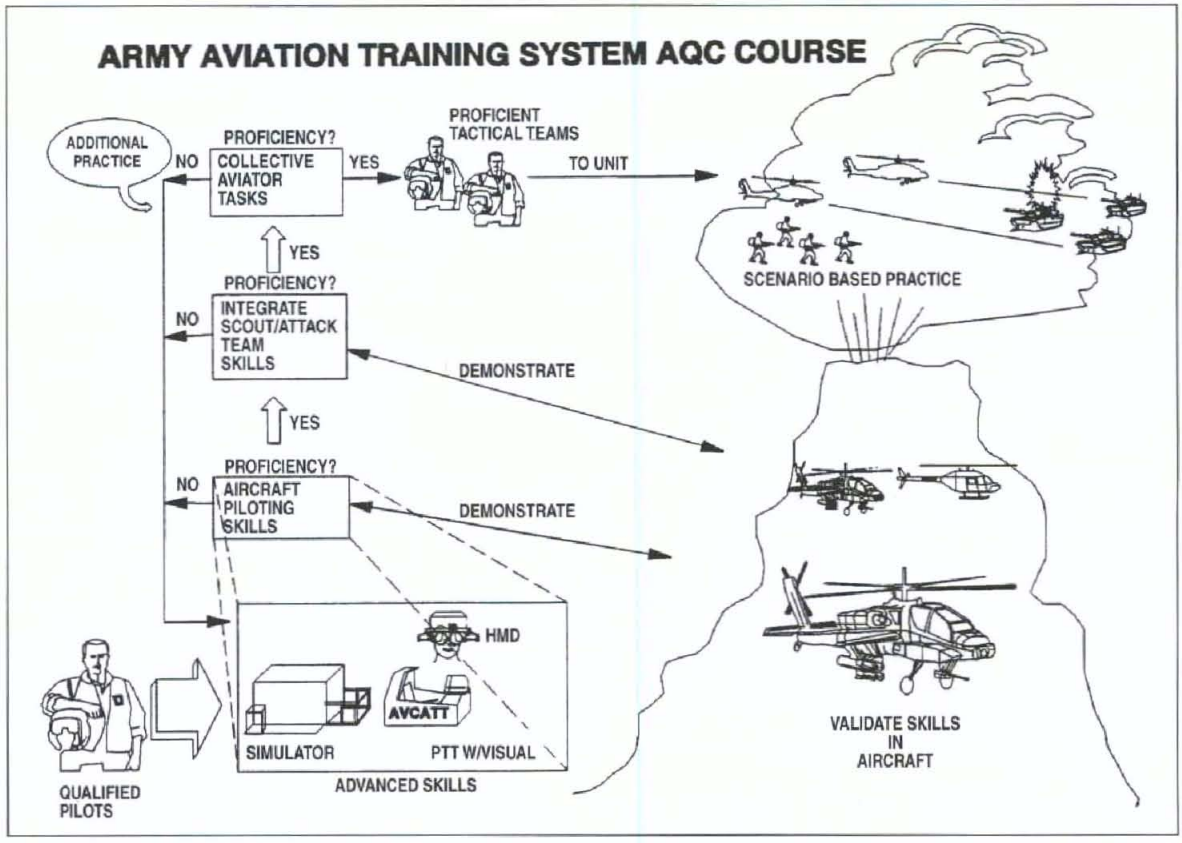

Figure 2. Advanced Aircrew Qualification Training System.

Scant attention has been paid to creating a learning environment optimized for skill acquisition and transfer of training to the dynamic, flexible environment which will characterize the Force XXI Army. Acceptance of these devices is typically based upon the opinion of the acceptance test pilot or engineering measurements which compare simulator functions with aircraft flight characteristics under equivalent flight regimes. Little effort is expended to define the training effectiveness of training systems.

Only a small amount of empirical research exists to define the training transfer effectiveness of Army training devices. This viewpoint is echoed in a recent report of the U.S. Congressional Office of Technology Assessment (OTA). The OTA states that, "... it is strikingly notable, however[,] that vast sums of money are invested in new and innovative pilot training devices and programs in the virtual absence of experiments providing quantitative estimates of effectiveness..." Even when training effectiveness experiments are conducted, the results can show that these devices fall short of the mark.

A recent experiment was conducted by the Army Research Institute Rotary Wing Aviation Research Unit to assess the transfer effectiveness of a simulator for sustaining gunnery skills. This research revealed that the simulator was of no apparent value in sustaining the skills of experienced crews after a six month period with only simulator gunnery training. Other research has shown mixed results for training flight maneuvers with simulators; some maneuvers show training transfer to the flight environment for some tasks, but not for others. These findings have had little influence in changing the devices or training process.

GEN Sullivan's charge to take a holistic view, the shrinking budget with its downward pressure on flight hours and personnel, and the capacity for technology to create better and less expensive training tools, has impelled the Army aviation community to take steps toward fundamental changes in the way training is conducted. All of these forces have given rise to a new systematic aviation training concept which has two basic tenets. First, simulation should be the primary training environment while the aircraft should be used for skill validation and mission execution. Second, all but the most basic flight training should take place in a mission context, consistent with the digitized battlefield within which the units of Force XXI will operate.

The same explosion in information technology which is leading the Army to Force XXI is creating greater opportunities than ever before in the training realm. Personal computer advances have provided the platform for a host of procedural and cognitive training to be presented. Networking makes the personal computer an expansive platform for providing information resources for the aviator. These resources can be provided to aviators, increasing the opportunities to learn skills required in performing as a member of an aircrew in Force XXI.

Considering the breadth of missions expected to be in the repertoire of Force XXI units (as stated in TRADOC Pamphlet 525-5), access to rapidly changing databases of information about mission requirements and procedures makes such tools mandatory. The quality of the visual image generators and display devices, such as helmet mounted displays is increasing. These devices are becoming available at relatively low cost and can provide an array of training systems which will meet most of the training and skill integration needs of Army aircrews.

As Figure 1 shows, student flow can be directed first to flight simulators, part-task trainers, and procedures trainers for the skill acquisition phase. Prior to any implementation of this program, these devices will have been subjected to a rigorous transfer effectiveness test. This evaluation will assure that these devices are valid training media for the skills, knowledge, and abilities they were designed to impart. Once the student illustrates proficiency on these devices, validation of that proficiency through demonstration of task competency in the aircraft can take place. If aircraft skills are insufficient, the student can be cycled for remedial training in the skill trainers.

Once proficiency is demonstrated in the aircraft on basic flight skills, students can learn advanced skills as a member of a crew. The same aircraft skill validation phase can be required for these advanced skills prior to graduation. The product of this training system can be aviators proficient in basic and advanced skills, including a familiarization for

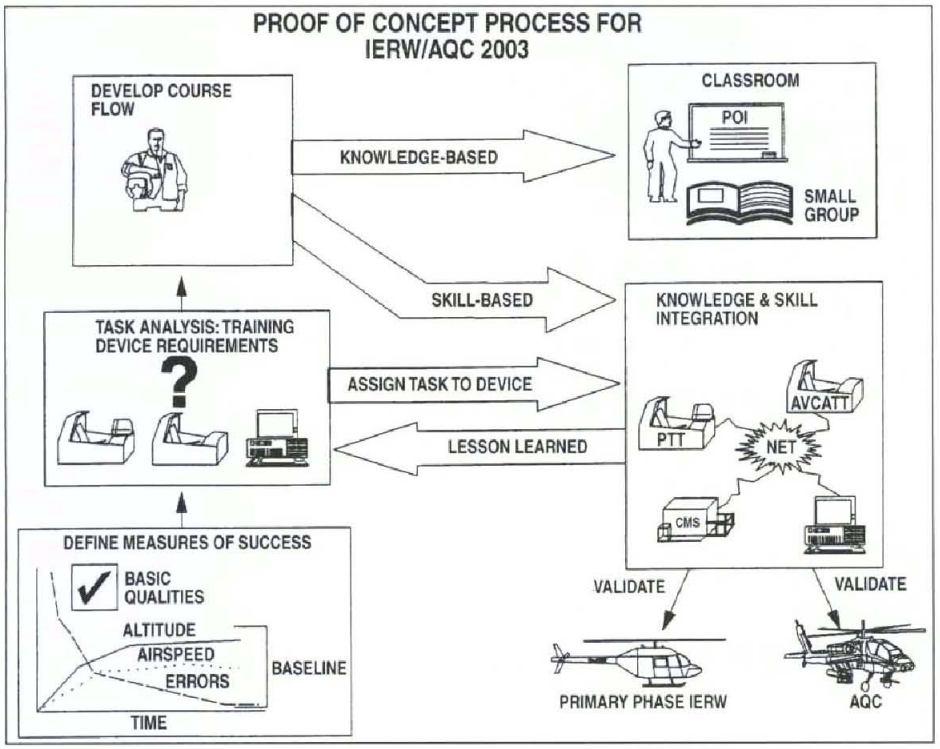

Figure 3.
Proof of Concept Process for the Army Aviation Training System.

both crew coordination and team/collective skills.

These students can be the qualified pilots who then go on to the Aircrew Qualification Course (AQC) as illustrated in Figure 2. Here the student is provided with a host of devices which serve as the environment for training to take place. A hierarchical progression of training from flight control to collective aviator tasks is attained. At the end of this phase, aviators are produced who are trained to take their place as members of proficient tactical teams. These aviators arrive at their duty stations with knowledge of the team and unit requirements within an operational context.

Since Force XXI soldiers will be expected to engage in unit level training using simulation for maintaining rapidly perishable teamwork skills, the appreciation of the role of simulation imparted to them throughout their training should serve them in Force XXI units. They should be able to immediately utilize the simulation tools as primary methods for honing skills and practicing missions. So, much of the simulation training devices provided for initial and advanced training contain many of the same features of advanced digitized systems which will become common on the Force XXI battlefield. As a result, this breed of aviator should also feel comfortable with new, digitized systems which will become common on the Force XXI battlefield.

Aside from the most basic flight skills training, all training should take place in a mission context. The goal of each phase and every course is the practice of basic skills expanded to include the role of the crew members in tactical missions they will perform as members of Force XXI units. These aircrews will be provided with the capability to grasp the tactical situation and make coherent decisions if contact is lost with upper echelons. This process of tactical decision making training should provide Force XXI with crews and aviation units which are inherently flexible in the face of changing missions. This is an absolute necessity as the Army evolves into Force XXI.

Both empirical research and effective analysis of current and future training requirements will be necessary to enable Army aviation to train in the required manner. The Army Research Institute Rotary Wing Aviation Research Unit, a key member of the Aviation Center Team, is engaged in a comprehensive program of research aimed at defining the most effective and efficient methods and devices to employ in the future Army aviation training system.

As illustrated in Figure 3, this research process begins with well-defined measures of success concerning the basic qualities required of aircrews for successful mission and task performance. Along with these measures, an analysis of the aviator individual, crew, unit, and team tasks is conducted to determine candidate devices for inclusion in the constellation of devices to be used to train aircrews. From this sequence flows a definition of the course requirements concerning which tasks are to be taught in the classroom, in small groups, or in the devices defined in the training device requirements phase. ARI's advanced modular research simulator, The Simulator Training Research Advanced Testbed for Aviation (STRATA), will be employed to emulate the devices defined in this phase. For example, STRATA may be configured to represent the mission multifunction displays for the mission equipment package of the Kiowa Warrior. Students may be trained using this device to impart critical skills and knowledge required to perform tasks as a member of a scout attack team. During this process, data will be collected concerning skill acquisition and training transfer effectiveness. These data provide feedback, enabling a means for continuous improvement to be applied to the system of aircrew training. In this fashion, Army aviation will have a validated, systematic approach to defining the training devices and methods which will yield the most effective aviation war fighting assets for Force XXI well into the next century–KEEPING ARMY AVIATION AT THE VANGUARD OF CHANGE.

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ARMY'S NEWEST COMMAND FOCUSES ON SOLDIER AS A SYSTEM

By BG Henry T. Glisson

In 1991, the Army Science Board was chartered to conduct a study of the "Soldier as a System." For years, the Army had managed its major weapons platforms as systems, ensuring integration, compatibility and balance throughout the modernization process. Such an approach had never been truly adopted for America's ultimate fighting system—the soldier.

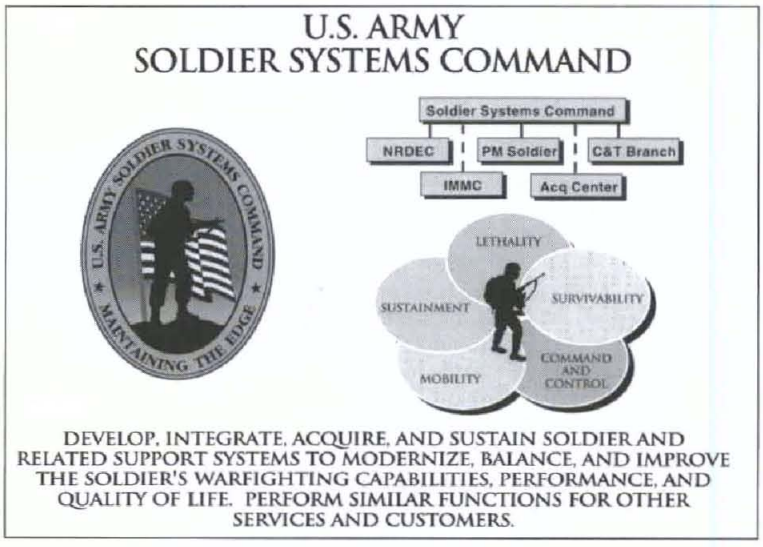
In the final analysis, there is only one way to achieve decisive victory in war—by putting soldiers in harm's way to take and occupy the ground upon which wars are fought. Here, the courage, character and sacrifice of U.S. soldiers make the real difference. It was not surprising, then, that the Army Science Board Study concluded that the soldier should also be treated as a system; the most important system in the Army. The 1991 recommendations become ever more critical today as we modernize the soldier to become an integral part of the Force XXI digitized battlefield, an extremely complex process which requires linkages and integration among all major fighting systems to be successful.

Clearly an organization was needed to provide oversight and management of the multiple programs involved, integrating and infusing technology, performing trade-off analyses among interrelated programs—reprogramming funds where necessary—and providing total life cycle management of soldier and related support systems; a big responsibility but an essential one. Recognizing this, the Army chief of staff authorized the establishment of the U.S. Army Soldier Systems Command (SSCOM) on Nov. 16, 1994.

The new command (Figure 1), led by BG Henry T. Glisson, and headquartered at Natick, MA, has as its mission: TO DEVELOP, INTEGRATE, ACQUIRE, AND SUSTAIN SOLDIER AND RELATED SUPPORT SYSTEMS, TO MODERNIZE, BALANCE, AND IMPROVE THE SOLDIER'S WARFIGHTING CAPABILITIES, PERFORMANCE, AND QUALITY OF LIFE, AND TO PERFORM SIMILAR FUNCTIONS FOR OTHER SERVICES AND CUSTOMERS.

To perform this one-stop soldier support, SSCOM is comprised of three subordinate activities: the Natick Research, Development and Engineering Center, located in Natick, MA; the Project Manager—Soldier located at Fort Belvoir, VA, and the Clothing and Textile Branch, located in Philadelphia, PA. Additionally, SSCOM acquisition and materiel management support for the command is pro-

Figure 1.



vided through a matrix arrangement with the Aviation and Troop Command in St. Louis, MO. The winner from all of this synergy is the soldier.

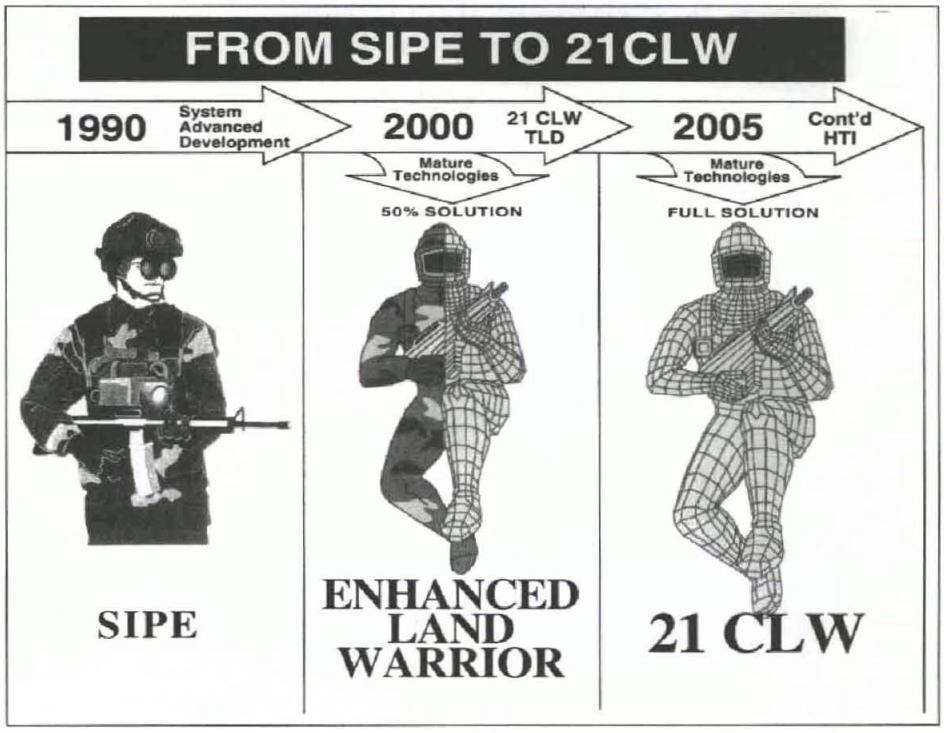
By doing collaborative, integrated work, SSCOM can more effectively modernize and enhance the soldier's lethality, sustainability, command and control, survivability and mobility in preparation for the 21st century digitized battlefield.

An indication of this potential was demonstrated during an exhibition of a Soldier Integrated Protective Ensemble (SIPE) during an advanced technology demonstration (ATD) in 1992. Focusing on advanced and state-of-the art technologies, a prototype integrated, functional, head-to-toe soldier fighting system was created with five subsystems: Integrated Headgear With Heads Up Display; Advanced Clothing and Body Armor; Microclimate Conditioning/Power; Weapons Interface and Individual Soldier's Communications Subsystems. This was the first time the soldier was looked at as a system; where all of the soldier's equipment was designed to enhance total capability through modular, integrated functioning of each of its component parts. The results were astounding. Not only could we make a quantum technological leap for our soldiers, we could also improve war fighting capability and reduce costs.

Additionally, the modular design of the equipment enables commanders to tailor soldier loads to meet specific threats and mission requirements based on Mission, Enemy, Troops, Terrain–Time Available (METT-T). This was a major breakthrough and gave us an azimuth and road map (Figure 2) for the next generation soldier. Taking lessons learned/concepts and hardware components which performed exceptionally well in the SIPE demonstration, the Army committed to quick, near term adoption and fielding of its first futuristic, high technology, integrated fighting systems for soldiers. This program, called Enhanced Land Warrior, consists of three systems: Land Warrior for dismounted soldiers; Mounted Warrior for armored vehicle soldiers and Air Warrior for aircraft soldiers.

PM-Soldier is responsible for the Enhanced Land Warrior. The Land Warrior system will provide an Integrated Headgear subsystem; a C4I subsystem; a Protective Clothing and Equipment subsystem; and a Weapon subsystem. The Mounted Warrior system will provide a Head Mounted subsystem; a Body Mounted subsystem; and a Platform Mounted subsystem. The Air Warrior system will also provide a Head Mounted subsystem; a Platform Mounted subsystem; and a Body Mounted subsystem.

Initial fielding of the Enhanced Land Warrior systems will occur in FY99/00. During the intervening years between FY95 and



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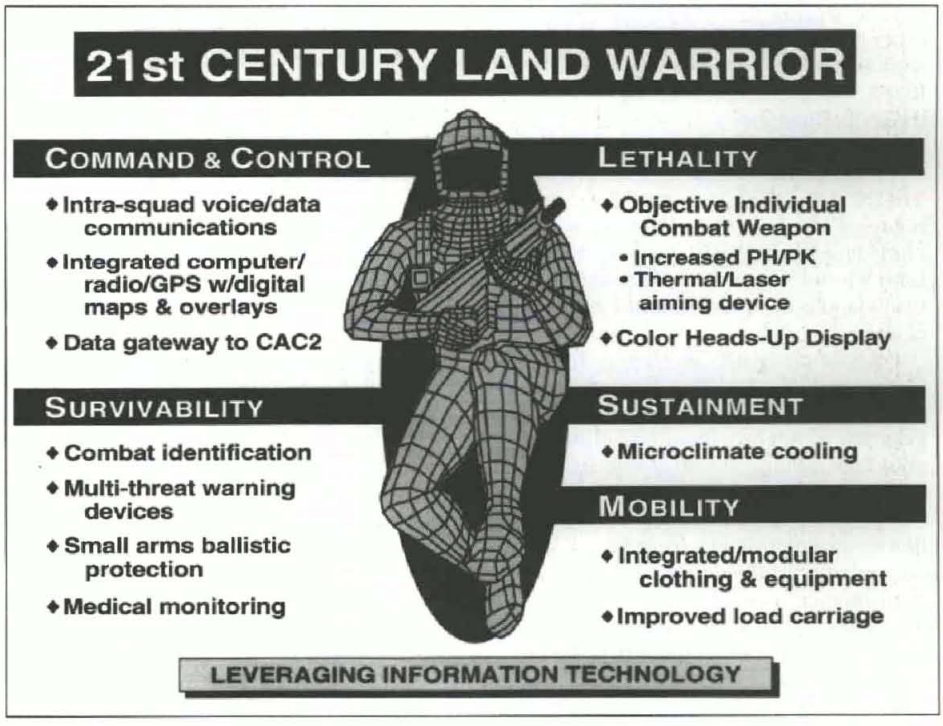

Figure 3.

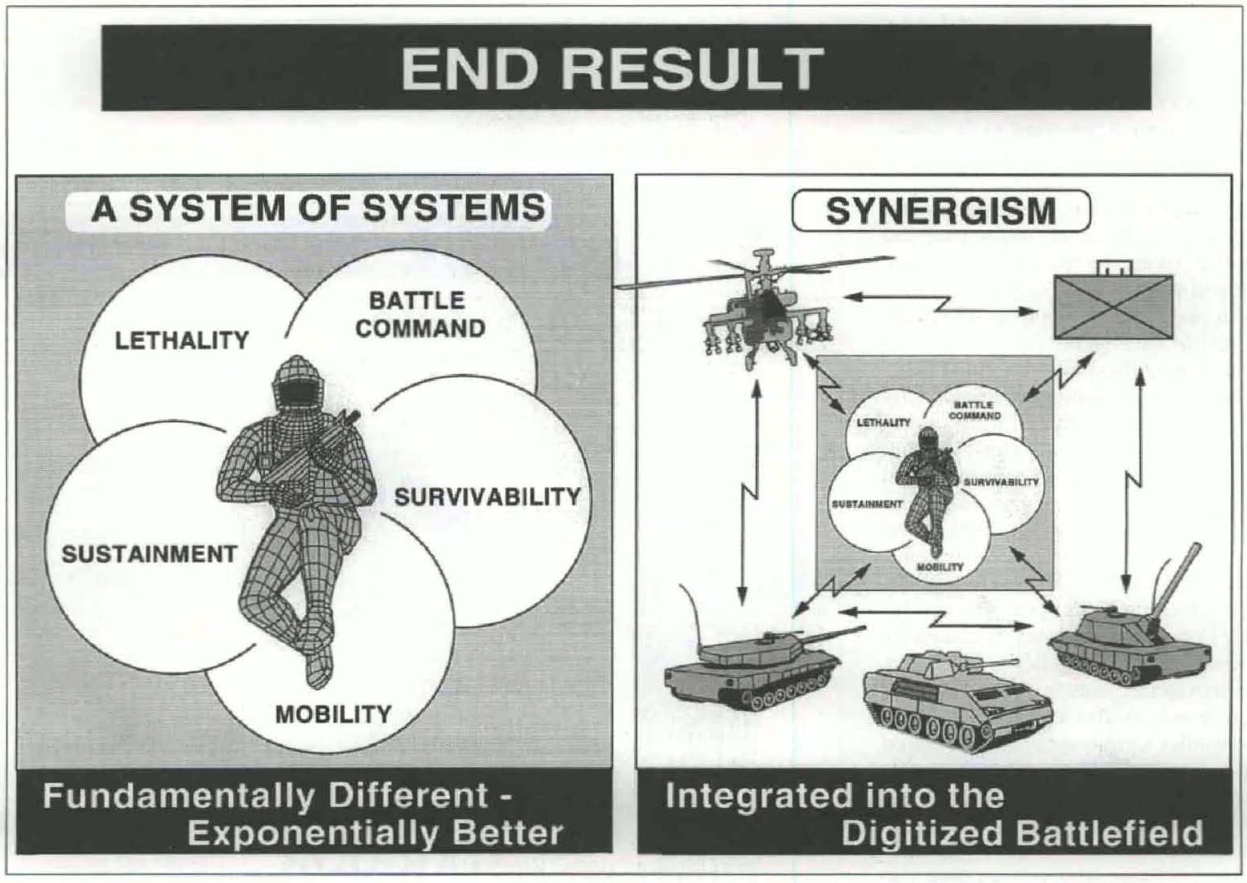

Figure 4.

FY99, the Army has scheduled an Integrated Technology Program known as 21st Century Land Warrior (21CLW) (Figure 3) and another ATD known as Generation II (GEN II) Soldier, both to be performed by the Natick RDEC. These demonstrations will address those technologies from the SIPE Demonstration which require further maturation before classification and fielding. As the GEN II/21 CLW demonstrations identify mature technologies which are fieldable, they will be included for fielding with the three Enhanced Land Warrior systems. But the Soldier Systems Command is not waiting until 1999 to make changes.

PM-Soldier, with assistance from the Clothing and Textiles Branch, administers the Army's Clothing and Individual Equipment Program which provides for continuous upgrade and fielding of soldier systems. Specifically, items are pursued which are non-developmental (commercial) or modified non-developmental which can be quickly tested, evaluated and fielded to enhance soldier performance or warfighting capabilities today. Commodity areas include clothing, individual equipment, communications, navigational aids, weapons and sights, and night operation equipment. This ensures the continuous infusion of available technology and modernization of soldier systems until the Enhanced Land Warrior is a mature system.

Key to the modernization process is the work accomplished by the Natick Research, Development and Engineering Center (NRDEC), which is organized and focused around applicable core technologies, and the soldier system capability areas of mobility, survivability, and sustainability. NRDEC works in collaboration with other government research organizations, industry and academia to apply technology generation and application with lessons learned from the U.S. Army Training and Doctrine Command (TRADOC) Battle Labs. Current projects include development of next generation body armor, chemical protective clothing, clothing and load-bearing equipment, development of precision-guided airdrop capabilities, laser eye protection, improved operational rations, new shelters, improved field food service equipment, Force Provider, 21 CLW/GEN II demonstrations, improved parachutes, and better field laundry/shower/latrine facilities. For more than 40 years, NRDEC has provided outstanding service to those who serve and that tradition continues today.

By 2005, digitization will markedly change the way we wage war. Incorporation of digitized information across all the battlefield systems will give our leaders and soldiers unprecedented capability. But the basic element of success will not change. In the final analysis, soldiers will determine, decisive victory or defeat. The mission of the U.S. Army Soldier Systems Command is to expediently improve the soldier's ability to quickly win the current battle, survive and fight again, if necessary, to win the war. This requires continuous modernization, technology generation and application, and integration/balance of the soldier systems.

Through advocacy, dedication and life cycle management of soldier and related support systems, the Army Materiel Command's newest command can and will prepare the Force XXI Soldier for the future battlefield (Figure 4). It is an uncompromising responsibility and challenge, but one which the SSCOM workforce willingly accepts.

BG HENRY T. GLISSON is commander of the U.S. Army Soldier Systems Command. He holds a bachelor's degree in psychology from North Georgia College and a master's degree in education from Pepperdine University. His military education includes the Quartermaster Officer Basic and Advanced Courses, the Command and General Staff College, and the Army War College.

COMBAT IDENTIFICATION FOR THE DISMOUNTED SOLDIER

By Robin Russell St.Pere

Introduction

The U.S. military has long recognized the danger of "fratricide" in combat. Casualties are an inevitable consequence of war that will be incurred on both sides of the battle-line. Less justifiable, however, is the accidental death of a soldier by friendly fire. Few traumas of war exceed the anguish and devastation of those troops who learn they have taken allies under fire. The emotional effects of friendly fire are disproportionate to its casualties creating feelings of resentment and guilt among troops.

Fratricide has been a problem for centuries, occurring in virtually every conflict. During the conflict in the Persian Gulf, the friendly fire casualty rate was at 18 percent. The U.S. Army has since tried to devise ways to better distinguish ground troops and weapon systems. These quick fix solutions included special infrared reflective tiles, small lights, luminescent tapes and other markers. The luminescent tapes, otherwise known as "Cat's Eyes," were the only standard military item available to ground troops. These luminescent tapes are attached to the web band which encircles the combat helmet. They are not a battle item and were originally designed to be used during training exercises only. They were not very effective during the Persian Gulf War as a means of soldier identification.

Changing Battlefield

The nature of the battlefield is changing. Fluid battlefields lacking easily identifiable sides are anticipated in future conflicts, virtually ensuring that forces will be intermingled leading way to confusion and increased lethality on the modern battlefield. Traditional command and control measures are losing some of their effectiveness to advances in technology. These advances have led to increased concern among all the Services as the lethal range of high technology weapons exceed the powers of even augmented human vision.

There is reason to suspect that the advance of military technology has increased rather than reduced the risk of fratricide. One technological advantage of today's U.S. military is the ability to fight at night. Depending on the various night vision devices (near-infrared image intensifiers and mid- and far-infrared thermal imagers), our soldiers have proven themselves quite capable of not only engaging, but defeating the enemy under the cover of darkness. However, the resolution of these devices is not always good enough to distinguish friend from foe.

Friendly Fire

The high percentage of friendly fire casualties of Desert Storm prompted the military to initiate a program to reduce the risk of friendly fire in future combat. The U.S. Army Combat Identification Program is now working to improve doctrine, training, leader development and organization, plus address new materiel development. The program is divided into three phases: near-, mid- and far-term. The goal of the program is to provide improvements in situational awareness and target identification, thus reducing fratricide and increasing combat effectiveness.

The U.S. Army Combat Identification Program is now working to improve doctrine, training, leader development and organization, plus address new materiel development.

Millimeter Wave Technology

The U.S. Army recently selected millimeter wave query/answer technology as the basis for its near-term target identification program. This program is called the Battlefield Combat Identification System. It will initially be developed for selected helicopters and ground vehicles, due to the ease of integration on these weapons platforms. However, millimeter wave technology is also being investigated for use by the dismounted soldier. The soldier as a weapon platform is very different than other weapon platforms such as vehicles or aircraft.

The soldier comes in all shapes and sizes and is strongly affected by additional equipment weight. Other factors that must be addressed when dealing with the soldier are: bulk, human factors, integration interfaces, manpower and personnel integration, power, human safety and anthropometrics. Another important consideration is how the dismounted soldier operates in his battlespace. The fact that dismounted infantry often fights at short range, in built-up areas, in heavy foliage, or in other confined spaces, may require different approaches to combat identification.

In addition to the soldier considerations just mentioned, the following issues also need to be addressed:

Besides military application, commercial markets such as drug enforcement, covert operations, recreational war gaming, and undercover police activities could use technologies developed for soldier combat identification.

- Compatibility with other combat identification systems;
- Minimizing the weight and logistic burden to the soldier; and
- Integration with planned future systems for the soldier such as Land Warrior and 21st Century Land Warrior.

Millimeter wave technology appears promising for soldier use if the components can be sufficiently miniaturized. Combat identification for the dismounted soldier is part of the overall Army Combat Identification Program. It's objective is twofold: to provide the soldier with a capability to be recognized by a battlefield combat identification system attached to friendly forces; and eventually, to provide the soldier with a capability to identify friendly forces on the battlefield.

Study Work Groups

Two work groups comprise the Combat Identification for the Dismounted Soldier Program. The first work group is the Fratricide Study Work Group. This group pulls its strengths from the Office of the Project Manager—Combat Identification, the Army Natick Research, Development and Engineering Center, the Surgeon General's Office, the Center for Army Lessons Learned, the Army Safety Center, the Army Training and Doctrine Command, and the Army Infantry School. The goal of this group is to provide a comprehensive analysis of soldier fratricide incidents, causes, potential solutions and recommend technical approaches. Its mission is to conduct a data base from actual and training simulations fratricide incidents. Data analysis will allow for the development of doctrine, training, leader development, organizational, and materiel solutions. It will help materiel developers, in particular, to match emerging and existing technologies that can be brought to bear on the problem.

The second work group is the Combat Identification for the Dismounted Soldier. This work group is made up of representatives from the Office of the Project Manager—Combat Identification; Army Natick Research, Development and Engineering Center; Army Communications-Electronics Command; Army Research Laboratory; Army Infantry School; Dismounted Warfighting Battle Laboratory; the Joint Special Operations Command; Office, Project Manager—Soldier; Army Training and Doctrine Command's System Manager—Soldier; Marine Corps; and the Army Armament Research, Development and Engineering Center with technical expertise in the areas of textile technology, electrical engineering, chemistry, and mechanical engineering as well as expertise in military training and doctrine. The group was established to investigate and develop near-, mid- and far-term combat identification technologies that provide the individual dismounted soldier with improved situational awareness and reduce potential fratricides through target identification.

To date, numerous technological investigations, including passive, active and passive/active technologies, have been explored. These include: ultraviolet/infrared metamers, laser induced luminescence, radar, fiber optics, data fusion, retro-reflection, thermal, liquid crystal and photochromic/electrochromic/thermodynamic colorants as potential technologies for application in soldier systems. Besides military application, commercial markets such as drug enforcement, covert operations, recreational war gaming, and undercover police activities could use technologies developed for soldier combat identification.

Future Technologies

In the near-term, the U.S. Army Natick RD&E Center, in conjunction with key players from the Army Communications-Electronics Command, Army Research Laboratory and Project Manager—Combat Identification, hope to develop a lightweight millimeter wave based device which will integrate into the clothing and individual equipment systems. The device would protect against friendly vehicle and weapons platform fire. As technology matures, this device will not only allow soldiers to be interrogated but provide the soldier the capability of interrogating a target too.

For the mid- to far-term, the combat identification program is intended as a follow-on to the near-term Battlefield Combat Identification System program. The mid- to far-term program will use advanced target identification and situational awareness technologies currently not mature enough for immediate fielding, but which may be available in five or more years.

Conclusion

The problem of fratricide will be difficult to overcome because of the technical challenge in fielding a device that can not only distinguish friend from foe, but will not disclose life threatening information to the enemy in the chaos of battle. Maturing combat identification and battlefield awareness technologies will lift some of the fog of war to give our soldiers the confidence that they will be neither victims or perpetuate fratricide.

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SLEEP, SLEEP DEPRIVATION, AND CONTINUOUS OPERATIONS

By COL Gregory Belenky, MC

Introduction

Sleep is as important to combat operations as beans and bullets. Sleep sustains battlefield awareness—the sum of mental abilities necessary for effective combat performance. As such, the U.S. Army Medical Research and Materiel Command (USAMRMC) is developing a field-deployable Sleep Management System (SMS) to maximize individual and unit performance during continuous combat operations. This effort is centered in the Department of Behavioral Biology, Walter Reed Army Institute of Research (WRAIR), where we are developing the means to measure sleep and predict the impact of less-than-optimal sleep in operational settings.

To quantify sleep during combat operations, we have developed the wrist-worn Sleep/Activity Monitor (SAM)—a device which measures and records arm movements, and analyzes these data to estimate sleep duration and continuity, the factors which determine the recuperative value of sleep. Sleep measured by the SAM correlates with electrophysiologically-defined sleep. To predict the impact of sleep on performance, we have developed, and are refining and validating, a quantitative Sleep/Performance Model (SPM). The SPM, integrated into the SAM, will form the core of the Sleep Management System.

The SMS will consist of:

- A data/information/knowledge base derived from studies of sleep and sleep deprivation.
- The wrist-worn, micro-processor based, self-contained SAM for unobtrusive measurement of sleep duration, continuity, and timing under operational conditions.
- The Sleep/Performance Model for prediction of individual soldier performance based on recent sleep history as measured by the SAM.
- Integration of the SPM into the SAM.
- A sleep-induction/rapid-reawakening two-drug system in which the first drug induces sleep and the second awakens and eliminates any residual drug hangover.
- A safe, effective stimulant to sustain performance temporarily when sleep is not possible.
- Modular integration of the SAM/SPM into the Personnel Status Monitor (PSM)/Soldier Computer.
- Supporting doctrine and informational/educational materials for implementation of the SMS.

Applications

The SMS has civilian as well as military applications. For example, the Department of Transportation (DOT) is interested in using the SMS for sleep/wake monitoring and work/rest scheduling of commercial motor vehicle operators and commercial pilots. The DOT is providing funds to the Department of the Army for SMS development.

Data/Information/Knowledge Base

Command, control, communication, and intelligence (C3I) are essential to operations from crew, squad, and platoon through division and corps. C3I depends upon rapid, accurate thinking. Battles can be won or lost at the small unit level—a small group delivering fire at the right place and time can determine the outcome of a major engagement.

Laboratory studies by the Department of Behavioral Biology, WRAIR, show that mental work declines by 25 percent during each successive 24 hours of continuous wakefulness (Figure 1). Sleep-deprived individuals are able to maintain accuracy on cognitive tasks, but speed declines as wakefulness is extended. A soldier's thinking can slow to the point that he cannot reach a correct decision within the available time when he is sleep-deprived. If the decision is system-critical, the system fails.

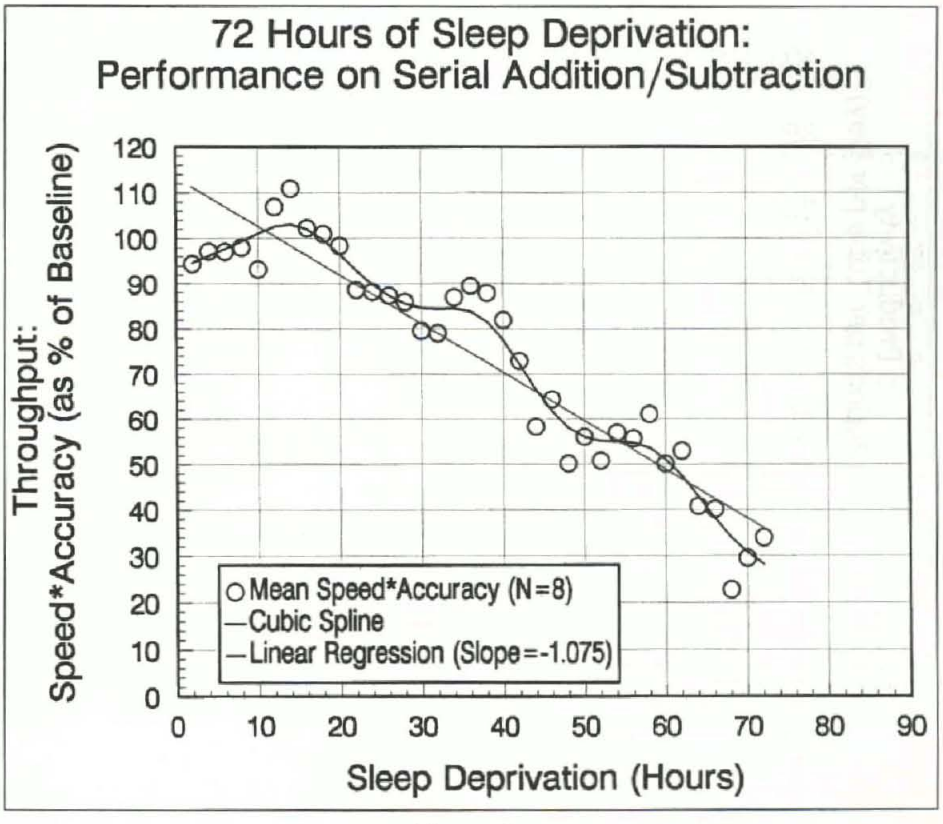

Figure 1.

Sleep deprivation degrades the higher, more complex mental processes. Soldiers lose battlefield awareness and the ability to integrate information into a coherent and accurate representation of the tactical situation. In contrast, simple mental processes are unaffected. This contrast between the effects of sleep deprivation on simple and complex mental abilities helps explain friendly fire incidents. In the sleep-deprived state, soldiers can still put the cross-hairs on a target and fire rounds accurately down range, but their orientation to the terrain and tactical situation is degraded. They can shoot and shoot accurately but no longer can distinguish friend from foe.

In collaboration with, and partially funded by, the Johns Hopkins University School of Medicine and the National Institutes of Health, researchers in the Department of Behavioral Biology are studying brain activation in normal volunteer subjects using Positron Emission Tomography (PET). These studies have shown that sleep deprivation degrades performance by reducing brain activation. The most profound decreases in brain activation are in brain areas supporting the higher, more complex mental functions (e.g., battlefield awareness)—consistent with the findings from behavioral studies.

Sleep/Activity Monitor

The central element of the SMS is hardware and software to accurately, objectively, and unobtrusively measure sleep in operational settings. Self-reports of sleep (e.g., sleep logs) require effort from the person whose sleep is being measured and are generally unreliable. The SAM is used for the unobtrusive measurement of sleep duration, continuity, and sleep timing under operational conditions. Designed in collaboration with Precision Control Design, Inc., the SAM is commercially available and used in outpatient clinics and other settings where unobtrusive sleep monitoring is required. Using the SAM, we have measured sleep in Ranger School, at the National Training Center, and in Operation Desert Storm.

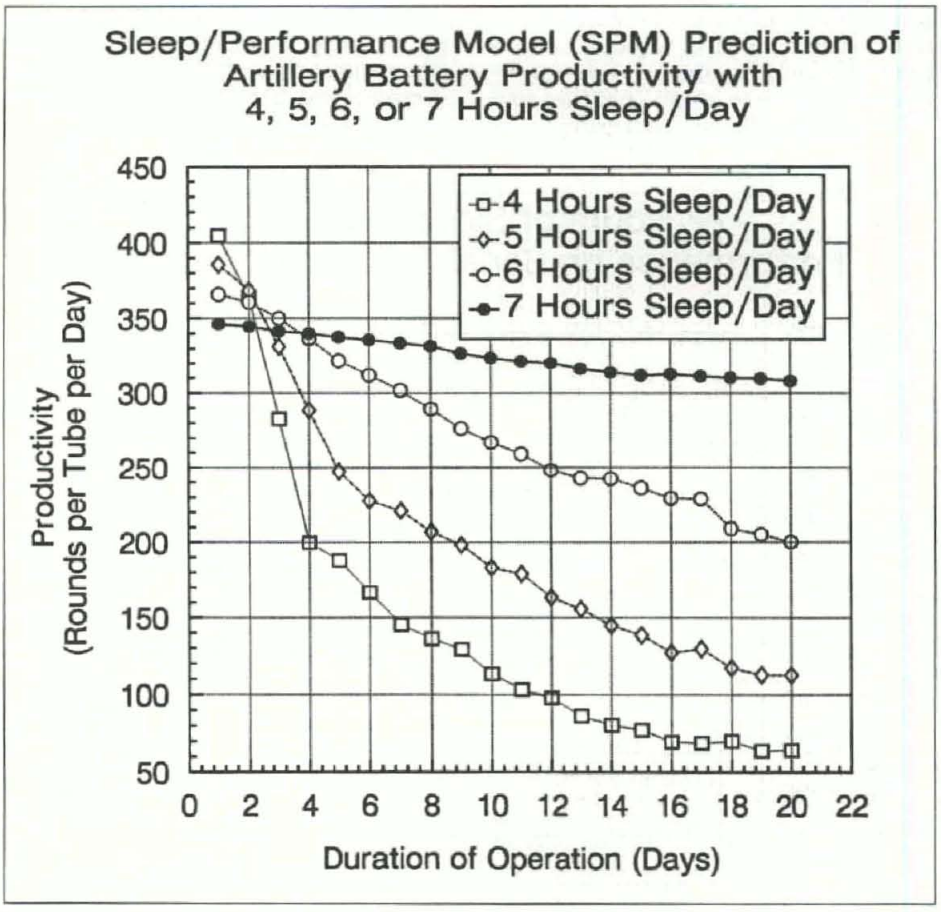

Figure 2.

Model the Effect of Sleep Deprivation on Performance

In collaboration with the Science Applications International Corporation (SAIC), the Department of Behavioral Biology developed the SPM, a computer model which predicts present and future performance based on prior sleep amounts. We constructed this model by taking as anchor points no sleep and six hours of sleep. These anchors are based on the assumption that six to eight hours of sleep each night will sustain performance indefinitely. Based on other studies, the model assumes that the bulk of recovery of lost sleep occurs early in the night's sleep. We have incorporated our model into the Army Unit Resiliency Analysis (AURA) model of artillery battery performance.

As shown in Figure 2, sleep of less than seven hours per night leads to degradation of performance. For a day or two, the shorter-sleep artillery batteries do outperform the longer-sleep ones (in terms of rounds per tube per day accurately delivered to the target) because they have more hours each day in which to fire rounds. However, by the second or third day, they are firing fewer accurate rounds over the 24 hour period even though they spend more time firing. To refine and validate our model, we are undertaking a study in normal volunteers of the effects on performance of three, five, seven, or nine hours sleep each night for eight consecutive days. This study is being funded by the Federal Highway Administration (FHWA) of the DOT. The refined and validated model will be integrated into the SAM and constitute the core of the Sleep Management System. This integration is being funded by the Federal Aviation Administration (FAA), another agency of the DOT.

Sleep-Induction/Rapid Re-Awakening

Studies show that the recuperative value of sleep depends upon both its duration and continuity. Even eight hours of total sleep time has no recuperative value when that sleep has been disturbed every two to three minutes (even without a full awakening or the person being aware of the interruption). The Department of Behavioral Biology is searching for a safe, effective sleep-inducing drug that will both increase the duration of sleep and improve sleep continuity in non-sleep conducive environments (e.g., long range deployments by air, combat operations) without impairing subsequent performance.

Studies using several different drugs and drug dosages show that sleep-inducing and

A Future SMS Application

The following scenario is a hypothetical future application of the Sleep Management System, based on research and development in progress in the USAMRMC: It is August 2004. An American expeditionary force is deploying to contain aggression by a disciplined, well equipped, technologically sophisticated, and well-led force in Southwest Asia. The Americans are deploying by air after five days of preparation during which there was little opportunity for sleep.

Sleep Management System (SMS) software located with command and control elements at all echelons periodically interrogates, through a local area radio-frequency (RF) network, the Sleep/Activity Module (SAM) of each soldier's Personnel Status Monitor (PSM), generating reports on sleep obtained and predicting effects on performance. The integrated SMS, including hardware, software, modular, integration into the PSM, pharmacological agents to assist in managing the sleep/wake cycle, and appropriate doctrine, had been introduced into the American Armed Forces in the late 1990s.

Reports generated by the SMS indicate that, on average, most personnel had managed 4.5 hours of broken sleep over the last five nights while higher echelons of command and control managed only 3.5 hours of sleep. The SMS predicts that performance by all echelons will be below optimum. On the basis of current intelligence, commanders are anticipating immediate engagement with the enemy upon insertion. Given mission requirements, optimum performance is essential. The SMS predicts that six continuous hours of sleep for all personnel will improve performance and increase the probability of a successful operation.

Lead elements are now only two to three hours from takeoff. As called for by doctrine, commanders elect to implement the SIRRA (sleep-induction/rapid reawakening) system for all soldiers once they are airborne. The SIRRA consists of two pills, orally administered, given sequentially. The first, a sleep-inducer, is administered prior to the sleep period to induce sleep. The second, an antidote to the sleep-inducer, is administered at the end of the sleep interval to restore full alertness and performance. The antidote is a specific blocker of the sleep-inducer; it is not a stimulant and, taken by itself, it has no effects.

Once airborne, soldiers take their sleep-inducer. Light levels, noise, and commotion are kept to a minimum during the sleep period. After 6.5 hours of sleep, the soldiers are awakened. Immediately, they take their antidote. Within 45 minutes all personnel are fully alert. They are refreshed from their sleep. Their thinking is clear and rapid. Their motivation is high. They are ready for combat.

A query to the SMS indicates that personnel obtained an average of 5.5 hours sleep during the in-flight sleep period. Factoring in this additional sleep, the SMS predicts individual and unit performance on arrival to be near 90 percent, a substantial improvement over pre-sleep, pre-flight estimates.

Enemy resistance to the insertion of the expeditionary force is suppressed. The build-up in-theater continues. Forty-eight hours into the operation, the expeditionary force comes under pressure as the enemy launches all its forces in a coordinated counterattack. Commanders expect the period of sustained operations to be intense but brief. At this point, again in accordance with doctrine, commanders elect to implement the STIMSUP to enhance the alertness of personnel at all positions and help ensure adequate performance over the ensuing 10-12 hours. The counterattack is repulsed; the operation proceeds as planned. Commanders continue to use the SMS to manage the sleep/wake cycle to optimize performance. Two weeks into the operation, organized enemy action ceases. The first phase of the operation concludes successfully with minimal casualties from enemy action and no losses from accident or friendly fire.

performance-impairing effects are tightly linked; insofar as a drug induces sleep, it will impair performance. To overcome this problem we modified our approach to include: a sleep-inducing drug to initiate sleep; and, an antagonist drug to restore full alertness and performance when the sleep period is over, or in the event of an emergency.

We call this the Sleep-Induction/Rapid Reawakening (SIRRA) system. We found that we can induce sleep with either triazolam (Halcionr) or zolpidem (Ambienr), and restore full alertness and performance with the antagonist drug, flumazenil (Maziconr). Flumazenil is not a stimulant; it has no effects on alertness or performance when given alone. Flumazenil specifically blocks the effects of sleep-inducing drugs. Having proof of concept, we are proceeding to work out dosages and dosing schedules for field use.

Stimulants to Sustain Performance

In a search for a safe, effective Stimulant to Sustain Performance (STIMSUP) when sleep is not possible due to operational reasons, the Department of Behavioral Biology established that a single dose of caffeine (300-600 mg—the equivalent of three to six cups of brewed coffee)—can improve performance for 10-12 hours after 48 hours without sleep. Caffeine, in tablet form, is currently considered the drug of choice for the STIMSUP component of the Sleep Management System.

Doctrine, Information, and Education

Developing the SMS involves determining effectiveness, assessing user acceptability, soliciting suggestions for technical improvements, and eliciting input for doctrine development. The Department of Behavioral Biology is working with the Dismounted Infantry Battle Space Battle Lab (DIBBL) at Fort Benning. Under Battle Lab auspices, we will deploy the SAM (with integrated sleep model) and other components of the SMS in units going through rotations at the Joint Readiness Training Center (JRTC).

Over a series of rotations, we will evaluate the SMS and recursively improve it. With the Battle Lab, we are: working on revisions of Army continuous operations doctrine, to include the suggestion that the assignment of an appropriate person be made at the company level to act as unit sleep manager; and, preparing a center for the Army lessons learned newsletter on the current information/knowledge base on sleep and performance during continuous operations.

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An Acquisition Success Story...

FORCE PROVIDER

Natick's Force Provider Team Completes R&D Program 12 Months Ahead of Schedule And $1.5 Million Under Budget

By COL Morris E. Price Jr. and James J. Tierney

Each Force Provider module, which will house up to 550 "guest" soldiers, is air transportable and comes with all necessary equipment to operate independently from other Army facilities.

June 21, 1994, was a great day for the U.S. Army Natick RD&E Center as the leaders of its Force Provider Team received the prestigious Secretary of Defense Award for Superior Management. Jim McLaughlin, MAJ Chuck Gault and Jim Tierney successfully managed this high visibility effort to develop, test and field a system that improves the quality of life for U.S. Army soldiers. Devising and executing an innovative acquisition strategy, the Force Provider Team completed the program 12 months ahead of schedule, $1.5M under budget and created a design that reduced the projected production costs by $130M. The Secretary of Defense award was presented to Team Force Provider by H. Noel Longuemare, under secretary of Defense (acquisition and technology) at a ceremony in the Pentagon last year. Other distinguished guests were James R. Klugh, deputy under secretary of Defense (logistics), Gilbert F. Decker, assistant secretary of the Army (research, development, and acquisition), and GEN Leon E. Salomon, commander, U.S. Army Materiel Command. This Secretary of Defense award was the crowning achievement following 22 months of intense efforts.

Force Provider is a "tent city" which will accompany Army soldiers to areas of the world where little infrastructure exists. Its prime mission is to offer soldiers a place to rest and recuperate from the rigors of field living. While staying in Force Provider, soldiers will have hot meals and showers, use clean latrines and receive laundry services. They will sleep in air-conditioned tents and have a full range of morale, welfare and recreational facilities available. These might include satellite television, recently released movies and a library. Other facilities will provide a variety of sports activities, shopping for snacks and toiletry items and access to telephones where they can make calls to loved ones. Each Force Provider module, which will house up to 550 "guest" soldiers, is air transportable and comes with all necessary equipment to operate independently from other Army facilities.

Army Chief of Staff GEN Gordon R. Sullivan initiated Force Provider after he saw the unsatisfactory living conditions offered to Army soldiers in Saudi Arabia during Operation Desert Shield. Soldiers were living in 1950s vintage general purpose tents and using makeshift latrines and showers. In stark contrast, the Air Force located their "Bare Base" systems literally across the street from Army compounds. There, airmen stayed in air-conditioned tents developed during the 1980s and used modern, sanitary latrine and shower facilities.

In response to a challenge from GEN Sullivan, Headquarters, Department of the

Army (HQDA) gave the Army Materiel Command (AMC) three years to prove a Force Provider type capability. The ultimate program goal was to begin buying 36 550-soldier modules during FY95. This three-year plan included the development of commercial NDI items resulting in a demonstration of capabilities. AMC subsequently named Natick as the lead developer for Force Provider. Natick took the initiative and created an innovative strategy that accelerated Force Provider's development and testing. Natick successfully fielded a complete module immediately after testing and began making improvements before purchasing the remaining 35 modules.

Concurrent engineering, testing and production planning were the primary characteristics of the newly developed acquisition strategy. To accelerate the engineering aspect, Natick pursued a 75 percent solution by centering on critical requirements that existing Department of Defense (DOD) equipment could meet. This choice simplified the program effort sufficiently to allow the primary focus to shift from full development to a system integration effort.

Focusing on system integration allowed Natick to maximize Force Provider's flexibility and increase its usefulness to the soldiers who will be responsible for its operation. Force Provider uses the TEMPER tent (Tent, Extendable, Modular, Personnel), from the Army deployable medical systems. Other Army inventory is used as well, such as the M85 laundry, and standard petroleum and water distribution equipment. Examples of systems adopted from other Services are the latrine and shower taken from the Air Force Bare Base System. Another example is the Navy's Triple Container that stores most Force Provider equipment.

While pursuing the 75 percent solution, Natick set about obtaining the various items needed to conduct an operational test. To accomplish this, Natick awarded contracts for a variety of subsystems and teamed up with other agencies to secure the rest. They asked Headquarters, U.S. Army Aviation and Troop Command (HQ ATCOM), St. Louis, MO, to find line items available in the Army supply system. Natick also leveraged its existing relationship with HQDA to locate and obtain existing inventory to assemble a complete Force Provider 550-soldier module.

Further program acceleration came through fielding the first 550-soldier module after the operational test. Force Provider was set up and operated on Nijmegen Drop Zone, Fort Bragg, NC, during October and November 1993. During that period, over 1,650 soldiers from the XVIII Airborne Corps rotated through the module during an integrated training schedule to try out the services available in Force Provider. Overwhelmingly, the soldiers showed high acceptance of Force Provider, especially when compared to their experiences. At the conclusion of the test, GEN Sullivan officially handed the module to the 1st Corps Support Command as an operational asset.

Force Provider has given the Army a new capability to project and sustain forces. Interestingly, Force Provider is much more than a soldier rest area; it is a multi-purpose system that supports direct military action overseas, humanitarian aid missions abroad and disaster relief efforts here at home.

Procurement planning was another key factor in the total program strategy. The scheduled period for contract awards was FY95. However, Natick attempted to speed up the purchase and assembly of Force Provider modules. Natick and HQ ATCOM prepared to award contracts as early as late 1993 in the event that they obtained end-of-year funds. This was possible because using existing DOD items in Force Provider presented a low-risk scenario that the Army was making a poor production decision. In effect, a significant history existed on each subsystem within Force Provider. Therefore, there was little reason to wait two years to begin purchasing equipment. So intriguing was this possibility that the Milestone Decision Authority approved a type classification—limited procurement decision concurrent with Milestone 0. In a best case situation, production is accelerated by 18 months. In the worst case, production starts exactly on the original schedule.

The final element of Force Provider's strategy was early identification of the areas that would require improvement beyond the 75 percent solution. The Force Provider team identified four areas for improvement before the operational test: development of containerized latrines, a winterization kit, materiel handling equipment and a waste water treatment capability.

Natick is pursuing solutions to these needs through a pre-planned product improvement program (P3I). Natick used the operational test to challenge or verify the need for these pre-planned improvements. Lessons learned during the test resulted in a strategy change with the addition of a containerized laundry and the deletion of materiel handling equipment. These P3I efforts were initiated immediately after the test. The current plan integrates each of these capabilities into the first two production modules in December 1996. This avoids the unnecessary procurement of the Air Force latrine and the Army M85 laundry currently in Force Provider.

Force Provider has given the Army a new capability to project and sustain forces. Interestingly, Force Provider is much more than a soldier rest area; it is a multi-purpose system that supports direct military action overseas, humanitarian aid missions abroad and disaster relief efforts here at home. It is one of these "other" scenarios that gave Force Provider its first opportunity. The Army deployed elements of Force Provider to the Grand Turks Island, north of Haiti, and to Guantanamo Bay, Cuba, in July 1994. The Force Provider system is supporting U.S. personnel who are processing Haitian refugees in these locations. Force Provider is playing a key role in providing quality facilities for personnel while they process the asylum claims of Haitian refugees attempting to enter the United States.

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HIGH PERFORMANCE COMPUTING: AN ARMY INITIATIVE

By Dr. Jagdish Chandra
and Dr. Tayfun Tezduyar

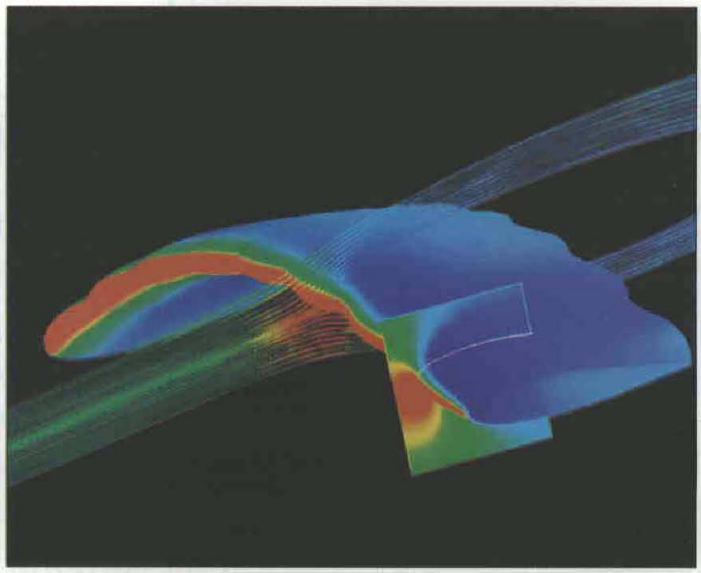

Figure 1.
Cray T3D simulation of a large parafoil; pressure distribution on the parafoil surface and a cross section, and stream ribbons color-coded with the pressure.

Introduction

High Performance Computing (HPC) is an enabling technology for a large class of Army needs, including weapon system design, simulation and modeling, intelligence, automation, advanced manufacturing, and training. Recognizing this, the Army, in 1989, established the Army HPC Research Center at the University of Minnesota. The Center consists of four integrated activities: interdisciplinary research into various aspects of HPC including novel solution techniques, advanced algorithms, applications, and graphics and visualization (GV); evaluation of advanced computing systems and implementation of an advanced HPC environment; infrastructure support and technology transfer to Army and other DOD activities; and, an aggressive outreach program through participation of Historically Black Colleges and Universities and Minority Institutions.

The prime contractor for the center is the University of Minnesota. Its academic partners are Clark Atlanta, Florida A&M, Howard, and Jackson State Universities. Its industrial partner, the Minnesota Supercomputer Center, Inc. (MSCI), maintains and operates the supercomputing resources of the Army Center.

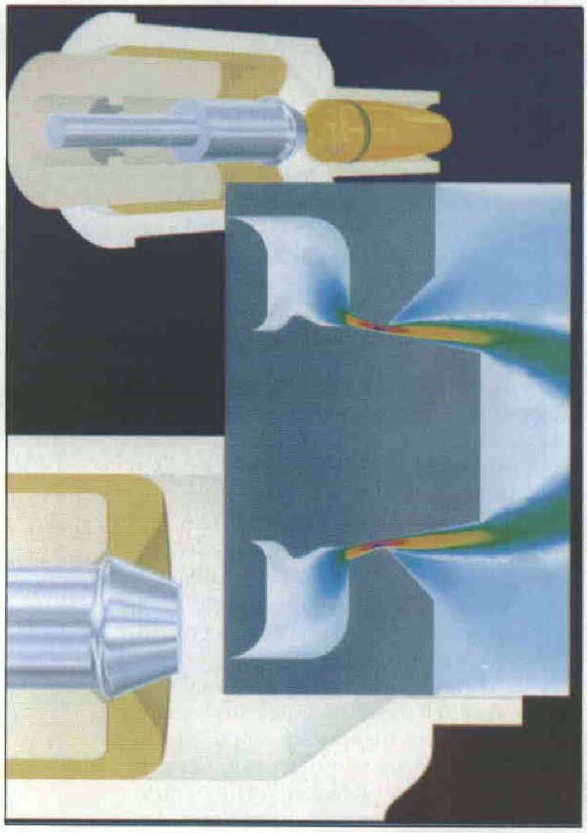

Figure 2.
Heterogeneous computation, with Cray C90 and CM-5, of flow inside a regenerative liquid propellant gun; gun configuration and the MACH number.

Research Activities

A number of center interdisciplinary research teams are working on HPC strategies using advanced computing systems, and applying these powerful strategies to Army problems. The Simulation and Modeling Team focuses on techniques to provide solutions to complex, 3D problems. Finite element computation of compressible and incompressible flows involving complex geometries with moving boundaries and interfaces is one of the major center activities. In this area, the Army Research Laboratory (ARL) and the center researchers are collaborating on the regenerative liquid propellant gun (RLPG) and on missile aerodynamics.

In a collaborative effort with Natick Research, Development, and Engineering Center, the center is simulating the deployment and gliding of large ram-air parachutes. Figure 1 shows the results from a recent simulation carried out on the Cray T3D, a new parallel computer.

The Advanced Manufacturing Team is focusing on HPC techniques and software for advanced material design and manufacturing processes. The advanced material design

efforts emphasize simulation of resin transfer molding and include collaborations with ARL and the Center for Composite Materials (CCM) at University of Delaware. The efforts in manufacturing processes emphasize computer-aided manufacturing, including process planning for on-demand manufacture, and algorithms and software for vision, robotics, and adaptive control.

The Environmental Sciences Team is working closely with the Army Corps of Engineers Waterways Experiment Station (CEWES) in application of advanced HPC techniques to groundwater modeling and environmental fluid mechanics. These activities include developing new models to predict the dispersion, absorption, capillary pressure, and dissolution of contaminants in groundwater, as well as developing new computational hydrodynamics tools based on the Navier-Stokes equations and their shallow-water approximations.

The Information Technology and Algorithms and Software Technology Teams are focusing on tools which facilitate efficient and easy implementation of many applications on various advanced HPC architectures. These tools include parallel scalable algorithms and libraries; database support for manufacturing and simulation; and virtual interactive distributed simulation. These teams also focus on visualization of large data sets resulting from simulations based on structured and unstructured computational grids. In a joint effort with the Tank-Automotive RD&E Center (TARDEC), the center researchers are also working on numerical methods and software for real-time simulation of multibody systems and interactions between rigid-body systems and deformable systems.

Advanced HPC Environments

As a result of an aggressive acquisition and systems integration program as well as being able to capitalize on the computing environment extant at the MSCI, Army center researchers have access to a feature-rich, robust, heterogeneous computing environment that is a model for excellence in HPC. The hardware provided by the Army includes a

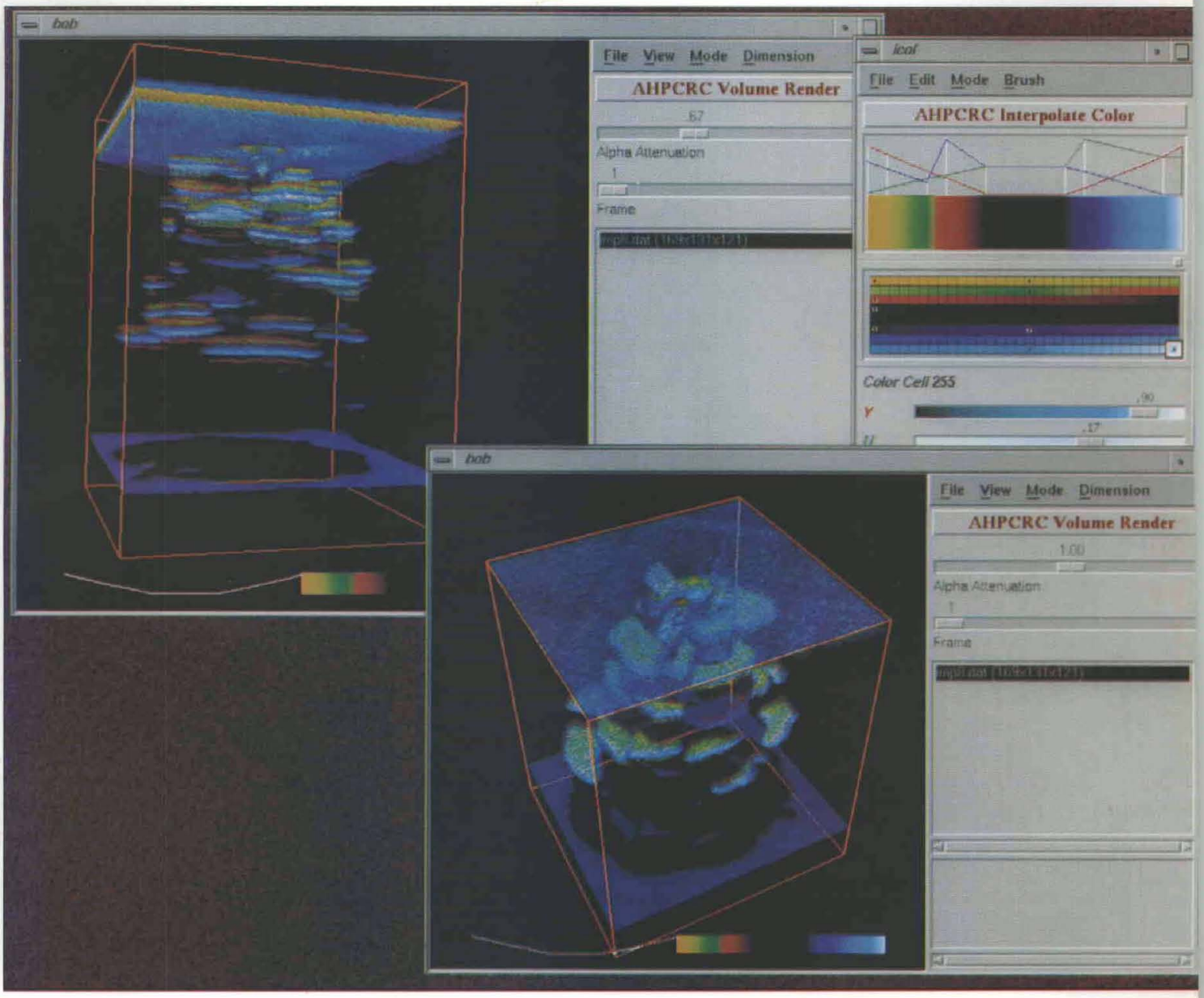

Figure 3.
Digitized echoes from ultrasonic nondestructive evaluation rendered with BOB.

Thinking Machines Corporation CM-5 with 896 processing nodes and an advanced GV lab, whereas the MSCI computational resources include a Cray T3D with 128 processing nodes, a Cray Y-MP C90 with nine processors, and a Cray-2 with four processors. This integrated environment provides researchers with the latest in computing technology, high-speed networking, and user-friendly system and graphics utilities.

The Army center researchers have always been at the forefront of effective and relevant utilization of advanced HPC systems. Soon after the CM-5 supercomputers became available nationwide, the center researchers were among the first to carry out application computations on this platform. The center researchers were also among the first who carried out application computations on the Cray T3D. At Supercomputing '92, the center used heterogeneous computing in simulating thermal flows in the Earth's mantle. The application executed on four different HPC platforms: a CM-5, a Cray-2, a CM-200, and an SGI workstation. This demonstration was judged the "Best of the Best" in Supercomputing '92 Heterogeneous Challenge Competition. In another heterogeneous computing application, recently the center researchers simulated the flow inside a RLPG by using the Cray C90 at MSCI for the direct solution of the coupled equations, while using the Center's CM-5 for the rest of the computations (see Figure 2). The exchange of data every time step is accomplished over a HIPPI channel.

The GV Laboratory at the center is a unique facility specifically to support the demanding requirements of visualization of gigabyte-size data sets. With the software written mostly at the center, the researchers are able to visualize the 3D flow simulation data generated by using structured grids as well as unstructured grids on complicated geometries.

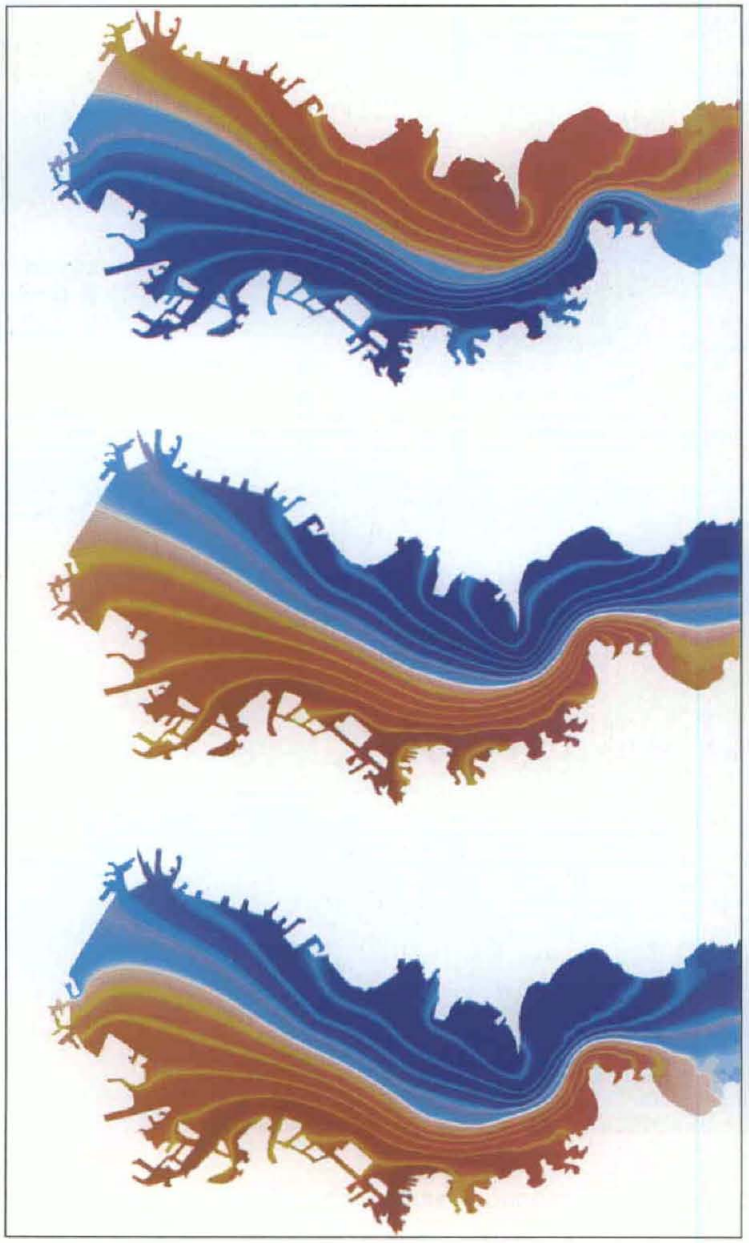

Figure 4. Parallel computation of the tidal waves in Tokyo Bay: stream function at low, mid and high tides.

Software Development

The center supports efforts to develop systems software, mathematical subroutine libraries, GV tools, and applications software. These are made available to the broader Army and HPC community through on-line libraries and one-on-one research collaborations. A good example of the system software developed at the center is Distributed Job Manager which provides interactive and optimal use of parallel computer resources.

In the category of GV software, Brick-of-Bytes (BOB) has been very widely disseminated to government, academe and industry. For example, BOB is extensively used by researchers in their modeling of composite materials at the CCM (see Figure 3). BOB provides for interactive volume rendering, and efficiently visualizes very large 3D data sets.

DASPK, a mathematical subroutine library of iterative algorithms for solving differential algebraic equation systems, and its data-parallel and message-passing-parallel versions found widespread acceptance at many research sites across the country and is used extensively at TARDEC.

Application software developed at the center have also proven to be very useful to the Army. For example, about the software developed for the flow simulation inside a RLPG, an Army official commented that this software "...provided crucial analysis in a short timeframe which was instrumental in the rapid recovery of our weapon to the firing line."

Technology Transfer, Training and Collaboration

The center has a major commitment to technology transfer, training and collaboration. As an innovative computational testbed, it is the focus of several technology transfer projects designed to move university research directly into Army labs and research centers. Several infrastructure support experts placed at both the center and the Army labs play a vital role in the day-to-day operation of the center and are an important link to the research program, serving as a bridge between the university and Army researchers. Technology transfer and collaborative projects cur-

Figure 5.
Army High Performance Computing Research Center 1994 Summer Institute students.

rently underway include:

- Real-time simulation of large-scale multibody systems (TARDEC)
- Design of liquid propellant guns (ARL)
- Groundwater modeling (CEWES)
- Parafoil aerodynamics (Natick RDEC)
- Resin transfer molding (ARL)

The center researchers have also been involved in industrial collaborations in areas such as hardware and software development, materials processing, environmental fluid mechanics, and flow simulation of high-speed transportation vehicles.

International collaborations are also encouraged. Examples include collaborations with the Chuo University in Japan; Observatoire de la Cote d'Azur in France; and Ecole Centrale de Lyon in France. Figure 4 shows an example of such collaborative efforts: parallel computation of an environmental fluid mechanics application, namely, the effect of tidal waves on the Tokyo Bay.

Education, Training and Outreach

Many Ph.D., M.S., and undergraduate students are involved in the center research projects. Approximately 20-25 graduate students and 10-15 postdoctoral fellows are funded each year by the center. Additional graduate students and postdoctoral fellows are funded by other federal, state and industrial research grants leveraged by the resources and activities at the center. For example, three of the postdoctoral fellows originally funded by the center were also awarded Postdoctoral Associateships in Computational Science and Engineering by the National Science Foundation. Graduate students are encouraged to spend time at the Army labs, working on projects supervised jointly by the Army and Center researchers. A center graduate student who spent several months at the ARL working on numerical simulation of liquid propellant guns later accepted a postdoctoral appointment there.

Since the Summer of 1991, the center has organized an annual six-week summer institute for training of promising undergraduate students. Each summer, 15-20 students from the United States and Puerto Rico attend this intensive training in HPC, with emphasis on numerical methods, parallel computing, and GV. The program also encourages these students, especially women and minorities, to pursue graduate studies or careers in HPC. The center faculty, postdoctoral fellows, and graduate students serve as lecturers and project mentors for the students. The Army researchers are also invited to give lectures, providing information on the research activities at the Army labs and potential internship and career opportunities. The 1994 Summer Institute had 18 students from 13 institutions including Clark Atlanta, Florida A&M, Howard, and Jackson State Universities (see Figure 5).

The Future

After an open competition, the follow-on requirement for operating the center beyond January 1995 has been awarded to the University of Minnesota and its partners: Clark Atlanta, Florida A&M, Howard and Jackson State Universities, and the MSCI. This team will continue to work with the Army and the DOD to maintain a national leadership role in HPC research and education, with a renewed and expanded emphasis on collaborations with the Army and an aggressive outreach program.

Army management of the center will transfer from the Army Research Office (ARO) to ARL. The center will become an additional technology partner under the ARL Federated Laboratory concept. The Federated Laboratory concept envisions a partnership of government, industry and academia to address the critical technologies of: advanced sensors, advanced and interactive displays, software and intelligent systems, telecommunications/information distribution, and advanced distributed simulation. This partnership creates an entirely new paradigm for accomplishing Army research. The center will prove to be a great asset in this new venture.

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SIX SIGMA IN PRODUCT DEVELOPMENT

Risk Reduction Techniques Benefit Customer And Supplier

By Rich Karm
and Ron Randall

Imagine a complex product moving through all the operations necessary for fabrication and assembly, but the product flows with no mistakes, no repairs and no corrections. Inspections and tests are minimal: there simply are no defects to be found. Now, compare this to the typical scenario with moderately good yields, but encumbered with the necessary rework, troubleshooting and repair. Which product is likely to have lower cost of manufacturing, shorter cycle time, and less problems in the field?

At Texas Instruments Defense Systems and Electronics Group (DSEG), we are absolutely convinced that higher quality products provide the benefits of reduced cycle time, lower cost and increased reliability. We adopted the Motorola Six Sigma stretch goal in 1991. From 1991 until today, we have seen a 60 percent decrease in production defects rates and a 50 percent reduction in manufacturing cycle times. These two improvements reduce schedule and cost risk for the manufacturer and the buyer.

Throughout industry, most of the quality improvement efforts are focused toward manufacturing processes. It seems intuitive that a major lift can be achieved by improving the quality of designs, so as to be more compatible with manufacturing processes. We know what a Six Sigma process is; but what is a Six Sigma design? This article will describe our approach to answering that question. But first ...

What is Six Sigma?

Six Sigma is a statistical yardstick for quality, a stretch goal, and a methodology for continuous improvement.

- As a measurement tool, Six Sigma quality means no more than 3.4 defects per million opportunities (dpmo). If the reader is familiar with the term "process capability indices," Six Sigma is analogous to C_p of 2.0 and C_{pk} of 1.5. These indices (C_p and C_{pk}) compare the inherent process capability to the requirement limit.
- Six Sigma is also a stretch goal: a reach which often requires revolutionary changes. "Conventional wisdom" (a typical, reasonably well-controlled process) is often found to be about Four Sigma quality, or 6,000 dpmo. Six Sigma represents a 2,000 times improvement. Business as usual, with steady improvement, won't get to Six Sigma. Breakthrough thinking is required.
- Achieving Six Sigma requires deliberate management which begins with thoroughly understanding the customer's requirements, understanding the capabilities for meeting those requirements, and continuously improving and iterating toward better results.

Achieving Six Sigma requires deliberate management which begins with thoroughly understanding the customer's requirements, understanding the capabilities for meeting those requirements, and continuously improving and iterating toward better results.

What is Six Sigma *Design*?

Let's start with an illustration. Suppose the customer requires a system which can detect a target at a range of at least 10 miles. This system might be an infrared unit, a low-light-level video system, or a radar set, for example. The contractor responds that his system will have a detection range of 13 miles. Figure 1a illustrates this situation.

This looks good, so far. But, will all the delivered systems have a detection range of precisely 13 miles? Of course not. So, if we build

20 of these systems, what is the detection range of the most marginal system? What about the best system? What about all the systems in between? Figure 1b illustrates what this might look like.

Given the statistical information in the histogram of Figure 1b, we can draw the probability distribution, illustrated in Figure 1c. These statistics indicate a wide variation across the 20 systems. Here are two problems that variation can cause:

First, some number of units will not meet minimum specification without screening, tweaking, or rework. All these actions contribute cost and cycle time, but not value, to the product.

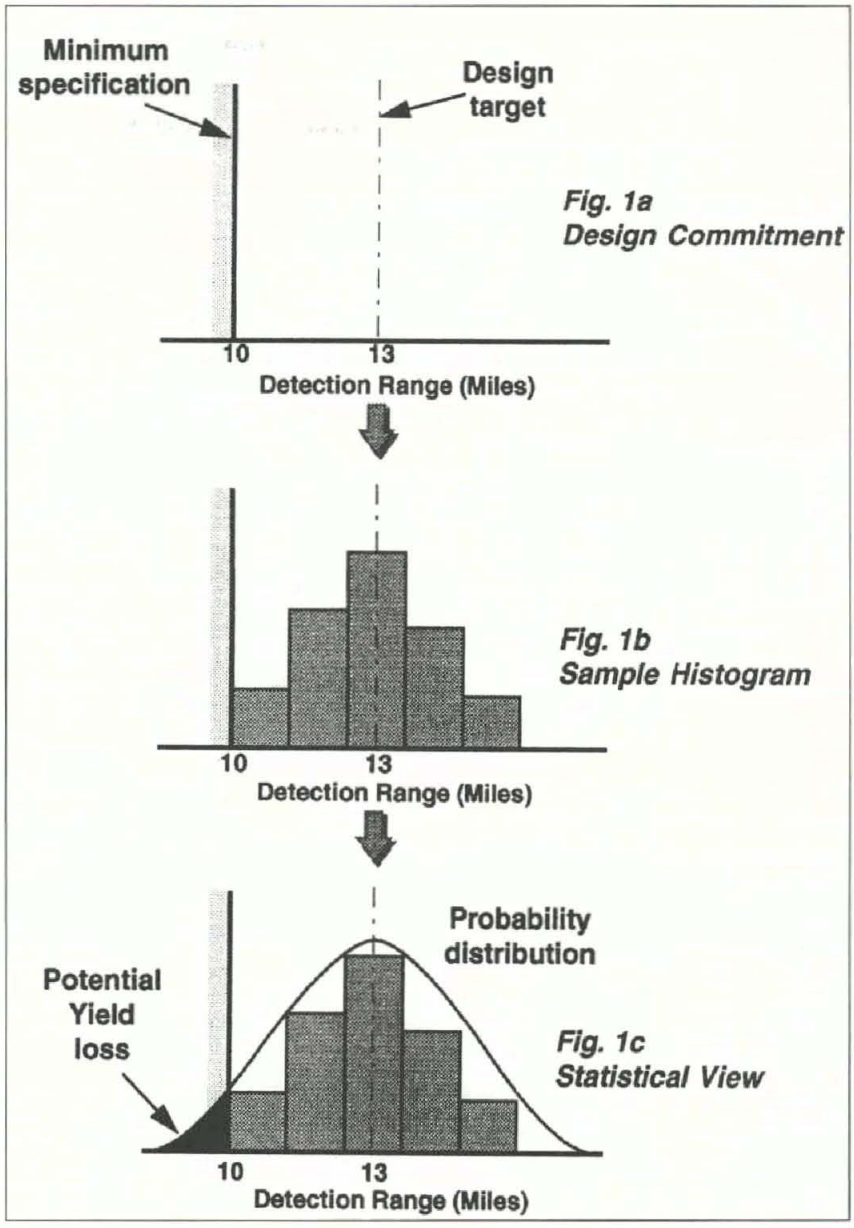
Second, the users prefer the best units, and may assume the more marginal units are actually defective. That, in turn, contributes to user dissatisfaction and perhaps unnecessary rework. Six Sigma design is a methodology to identify and correct this situation before hardware is built.

In simplest terms then, *Six Sigma design is the application of statistical techniques to analyze and optimize the inherent system design margins. The objective is a design which can be built error-free.*

How Can the Customer Benefit From This Information?

To help answer that, let's take the example of Figure 1 to another level. Suppose you wish to evaluate two different design approaches or two different suppliers (A and B). Figure 2 illustrates how this might look statistically. Clearly, supplier B's units will operate at a more predictable performance level. We would predict less trouble with the units in production and in field deployment, less risk with delivery schedules, and overall shorter production cycle times.

Figure 2 illustrates another key point: Be wary of supplier A if he claims he can provide a unit with a 16-mile detection range.



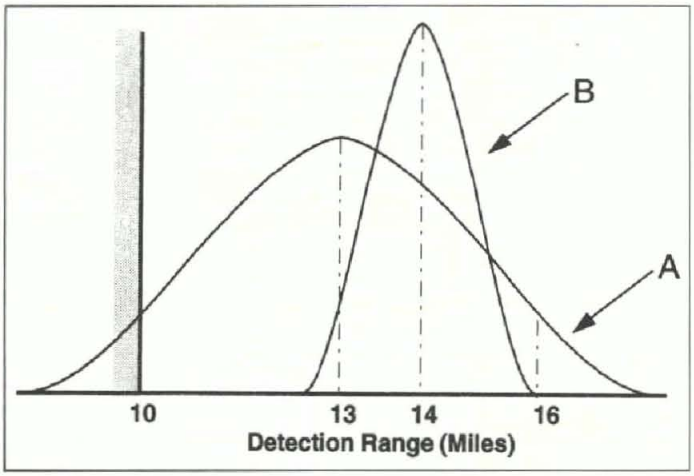


Figure 2.
Comparison of two suppliers (A and B).

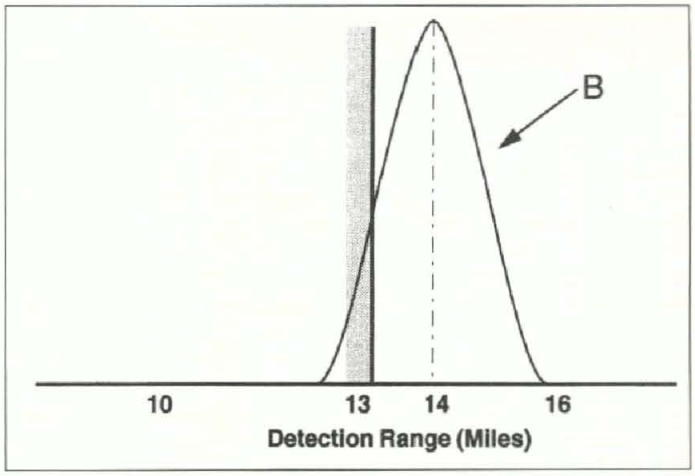


Figure 3.
Pushing design capability.

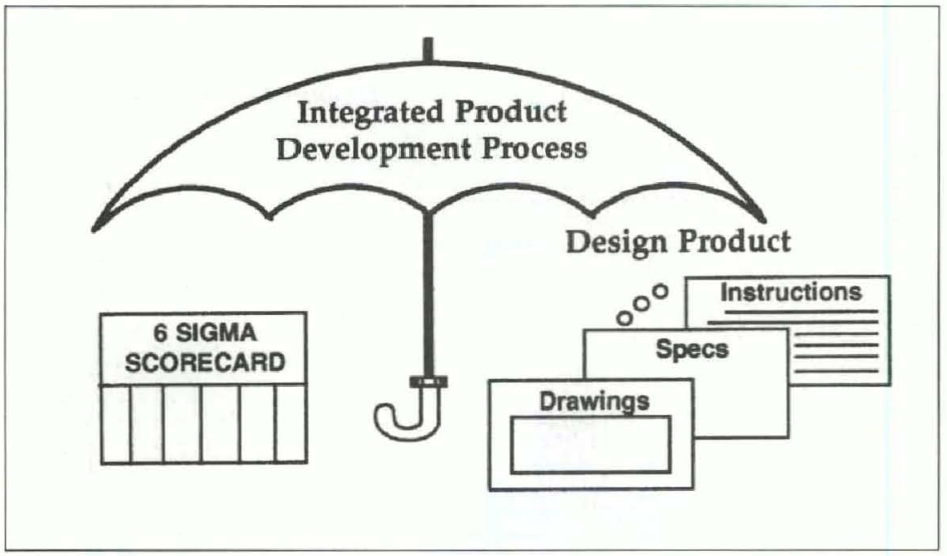


Figure 4.
Design umbrella.

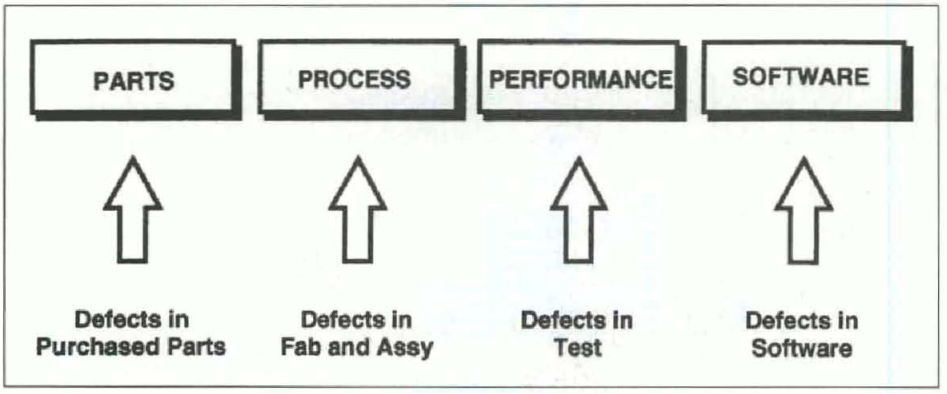


Figure 5.
Scorecard metrics.

Technically, he's right; he's probably even done that...once or twice. But the risk (and cost) of doing that consistently is substantial. Our knowledge of the system's statistics allows us to anticipate those risks and better evaluate alternatives.

Consider one last example. We have chosen supplier B (or design approach B), but we really would prefer a detection range of 13 miles. Obviously, 13 is better than 10, so we get a "better system," right? Not necessarily. Figure 3 shows that we are pushing the limits of the design capability. At a specification of 10 miles, the production yield is close to 100 percent. At a 13-mile requirement, the very same hardware will require additional testing, screening and tweaking, all of which add cost and cycle time. Then ask this: what's the difference between a system with a 12.5-mile detection range (which does not meet the new requirement) compared to a system with a 13.5-mile detection range? Clearly, the difference is very slight. That leads to one more question: We *want* a system with a 13-mile detection range, but do we really need that extra performance, and what does that extra performance *cost?* Thus armed with the additional knowledge gained from understanding the statistics, *the customer and supplier can now make better decisions* and pursue design trade-offs such as:

- different system architectures;
- different or improved component parts;
- different or improved manufacturing processes;
- cost vs. performance;
- re-allocation of system specifications;
- selection of contractor and first tier suppliers.

How Does DSEG Employ Six Sigma Design?

First, the Six Sigma design methods are part of our integrated product and process development (IPPD) approach. (See January-February 1994 issue of *Army RD&A Bulletin*.) Our internal IPPD process brings together all the design stake-holders into the Integrated Product Development Teams. Figure 4 illustrates how IPPD (which, internally we call the Integrated Product Development Process) is the overriding methodology of planning and managing the development effort. The output of the design effort is not the hardware itself, but rather the capture of the design in documentation such as drawings, specifications, and assembly instructions.

Second, we use a Six Sigma design scorecard to assess the integrity of the design with respect to its manufacturability. The unit of measure for manufacturability is the number of defects we predict to occur as the product is built and tested.

The Six Sigma Design Scorecard

The scorecard and associated work sheets provide structure to our design-for-manufacturability efforts. We have defined four elements to our Six Sigma design scorecard, as shown in Figure 5.

- *Process Sigma* estimates the defects which will occur during fabrication and assembly, and relates to the compatibility between the manufacturing processes and the design details.
- *Parts Sigma* estimates the number of defective parts based on the bill of material and chosen suppliers.
- *Performance Sigma* estimates the defects due to inherent design margins.
- *Software Sigma* estimates the defects in the software products as they progress from requirements definition through coding, integration and test.

The Integrated Product Teams use the prediction techniques to identify, prioritize and eliminate potential sources of manufacturing defects. The key is that these techniques are applied long before the design is committed to hardware.

The scorecard system was first used in mid-1992. By the end of 1993, most new design programs in DSEG were using the scorecard. One program manager stated this: "By using it in the design phase, it allows us to identify our defect drivers, thus allowing the en-

gineers to see where the defects are in the design. We can catch them before the manufacturing process, thus reducing the costs."

Manufacturing Process Capability Data

A key element of concurrent engineering is product development teams which are multi-functional. Equally important is ready access to reliable data on the manufacturing process capabilities, which we have in an on-line library. The data for this library were readily captured, thanks to our years of using statistical process control on the factory floors.

Given access to the data, the designer can modify the design parameters to minimize manufacturing defects. As an example, one of our designs required a close tolerance fit between a tank thermal sight retainer window and the head mirror housing. The initial design tolerance of the retainer window using a punch press as the primary process looked like Table 1.

The punch press process did not have the capability to hold the true position of .014, but other options would have greatly increased manufacturing cost. The designer reviewed actual punch press process capability data and assembly stack-up rules to re-allocate the tolerances from the assembly process to manufacturing processes and create a more economic design. The new tolerances and expected yields are shown in Table 2. Again, the key is that the design was modified before any hardware was built.

A Tool For Risk Analysis

Even before the detail design phase, statistical techniques are used to analyze the system specifications. One of our systems engineers stated that the scorecard serves as a good risk management tool. "We use it to track down the problems in our design, so it's a good tool to get an early picture of the kind of design you need," he said. "It's also a good tool for measuring design time."

To oversimplify a bit, this technique means looking at each critical system requirement as shown in Figure 1c. We can calculate the statistical design margins, then estimate the Sigma value, defect rate, or probability of meeting each requirement. The engineer, the program manager and the customer all benefit from this quantitative visibility into the potential risks.

The Customer's Role

True concurrent engineering involves the customer. Technical risk to the contractor inevitably means risk to the buyer or user. That risk translates into problems, cost and time...for both supplier and customer.

The Sigma value is a comparison of capability to requirements. In years past, we have focused on manufacturing capability improvements to enhance production yields. Now we better recognize how careful requirements allocation and trade-off can provide substantial risk reduction and cost savings. Moreover, failure to do so can be a non-recoverable blunder. The customer plays a key role in these requirements allocations and trade-off decisions. In most cases, the customer controls the top level specifications; as a minimum, he defines the needs and expectations.

One of our customers left the two-day Six Sigma class with the comment, "You can't get to Six Sigma without us, can you?" In a word, no. He also understood that, as we progress toward Six Sigma, he reaps the benefits, too.

Since implementing our Six Sigma design methods, we have witnessed the expected production defect levels come down rapidly while the product is still in development.

TABLE 1

	Tolerance	Expected Yield Loss
22 Slots	TP of .014"	68.20%
39 Surfaces	+/- .010"	.00%
15 Surfaces	TP of .056"	.00%

TABLE 2

	Tolerance	Expected Yield Loss
22 Slots	TP of .020"	3.79%
39 Surfaces	+/- .010"	.00%
15 Surfaces	TP of .056"	.00%

Summary

Since implementing our Six Sigma design methods, we have witnessed the expected production defect levels come down rapidly while the product is still in development. Reducing defect levels has also reduced program risk and cost for that critical phase referred to as the "transition to production." We're seeing a more intelligent approach to setting requirements and specifications. We're also seeing effort and funding directed early to potential risk areas.

In a sense, we are simulating the initial production shake-out period. The participants in this simulation are not just the designers, but the producibility engineers, process engineers, manufacturing engineers, fabrication shops, component engineers, purchasing, and the customers. This statistical design methodology has thus been a significant enabler to concurrent engineering.

We know that Six Sigma works in production. We now have statistical methods and tools to go upstream from production into product development. The potential benefit is enormous in avoided problems, reduced cycle times, reduced cost, and improved product reliability. The customer and supplier reap these benefits together.

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RON RANDALL is a senior member of the technical staff with Texas Instruments Defense Systems and Electronics Group. He is the DSEG Six Sigma champion, and holds a B.S. in mechanical engineering from the University of Texas at Arlington. Randall is an examiner for the Malcolm Baldridge National Quality Award, and a registered professional engineer in Texas.

REPAIR OR REPLACE?

The Army at Financial Crossroads

By Dr. Kenneth J. Oscar
and Nannette M. Ramsey

Introduction

The Army is restructuring and changing the way it does business to focus on maintaining a superior strategic force into the 21st century. The Army is downsizing, pursuing better information systems, and streamlining processes to maximize the limited resources available. However, all the efficiencies the Army institutes will not be enough to satisfy the needs of a modern Army if the budget continues to decline and modernization and replacement needs cannot be met. The composition of the Army equipment inventory is formed through technology insertion; procurement of new equipment/systems; the retirement of old, obsolete equipment; and the sustainment of existing systems/equipment. Inability to effect these types of changes will result in an overage inventory that falls short of meeting mission requirements.

The Army Budget

The Army budget is made up of five appropriations: military personnel; operation and maintenance (O&M); procurement; research, development, test, and evaluation (RDTE); and other. The "other" appropriation includes such things as military construction, Army family housing, and Base Realignment and Closure (BRAC).

Figure 1 shows the current and historical proportion of these five appropriations as part of the total Army budget. The chart reveals that the Army budget has gone down approximately 25 percent in the last 10 years, however the five appropriations have not been reduced proportionately. There has been a radical shift in the proportion of the budget spent in the area of procurement. While the overall budget has been reduced by 25 percent, the procurement account has declined more than 72 percent. This translates into a 63 percent reduction in the

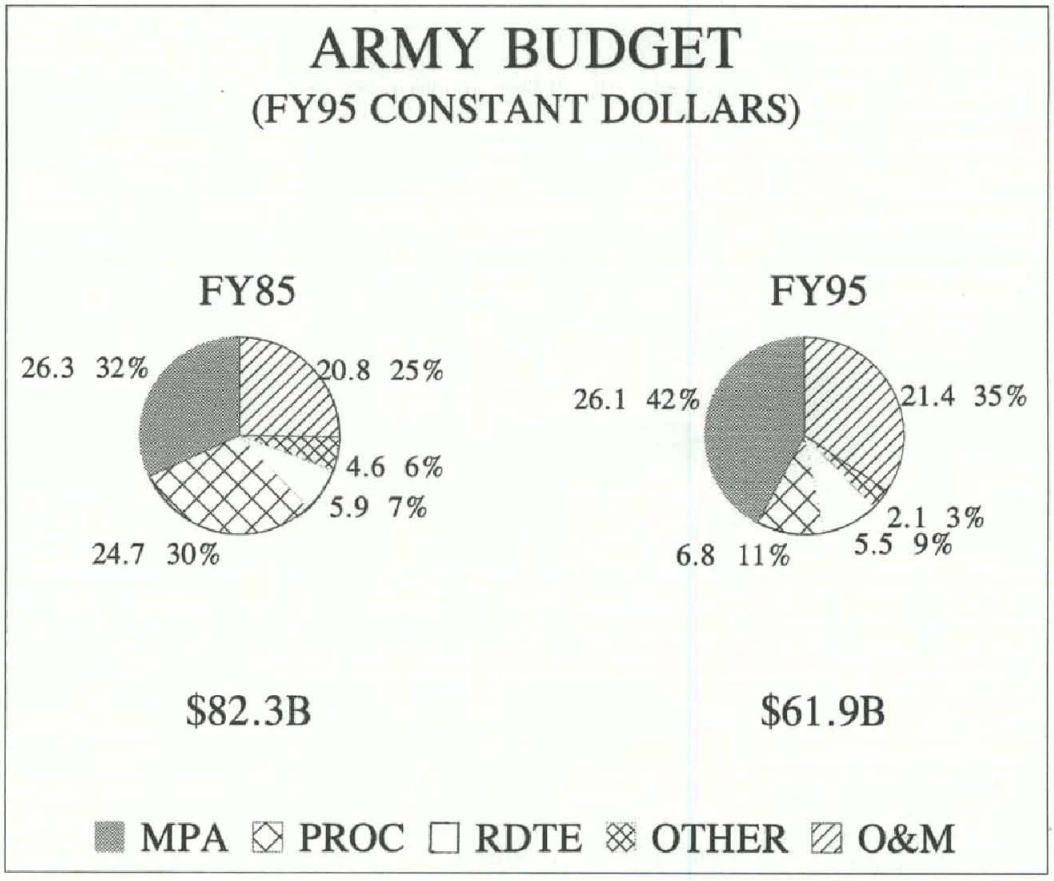

Figure 1.

proportion of the total budget spent in procurement. The O&M and military personnel account (MPA) segments, on the other hand, have remained fairly steady in constant dollars, but, as a proportion of the overall budget, the O&M segment has increased 40 percent and the MPA segment has increased 31 percent (from 25 percent of the total budget to 35 percent and from 32 percent to 42 percent respectively).

The procurement appropriation is used to buy new equipment, replacing existing equipment with modern hardware as new threats develop around the world. Although this money is called modernization money, some of it is also used to replace worn out equipment (see Figure 2).

Historically, the RDTE portion of the Army budget has been held at a fairly steady level, although in recent years it is dropping. The procurement budget, however, has reached its lowest level in history. In fact, it is reduced to a level lower than after World War II and Korea. The precipitous decline in the procurement budget is shown in Figure 3. The RDTE budget, which used to be about one-fourth of the procurement budget, in FY95 is nearly equal to it. This budget scenario translates into very little replacement of aging equipment and little transition of technology generated with the RDTE portion of the budget.

To demonstrate this, Figure 4 shows equipment procurement quantities for several classes of equipment. In 1985, we procured 13,405 Tactical Wheeled Vehicles (TWVs), but will only procure 4,957 in FY95. The same reduced levels appear in the procurement aggregate for helicopters and tanks.

Force Structure Should Drive Funding

These reduced procurements impact the rate at which the Army's aging equipment is replaced. Yet, it is the force structure that should translate into equipment requirements, in turn identifying the necessary budget. More specifically, the current Army requirement is to support 10 active divisions. Figure 5 identifies a summary of equipment quantities of key systems required for this force structure for various categories of equipment and the estimated funding requirement to replace equipment as it becomes practical to do so. The total Army budget estimate required to replace the aging equipment in the current force structure at an acceptable rate is $9 billion. An additional $4.5 billion, approximately half the estimated replacement funding requirement, is needed for modernization. This yields a total budget requirement of $13.5 billion. The current budget of $6.8 (shown in Figure 1) is approximately half of the $13.5 billion needed.

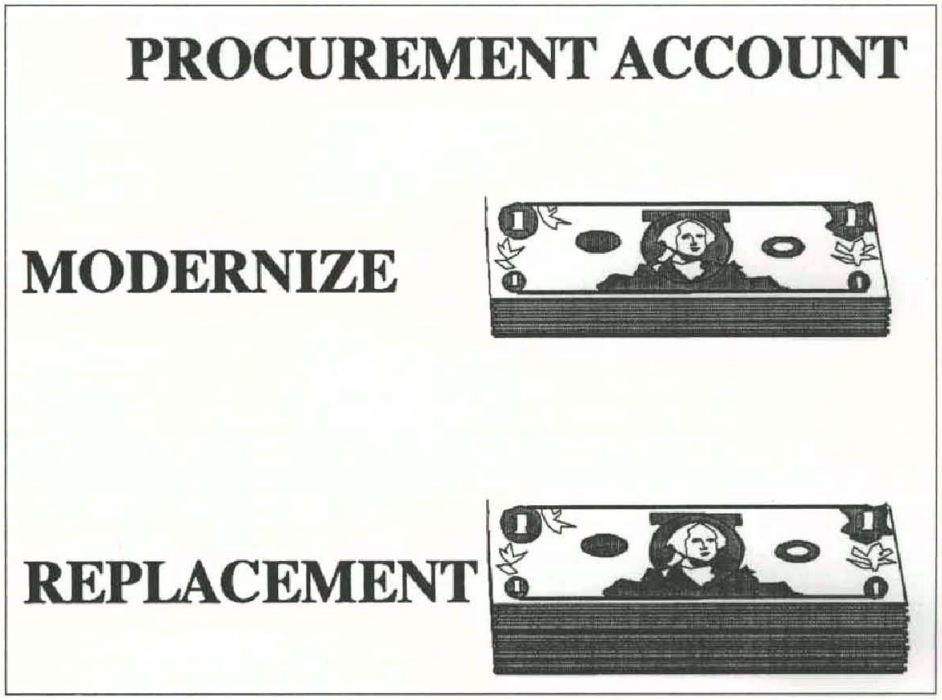

Figure 2.

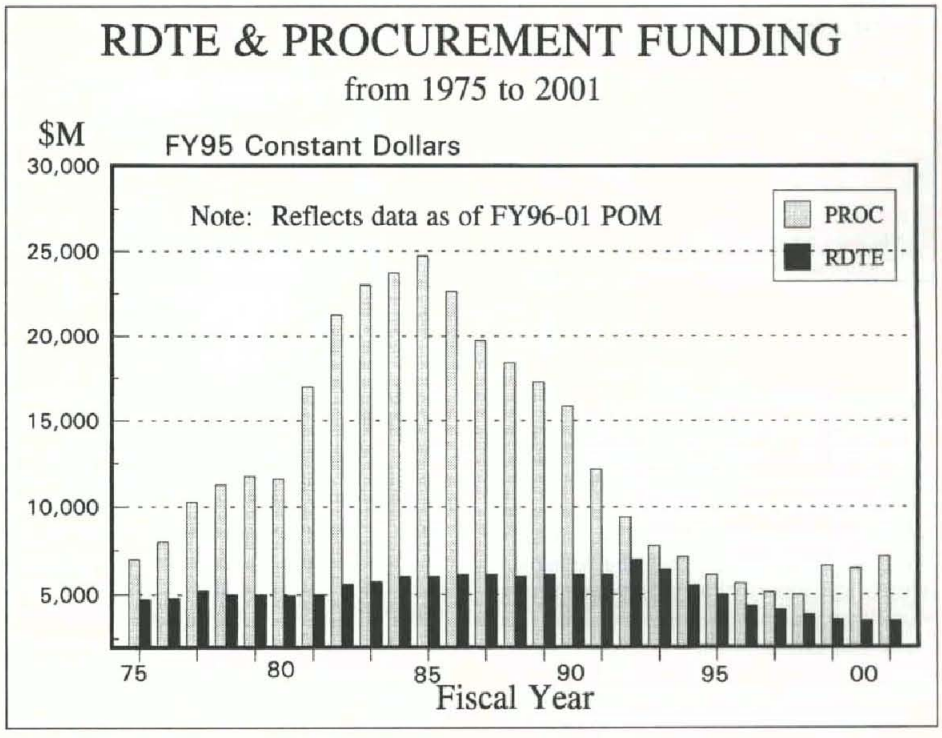

Figure 3.

HISTORICAL EQUIPMENT PROCUREMENT REVIEW

	1985	1990	1995
TRUCKS	13,405	2,225	4,957 *
HELICOPTERS	141	215	60
TANKS	720	450	70

* Includes FMTV

Figure 4.

10 DIVISION/NG/AR FORCE EQUIPMENT SUMMARY

	QTY NEEDED	AVG LIFE EXPECTANCY	REPLACE #/YEAR	FUNDS NEEDED (IN BILLION)
TAC WHEELED VEHICLES	204,521	17	12,031	1.0
HELICOPTERS	5,000	20	250	2.5
TANKS	6,000	30	200	2.0
Other Tracked Vehicles	21,000	30	700	
OTHER	*	*	*	3.5
		TOTAL REPLACEMENT COST		9.0

* Includes Ammo, Missiles, Communication, Soldier Systems

Figure 5.

Impact of Shortfall

This budget shortfall will result in little modernization, continued problems in the industrial base, and higher operation and support (O&S) costs (see Figure 6). Funding levels are not expected to improve in FY96. Soon we will not even be able to replace worn-out equipment let alone perform any significant modernization, and our O&S costs will bankrupt us.

Effect of Cost of Ownership

When older inventory is not replaced at the point when it reaches the end of its service life, O&S costs escalate. Figure 7 displays typical cost curves for ownership of equipment for acquisition and O&S. Also shown is a combined cost curve which represents a total of the two cost curves. Replacing the inventory with new equipment every year would be very costly, but it would result in low O&S costs because there would be little maintenance on the new equipment. As the equipment inventory ages, the maintenance costs start growing until the inventory reaches an age where maintenance costs are prohibitive. The service life, which varies by system, corresponds to the lowest point of the combined cost curve and is the most economical point at which to replace the aging inventory. This is because it will actually be cheaper to buy and maintain the new equipment than keep the older equipment and maintain it. However, since the budget is so low that most new procurement is prevented, the Army cost of ownership is rising.

Replacement Impact

The budget figures indicate the Army will have to maintain the older equipment as they are translated into actual procurement quantities for equipment such as TWVs. The current Army inventory of TWVs worldwide numbers approximately 250,000 with an average service life of 17 years. In FY95, the Army is procuring less than 5,000 TWVs. At this rate, it will take 50 years to completely turn-over the TWV fleet. This will leave the Army with vehicles that are older than the soldiers who drive them. To exacerbate the aging problem, the Army is participating in more exercises, such as Operation Just Cause and Operation Restore Hope, than it did in the past. Consequently, the affects of salt water (as a result of shipping), inadequate road systems, and sand are increasing the need for fleet maintenance and the aging process is accelerated.

A more specific example of the problem is the popular High Mobility Multi-purpose Wheeled Vehicle (HMMWV) with an age distribution that is expected to go from a median age of six years in 1994 to a median age of 19 in 2010. This is five years beyond its projected service life. Another example is the medium fleet which consists of 2 1/2- and 5-ton vehicles, most of which would be replaced by the Family of Medium Tactical Vehicles—if it were not for fiscal constraints. In FY93, the 2 1/2-ton fleet started to reach its service life for Force Package 1 (first to fight) soldiers. Cuts to the FMTV program may leave these trucks in service. Approximately $1.3 billion is needed for "bare bones" maintenance on Army TWVs. To stretch maintenance dollars, fleet managers have: reduced the OPTEMPO to save wear and tear on the equipment; parked "old dogs"; and where possible, are using 5-ton trucks to do the work of 2 1/2-ton trucks because of the high maintenance required on the older, lighter vehicle.

Much of the Army's helicopter fleet is also aging and, with the current budget outlook, the trend will continue. Table 1 shows the service life for the three major categories of helicopters. The service life shown for each category reflects consideration of technology, logistics supportability, margin for growth, and changes in threat. A goal for the fleet is to keep the average age at or below 50 percent of the service life. Helicopters beyond their service life have higher supportability costs and promote the risk of decreased combat effectiveness and safe operations. The CH-47D helicopters have actually "used up" one life as a CH-47 A/B/C airframe before the D model modification program which added 20 years to the service life. As can be seen in the table, the attack/reconnaissance fleet, with the average age at the service life, is in

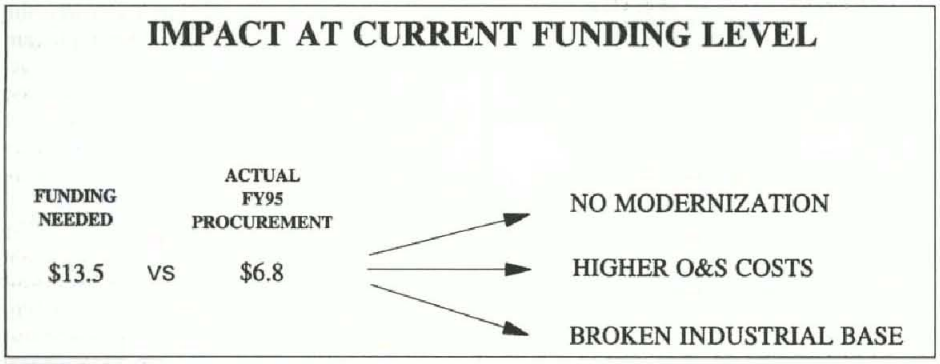

Figure 6.

the most need of attention. Based on Table 1, the attack/reconnaissance fleet has reached that age that makes modernization of the fleet a better option. However, the state of the budget and the lack of emphasis on modernization does not allow that option to be implemented.

A look at end item maintenance costs identified in the U.S. Army Cost and Economic Analysis Aviation Cost Report shows that for a UH-1H fleet size that basically remained constant from 1989 to 1991, the end item maintenance costs climbed from $28 million to $43 million in the same period. This occurred at a time when the OPTEMPO hours were decreasing. This demonstrates how maintenance costs can rise as systems age.

The tank is yet another system for which the replacement rate has dropped so dramatically that the inventory will have to remain in service far beyond any other time in history. In the late 1980s, 60 new M1 tanks per month were manufactured in order to equip a force structure that required approximately 10,000 tanks. At the production rate of 60 per month, the total requirement could be met in approximately 14 years. In comparison, the current force structure requires approximately 6,000 tanks while the budget allows for upgrading around 70 tanks per year. At this rate, a tank will have to last 86 years before it is replaced or upgraded as shown in Figure 8.

Other Considerations

When we look at intangible costs related to operations and support activities, another point to consider is operational readiness. When a vehicle, tank, or aircraft is "down" for maintenance or repair, float equipment from the readiness pool will be used until the disabled equipment is repaired. This process assures the mission effectiveness of Army units. The older the Army's vehicles, tanks, and aircraft become, the frequency rate and quantity of equipment that will be "down" for maintenance and repair will increase. This will, in turn, require a larger readiness float pool—an additional cost. An intangible cost associated with the maintenance of these systems is equipment availability to support various Army missions.

An additional concern is that with little modernization, the equipment inventory will not only age, but there will be little technology inserted into the weapon system fleet. With modernization, we can change fielded equipment to enhance its performance. We may also want to modernize our equipment to meet a changing threat, safety or environmental requirement.

The reduced procurement levels are also impacting the industrial base. With budget cuts, some contractors are closing production lines while others are going out of business. Capacity is being lost. Major companies are announcing that they no longer wish to do business with DOD. The government is having to pay the bill to qualify new contractors for the few systems we are still procuring and it is a bill we can ill afford. Although the Army is working to assure critical capabilities are not lost, it is hard to maintain cognizance of contractor activity at the sub-tier level. If there is a break in production and industry must restart from a cold base, there are significant start-up costs, higher unit cost and long production lead times (24-30 months). Industry will need to requalify their vendor base and manufacturing processes, and may have to acquire and train new personnel.

Conclusion

The Army has a set of reasonable continuous modernization goals to acquire capable, cost-effective equipment. Continuous modernization means that for every class of major weapon system that makes up our key war fighting capability, our goal is to have either a system in production, being upgraded, or a replacement next generation system in development. However, resources are not available to maintain, much less improve, the level of equipment modernization. A lapse in this process can cause repercussions that

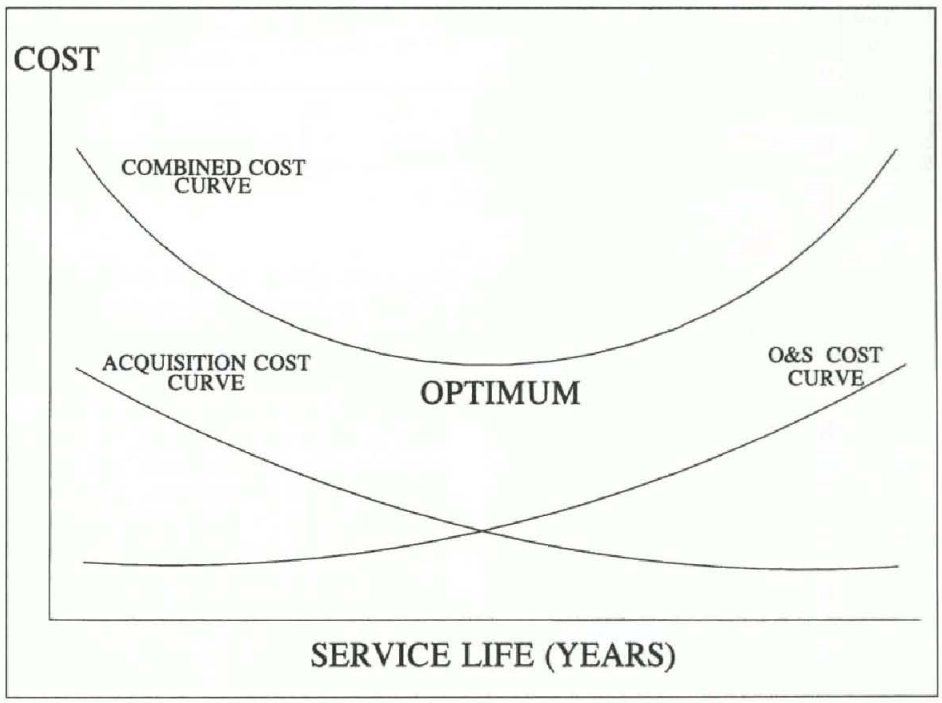

Figure 7.

Table 1.

HELICOPTER	MODEL	SERVICE LIFE	AVE AGE OF FLEET
ATTACK/RECON FLEET	AH-1 OH 58A/C AH-64A OH-58D	20	20
UTILITY FLEET	UH-60A UH-60L	30	22
CARGO FLEET	CH-47D	20 + 20	22

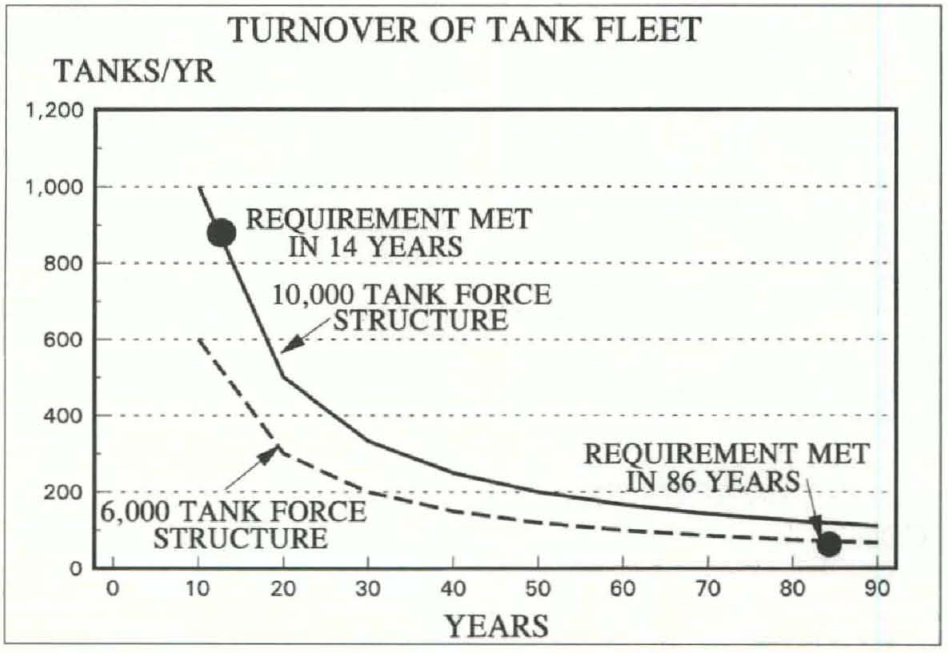

Figure 8.

effectively lessen our war fighting ability by eroding the industrial base and related critical skills, interfering with the fielding process, stagnating technology, increasing the age of the fleet, and dulling our war fighting edge. A cohesive integrated strategy with regard to the spending of procurement funds to replace older inventory will allow the Army to more judiciously maintain it's equipment inventory and avoid the excessive O&S costs that come with having to maintain equipment that has exceeded its service life. It also facilitates the development of a procurement strategy that replaces equipment at a reasonable cost as it wears out and keeps manufacturing facilities running continuously.

If we try to maintain the current equipment inventory without procurement of technologically advanced systems we are deteriorating our capability to defeat future opposing forces. We cannot afford to put off the replacement of all categories of equipment. If we continue along these procurement levels, our trucks, helicopters and tanks will continue to age and maintenance costs will continue to climb. At some point, the costs to maintain the aged equipment will be prohibitive and the bill to replace it will be astronomical. With current budget deficits, it would appear that we just cannot afford the necessary budget to steadily replace equipment. A little foresight tells us we cannot afford to wait. Not only will the maintenance bill continue to climb along with the cost to eventually replace the worn out inventory, but when we eventually try to replace the equipment, there may not be much of an industrial base available.

The Army is actively pursuing three initiatives as part of a strategy to help mitigate the lack of procurement dollars. First, acquisition reform initiatives, including full use of simulation, are being aggressively put into place to maximize the return on our procurement dollars. Second, horizontal technology insertion on existing platforms will optimize modernization. The third part of the strategy involves careful identification and support of essential industrial capabilities that will ensure an adequate base will be there when funding upturns. These measures will lessen the rising cost of ownership and hopefully the future procurement budget will rise before the increasing bow wave of deferred replacement costs are unaffordable and irreversibly affect future readiness.

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NANNETTE M. RAMSEY is a general engineer with the U.S. Army Industrial Engineering Activity, Rock Island, IL. She holds a B.A. degree in economics, a B.S. degree in engineering, and an M.B.A. from the Florida Institute of Technology.

Army Acquisition Workshop...

ACQUISITION COMMUNITY DISCUSSES PLANS FOR 21ST CENTURY

Approximately 300 representatives from the Department of Defense, industry, and academia met earlier this year at the Army Acquisition Workshop in San Antonio, TX. The theme was "Army Acquisition—21st Century Management for Force XXI."

Sponsored by the Army Acquisition Executive Gilbert F. Decker, and hosted by the Center for Professional Development and Training at The University of Texas at Austin, the workshop provided program executive officers (PEOs) and program/product/project managers (PMs) the opportunity to receive current acquisition philosophy and insight. In addition, the workshop served as a vehicle to inform attendees about matters impacting their ability to more effectively execute acquisition programs.

Gilbert F. Decker, who also serves as assistant secretary of the Army (research, development and acquisition), welcomed the attendees. He noted that this year's workshop had a broader range of attendees, including members of the other Services and industry leaders. He also stressed the importance of matrix management, indicating that it may not be flawless, but it's a very necessary form of management. Both military and industrial organizations can benefit from matrix management, he said. Its success depends on great teamwork and respect, he added. Decker closed his remarks by expressing his anticipation that the conference would result in greater teamwork, and serve as a mutual learning experience for the attendees. Decker then introduced the keynote speaker, Under Secretary of the Army Joe R. Reeder.

Reeder spoke on the state of the Army—where it is going, and why the Army acquistion leadership is essential to that progression. He stressed the importance of Force XXI, noting that it will only be a mirage unless quality people are hired and retained. Reeder also spoke on the need to remain focused on the primary goals of protecting the American people and providing good equipment for our soldiers. Reeder also stated that our Army remains the best in the world and emphasized we must always find a way to maintain it. Reeder closed by thanking the attendees for their tremendous efforts in providing our soldiers with the best equipment in the world.

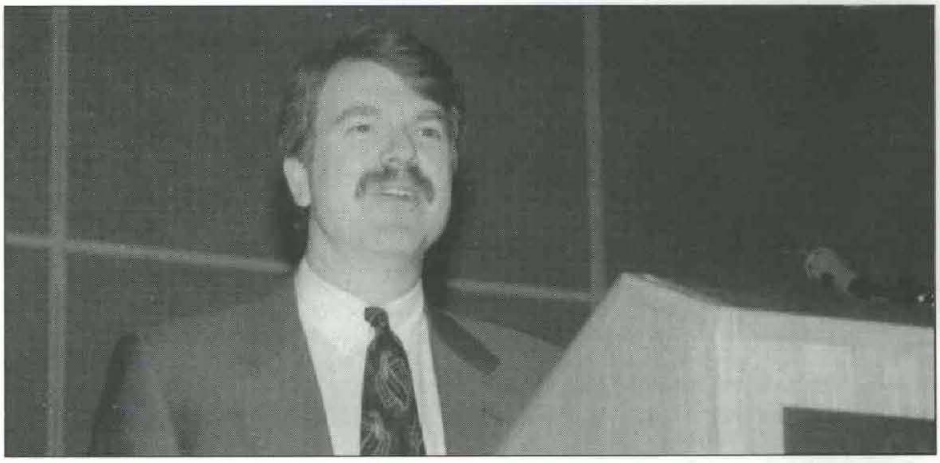
Joshua Gotbaum, assistant secretary of Defense for economic security, spoke about the Office of the Secretary of Defense (OSD) industrial base initiatives. He cited some basic concerns in preserving the industrial base, including the potential loss of some capabilities if not supported and the declining budget. Gotbaum also emphasized the importance of sector studies, stating that they are being used as tools to help the Army, Navy, and Air Force gather better data and establish a dialogue with industry. He, like other speakers, stressed the importance and difficulties of preserving the industrial base.

An overview of the Army's space role was given by LTG Jay M. Garner, commanding general, U.S. Army Space and Strategic Defense Command (SSDC). His presentation, SSDC and Force XXI, focused on changes in doctrinal emphasis, tenets of Army operations and the declining budget. Garner projected three new areas of doctrinal emphasis for Force XXI—force projection, peace operations, and combined operations. "If we're going to control the force, what we have to do for the 21st century is operate over wide areas, have total knowledge of power movement, deny enemy control of information, and have assured access to space," said Garner. "The challenge to all of us is to be able to define our requirements, work the technologies, turn it out to the PMs, and get space-related products directly down link to the war fighter," said Garner.

A presentation on non-developmental items (NDI) and foreign comparative testing (FCT) was provided by COL Randall G. Catts, who is the manager, foreign comparative testing in the Office of the Director for Test and Evaluation, Office of the Under Secretary of Defense (Acquisition and Technology). Catts gave an overview of the FCT program and discussed current projects to illustrate the range of available opportunities. Catts noted the need to determine whether there is interest in a particular foreign item, how to test it and then to execute the test. "Success is measured by procurements as a result of testing, not the amount of testing we do," said Catts.

LTG Thomas G. Rhame, director, Defense Security Assistance Agency (DSAA), spoke on the conventional arms transfer policy. According to Rhame, key objectives for the conventional arms transfer policy include: maintaining American strength; helping allies meet security needs; promoting regional security; maintaining a healthy and adaptive Defense industrial base; and supporting U.S. national security at home and abroad.

A panel discussion was held on "Defense Industry's Perspective for the 21st Century."



Joshua Gotbaum, assistant secretary of Defense for economic security, spoke about OSD industrial base initiatives.

Sara E. Lister, assistant secretary of the Army (manpower and reserve affairs), spoke on manning Force XXI.

Panel members included: moderator, Thomas W. Rabaut, president and chief executive officer, United Defense LP; MG(USA Ret.) Lynn H. Stevens, program manager, Brilliant Anti-Armor Submunition (BAT) Program, Electronic Systems Division, Northrop Grumman Corporation; Eric M. Levi, retired vice-president and assistant general manager, Missile System Division, Domestic and International Requirements, Raytheon; and MG(USA Ret.) Donald R. Infante, vice-president and manager, Defense Systems, Hughes Aerospace and Electronics Company. Each gave a brief presentation about their programs and then addressed questions from the attendees. Topics included: reducing elements of bureaucracy in weapons acquisition by both government and industry; the effects of the computer chip on weapons acquisition and modernization; integration of chip technology into the products; specialized testing; and commercial specifications and standards.

GEN Leon E. Salomon, commanding general, U.S. Army Materiel Command (AMC) presented AMC's perspective of Force XXI. He said that AMC's goal is to provide relevant, responsive and best value support to the customer. He listed some of AMC's Force XXI challenges, which included: giving PEOs the support they need, dealing with accelerating technology obsolescence, world-wide proliferation of high-tech manuals, information warfare, and merging the commercial and Defense industries.

Sara E. Lister, assistant secretary of the Army (manpower and reserve affairs), spoke on manning Force XXI. "One of the premises of Force XXI is that the Army of the future will be flexible and creative enough to meet threats that we are unable to predict today," she said. "We must prepare by using the best technology to develop adaptable forces capable of doing the job, whatever that job is," she added. According to Lister, her thoughts about manning the force are based on the assumptions that there will not be enough money to do all that is needed and that the world will continue to be dangerous place. She projected that jobs will be more complex, require greater understanding of computers and the ability to think creatively, whatever the situation, and that every Army soldier and civilian will be challenged to do a bigger job with fewer resources.

An overview of Defense Contract Management Command (DCMC) Support for Force XXI was given by RADM Leonard Vincent, deputy director, acquisition and commander, DCMC. Vincent stressed the need for greater government and industry cooperation. He said that traditional relationships between industry and government must change and that adversity must be replaced with more open communciation and other cooperative efforts.

The dinner address, given by Paul G. Kaminski, under secretary of Defense for acquisition technology, focused on acquisition reform. Kaminski said that he is part of a team that is promulgating a shift in the balance between the use of military and commercial elements of our industrial base. This team, he said, is collectively moving our system to place greater reliance on commercial sources at the subsystem and component levels with the intent of reducing not only costs, but the acquisition cycle time, which will allow for faster fielding of advanced technology. Some of the suggestions offered by Kaminski included: right-sizing of our infrastructure; reducing the cost of weapon system ownership; implementation of acquisition reform; and improved leveraging of our national industrial base and that of our allies. He called for new incentives and opportunities in the way we conduct our acquisition process, resulting in a legacy for the long-term future.

Kaminski was followed by presentation of the PM of the Year awards. (See sidebar below.)

Following presentation of the PM Awards, Decker recognized LTG William H. Forster,

PM of the Year Awards

Recipients of the FY 94 Project and Product Manager of the Year Awards were recognized earlier this year during a dinner presentation at the Army Acquisition Workshop in San Antonio, TX.

COL Willie B. Nance Jr., project manager, Army Tactical Missile System—Brilliant Anti-Armor Submunition, received the award for his contributions to the TACMS-BAT Project. Nance is responsible for supervising a staff of 191 acquisition and technical professionals and managing program costs, schedule and performance, and courses of action to achieve acquisition requirements. He also manages the government and contractor acquisition teams in support of program objectives to include development, testing and integration of five major products covering the entire acquisition spectrum. Nance successfully managed the combination of two distinct, complex projects and managed the transition from two projects into one.

LTC Charles A. Cartwright, product manager, Paladin/Field Artillery Ammunition Support Vehicle, was recognized for his accomplishments in the management of these programs through a transitional period. He is responsible for supervising a staff of more than 40 and for maintaining program baseline cost, production schedule, technical thresholds, fielding logistically supportable and technically capable systems, and testing and fielding hardware and software product improvements. In addition, he coordinates and manages the activities of more than 200 managers and engineers in government laboratories, depots, arsenals and test facilities. Cartwright transitioned the M109A6 Paladin production program from low rate to full-scale production and was instrumental in establishing what is considered the Army's "model program" of government and industry cooperation. In Jan. 1994, he was directed to take management of the then-troubled FAASV program, and within a few short months brought the program back on schedule.

The awards were presented at the dinner ceremony by Gilbert F. Decker, assistant secretary of the Army (research, development and acquisition) (ASA(RDA)) and Army acquisition executive; LTG William H. Forster, director, Army Acquisition Corps and military deputy to the ASA(RDA); and Paul G. Kaminski, under secretary of Defense for acquisition and technology.

Decker made closing remarks in which he expressed his pride to be part of the Acquisition Corps and commended the PEOs and PMs for their contributions.

George T. Singley III, deputy assistant secretary of the Army for research and technology, spoke on Army Research Lab streamlining and technology development for the 21st century.

LTG William H. Forster, director, Army Acquisition Corps, provided an update on AAC career development.

director, Army Acquisition Corps, for significant and dramatic contributions to the Army Acquisition Corps, and the Army modernization program. Forster was commended for his personal involvement and leadership which led to the AAC becoming a fully-integrated military and civilian Acquisition Corps. "...For these initiatives and for many other successful battles he has fought on behalf of the AAC and the Army, I extend my heart-felt appreciation for a job well done," said Decker.

The second day of the conference began with a panel discussion on "Changing Resources and the Impact on Force XXI." Panel members included: moderator, Keith Charles, deputy assistant secretary of the Army (plans, programs and policy); BG William A. West, director of operations and support, Office of the Assistant Secretary of the Army (financial management); and BG Joseph E. Oder, director of requirements for horizontal technology integration, Office of the Deputy Chief of Staff for Operations and Plans. Each gave a brief overview of their specific programs and then addressed questions from the attendees.

Anthony J. Gamboa, deputy general counsel (acquisition), Office of the General Counsel, Office of the Secretary of the Army, explained the legislative changes in acquisition law. He gave an overview of the Federal Acquisition Streamlining Act (FASA) of 1994. According to Gamboa, the FASA '94 was based on the recommendation of the Section 800 panel which was comprised of experts from the Services, academia, and industry.

BG(P) Jan A. Van Prooyen, deputy commanding general, U.S. Army Space and Strategic Defense Command (SSDC), gave a presentation on missile defense technologies. Van Prooyen noted that modernization is a continuing process. Van Prooyen also discussed five areas of advanced technology weapons programs in support of space, which were: Light-weight Exo-Atmospheric Projectile Technology, Tactical High Energy Laser, Anti-Satellite Technology Program, Sensors Technology; and Measurement Platforms.

A question and answer session provided attendees with the opportunity to direct their questions to Mr. Decker. Topics included: downsizing; career opportunities and career development; acquisition streamlining; acquisition reform; DA, OSD and congressional oversight; modernization; technology; simulation; budget constraints; and Force XXI.

George T. Singley III, deputy assistant secretary of the Army for research and technology, spoke on Army Research Laboratory (ARL) streamlining and technology development for the 21st century. Singley noted that the laboratory system and the way the Army and the Department of Defense conducts science and technology is changing. Singley said it is more relevant, not just to the military, but to the rest of the acquisition community and to the war fighter. We are making the technology available to the acquisition community a lot sooner in a more efficient way, he added. Singley also discussed the Federated Laboratory concept, noting that it is relevant to the PEO and PM community because it will make available to them the best class laboratories in industry and academia.

LTG Otto J. Guenther, director of information systems for command, control, communications and computers (DISC4), Office of the Secretary of the Army, followed with an overview of the Army Enterprise Strategy and the DISC4 role. Guenther stressed the importance of the Enterprise Strategy in that it provides an overarching process to ensure a seamless architecture from top to bottom on the battlefield.

MG Joe R. Rigby, director, Army Digitization Office, spoke on Army Digitization Integration Processes. He said that the payoff is having the right force, at the right place, at the right time, with decisive victory.

A panel discussion followed on "Technology Integration Processes." Panel members were: moderator, LTG Guenther; MG Rigby, BG(P) Van Prooyen; BG Oder; BG Peter C. Franklin, assistant deputy for system management, OSARDA; and George T. Singley III. Topics included: horizontal technology integration projects; and joint participation in advanced warfighting experiments.

LTG Forster closed the workshop with an update on AAC career development, emphasizing the need for certification in multiple acquisition career fields, an improved central referral system for civilians, more developmental assignments, and more focused graduate programs. Forster also reviewed AAC accomplishments and encouraged the attendees to keep up their great work.

SPECIAL FORCES RESEARCH PROGRAM

Enhancing Manpower and Personnel Effectiveness in the 90's

By Dr. Judith E. Brooks

Introduction

U.S. Army Special Forces are regionally-oriented units with special purpose missions and characteristics. They are an increasingly important element of the total Army forces and are critical to the Army's ability to perform its strategic roles in national security. Special Forces growth in recent years, sustainment in an era of force reductions, and requirements for highly skilled soldiers have challenged the Special Forces manpower system.

To help meet this challenge, the U.S. Army Research Institute (ARI) and the U.S. Army John F. Kennedy Special Warfare Center and School initiated a research program to refine the assessment and selection process and to identify training requirements and needed performance enhancements. This program is resulting in improved Special Forces manpower and personnel effectiveness.

Approach

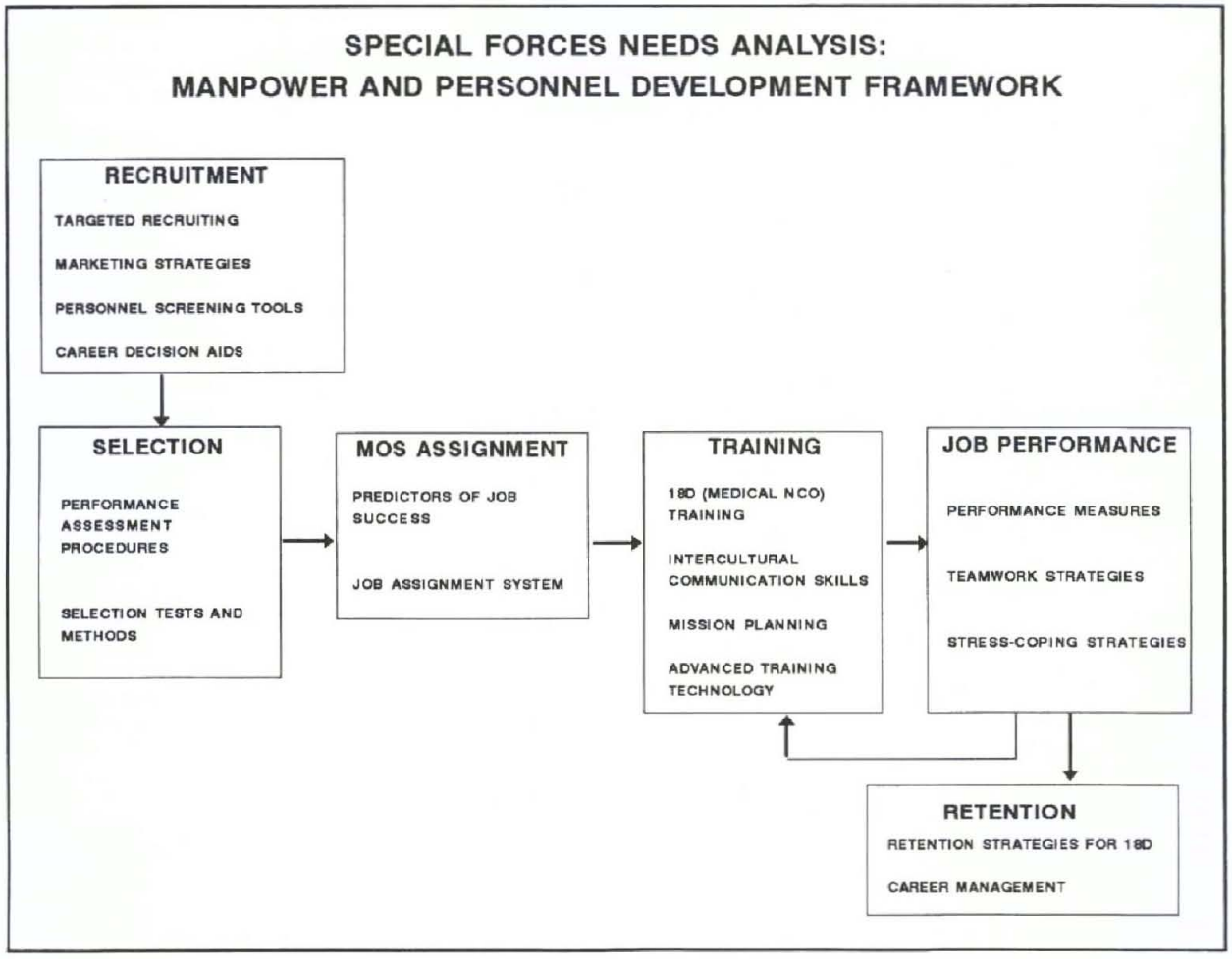
In 1990-91, ARI conducted a needs analysis to identify important manpower and personnel issues that could be addressed through research. At that time, ARI researchers were already helping the Special Warfare Center and School develop a personnel database to answer immediate questions about the characteristics and success rates of candidates attending the Special Forces Assessment and Selection Program. Analyses of this database and interviews with leaders and staff at the Special Warfare Center and School suggested how research might lead to improved personnel flow and enhanced skill levels.

The needs analysis yielded a framework for organizing areas needing enhancement. The framework reflects key elements of Special Forces manpower and personnel development: In-service recruitment of enlisted soldiers and officers, selection, assignment of enlisted soldiers to a military occupational specialty (MOS), qualification training, performance in a Special Forces job, and personnel retention. In each major area, we identified needs that could be scientifically addressed.

The analysis of recruitment, for example, suggested a need for effective recruiting strategies, personnel screening tools, career decision aids, and pool expansion strategies. Selection needs included improved performance assessment procedures and validated selection tests and methods. With respect to MOS assignment, we saw a need to develop predictors of job success and an improved job assignment system.

In the area of training, the analysis uncovered a need to examine medical sergeant (MOS 18D) training, as well as a need to improve specific skills related to intercultural communication and Special Forces mission planning. Improved performance measures, teamwork strategies, and stress-coping strategies were among the needs identified in the job performance area. Retention issues included Special Forces career management overall, and, in particular, strategies for retaining medical sergeants.

These findings, developed in the context of a systems approach for conducting research, supported the development of a long-term research program. Work continues on the personnel database which now permits researchers to track individuals all the way through qualification training. Planned expansions for the database will provide an opportunity to also record and track performance in operational settings. To further support the research program, ARI now has a Scientific Coordination Office at Fort Bragg, NC. This office will provide support



through the entire research and development life cycle, from planning and research execution, to prototype development, implementation, and evaluation.

Major Program Accomplishments

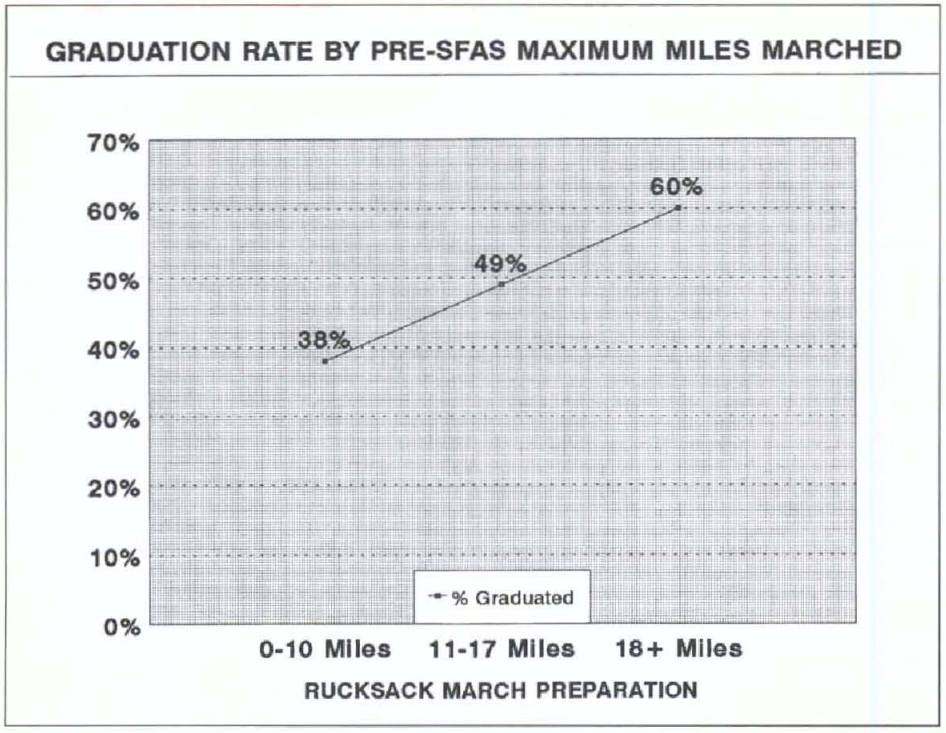
Several accomplishments to date are linked to the recruiting area. Recruiting was of major concern for Special Forces early in our program, because the reactivation of 3rd Special Forces Group (Airborne) created an immediate need for new personnel. We began with an in-depth analysis of Special Forces recruiting that stimulated two key projects.

One was to evaluate the impact of a physical training handbook on preparation for and performance in the Special Forces Assessment and Selection Program. The handbook, designed by the Special Warfare Center and School, the U.S. Army Recruiting Command, and ARI, lays out a five-week physical training regimen to help recruits prepare for this rigorous program. Candidates who received the handbook and knew their program start date at least four weeks in advance did more preparatory ruckmarch training, were less likely to fail physical fitness prerequisites, and were more likely to be selected. The results helped the candidates and recruiters highlight the importance of physical preparation.

The other project addressed the need for a career decision aid for soldiers who are considering Special Forces. Researchers identified the additional information needed for soldiers and their wives to make an informed decision, and developed a realistic job preview in booklet form. The booklet includes information about the differences between Special Forces and conventional forces, myths vs. the reality of Special Forces, assignments to Special Forces MOS and regionally-oriented groups, qualification training, missions, career progression, common family adjustment issues, and family support mechanisms. ARI is evaluating the booklet, including its impact on soldiers' commitment to and knowledge about Special Forces.

ARI conducted one other recruiting project at the request of the Office of the Deputy Chief of Staff for Personnel. This investigation focused on the reasons for low minority representation in the active duty enlisted Special Forces. Researchers identified critical stages in the qualification process and examined factors at each stage that might restrict the flow of minorities, especially blacks, into Special Forces. The results have helped focus efforts by the Special Warfare Center and School to identify and implement new strategies for increasing minority representation.

In support of the Special Forces Assessment and Selection Program, ARI conducted research to improve the assessment skills of the Special Warfare Center and School cadre who assess candidate performance. The new program alleviates the problem of normal cadre turnover by rapidly providing new cadre with the skills they need to function independently as assessors. ARI researchers and Special Warfare Center and School staff developed a program using films, workbooks, manuals, and other aids to structure assessor skill



development. The expected payoffs include more efficient use of staff time, more consistent cadre ratings, and improved selection decisions.

Other major accomplishments include three projects in the area of qualification training. One investigation focused on causes of high attrition from the Medical Sergeant's Course. Researchers identified the major attrition factors and developed recommendations to achieve an optimal attrition rate. A second project looked at the relative importance of general cognitive abilities and spatial abilities to land navigation performance. The findings supported the potential usefulness of paper and pencil spatial tests as diagnostic or screening instruments and have implications for the development of specialized land navigation training. Third, we examined mission planning skills and factors affecting the performance of teams planning in isolation at the Joint Readiness Training Center. Our analyses led to recommendations for enhancing Operational Detachment Alpha Leader Training at the Special Warfare Center and School.

Finally, the results of a recently completed Special Forces job analysis are proving useful for addressing several areas identified within the needs analysis framework. This work resulted in the development of behavior-based rating scales for Special Forces jobs, definitions of individual attributes important for successful performance, and ratings of the importance of various task categories for effective performance in the field. The information obtained through this research provides a solid basis for developing new performance measures and for identifying appropriate predictors for Special Forces job performance.

Current R&D Efforts

Building on-the-job analysis findings, ARI is laying the foundation for a comprehensive validation of new and existing predictors of Special Forces job performance. This project involves developing a roadmap of key decision points (i.e., in recruiting, selection, assignment, and training) and, at each point, gathering information about the predictor and criterion measures that are currently used or available. Through literature reviews, interviews, and expert judgments, we will be able to identify promising predictors, areas measured by several predictors or criteria (i.e., redundancies), and measurement gaps (attributes and criteria for which no measures exist). Following this, decisions will be made about the most appropriate validation strategy needed to produce an enhanced selection and job assignment system.

Also underway is an examination of peer assessment in Special Forces selection and training programs. The Special Warfare Center and School has expressed a need to maximize the information that can be obtained from peer evaluations both in the assessment and selection program and the qualification course. ARI researchers are identifying the critical dimensions peers use in evaluating performance and linking them to performance categories and individual attributes derived from the job analysis. The goals are to describe the role of peer evaluations as predictors and criteria in the assessment and training process and to recommend improved peer assessment techniques.

Looking to the Future

As needs change and new priorities come into focus, our research program must adapt accordingly. One anticipated direction for research is in the area of intercultural communication. For the types of missions that Special Forces soldiers currently perform and will likely perform in the future, intercultural communication is vital. It involves not only foreign language skills but also non-verbal communications, cultural awareness and area orientation, and interpersonal skills. ARI envisions research to support a renewed emphasis on personnel selection and training that will help ensure intercultural communication success. Also, research on recruiting is likely to be extended. A shortage of Special Forces officers suggests a potential need to address officer recruiting strategies and, perhaps, issues related to officer career paths. Moreover, as the Special Warfare Center and School implements new ways to recruit high potential minority candidates, ARI is also likely to participate in the evaluation and refinement phase of these recruiting strategies and programs.

Although current ARI research focuses on U.S. Army Special Forces, many of the findings are likely to be broadly applicable to other Army elements. As Army roles and missions continue to evolve, there will be greater opportunities to share findings and methods in ways that may enhance overall Army manpower and personnel effectiveness.

NOTE: Questions concerning this program may be directed to Dr. Brooks at DSN 667-0312, Commercial (703)617-0312 or to ARI's Scientific Coordination Office—Fort Bragg, ATTN: Dr. Michael Sanders, DSN 239-7413, Commercial (910)432-7413.

JUDITH E. BROOKS is a senior research psychologist at the U.S. Army Research Institute for the Behavioral and Social Sciences. She holds B.A. and M.A. degrees in psychology from State University of New York at Geneseo and a Ph.D. in cognitive psychology from Southern Illinois University at Carbondale.

PEACEKEEPING...

An Additional Army Mission

By Joe Sites

What's Different About Peacekeeping?

GEN George Patton once said that the mission of the soldier was not to die for his country, but to make some other soldier die for his country. More recently, Harry Summers, noted military author and commentator, said that the mission of the Army was to kill and maim people and destroy things. These similar statements of the Army mission may be indelicate, but in essence, they are true. They state what the Army was supposed to do. With the fall of the Soviet Union, this mission of killing and destruction did not disappear. Interestingly enough, at the very time that forces were and are being reduced and resources decreased, the Army has been assigned an additional and, it must be emphasized, new mission—peacekeeping. These two missions, war fighting and peacekeeping, could not be more different. The mission of killing and destruction was understood, organizations were created specifically for those purposes. The organizations equipped to deliver firepower on the enemy and personnel were trained to be "all that they could be" in delivering that firepower. Peacekeeping operations, if properly defined, end when shooting begins. Quite simply, the old and still valid Army mission to conduct war requires shooting. The new mission, peacekeeping, requires that a variety of activities be conducted without shooting.

The Need to Adapt

If the Army is to be relevant to current and expected international policy of the United States, it will participate in peacekeeping operations. For the foreseeable future, peacekeeping is not a "flash-in-the-pan." At the same time that we recognize that our Army will participate in peacekeeping operations, we must also recognize that our Army does not have peacekeeping organizations. Our troops are not trained for peacekeeping operations, and although we have equipment which can aid peacekeeping operations, there have been no general requirements stating what is needed. If there are those who doubt the need for peacekeeping organizations, special training and special equipment, they need to speak with personnel who have participated in Somalia, Northern Iraq and Macedonia. Peacekeeping is a new ball game. We wouldn't expect the Redskins to do a good job playing basketball against the Bullets. We can not expect our Army to successfully take on this new peacekeeping mission without creating new organizations and providing new and different training and equipment.

General Types of Peacekeeping

There are four general types of peacekeeping operations. They are:

- **Show the Flag.** Show the Flag operations are designed to let the world and the contestants in a trouble spot know that the United Nations and its members are interested in what is happening. Further, there is an indication that if things get worse, the U.N. may do more.
- **Observation.** Observation operations are one step up the ladder from Showing the Flag. In these operations, U.S. forces not only show the flag, they observe something. This could be movement of forces, civilians, preparations for war or any activity related to the trouble spot.
- **Delivery of Supplies.** Delivery of supplies is a variation of showing the flag with the additional purpose of trying to alleviate human suffering. Although, accepted by nonparticipants as humane, it is often difficult for one side to understand why outsiders are aiding its enemies.
- **Protection of People.** Protection of people is a tad short of war. Providing armed personnel to provide protection to voters during an election is probably the most innocuous protection of people operation. It should be remembered that whenever people need protection, there must be weapons of some sort present and when U.N. forces need to use their weapons, it is no longer a peacekeeping operation.

If the Army is to be relevant to current and expected international policy of the United States, it will participate in peacekeeping operations.

General Characteristics

One general thread that runs through the peacekeeping operations is the requirement that U.N. forces be seen. If they are to do their job, they must be recognized for what they are. The blue helmet, the letters "U.N." on helmets and equipment, and vehicles painted white are all used to insure that U.N. forces are recognized for what they are. Soldiers need camouflage, peacekeepers need plumage.

A second characteristic of peacekeeping operations is the requirement to use restraint. In war, weapons are used with reckless abandon. In peacekeeping operations, there is often the need to present a threat of weapons use, as well as a need for non-lethal weapons. Other armies, notably British and Israeli, are familiar with rubber bullets and other non-lethal weapons. The requirement for our soldiers to have these things and to know how to use them is very new.

A third thread which runs through all U.N. operations is the chain of command. In most

If there are those who doubt the need for peacekeeping organizations, special training and special equipment, they need to speak with personnel who have participated in Somalia, Northern Iraq and Macedonia.

of its conflicts, the U.S. Army has taken orders from U.S. commanders and their staffs. Participation in U.N. operations as a part of NATO can lead to an organization which has as its top layer a U.N. commander and his staff. The next layer could be a NATO commander and his staff and down at the third level could be the U.S. Army commander and his task force. In addition, if U.S. air and naval forces are part of the U.N. operation, there may be no direct link between them and the Army.

Organizational Requirements

Based on the understanding that there are a finite number of possible U.N. operations, it would be possible to design a prototype task force which could accomplish the basic requirements of showing the flag, observing, delivering supplies and protecting people. Acceptance of U.N. missions would require formation of the task force, provision of equipment and training of personnel. The task force requires sophisticated communications, observation devices, survey, psychological warfare equipment and special transportation. Some examples of equipment which would assist the execution of each type mission are readily apparent.

- **Show the Flag**
  - Semi-permanent Structures for Observation Posts
  - Flags—U.N. and National
  - Lights (Flood Lights-Spot Lights)
  - Adequate Communications
  - Rapid Means of Egress
  - Helicopter Landing Pads
  - Limited Personnel Protection
  - Non-lethal Weapons

- **Observation**
  - Electro-optical: Night Vision Devices, Stabilized Binoculars, Telescopes, Radars, TV, Filmless Cameras
  - Adequate Communications (Between Observation Posts, Patrols and Task Force CP)
  - GPS
  - Boundary Markers
  - Flares
  - Helicopters equipped with SLAR and other observation devices
  - Spotlights
  - Public Address System (with pre-translated tapes) to warn prospective crossers of border violations or other instructions

- **Delivery of Supplies**
  - Wheeled Vehicles
  - Reconnaissance Vehicles (Motorcycles) (Riot Control Wheeled Vehicles)
  - Mobile Communications Net (All-inclusive within convoys and to Home Base)
  - Light Weight Haulers
  - Fork Lifts
  - Forces to Aid Extraction of Convoys (Lethal Weapons)

- **Protection of People**
  - Riot Control Gear
  - Non-lethal and Lethal Weapons

Where Do We go From Here?

The Army Materiel Command Field Assistance in Science and Technology Activity has contributed to the peacekeeping operations in Somalia, Northern Iraq, and Macedonia. Special observation equipment has been provided, but invariably, there are requirements for training and maintenance. USAREUR, with all the distractions of draw-down, has responded to the requirement to provide forces in Macedonia, but for a smooth-running operation in future U.N. operations a great deal more needs to be done. It is a simple fact that the U.S. Army must be prepared to participate in peacekeeping operations. We have the organizational skills to produce world-class peacekeeping organizations. We have the soldiers who are capable of operating the most sophisticated equipment in the world. We have produced the best military equipment in the world and we can acquire the best peacekeeping equipment in the world. We just need to bring it together.

JOE SITES is vice president, director of Defense Systems at Baum Romstedt Technology Research, Inc., Vienna, VA, and a 1951 West Point graduate. During his 30 years of active duty, he served in both the Korean and Vietnam conflicts. He also served nine years in Europe including assignment as a student at the Italian War College and as an operations officer on a NATO staff at Verona.

DIGITIZING THE BATTLEFIELD

By David A. Davison
and Steve Taulbee

As Army strategists and technologists peer over the rim of the 21st century, they can see opportunities for technological advancement that will change the way war is waged.

An explosion in the information sciences is now taking place. The speed and ease in which information can be gathered and distributed is constantly increasing. These developments have poised information technology as a paramount weapon to be employed—and reckoned with—on the future battlefield. Success there will depend on the Army's ability to apply current and emerging information technologies to "digitize the battlefield" and provide commanders with complete, accurate and detailed information about battlefield events as they happen.

Operations Just Cause and Desert Storm provided a glimpse of the future battlefield. America's military was able to successfully conduct swift, simultaneous and synchronized attacks on numerous objectives at night, using forces stationed in various locations. This application of modern technologies, organization and doctrine achieved decisive results which were not possible a few years ago.

However, research never stops and the technology and tactics that won in Panama and Southwest Asia will not win the battles of the 21st century.

GEN Gordon R. Sullivan, Army chief of staff, has made winning the information battle the first objective of the Army's modernization strategy for Force XXI. The foundation for winning the information battle is successfully applying information technology throughout the battlespace or "digitizing the battlefield."

Closing the Opportunity Gap

The Army Research Laboratory (ARL) is focusing the Army's technology base research programs to meet GEN Sullivan's mandate to digitize the battlefield and close the "opportunity gap" that has opened between commercial and military information systems.

Today's command and control process is manpower intensive and the state of the battlefield is defined for the commander with information that is minutes, sometimes hours, old.

As the Army begins to digitize the battlefield, part of the work load will be picked up by computers and the commander will have access to current information on the state of the battlefield. Enhanced situational awareness will keep the commander informed at all times of the location of friendly and enemy forces greatly reducing the chance of friendly fire incidents.

On the future digitized battlefield, computers will carry most of the routine load of the commander at all levels of command. Not only will the commander have access to near-perfect information on the battlefield, he will have a wargaming capability that, like a chess program, will enable him to game, in real time, multiple courses of action to help him select the best one.

New information technologies already developed for the commercial marketplace have great potential for use in digitizing the battlefield if they can be adapted to the battlefield's hostile environment. Some, such as hand-held computers, cellular telephones, direct-broadcast television and wireless computing, are already here. Others are on the way, such as personal communications systems that will use cellular technology to transfer and display voice and graphics. New generations of devices emerge every few years priced for the mass market.

ARL is focusing its tech base to maximize the opportunity to adapt and integrate this rapidly developing commercial information technology into Army systems.

Organizing for the Future

ARL's task is to supply the scientific support to the Army as it strives to close the technological opportunity gap. To accomplish this, ARL is developing a "federated laboratory," which will bring together physical scientists and engineers from ARL, university and industry laboratories, as well as military scientists who develop doctrine. (See the November-December 1994 issue of *Army RD&A Bulletin.*) The federated laboratory will provide the technology for the Army to close the opportunity gap permanently, while ensuring that future technology and doctrine are developed in tandem. This relationship will make efficient use of the strengths of both government and private sector resources.

Where there is little external expertise, or market, for the technologies, ARL will continue strong in-house research and development to meet Army-unique requirements. Where the centers of expertise are definitely outside the government and the potential of the technologies has a much broader application, ARL will forge direct associations with industry and university laboratories with recognized competencies in specific technology areas.

The result is that ARL will draw upon the best of the public and private sectors to produce the research and technology needed for present and future Army information warfare systems.

In addition, a close working relationship will be formed with the research, development and engineering centers (RDECs). This framework will enable the Army Materiel Command to identify the best emerging information technologies for accelerated development and acquisition by the Army.

Strong Interaction with TRADOC

ARL will also have a strong interaction with the Training and Doctrine Command (TRADOC). As the "architect of the future," TRADOC must understand the impact of the emerging technologies on future operational concepts. At the same time, TRADOC must ensure that evolving operational concepts for the digitized battlefield are

supported by ARL's research program.

The foundation for this partnership is "Futures Concepting," a new TRADOC-ARL initiative designed to bring physical and military scientists together to simultaneously develop future technology and doctrine. The intent of Futures Concepting is to develop future technology and doctrine in tandem thereby eliminating any gap. In this way, when a technology is ready for battlefield application, so is the doctrine.

Information Technologies

The road that will take the Army to the future digitized battlefield has many obstacles. Advanced information technology in the commercial world was developed to operate in relatively benign conditions. The hostile environment of the battlefield is much different.

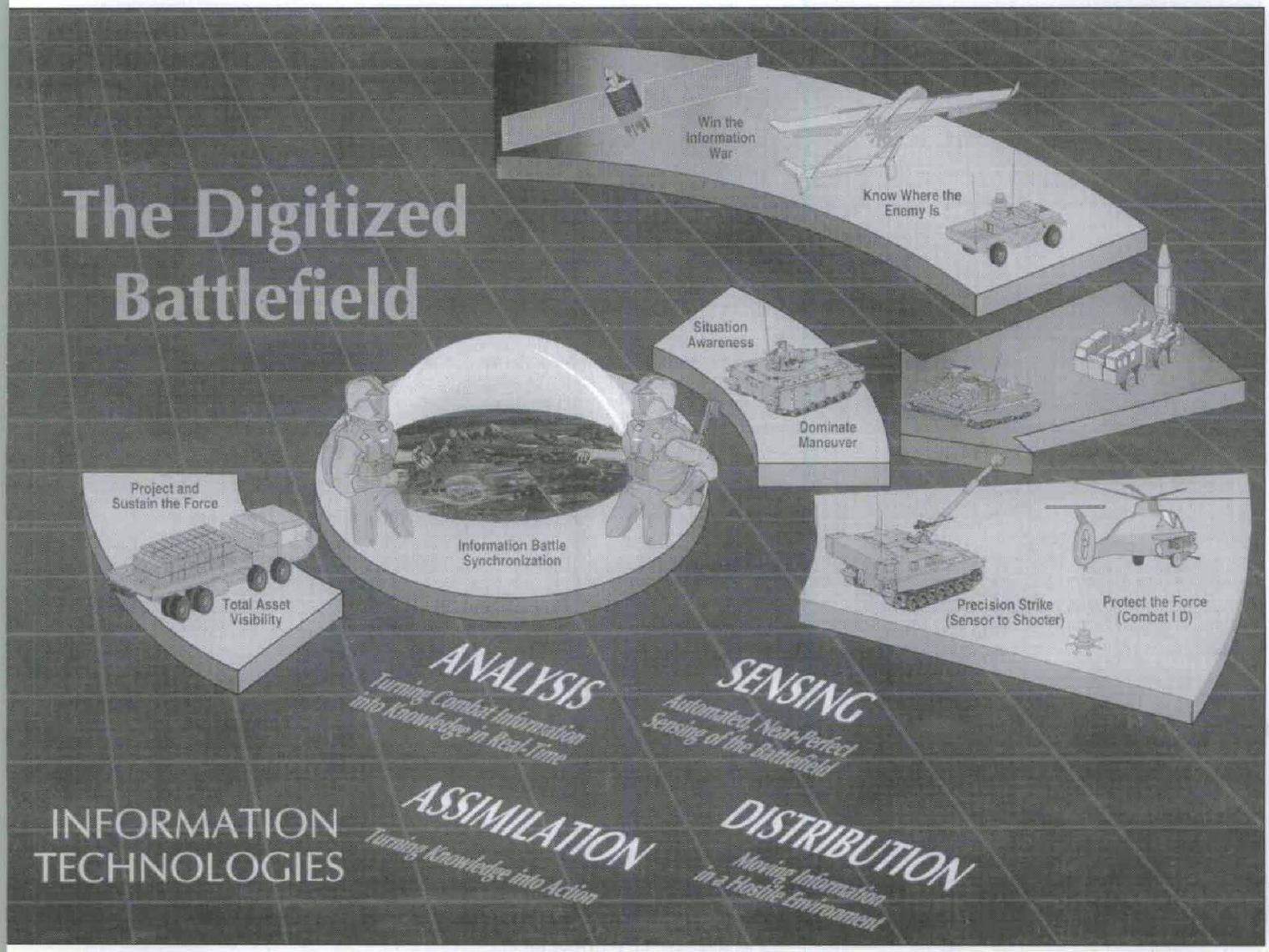
Combat information must be gathered by automated sensors providing near-perfect sensing of the battlefield. That information must be moved instantaneously through and around a hostile battlefield environment, where the enemy is trying to jam or corrupt the information as it is distributed to multiple mobile nodes, which are themselves vulnerable to destruction. This wealth of information must then be turned into useful knowledge and presented in a format that can be easily and quickly understood by commanders and their troops. The emerging challenge is this: Can the Army provide a small, affordable, deployable system for on-the-move collaborative planning and situational awareness that requires little infrastructure, is based on commercial technology, and is compatible with systems currently in the Army inventory, but capable of eventually moving beyond those systems?

ARL has identified four broad areas of technical endeavor in which the Army must excel to fully exploit the information technology explosion and close the technological opportunities gap. A brief discussion of each of these areas follows.

Sensing

Sensing technologies must provide the commander with automated, near-perfect information about the battlefield, including target data, friendly and enemy locations, terrain features, and time-dependent data such as vehicle movements and weather conditions. The primary challenge is to autonomously extract combat information from raw sensor data and package it for transmission over tactical networks. This will be accomplished by integrating new sensors, signal and data processors, and communications hardware in a low-cost, low-power, miniaturized package. The extraction of combat information also requires accurate knowledge and predictions of how the battlefield environment affects sensing.

Sensing is the first step in battlefield digitization, and it is critical to harness the technology needed to automatically develop accurate information about what is taking place and then transmit it in real time to command and control elements. Areas of research



The combat information processor is a task-specific multiprocessor testbed, developed at ARI, that is designed to explore hardware and software architectures for the collection, storage, process and display of combat information in real time.

include automatic target recognition, atmospheric profiling, multisensor fusion, neural networks, learning theory, complexity theory, integrated sensor/processor/communications architectures, target environment and background modeling.

Distribution

Distribution technologies must be identified to enable the Army to distribute the right information to the right place at the right time, through a hostile battlefield environment. Information that must be distributed across the battlefield includes images from sensors, graphical representations of battle plans, status and location of friendly and enemy forces, and weather and environmental information. As analysis and assimilation research efforts create the capability to condense and present this wealth of information in a usable format to the commander, users will identify the need for additional information. To meet this need, ARL will tap into the wellspring of technology being generated at university and industrial telecommunication research centers. ARL will focus its research efforts in the following areas to build, in collaboration with industry and academe, the technical foundation to support seamless battlefield communications: information abstraction, automated distribution, adaptive networks, multi-access network schemes, tactical protocols, wireless broadband integrated services digital network.

Analysis

Technologies are required to process, in real time, the vast quantity of information received from multiple sensors and other sources and to provide the commander accurate, timely knowledge of the fast-paced, widely dispersed operations of the future battlefield. The challenge to ARL is to provide the technical foundation in knowledge representation schemes, reasoning paradigms, and processing architectures to support real-time, knowledge-based operations. Battlefield information that is complex, "noisy," and often uncertain (in part because of deception) must be presented in a form that gives the commander timely and accurate situational awareness in a distributed, dynamic environment. Success in this effort will require intensive research in the following areas: terrain, environmental reasoning, tactical event detection and synchronization, automated querying over heterogeneous databases, battlefield weather intelligence, scalable architecture applications and advanced human computer interfaces.

Assimilation

Having received a wealth of "first-hand knowledge" of the battlefield events almost instantaneously after they occur, the commander or soldier must be able to make sense of this information so that a tactical decision can be readily, but not hastily, made. Turning knowledge into action will be, in the information-intensive environment of a digitized battlefield, a stressful task that could exceed the cognitive and sensory limits of the soldier. ARL has the challenge of measuring the ability of the soldier to assimilate information in a stressful environment and defining concepts and technologies to efficiently present and transfer battlefield knowledge to the warfighter. The following are the primary research areas which ARL will concentrate its resources to achieve the capability for turning knowledge into action: three-dimensional auditory and visual displays, high-definition, color, flat-panel displays, large-screen displays for command and control, human performance in information-rich environments and soldier performance in intelligence and electronic warfare operations.

Summary

The dawn of the information age promises to revolutionize warfare. The Army can close the gap that has grown between military and commercial technology by exploiting the explosion in information technologies. The Army Research Laboratory, by drawing upon the varied and best resources of the Army, private industry and academe and by partnering technology and doctrine development, will be well equipped to help the Army define and equip Force XXI to fight and win in the information age.

DAVID A. DAVISON is a public affairs specialist with the Army Research Laboratory. He holds a B.S. degree from Youngstown State University and has done graduate work at the University of South Carolina.

STEVE TAULBEE is an engineer with the Army Research Laboratory where, as the laboratory's technical program development coordinator, he has compiled a variety of technical publications and managed an active exhibits program. He holds bachelor's degrees in engineering and science from Penn State University.

From The AAC Career Manager...

MAJ Bridges Joins Acquisition Career Management Office

We are pleased to announce the arrival of MAJ Jon Bridges to the Army Acquisition Career Management Office. He will serve as the executive officer to the deputy director, acquisition career management, as well as the Army Acquisition Corps Management Information System (AACMIS) project officer. MAJ Bridges came to us from the Program Executive Office, Standard Army Management Information Systems (STAMIS), where he served in the Personnel Electronic Record Management System Product Management Office and the STAMIS Tactical Computer Project Office. He holds a B.S. in business administration from Murray State University, a master's degree in management information systems from Auburn University, and is a graduate of the Materiel Acquisition Management and System Automation Courses.

Army Acquisition Corps Scholastic Achievement Award

Congratulations to LTC Brad R. Naegle for his selection to receive the Army Acquisition Corps (AAC) Scholastic Achievement Award in Systems Acquisition Management at the Naval Postgraduate School. LTC Naegle's academic achievements exemplify his dedication to excellence and the AAC. LTC Naegle is currently assigned to the Program Executive Office—Tactical Wheeled Vehicles.

Colonel Promotion Selectees

Congratulations to the following Army Acquisition Corps (AAC) officers selected for promotion to colonel by the FY 94 Colonel Army Competitive Promotion Selection Board. Overall selection rate for the Army was 50.3 percent. Overall selection rate for the AAC was 56 percent.

NAME	FA	BRANCH
ANDERSON, LARRY D.	51	OD
ANSLEY, STEPHEN P.	51	OD
BERRY, CORLIS S. III	51	OD
BURKE, DONALD S.	51	AV
CANNATA, GREGORY A.	97	OD
CARR, HERBERT M.	51	AD
CERUTTI, EDWARD A.	51	FA
COMO, JOHN A.	51	AD
DAVENPORT, BRIAN W.	97	QM
DEETER, LOUIS P.	51	OD
DEKANTER, SCIPIO JR.	51	SC
DOBECK, KENNETH R.	51	EN
DODD, MARY C.	53	AG
DRESEN, THOMAS E.	51	OD
EHLY, WILLIAM E.	51	OD
FLAVIN, MARK J.	97	QM
HAMILTON, PHILIP E.	51	IN
HORTON, WALTER S.	51	AR
JEONG, JOHN C.	97	QM
JESKA, ROBERT S.	97	AD
KEE, STEPHEN G.	51	AV
KEEBLER, HENRY C.	51	OD
KERSH, TODD B.	53	FA
LANCE, DARELL G.	51	AV
LANGBEIN, GEORGE L.	53	SC
MCARTHUR, WILLIAM S.	51	AV
MCMILLEN, LEROY B.	97	AV
PLANCHAK, JOSEPH E.	51	AV
RAIFORD, ROBERT C.	51	SC
ROMANCIK, DAVID J.	97	AD
RUSSELL, MARK W.	51	AV
SAVAGE, RICHARD T.	51	AV
SORENSON, JEFFREY A.	51	MI
TETER, WILLIAM A.	53	IN
TONER, SHEILA C.	97	QM
TRIPLETT, CHARLES L.	53	IN
URIAS, JOHN M.	51	AD
VIGEN, EDWARD M.	53	MI
VOSS, JAMES S.	51	IN
WALSH, JOHN C.	97	IN
WOLFE, JACK L.	51	OD
YOUNG, JAMES E.	51	AV

PERSCOM Notes. . .

Career Field Certification

Career field certification is still a requirement. Every acquisition officer must be certified in at least one career field and meet the certification requirements of *each* position to which he or she is assigned. By going to one FA, we hope to allow more officers to become certified in multiple career fields. **Officers must still meet all the educational, training and experience criteria** for career field certification.

MAMB Does Slating For PMs and Commands

Starting with the FY96 PM and Acquisition Command Board, the Military Acquisition Management Branch (MAMB) will do the slating of the officers selected for PM, which is subsequently reviewed by the deputy chief of staff for personnel and approved by the director, acquisition career management/army acquisition executive. In the past, the PM selection board would not only select the officers, but slate them as well. This was the only board that both selected and slated officers. MAMB/PERSCOM has always done the slating for the Acquisition commands, and this year will slate the program managers also. This brings the Acquisition Corps slating into line with the other branches of the Army—all command slating is done at PERSCOM.

DAU Courses Vs. the MAM Course

This is to clear up the confusion about the Fundamentals of Systems Acquisition Management Course (ACQ 101), Intermediate Systems Acquisition Course (ACQ 201) and the Materiel Acquisition Management Course (MAM). The MAM Course is the equivalent of ACQ 101 and ACQ 201. This means if you have completed the MAM course you do not need to attend either of the ACQ courses. The MAM Course is eight weeks in length and is taught at Fort Lee (Army Logistics Management College (ALMC)). To sign up for this course you need to contact your assignment officer. If you plan to take the course TDY and return, approval in writing must be submitted by your command to your assignment officer. ACQ 101, a two-week course, and ACQ 201, a one-month course, are both Defense Acquisition University Courses. These courses are taught at various U.S. military installations, such as ALMC; Fort Belvoir, VA; Redstone Arsenal, AL; Wright Patterson Air Force Base, OH; and Fort Monmouth, NJ. Instructions on how to sign up for these courses can be found on page 16 of the *AAC Playbook*. Either the MAM course or ACQ 101 and ACQ 201 satisfy the prerequisites for attending the Advance PM (PMT 302) course at the Defense Systems Management College.

CAREER DEVELOPMENT UPDATE

AAC Playbook

In January, the MAMB mailed out the *AAC Playbook*, which is a compilation of newsnotes and information papers. The *Playbook* was sent to every officer in the AAC. We have gotten many comments, both good and bad, on the *Playbook*, and we welcome your comments on making it a better product. We hope to put out an updated *Playbook* every year. The need to put an insert in the *Playbook* shows just how fast things in the AAC change. With the exception of time-sensitive information, MAMB will continue to use *Army RDA* as the primary vehicle to get information out to the field. If it is not delivered to your home address, it is time for you to update the address PERSCOM has on file.

Information Number

The MAMB has an information telephone number to handle routine questions such as promotion data or list release dates. We ask officers to use this automated number to get information. The number is commercial (703) 325-3411, or DSN 221-3411.

On the Horizon

"Deep Battle" MAPL

Based on the FY 96 Military Acquisition Position List (MAPL) outbrief to LTG William H. Forster, director, Army Acquisition Corps (AAC) and MG(P) Ronald V. Hite, deputy for systems management, Office of the Assistant Secretary of the Army (RDA) earlier this year, several actions have been initiated to address the future direction or "Deep Battle" MAPL in order to better posture the ability of the AAC to successfully support Force XXI. A summary of the actions follow:

• **MAPL Long-Range Plan:** To date, the management of the Army's military acquisition positions has been focused on the near term execution of each year's MAPL with major commands (MACOMs) generally retaining a "status quo" baseline with little changes from the original/FY92 MAPL. This will no longer be the case. Beginning this fall, both the FY97 MAPL and PERSCOM Accessions Boards will be based on an AAC long-range plan which will be directly tied to the Program Objective Memorandum (POM), and provide specific direction to "shape" the AAC toward Force XXI. This process has already begun with the recoding of numerous positions within the PEOs/PMs. Forster's message to all PEOs (171010 February 1995) provided the following specific guidance ... "I would expect a minimum of one FA 53 position in every project management office whose programs include either C3I and/or embedded software requirements. In addition, I would also like to see an increase in the number of FA97 positions in those programs past Milestone II."

• **AAC Force XXI Training:** In addition to DOD software courses being developed by the Defense Systems Management College, the AAC Proponency Office has the lead to develop a plan to support AAC-specific training requirements for Force XXI (i.e., information technology, digitization of the battlefield). This plan will address military, civilian and reserve members and include a means to export the training to the PEO/MACOMs in the near term.

• **Advanced Civil Schooling (ACS)/Training With Industry (TWI):** In order to address the need for an increased number of technical degrees to meet Force XXI requirements, a review of the funding, throughput and sources of advanced degrees is in process. As a start, every position on the FY96 MAPL now has an associated advanced degree area of concentration which forms the initial requirements baseline for both the ACS and TWI programs. Based on guidance from the director of acquisition career management during the FY 96 MAPL outbrief, future ACS and TWI programs will focus heavily on technical and/or systems engineering type degrees with the Naval Post Graduate School as *the* offerer (except for specific requirements such as the simulation program at the University of Central Florida). In the TWI arena, the focus has already shifted from what was a one-time FA97 production-oriented program to now include several software and information technology organizations such as Carnegie Mellon. Questions on the above subjects or any other AAC proponency subjects should be directed to the appropriate ASA (RDA) FA proponency offices listed below.

FA 51 (LTC Mark W. Jones): JONESM@BELVOIR-AIM1.ARMY.MIL
FA 53 (LTC Earl Rasmussen): RASMUSSE@BELVOIR-AIM1.ARMY.MIL
FA 97 (MAJ Vicki Diego-Allard): DIEGOALV@BELVOIR-AIM1. ARMY.MIL

From the Proponent FA 53. . .

Force XXI, digitization, horizontal technology, simulation, virtual reality, and distributed networks are terms that are spoken more and more often. These concepts are playing a key role in shaping the future of our force structure and how we do business. The movement to an information-dependent environment is a necessity to ensure our ability to quickly deploy and mass decisive forces when required in our current and foreseeable, fiscally-constrained reality. How does one grasp and deal with such a rapidly changing scenario? How does one prepare to move into the 21st century? Where do we go from here? The answer must include exploiting the talents available in a functional area (FA) 53 officer. In the next two issues of *Army RDA*, the Army Acquisition Corps (AAC) Proponency Division will present a two-part series about FA 53 (automation) officers, what they are, and what they can contribute. The Army currently has more than 2,000 officers who are designated with FA 53. These Army automators are broken into three basic categories: AAC—391; Single Track—79; and Dual Track—1556.

Reserve Officer Opportunities in R&D

The following U.S. Army Reserve (USAR) officer positions are available in the Office of the Assistant Secretary of the Army (Research, Development and Acquisition) (OASARDA). All vacancies are restricted to USAR individual mobilization augmentees (IMA) or those Reserve officers desiring to enter the IMA program.

POSITION	AUTH GRADE	AUTH POS. CODE	DUTY SECTION
STAFF OFFICER	06	51A00	DIR OF ADVANCED CONCEPTS SPACE
STAFF OFFICER	06	97A00	DIR, CONTRACTING
STAFF OFFICER	06	97A00	DIR, CONTRACTING
STAFF OFFICER	05	51AOO	DIR, RESOURCES
STAFF OFFICER	05	97A00	DIR, ACQUISITION & IND BASE POLICY
ASST DIR (LOG)	06	51A00	DIR, AVIATION AND IEW SYSTEMS
STAFF OFFICER	05	15D51	DIR, CLOSE COMBAT
STAFF OFFICER	05	13A51	DIR, CLOSE COMBAT
STAFF OFFICER	05	35G51	DIR, AVIATION AND IEW SYSTEMS
STAFF OFFICER	05	18A00	DIR, SPECIAL PROGRAMS

For additional information, contact the IMA Management Division, U.S. Army Reserve Personnel Center, at DSN: 892-2327, commercial (314) 538-2752, or toll free, 1-800-245-8466. In addition, specific OASARDA agency information can be obtained from SFC Seard at DSN 225-6496 or commercial (703) 695-6496.

CAREER DEVELOPMENT UPDATE

Mentor Workshop Conducted

A training session/workshop was conducted March 7-9, 1995 in San Antonio, TX, for mentors of Department of Defense Scholarship Program graduates. These mentors are charged with administering the initial career development phase and internship for the program's graduates.

Hosted by Dr. Bennie H. Pinckley, deputy director for acquisition career management, the meeting was attended by six of the nine mentors involved in the program. The attendees included the following four of five new mentors: Pat Kofalt, chief, logistics management, Office of the PM, SOLDIER; Dave Lacy, chief, Seeker Division, Office of the PM, National Missile Defense; John Shannon, project manager, Aviation Life Support Equipment; and Mike Viggato, program analyst, Office of the Program Executive Officer (PEO), Armored Systems Modernization. One new mentor, John Green, deputy PM, SMOKE, was unable to attend. The newly appointed mentors were ably introduced to the program by two of the four previously existing mentors: Linda Gentle, chief, program management, Office of the PM, Multiple Launch Rocket System; and Marlene Seaton, program analyst, Office of the PM, Instrumentation, Targets and Threat Simulators.

Other workshop participants included Dr. John Daly from the University of Texas—who presented a one-day training session—and Dr. Jerry Davis, also from the University of Texas, who is developing a mentor training course for the Army which will be announced in the near future. Also in attendance were Dale Fradley, chief of program management, Army Acquisition Executive Support Agency; and Jim Welsh, from the Acquisition, Education and Training Division, Office, Deputy Director, Acquisition Career Management. Both individuals are responsible for implemention of Dr. Pinckley's Mentor/Intern Program.

BOOKS

Activity Based Management For Service Industries, Government Entities And Nonprofit Organizations

By James A. Brimson and John Antos

Reviewed by MAJ Taylor Chasteen of the Production Base Modernization Activity at Picatinny Arsenal, NJ.

Here is a timely book that capitalizes on the present craze associated with activity based management (ABM). The current right sizing of the Department of Defense is focusing everyone's attention on increasing the value the taxpayer gets for his Defense dollar. Activity based management has come into vogue as one tool to accomplish this task. The book gives the reader a thorough description of what ABM is and how it works. Besides writing a very readable book, the authors have included several "real world" examples in the appendix and a glossary for the uninitiated in the language of ABM.

The authors have done a good job of covering the subject along with including "news you can use." Among the more interesting ABM tools covered in the book are the following: a methodology to identify activities, resources and cost objects; data collection techniques and creating activity maps. The "news" that the book expounds includes the robust utility of ABM that breaks down into: identification of non-value added activities, cost driver analysis, benchmarking, product costing, activity budgeting and many more. The reader develops the feeling that the only thing standing between his organization and becoming "world class" is the use of ABM.

Although the book has a broad scope and is packed with information, this is not a do-it-yourself cookbook. Rather, the book is a primer. It piques the reader's curiosity and implicitly poses enough questions to fill another volume. For instance, how does management decide if ABM is right for their organization? What are the critical success factors for implementing ABM? What are the lessons learned from failed ABM attempts? Should the organization hire consultants to implement or train resident experts? How much will implementation cost? The authors make a good case for why an organization should implement ABM. However, perhaps by design, the book does not address many critical issues managers must consider before investing in ABM.

In conclusion, although a welcome addition to the activity based canon, the book has its shortcomings. First, the book does not focus as much on government entities and nonprofits as the title would suggest. The narrative information is essentially generic. The authors argue convincingly, however, that the information is applicable in whole or in part in government settings because "the building blocks of all organizations are activities and processes." Second, the purpose of the appendix is not clear and the individual examples seem truncated. There are, however, several examples of ABM being used in government settings to include Defense environments. On the whole, Brimson and Antos have provided a good springboard into the world of activity based management.

ACTIVE DUTY ADDRESS CHANGES

A reminder to active duty officers in functional areas 51, 52, 53, and 97: Since *Army RD&A* uses your address as listed in your Officer Record Brief (ORB), it is important that you keep your ORB updated. A number of requests for change of address have been mailed directly to us, but the editorial office does *not* have the ability to make those changes. If you have moved or changed your address recently, please change your ORB so *Army RD&A* can reach you at the proper address in a timely manner.

A Competitive 8(A) Program Success Story

The following was a "good news" experience for the Albuquerque District, U.S. Army Corps of Engineers. It concerns a construction project to construct a dormitory at Holloman Air Force Base in southern New Mexico.

Section 8(a) of the Small Business Act (15 U.S.C. 637(a)) established a program that authorizes the Small Business Administration (SBA) to enter into all types of contracts with other agencies and let subcontracts for performing those contracts to small and disadvantaged business (SDB) firms eligible for program participation. Contracts may be offered to the SBA for performance by eligible 8(a) firms on either a sole source or competitive basis.

As required by Federal Acquisition Regulation 19.805, acquisitions offered to the SBA under the 8(a) program for construction, which are expected to exceed $3 million, shall be awarded on the basis of competition.

More than five years had passed since the Albuquerque District had tried a competitive 8(a) solicitation. This method was being strongly requested by the New Mexico 8(a) Association (an organization of 8(a) contractors in New Mexico) and the SBA. Additionally, if successful, this method would significantly help us meet our 8(a), SDB, and small business goals. Therefore, we decided at the end of FY 94 to identify a project for this program.

In order to increase the probability of numerous and acceptable bids, we decided not to limit our 8(a) bidding population to just the Albuquerque region. We also added the El Paso and Lubbock areas for potential sources.

A market survey of 16 potential 8(a) contractors was conducted to determine if they would bid on the dormitory project at Holloman as 8(a) competitive. Seven responded that they would bid while several others stated they were interested . The decision was made Aug. 30, 1994 to offer this project to the Small Business Administration as an 8(a) competitive solicitation.

The decision was not made by consensus. Several individuals argued that bids would be high and, therefore, we would have wasted the customer's (U.S. Air Force) and our time and money. Our previous experience with this method five years earlier was a disaster and this was reiterated more than a few times. However, it was also pointed out that we had worked with many responsible, highly capable, very price-competitive 8(a) firms in the past five years and there was a high probability of receiving acceptable bids. After all sides were heard, our district engineer decided to go competitive 8(a) with this project.

The project was issued Oct. 28, 1994, with bid opening held Dec. 9, 1994. Five bids were received, ranging from $3,509,472.00 to $3,939,240.00. The government estimate was $3,725,439.00. Three of the bids were below the government estimate.

By going competitive 8(a) with this project, the Albuquerque District: received very competitive prices below the government estimate; will award to a low bidder who is a proven good performer; makes an award which significantly contributes to the district meeting its 8(a), SDB, and small business goals; and awards the project to a contractor within the state where the work is being performed.

There is always risk in every method of solicitation. However, there is added risk in trying a new, relatively unproven method. In this case, we did our homework, discussed the options, the unknowns, and the risks and made a courageous leadership decision. It was the right decision.

Innovation in government is essential, just as it is in private industry. The risks associated with trying new ideas must be taken in order for us to succeed as individuals and as organizations. Certainly, not all risks will result in success stories, but those that are calculated and informed move us in a healthy and progressive direction.

The turtle only makes progress when he sticks his neck out. By sticking our necks out on this project we were able to make this a success story.

The preceding article was written James D. Van Nest, chief, Contracting Division, Albuquerque District, U.S. Army Corps of Engineers. He is a certified professional contracts manager and has a B.A. degree in business administration from the University of Washington.

Cooperative R&D Agreement Fosters High Energy Battery Development

The Army Research Laboratory's Electronics and Power Sources Directorate and MATSI Inc., of Atlanta, GA, have established a cooperative research and development agreement (CRDA) to design, build and evaluate ultra-high energy, single-use, zinc-air batteries for portable electronic devices.

Development of this dual-use technology will extend the operating time of all power-intensive portable communication electronics equipment. Operating time at high power levels is the major factor currently limiting performance in this type of equipment.

The goal in establishing this CRDA is to support military needs and objectives while fostering development of these ultra-high energy batteries. Substantial commercial potential for these batteries exists in areas such as laptop computers and cellular telephones.

Science and Engineering Apprenticeship Program Proves Valuable

The Institute for Advanced Technology (IAT) recently completed its third year of participation in the Department of Defense (DOD) Science and Engineering Apprenticeship Program for high school students. The apprenticeship program provides local high school graduates with hands-on experience in a stimulating research environment. The long term goal is to encourage them to pursue careers in the science and engineering disciplines, particularly in areas related to the needs of the DOD. Participants are selected on the basis of their academic record, scholastic aptitude test results, applications, and references from their teachers. Students are paid a basic rate over the summer and work directly with a scientist or engineer mentor on an individual or team project.

Two students participated in the program with IAT during the past summer. Nathan Atkinson is a 1994 graduate of Georgetown High School, Austin, TX. He enjoys mathematics and working with computers, and plans to pursue a degree in electrical engineering at Texas A&M University. T.J. Dawkins is a 1994 graduate of Leander High School, Austin, TX. T.J. is interested in environmental engineering and plans to pursue a civil engineering degree at Texas A&M University.

For his research project, Nathan worked directly with Dr. Tom Kiehne, IAT assistant director for hypervelocity physics, and Dr. Stephan Bless, technical director for impact physics. His project was titled "A Close Encounter with Penetration Mechanics." The study dealt with novel ideas for warheads designed to penetrate tank armor at high velocity. Thus, Nathan was asked to quickly climb the learning curve in this discipline so that he could analyze and compute trends based upon existing data. By his own admission, he learned a great deal in a short time. Nathan came away from the research experience with a deep appreciation for the physical considerations involved in warhead designs.

T.J. worked directly with Pat Sullivan, IAT assistant director for electrodynamics, and Dr. Chadee Persad, technical director for materials science, on a project entitled "Bonding of Yttrium Barium Copper Oxide for Use as a Resistive Layer on Conductive Rails in Electromagnetic Railguns." His research addressed the potential of conductive ceramic as a resistive layer with a specific task centered on analyzing bonding techniques.

The apprenticeship program has proven a valuable vehicle for introducing motivated high school students to the realm of scientific and engineering research. At the end of the apprenticeship, the students made formal presentations and prepared a technical report which summarized their project results. Most participants go on to prestigious universities in pursuit of science and engineering degrees and several have either returned in subsequent summers, or stayed on part time to continue their research.

The Institute for Advanced Technology is an Army University Research Center dedicated to support the U.S. Army with scientific and engineering research essential to the national security of the United States. As an autonomous laboratory research center of the University of Texas at Austin, IAT's specific tasks are to conduct basic and applied research in electrodynamics and hypervelocity physics; conduct independent and objective technical assessments, testing and analysis of critical technology issues; and plan, develop, and present technical education programs for Army officers and civilians in electrodynamics, hypervelocity physics, and related critical technologies. Dr. Jerry Davis, assistant director for education, IAT, oversees the apprenticeship program.

The preceding article was written by LTC James C. Pollard, U.S. Army, retired, who is the education coordinator for the Institute for Advanced Technology.

The Power of Prototype

The force of an anti-tank mine exploding under the front tire of a 5-ton truck has almost always meant certain death to the driver and passenger. The human body can withstand about 15G (15 times the force of gravity) without sustaining injury. The force of a mine explosion is nearly 100G.

The Tank-automotive and Armaments Command, Warren, MI, was recently tasked with finding a way to reduce the lethality of such an explosion and providing additional ballistic protection to the crew on board. Since the 5-ton truck is probably the most widely used vehicle for military and humanitarian ground transportation worldwide, their task was extremely important to thousands of TACOM soldiers. Their first step was to reduce the G-force by designing a special seat with shock absorbing capabilities and additional strength.

Engineers at TACOM faxed a conceptual hand-drawn sketch to Rock Island Arsenal and expressed the urgency of their request. Arsenal engineers immediately started computer aided design (CAD) drawings and developed a technical data package within two days.

Working with TACOM engineers, the arsenal's Prototype Process Planning Action Team defined the parameters of the design and released the package for the initial production of two seats. The design called for nine individual aluminum components which formed a welded seat. Shop orders were written and the plan was set into motion.

The components were sheared to near-net configuration and all sides were machined. Prototype machinists, process planners, engineers and welders worked together to tack together the puzzle that would become a seat. When all the pieces fit together properly, the seats were welded together.

All welds were X-rayed and dye penetrant inspected by arsenal quality assurance personnel.

The finished seats were air shipped to the customer just six days after receipt of the conceptual sketch.

One of the seats underwent testing on a specially designed shock absorbing system which subjected it to the impact of an anti-tank mine exploding under the front tire of a 5-ton truck. A "crash test dummy" measured the impact that explosion would have on a human body. The results showed the prototype seat had reduced the G-force to approximately 30G. In an actual explosion, the driver of the vehicle would probably have sustained serious injury but would have survived.

An entire lethality reducing kit has been designed to add armor to the under carriage, doors, windows, top and to add applique armor for the seat itself. The arsenal's prototype team is producing most of the kit.

Production of these prototype seats could be considered a remarkable accomplishment by any manufacturing facility. But with the installation's state-of-the-art machining capabilities, new surface treatment and plating facility, new forging capabilities and one of the Army's premier foundries, the arsenal has shown that the "just in time" concept of manufacturing is not only possible—at Rock Island Arsenal, it is a reality.

Micky Myers, Yuma Proving Ground explosive test operator, demonstrates the operation of "Andros," with her sister robot, "Brutus," in the background.

Yuma Robots Clear Mine Fields

Many youngsters play with remote control race cars for fun, but U.S. Army Yuma Proving Ground explosives experts have brought it to a new level. By maneuvering several remotely operated electric and diesel-powered robots up and down hills, explosive test operators clear mine fields and recover explosive mines, artillery rounds, and other unexploded ordnance items more safely and quickly than ever before.

Yuma Proving Ground has developed a reputation in recent years as an international leader in the development and use of robots to recover unexploded ordnance. By performing detailed failure analysis of tactical munitions, proving ground testers provide solid technical information to ordnance developers, which has enabled them to shave tens of thousands of dollars from their development costs. The result is a better bargain for the American taxpayer and new munitions for American military forces that are developed and deployed more quickly than ever before.

The motorized robots are operated either by radio or guide wire by trained personnel seated within a specially-built armored control vehicle. Several robots are used, depending on the type of terrain and specific type of ordnance to be recovered.

One of the smaller robots, emblazoned with the name "Andros" on its side, is an electrically-powered, tracked, all purpose vehicle. Moving at a speed of only two miles per hour, it is equipped with video cameras which monitor its movements as it grasps ordnance with metal jaws at the end of it's extended pneumatic arm. Each Andros unit costs approximately $100,000, but protects workers from injuries and saves a great deal of money on a long term basis.

Another robot, dubbed "Brutus," was transferred to YPG from Jefferson Proving Ground, IN. Much larger than its sister, Andros, Brutus features a diesel engine which can power it two times farther (over one mile) than the smaller unit. It also incorporates a more powerful pneumatic arm and jaws. Workers have found Brutus to be the robot of choice for crossing rough terrain.

Yuma Proving Ground's intensive use of robots to recover unexploded ordnance offers the incalculable benefit of being able to save lives when necessary, but it also greatly improves the ordnance development cycle.

Washing/Leaching Technology Removes Metals From Soil

Using an innovative combination of advanced soil washing and leaching technologies, the Twin Cities Army Ammunition Plant (TCAAP) in Minnesota is pursuing remediation of an area of land contaminated by open burning and open detonation of munitions. Ten acres of land were found to be contaminated with lead and other heavy metals, but no existing cleanup technology was readily available. Application of the new technologies will allow reuse of the property by 1995 and at an acceptable cost.

Built during World War II, the 2,400-acre installation lies among densely populated Minneapolis/St. Paul suburbs. Now on modified caretaker status, TCAAP no longer has an ammunition production mission. Activities, instead, are concentrated on the cleanup and restoration of contaminated soils and groundwater under the Army's Installation Restoration Program. The largely undeveloped TCAAP land is a wildlife sanctuary and is targeted for popular nature walks and tours as a part of eventual reuse and reutilization.

Cleanup options considered by the Army included paving or capping the site to reduce the migration of metals from the affected area, mixing the affected soil on-site with a cement-like grout to stabilize or immobilize the metals, and even digging up all the affected soil and shipping it to a hazardous waste landfill for disposal. According to Michael Fix, the TCAAP commander's representative, these methods were not suitable for TCAAP and did not meet the Army's goals.

TCAAP selected a relatively new technology called "soil washing/soil leaching," which combines soil washing and metals leaching and generates minimal waste streams. A full-scale lead recovery process like this had never been fully demonstrated in the United States. The soil washing process was adopted from the mining industry and involves the excavation of the affected soil, and the separation of the larger soil particles and debris from the more heavily metal- saturated "fines" (e.g., sands and silts) by means of a series of physical/chemical separating steps. Soil washing also removes larger, loose metallic fragments.

In the process, soil is stockpiled and fed into a hopper to accommodate a processing rate of 10 to 20 tons per hour. The soil first goes through a machine which breaks up the clumps and screens out material larger than a quarter inch in diameter. The coarser material is then fed through a conveyor system where cartridge casings are removed for storage and disposal. The rinsed stones and gravel are tested for metals and returned to the site.

The fine material is further separated by another machine into sands and fine silts/clays. Heavy metal fragments are separated from the sands in a mining industry "jig" and stored in drums for recycling. The sand is chemically leached. The fine material contains most of the lead after soil washing and, following separation from the coarser particles, is sent on for soil leaching. Soil leaching involves chemical processes to remove metals from the sands and fine silts and clays, and depends on differing physical and chemical properties of the sands and fine soils.

In the treatment circuits, the soil undergoes an acid wash that dissolves fine metallic fragments and ionic metals into solution. This occurs in a continuous flow process through a series of mixers and clarifiers where the leaching agent flows counterflow to the incoming soil stream. The material is progressively cleaner as it proceeds through the processing steps.

The clean sands and fine soils are dewatered, neutralized, tested, and added to the clean coarse material for return to the site. The spent leachate is sent to a recovery unit where it flows through an electrochemical reduction system that precipitates the metals out into a cake.

Metals reclamation is accomplished by collecting the discrete metal particles from the physical soil washing process, and the precipitated metal from the chemical soil leaching process. The metals are drummed and shipped via licensed hazardous waste transporters to a lead smelter. Through reclamation, these metals are removed from the hazardous material cycle for future reuse.

The TCAAP site is being cleaned up to satisfy both a federal facilities agreement (under Superfund) between the Army, EPA, and the Minnesota Pollution Control Agency, as well as TCAAP's permit requirements under the Resource Conservation and Recovery Act (RCRA).

According to Fix, the site has received so much attention and positive press that TCAAP conducts guided tours every other Wednesday for interested regulators, engineers, consultants, and the public. In addition, the site is being evaluated under the EPA SITE (Superfund Innovative Technologies Evaluation) Program, as a successful demonstration of the "soil washing/soil leaching" technology.

The TCAAP site is one of the nation's first RCRA cleanup projects using soil washing/soil leaching to remove metals. The result will be a "clean closure" of the site, along with a significant reduction in the need to dispose of wastes in a landfill. Peter Rissell, a project manager with the U.S. Army Environmental Center's Installation Restoration Division, said the Army plans to use soil washing/soil leaching at additional TCAAP sites where metals are present. A full technical and cost evaluation of the technology is being conducted by the U.S. Army Environmental Center's Environmental Technology Division. When this evaluation is complete, it will be the basis for using the technology at other Army sites.

The preceding article was submitted by the U.S. Army Environmental Center Public Affairs Office.

Walker Signs Health Hazard Assessment Plan

Late last year, Lewis D. Walker, deputy assistant secretary of the Army (environment, safety and occupational health) signed the historic Health Hazard Assessment Program (HHAP) Strategic Plan.

The plan is the result of a two-year team effort by representatives of the Office of the Surgeon General, the U.S. Army Center for Health Promotion and Preventive Medicine (Provisional), the U.S. Army Materiel Command, and the U.S. Army Medical Research and Materiel Command. The team created a blueprint for moving the Health Hazard Assessment Program into the 21st century. Key players in the development of the plan attended the ceremony. The strategic plan focuses on the vision of the individual soldier as the single most important element in the performance of the Army.

The strategic plan states, "The U.S. Army established the Health Hazard Assessment Program to eliminate or control health hazards in the life cycle management of weapons, munitions, equipment, clothing, training devices, other materiel." The strategic plan concentrates on the following four pillars: prevention; protection; performance; and sustainment and survivability. Program efforts will focus on actions related to providing materiel systems free of health hazards.

"The plan focuses on Army readiness by protecting health and maintaining stewardship of our resources," said Walker.

The HHAP supports the four elements of combat power, which are maneuver, firepower, protection, and leadership, and supports the breadth and diversity of the Army technology base.

TARDEC Leads NATO Efforts

The U.S. Army Tank-Automotive Research, Development, and Engineering Center (TARDEC), representing the United States, is currently teamed up with other North Atlantic Treaty Organization (NATO) members in the quest to standardize Battlefield Management System (BMS) electronics in tanks and armored vehicles. TARDEC, the U.S. representative and chair, is teamed up with representatives from France, Germany, Italy, and the United Kingdom to make up the Working Group of Experts 1 (WGE.1) of the NATO Army Armaments Group (NAAG) Project Group 25/WGE.1.

WGE.1 was chartered "to arrive at standardization agreements that can be realistically applied to participating NATO groups regarding electronics associated with battlefield management and interoperability," according to Art Rofe, deputy director of the Vetronics (vehicle electronics) Technology Center at TARDEC.

TARDEC, located at the Detroit Arsenal in Warren, MI, is the nation's laboratory for advanced military automotive technology. Its mission is to conduct research, development and engineering work to achieve global superiority in military ground vehicles. TARDEC associates design and develop vehicles for all U.S. Armed Forces, numerous federal agencies, and more than 60 foreign countries. TARDEC is recognized Armywide as experts in virtual prototyping, technology transfer, vehicle electronics, concurrent engineering, and technology integration and insertion.

WGE.1's mission is to standardize battlefield management electronics with emphasis on components that would minimize translation required for interoperability. BMS technologies, such as Fiber Distributed Data Interface (FDDI) proposed by the German delegates and the draft Standardization Agreement (STANAG) for Small Computer Systems Interface (SCSI) proposed by the United States, are examples of the standardization efforts of WGE.1. If BMS technologies, such as the FDDI or the STANAG for SCSI, can be realistically applied to all the NATO groups involved, communication between countries can be improved. The mission is to improve transmittal and linkage of data between countries operating together on the same battlefield.

The Vetronics Technology Center is responsible for the electronics for military ground and land vehicles and is working on a homogeneous group of standards applicable for future and existing vehicles. The proposed future U.S. standardization efforts are: computer resource subsystems, data distribution and control, crew controls and displays, and power generation and management.

Topographic Engineering Center Awards Contracts

The U.S. Army Topographic Engineering Center, Alexandria, VA, has awarded two contracts totaling $2.32 million and $2.78 million respectively, to Raytheon Systems Development Co., Bedford, MA, and PRC Inc., McLean, VA, for the research and development (R&D) of a multiple intelligence correlator (MICOR). This R&D effort is part of the Advanced Research Projects Agency's (ARPA) War Breaker Program.

The goal of the War Breaker Program is to develop and demonstrate technologies and systems leading to a fully integrated, end-to-end system capable of targeting and attacking time-critical targets before the enemy is prepared to strike. The MICOR is designed to accept, understand and automatically correlate intelligence information from multiple sensors to quickly create a clear intelligence picture for the rest of the War Breaker system.

The two contracts are for Phase I competition. A down selection for further development of a MICOR prototype system will be made at the conclusion of Phase I.

Environmental Products Catalog Published

The Defense General Supply Center (DGSC), Richmond, VA, has published their first catalog of *Environmentally Preferred Products.* DGSC is one of the Defense Logistics Agency's five supply centers. It manages federal stock group 68, which encompasses hazardous as well as environmentally-preferred chemicals.

The catalog contains more than 300 stock-numbered items available right now from DGSC through the normal requisitioning procedure. The catalog is being distributed to DGSC's military and federal civilian customers worldwide. Some of the product categories are aqueous cleaner/degreasers, deicers, aircraft cleaning compounds, spill control products, marine cleaning compounds, recycling equipment, etc.

The catalog includes useful voice and fax telephone numbers to enable customers to easily reach technical staff at DGSC. If your office has not received a copy please call DGSC's Marketing Office at (800)352-2852, DSN 695-5698, Fax (804)279-5695.

RD&A NEWS BRIEFS

Installation of the new gun mount.

Upgunning the Abrams

Infantrymen who depend on the sure-fire capability of the M1A1 Abrams Tank can look forward to a more powerful weapon. Some 1,600 existing M1A1 vehicles are expected to be upgraded; nearly 500 have been completed to date.

"The purpose of the upgrade," says Mike Dahms, an Armament and Chemical Acquisition and Logistics Activity program equipment specialist, "is to modify the gun mount and cradle to accommodate the new 120mm round. This more powerful round will greatly enhance the force and power of the Abrams."

Since program inception in 1993, Rock Island Arsenal upgrade teams have upgunned tanks at military bases and National Guard sites throughout the U.S. and overseas—from Fort McClellan, GA, to Camp Doha, Kuwait. The multi-million dollar program is scheduled for completion in 1996.

Upgrades are performed by four arsenal teams of three machinists. "These teams are required to meet very aggressive schedules. They work 10 hours a day, six days a week to complete an average of one tank upgrade a day," said Dahms.

Teams remove the 2,000 pound gun mounts, pull out the old recoil mechanism, insert a new recoil mechanism, and assemble the parts. The old recoil is then shipped back to Rock Island Arsenal for modification.

"Adding more firepower and lethality to the Abrams is a rewarding job, but the real bottom line is that we're building the machines that will give our soldiers the competitive edge on the world's battlefield—and we're proud of that," Dahms said.

Depot Workers Design Anti-Fratricide Devices

Identifying friendly forces can be a challenge on the battlefield, but a device designed and manufactured at Letterkenny Army Depot may help to eliminate casualties due to "friendly fire."

The device, known as a battleboard, is attached to a vehicle to identify it as belonging to friendly forces. When the vehicle is viewed through an infrared device, the battleboard registers as a cold spot.

Depot workers have completed and fielded the first 25 sets of boards with another 150 sets to be completed sometime in early 1995. Fabricated from aluminum, the battleboards are being attached to M109 howitzers, FAASVs, armored-combat earth movers, and nuclear, biological and chemical reconnaissance vehicles.

Letterkenny is one of three depots designing and fabricating battleboards. In addition, the Tank-automotive and Armaments Command, in Warren, MI, produces battleboards.

Army Selects Experimental Force

The U.S. Army is moving closer to the 21st century by selecting the 2nd Armored Division at Fort Hood, TX, as its "Experimental Force" (EXFOR). The EXFOR will conduct experiments to further develop concepts contained in TRADOC Pamphlet 525-5, *"Force XXI Operations,"* and to gain insights into equipment, new organizational designs and new operational and doctrinal concepts for America's Army in the 21st century—Force XXI.

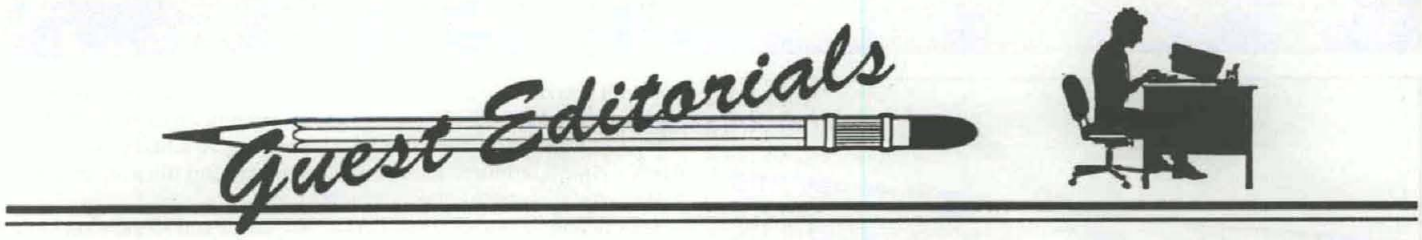
The initial component of the EXFOR will be a redesigned "digitized brigade-size task force," called Task Force XXI, plus a combat support and combat service support "slice" from divisional units. "Slice" units provide intelligence, artillery, aviation, air defense, engineer, maintenance, medical and logistics support to the task force during combat operations. Task Force XXI, along with a division command and control element, will conduct an Advanced Warfighter Experiment (AWE) of digitized communications and fire control equipment scheduled for early 1997.

The Task Force XXI experiment further evaluates the operability of "seamless" communications between command levels, designed to improve significantly the control of maneuver units and the integration of the fires of the different weapons systems available to the commander within that commander's battlespace. Task Force XXI will provide insights to the design of the operating forces for Force XXI through experimentation with a fully modernized brigade-size task force.

The Advanced Warfighter Experiment of battlefield synchronization, conducted at the National Training Center in April 1994, highlighted how digital technology can enhance lethality, operations tempo and survivability. Two additional AWE's, Focused Dispatch with heavy forces and Warrior Focus with light forces, will be conducted in 1995 to gain additional insights on the impact of information technology and organizational and operational changes that improve performance on the battlefield. Warfighter insights on organizational design and operational concepts gained from the AWE's will be incorporated in the Task Force XXI experiment. The task force is expected to take between six and nine months to outfit and train with the digital equipment, organizational design and new operational concepts prior to the experiment.

During the Task Force XXI experiment, information will be passed digitally, horizontally and vertically, rather than by voice, over a reduced number of networks. This information will include exact location of friendly elements through use of the Global Positioning System. These initiatives are designed to reduce transmission time and increase the accuracy of the information, which will compress the commander's decision-making time and enhance both combat effectiveness and friendly force protection. Weapons and communications systems within the task force will be outfitted with digital systems known as "appliques," which are added on to existing communications equipment.

The Task Force XXI experiment will pave the way for a full division-level experiment, followed by a CONOPS exercise with a digitized corps. Other Army projects designed to take the Army into the 21st century are on-going. The Louisiana Maneuvers Task Force synchronizes Force XXI efforts on a day-to-day basis. The TRADOC Battle Labs focus on the practical applications of assessing new warfighting ideas and technologies for use on the battlefield. Experiments at the Battle Labs indicate that digitization can enhance every aspect of fighting and sustaining America's Army into the 21st century.



FORCE XXI AND QUALITY SOLDIERS

THE ESSENCE OF AMERICA'S ARMY

By LTG Theodore Stroup
Army Deputy Chief of Staff for Personnel

Force XXI is the transformed Army of the 21st century. Force XXI is 21st century technology. It is an information-based force, capable of flexible engagement to achieve dominance in the battle space through improved lethality, readiness, and shared situational awareness. It can be conceptualized in a variety of terms such as battle dynamics, knowledge-based operations, tempo, and its joint and multinational aspects, to name a few. The operational concepts of Force XXI are being built around intelligent, physically fit, highly motivated, educated and well-trained soldiers with confident, competent leaders who can leverage technology to its full potential. In short, every concept of Force XXI highlights the fact that the soldier is a fundamental ingredient of America's Army—the stuff of Force XXI.

Leveraging information-age technology to its full potential is more than acquiring or improving materiel that exploits the benefits of emerging technology. The force structure will be transformed. Soldiers' jobs will change. We are working to define exactly what a "quality soldier" will be in the 21st century. The Army will continue to develop strategies for attracting, accessing, allocating, and sustaining quality soldiers for America's Army.

As new systems and product improvements are developed, they must be integrated with the soldier. Optimizing quality people through a disciplined process for assessing the impact of system design on individual operators and maintainers is crucial to the Army of the 21st century.

As we integrate information-age technology into units and experiment with that technology, we may not necessarily train the way we train today. The nature of training will change, both in terms of its content and the way it is delivered as we leverage the use of information-age technologies. As we increase the use of simulations and other new technologies, we are working to develop the training strategies needed to capitalize on these new training capabilities and to ensure readiness for the future. Training is and will remain the glue that binds the force.

Achieving the full potential of this 21st century force will require special kinds of leaders; leaders who can be agents of change: who can create and lead a structurally flat, fast unit; and who can develop procedures that can keep the leader informed. It will require leaders who can cope with the load of shared situational awareness and hierarchial responsibility necessary to synchronize the combat power of an information-age Army. We are working to refine our leader development strategies and to define the requirements for 21st century leaders. The Army will develop ways to identify leaders and raise them to their fullest potential to meet the demands of Force XXI.

The deputy chief of staff for personnel (DCSPER), as the head of the Army personnel community, maintains cognizance over all personnel-related research in the Army. The ODCSPER is the agency responsible for the manpower, personnel and training systems research and development that supports Force XXI. Integral to the Army's soldier-oriented research effort is the Army Research Institute for the Behavioral and Social Sciences (ARI), the Army's lead laboratory for manpower, personnel and training systems research and development. Previous issues of *Army RD&A* have highlighted research and development programs supporting Force XXI at the Army Materiel Command and the Corps of Engineers. This issue of *Army RD&A* presents selected ARI soldier R&D programs, highlighting ARI support for Force XXI.

Force XXI is not a panacea; it is a dynamic process to force us to think about the future. It is a way to empower trained soldiers with information-age technology—to put them into appropriate organizations with confident, competent leaders where they can achieve their maximum potential. "Quality Soldiers...The Essence of America's Army...today and in the future."

OASA (RDA) ACQUISITION PHILOSOPHY

MISSION

To **acquire** and **field** the most **effective, affordable** and **supportable** weapons and materiel for our soldiers.

EXECUTION

Recognizing that the DOD no longer serves as the primary motive force in developing new technologies, nor alone continues to sustain broad sectors of the industrial base, we must focus our efforts on acquiring the latest technologies from commercial sources using commercial business practices. To accomplish this **we must eliminate, as much as possible, unique government requirements in our acquisitions.**

To do this wisely, we must also understand the potential, and be in a position to influence, the development of emerging technologies. **We must leverage our intellectual and dollar resources** by cooperating in every way possible with academia, industry, national laboratories and allies in the pursuit of advanced, high pay-off technologies.

To be successful, and to make every dollar provide the most for our soldiers, each of us **must seek innovation in how we help users define requirements, and how we acquire, test, field and provide for the sustainment of the equipment our soldiers deserve.**

GILBERT F. DECKER
ASSISTANT SECRETARY OF THE ARMY
(RESEARCH, DEVELOPMENT AND ACQUISITION)

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