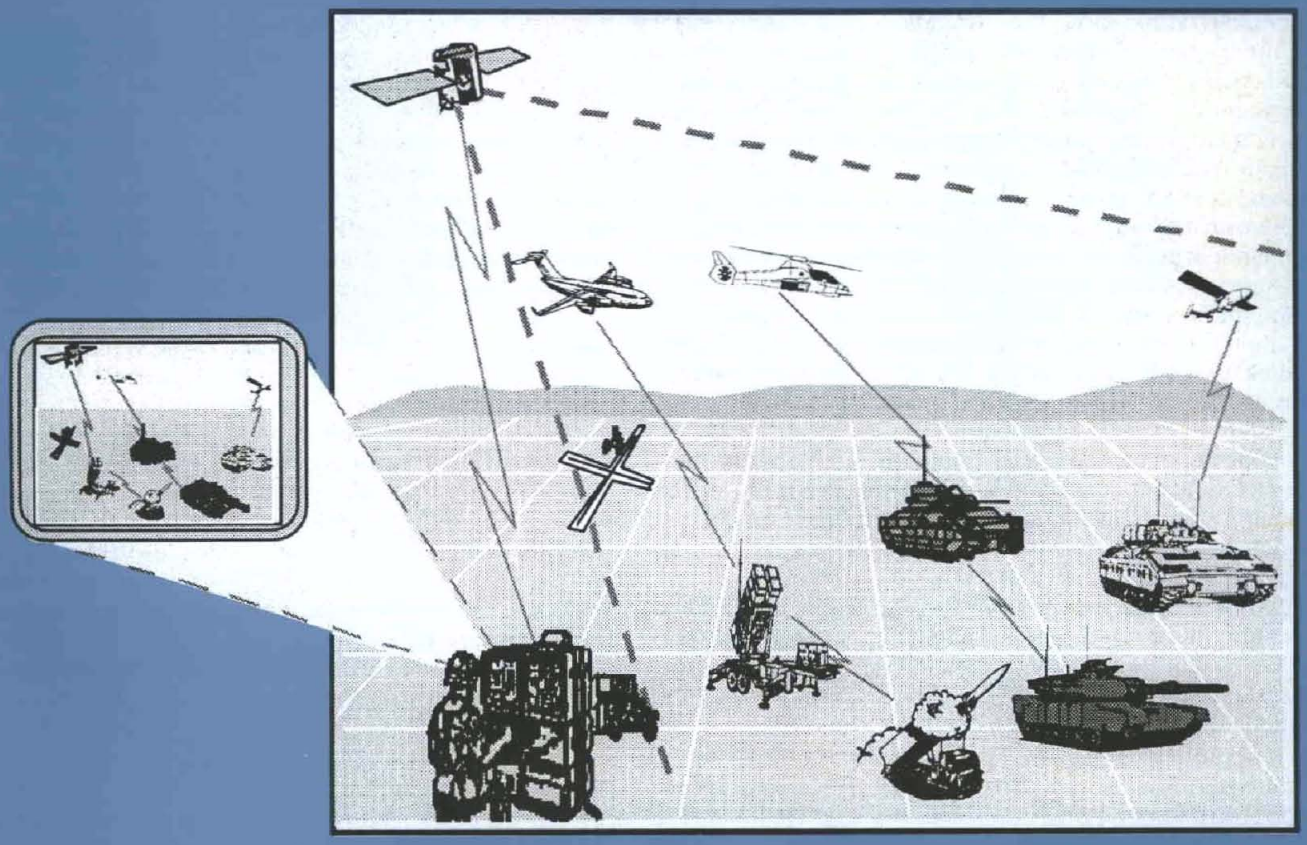
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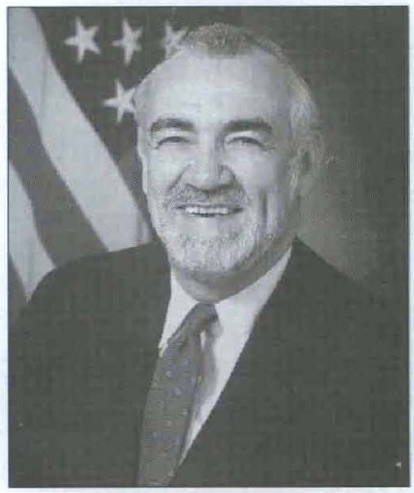
NOVEMBER - DECEMBER 1994

BATTLEFIELD DIGITIZATION



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FROM THE ARMY ACQUISITION EXECUTIVE . . .



Digitizing our battlefield systems is fundamental to winning the information war. Digital data networks allow rapid sorting and sharing of critical battle information throughout the battlefield. This technology allows the commander to see the battle more clearly and better coordinate his forces by sharing his view of the battlefield with his tanks, fighting vehicles, artillery, command centers, and attack helicopters. The system will use standard protocols and formats, widely accepted in commercial practice. They will allow command, control and intelligence information such as map overlays and friendly and enemy locations to be passed in near real-time to every key system in the combined arms task force, as well as to higher headquarters and adjacent commands. It promises to significantly reduce fratricide, a major problem in the fog of ground combat. In short, we must destroy, disrupt, and control enemy information sources and distribution while ensuring our commanders get accurate and relevant data in time to use it.

A series of Advanced Warfighting Experiments using simulation and the Battle Labs are scheduled to lead-up to the Brigade '96 experiment, the next major event in evaluating the digital battlefield concept. It will take place at the National Training Center in October 1996. Plans also include a digitized division in 1997 and a corps in 1999.

Beyond digitizing the brigade, division and corps, we must begin to think about the entire Army in the field and the information war implications of Force XXI. The one aspect of this consideration is the determination of the information architecture required to enable digitization to work.

This year an Army Science Board summer study was devoted to the Information Technical Architecture for Command, Control, Communications, Computers and Intelligence (C4I). This particular study was required as the foundation for digitization and information transfer on the future battlefield. The findings have been ratified and adopted 100 percent by the Army.

The C4I information infrastructure is a critical component of the Army's operations, and it will become 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. By establishing a set of commercially accepted standards that apply to human interfaces, information structures, information processing software and information transfer, we will move the Army to a common open architecture across all systems. This will enable us to efficiently digitize our systems in an era of reduced Defense budgets, Joint and Combined and split base operations, and huge investments in information technologies.

Based on the summer study, GEN Tilleli and I have signed a memorandum implementing the study's primary recommendations. Effective immediately, the Army Acquisition Executive will also be the Army's Technical Architect responsible for oversight and maintenance of the Army Technical Architecture, ensuring that all Army information systems are developed in compliance with the architecture, interfacing with DOD and other service C4I architecture/interoperability offices and ensuring that the mandated technical architecture is included in procurements. All PEOs and major commands will be directed to comply with the technical architecture. The Director of Information Systems for Command, Control, Communications and Computers (DISC4) will develop and maintain the technical architecture for battlefield systems and installations and submit the original detailed architecture changes and modifications to the AAE for approval. The CECOM Research, Development and Engineering Center will be the systems engineer for the architecture. The Army Digitization Office will oversee and coordinate the integration of Army battlefield digitization activities and assure compliance with the technical architecture. ODCSOPS, TRADOC and AMC will develop the operational architecture, requirements and required materiel and assure compliance with the architecture. Finally, the Army Science Board will establish a standing panel to provide a quarterly progress report on our implementation efforts.

I believe that this seminal effort is critical to the future of the Army as we must manage our resources and win our battles in widely disparate areas against a variety of foes. It is the first real step toward total interoperability. This concrete step is clearly in the right direction and will support acquisition reform as well as efficient modernization efforts. All elements of the Army acquisition community must support it.

Gilbert F. Decker

NOVEMBER–DECEMBER 1994
PB 70-94-6

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Army RD&A Bulletin **(ISSN 0892-8657) is published bimonthly by the Office of the Deputy Director, Acquisition Career Management. Articles reflect views of the authors and should not be interpreted as official opinion of the Department of the Army or any branch, command, or agency of the Army. The purpose is to instruct members of the RD&A community relative to RD&A processes, procedures, techniques and management philosophy and to disseminate other information pertinent to the professional development of the RD&A community. Private subscriptions and rates are available from the Superintendent of Documents, U.S. Government Printing Office, Washington, DC 20402 or (202) 783-3238. Second class official postage paid at Fort Belvoir, VA and additional offices. POSTMASTER: Send address changes to DEPARTMENT OF THE ARMY, ARMY RDA BULLETIN, 9900 BELVOIR RD, SUITE 101, FT BELVOIR, VA 22060-5567. Articles may be reprinted if credit is given to Army RD&A Bulletin and the author. Unless otherwise indicated, all photographs are from U.S. Army sources. Approved for public release; Distribution is unlimited.**

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By order of the Secretary of the Army:
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07501

ARMY RD&A BULLETIN

Research Development Acquisition

Professional Bulletin of the RD&A Community

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COVER

Battlefield digitization—considered a turning point in modernizing the Army—will allow commanders to prevail with the right force at the right place at the right time.

FORCE XXI: DIGITIZING THE BATTLEFIELD

By GEN Gordon R. Sullivan
Chief of Staff, U.S. Army

Introduction

As we move toward the 21st century, our Army will be called on to respond to crises in a world that is increasingly unpredictable. We will be called on to respond to crises which demand capabilities that could not have been anticipated a few years ago. But whatever the mission, the nation will expect us to succeed, to "win."

As we face the 21st century, this complex global political matrix is juxtaposed with a revolution in information technology that is changing our ideas about how to organize and how to fight. The power of the microprocessor, having its genesis in visionary Army research and development programs, is only now beginning to be understood and harnessed. The power of information can give us great advantage in gaining a seamless common view of the battlefield. Using digital communications and information processing, we can act more quickly and more synchronously.

Digital Technology: The Foundation

We have been proactively adapting, changing, and responding to this changing environment since the end of the Cold War. Our objective has been to develop a versatile Army capable of delivering victory anywhere and under any circumstances, wherever the nation sends us. To do that has required a change in our thinking, our doctrine. No longer do we have a forward based force oriented on a global threat. Instead we have trained our sights on force projection, split based operations, and operations other than war. This new doctrine has been codified and disseminated to the force in the Army's foundation document, *FM 100-5, Army Operations. TRADOC Pamphlet 525-5, Force XXI Operations,* looks beyond FM 100-5, even further into the future.

But doctrine alone does not suffice in a world exploding with new technologies. Digitization of information; converting it to zeros and ones, then manipulating, transferring, and displaying it provides probably the greatest technological leap forward on the battlefield since the introduction of the internal combustion engine. Digitization—harnessing the power of information—will enable us to realize the vision of TRADOC Pam 525-5, to create a force for the future, a force leveraging unique American strengths.

Because digital technology continues to, literally, explode in its potential, we must develop a plan for incorporating it in such a way as to allow growth of the system without losing what has been gained. It is critical, therefore, to define carefully our strategic approach to the task of digitization. We have identified six points which must outline our attack on development and acquisition.

1. Create development and procurement processes that accommodate new and maturing technologies rather than focusing on an end item defined years earlier. In essence, we must create a dynamic process where the requirement, especially for information components, is allowed to evolve throughout the acquisition process. We must define requirements in the context of *capability* rather than specification. As the acquisition process proceeds, we must continue to look for opportunities to insert even newer technology which enhances the basic system. This means that the materiel developers must interact with the TRADOC Battle Labs continuously. Finally, we must tie technology development and doctrine development more closely together to enable us to see into the future.

2. Develop an open technical architecture for digitization, using industry standards whenever possible. With the Defense Department's R&D budget only about 1 percent of the total U.S. industry expenditures, we must avoid closed architecture and proprietary systems. This will allow growth based on "their nickel" and let us leverage our scarce R&D dollars by spending them on truly unique requirements. By initially defining the types of technology necessary for a capability, three categories can be defined: that which is readily available, that which is under commercial development, and that which is too unique or advanced to warrant commercial efforts. Our R&D funding should reflect this reality by avoiding duplication and concentrating on unique military applications. In this way we can optimize technology transfer between the commercial and defense sectors.

3. Bring legacy systems into alignment with the open architecture. In the future, we must develop systems which can be enhanced and upgraded, and which allow systems growth. We must align all product improvements with those standards. In the past, we have leapt forward to new, more advanced systems across the whole battlefield. But today, many "legacy" systems remain which must be capable of working with more advanced systems. In the past we have product improved (PIP) legacy systems, but generally only to achieve marginal improvements. Concentrating on the information components of legacy systems, we must strive to achieve PIPs which will enable these legacy systems to be compatible with more advanced systems, to leap ahead on information capability. Only by making such improvements can we achieve a seamless open architecture *on the battlefield.*

4. Encourage industry to use Army standards wherever we are out in front. In those cases where Army R&D has moved ahead of industry standards, we must encourage industry to adopt the Army's approach and standards. The strength of our labs is such that we will continue to lead in many areas of information technology. By ensuring that the Army is represented on the various standards committees, we can ensure that we are developing processes and protocols in such a way that our developments can be handed off to industry for further development as our standards are accepted. Our scientists and engineers are great thinkers, and our strength is on the cutting edge.

5. Focus on capabilities rather than on equipment. In digitizing the battlefield, we cannot afford to first digitize each of our analog processes and then refine their uses. We must look for ways to collapse multiple communications and information systems into a single, more flexible digital version, or to eliminate systems which are no longer needed. Our focus must be on the information, not on the means of communication or manipulation. Legacy systems will bear the load of moving us into the near future but will require modifications to provide digital connectivity. We must do this with an eye on true networking, reduction of individual systems, and innovative digitization. To do so

will require coordination between programs and elimination of some older systems; but we must open to this range of options if we are going to gain the power available in digitizing.

6. Take a holistic approach to the problem. We must bring our field systems into alignment with our garrison systems. We have long said that we fight as we train, and train as we fight; now we must apply that concept to the information battlefield. Both tactical and administrative information systems must be developed to be seamless. We must enable commanders to see into a reporting system which is congruent from top to bottom and which is sufficiently transparent so that commanders have only what they need, in a form they can use, when they need it. Doctrine will help us define standard methods of determining the "windows" for each commander into that "battlefield information highway." We must not limit our future commanders by shallow thinking about emerging technology. When the repeating rifle was introduced, it was discouraged by some because it would encourage soldiers to fire too many bullets. We must not constrain the potential of the information age with similar thinking.

Force XXI: The Plan

Force XXI is our vision to synthesize technology, doctrine, and organization into an Army which can fight and win the nation's wars into the 21st century. Like digitization, which enables Force XXI, it is both a process and a series of concrete, achievable objectives. And it is a concept which encompasses the whole Army, both the operational forces and the sustaining base. That is, we must grow into one Army seamlessly connecting TOE units to the TDA Army including our civilian and contractor components—one force, from foxhole to factory.

It is not possible to know exactly what that force will look like but by establishing prototype forces, first at brigade, then division, and finally corps, we will create a structure to allow us, through experimentation and evaluation, to create the force through a process of discovery learning and continuous change, a force to operate on the digitized battlefields of the 21st century. Concepts are being developed and equipment selected to form the first digitized force: Brigade 96. Breaking the industrial age paradigm of serial processing, Division 97 will follow shortly thereafter; while we will still be learning at brigade, we can begin to learn at division. Lessons from each will be woven into the way each are then built. This parallel development and continuous change will continue as we develop the corps and other echelons above divisional units—all the way throughout the force. This is parallel or information age processing. Quick introduction of several organizations will cause us to break down the stovepipe information structures and encourage seamless integration.

Seven Objective Capabilities:

- Lethality
- Survivability
- Sustainability
- Versatility
- Deployability
- Optempo
- Joint and Combined C2

A series of mini-experiments and evaluations will examine the effectiveness of various combinations of doctrine, organization, and technology to enhance the seven objective capabilities shown in the accompanying list. The after action review process, carefully instituted and documented, will provide the insight to support change. What went right, what went wrong, why, and how can we improve? It is impossible to predict all the new difficulties and opportunities. But we are a learning organization and, by leveraging live, constructive, and virtual simulation, this process will enable us to achieve streamlined, interactive development that will be much more effective than more sequential, conventional processes.

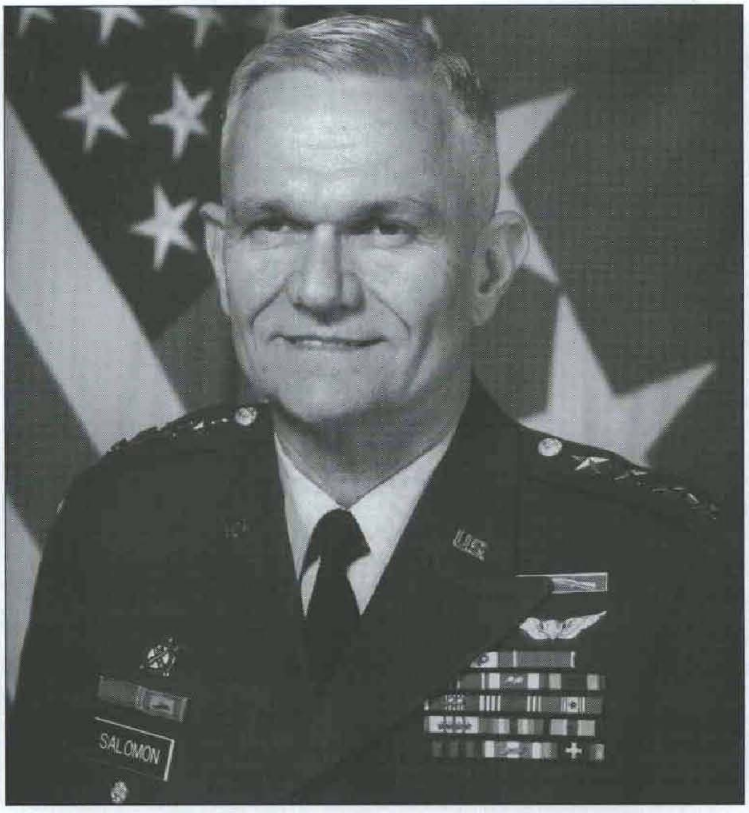
In April 1994, the Army kicked off this process in an Advanced Warfighting Experiment at the National Training Center, combining a complex set of advanced technology demonstrations and advanced concept technology demonstrations. Over 144 systems were connected digitally. Digital communications undergirded the command and control and logistics efforts throughout the task force. Although the many prototype systems and immature training development fell short of expectations in some respects, overall the experiment was a tremendous success, demonstrating significant improvements in lethality and survivability; more accurate, more responsive intelligence; smoother hand off to joint systems; and faster sensor-to-shooter timelines. This experiment confirmed our direction.

A systemic approach to experimentation has been developed to accommodate what we are learning. Using an initial baseline established with today's force, Operational Test and Evaluation Command and TRADOC will evaluate successive experiments and establish a "rolling baseline" as a basis for continuous improvements and change. This dynamic approach will enable us to build a force optimized for tomorrow—not for yesterday.

Leading Into the Future

Most armies would be content to sit on their laurels following victories like the Cold War and the Persian Gulf War. Instead, we recognized the changing political environment and the difficulties we must face as a power projection Army. We also recognized the power of the revolution in information technology that is enabling us to transform the best Army in the world today into the best Army in the world tomorrow. Digitization technologies provide the means, the leverage, by which we can achieve that vision.

GEN GORDON R. SULLIVAN is chief of staff of the Army. He received a B.A. in history from Norwich University in 1959 and was commissioned in the armor through ROTC. He also has an M.A. in political science from the University of New Hampshire and is a graduate of the Army War College. He served two tours in Vietnam, in 1962-63 as an advisor with the Vietnamese 21st Infantry Division and as a MACV intelligence officer, and in 1969-70 with I Field Force Headquarters.



INTERVIEW WITH GEN LEON E. SALOMON COMMANDING GENERAL U.S. ARMY MATERIEL COMMAND

Q: How would you describe your management philosophy?

A: My management philosophy begins with and is embedded in what I like to refer to as a value-based Army. By this, I'm referring to loyalty to the nation, loyalty to the service, selfless service, and personal responsibility. I believe these attributes, coupled with openness, integrity, concern and fairness toward all soldiers, civilians and their families, are prerequisites to effective management. Equally critical, however, is the key leadership ingredient of setting and enforcing realistic and achievable performance standards for all employees . . . and maintaining a sense of humor in all our day-to-day activities helps to keep all of this in the proper perspective. Quite simply, I believe in empowering employees to be responsible risk-takers. If you're at bat and the count is three balls and no strikes, don't be afraid to swing away if the next pitch looks good. The challenging times we face demand nothing less.

Q: What impact is the DOD downsizing and restructuring effort having on AMC?

A: Well, we have undergone some fairly significant downsizing, from 102,000 civilians in 1989 to about 72,000 today. And we are going to continue to get smaller, just from looking at the numbers over the POM years. We've been proactive in this effort, combining some of our subordinate commands, closing out depots, consolidating our labs, and other general closures and realignments that have reduced our infrastructure and overhead. Also, we've achieved an almost 50 percent reduction in our headquarters over this time period. So, we'll continue to look at ways to reduce our infrastructure, to make organizational changes, and to examine and change the way we do business. And, all of this will be grounded in our capability to provide integrated, life cycle, weapon systems support to the Army.

Q: How will the Army's acquisition process benefit from the current trend toward greater use of commercial specifications?

A: Military specifications make it difficult for commercial firms to be innovative and apply their expertise to meet our needs. Military-unique specifications and standards also prevent Defense contractors from adopting new technologies and manufacturing techniques that reduce cost, and they keep us from benefiting from rapid technology cycles driven by the commercial marketplace.

Thirty years ago, military specifications and standards defined the state of the art. Today, many are outdated, and they create a wall between the commercial and military industrial sectors.

By using performance specifications that specify what we want, not how to produce it, we allow industry to quickly apply technology to our needs. It also allows industry to optimize production capacity and at the same time move to a national production base—really important as we downsize. We'll be able to tap into the commercial manufacturing base to replace the capabilities lost as defense-unique firms are downsized, converted or eliminated.

An additional aspect to the new way of doing business with AMC is that we encourage all businesses, including small and disadvantaged businesses, to educate themselves on the acquisition reform process. Businesses must remain flexible and adapt to the environment. Furthermore, small and disadvantaged businesses will recognize this change provides many new possibilities and actually opens their access to military and commercial markets. To the extent that it is possible, AMC will assist in this education process.

For spares and breakout procurements, we can purchase the design contractor's technical data and provide that as information along with our performance specifications. This will provide offerors the option of producing a like configuration or their own unique configuration. In the long run, we will be doing less business with the traditional "build-to-print" businesses. Since some small and disadvantaged businesses don't have engineering capabilities, I see they need to restructure their organizations to ensure they increase their competitiveness. Our MIL SPEC/STD reforms provide inherent cost reductions. These reductions should allow the small and disadvantaged businesses to adjust their staff by adding or increasing in-house engineering capabilities. Also, I see excellent opportunities for the engineering consulting market to assist businesses with little or no engineering capabilities.

Ultimately, as all businesses adapt to this change, they will need to evaluate their business strategy and make decisions on whether or not to compete. Then, they must change their capabilities accordingly.

The bottom line is, we'll be able to get more technologically current and affordable products to meet the soldiers' needs.

Q: What is the mission of the newly established Army Non-Developmental Item Advocate?

A: First, let me say that the NDI advocate is Dr. Kenneth J. Oscar, my principal deputy for acquisition. His mission as NDI advocate for the Army, not just AMC, focuses on the use of commercial and non-developmental items to meet procurement needs. He is primarily responsible for challenging barriers to the acquisition of commercial items and other types of NDI. Ken has to make sure that whenever the Army buys something, we ask, "Have we considered a commercial alternative; is there an NDI solution rather than a military-unique development?"

He also reviews policy matters on NDI use, and reports to the Army Acquisition Executive (AAE) on opportunities and actions taken. Darold Griffin, who recently retired as the principal deputy for acquisition, built a network of established associate NDI advocates throughout the Army. Ken now uses this valuable network to assist him with this very challenging mission. They are located at AMC's major subordinate commands, the Corps of Engineers, Information Systems Command, and Medical Materiel Agency. He plans to expand that network to our test and evaluation community.

Ken knows this is a big job and that he'll need the people in the acquisition "trenches" to make it happen.

Q: What suggestions do you have to improve the DOD-industry relationship?

A: Issue-oriented dialogue is the key to improving the DOD-industry relationship. There are a number of initiatives which promote early and meaningful communication during all phases of the acquisition process.

First, AMC supports and participates in the annual American Defense Preparedness Association sponsored Atlanta Conference. Both government and industry representatives meet to address and resolve acquisition process issues.

Secondly, I hold informal roundtable discussions each quarter with industry chief executive officers (CEOs) and key members of the AMC staff for the purpose of improving the acquisition process.

In addition, our major buying commands conduct Advance Planning Briefings for Industry (APBI) to promote early and meaningful communication with industry during all phases of the acquisition process. We publish an updated schedule of these briefings every six months.

Further, Technical and Industrial Liaison Offices (TILO) have been established at HQ AMC and the major subordinate commands (MSCs) to provide continuity and serve as the primary points of contact with industry for release of information and guidance on research and development programs.

In more concrete terms, AMC is actively involved in pursuing Cooperative Research and Development Agreements (CRDAs) with industry. Currently, we have almost 200 such agreements in effect. CRDAs not only play an essential role in leveraging the shrinking R&D budget, but also promote a close working relationship between Army and its partners in the Defense industry. In addition, the mutual benefits gained from access to each other's technology is enormous.

Our Alternative Disputes Resolution Program encourages the fast, fair resolution of contractor concerns. For example, the HQ AMC-level bid protest forum has been widely recognized as providing protesters with the same result they would receive at GAO, but in a fraction of the time and cost.

AMC also sponsors a program for Industry Visits to Army Units. The visits are organized by battlefield mission area, and supported by FORSCOM and TRADOC. I invite industry CEOs to send senior design and maintenance engineers for a total of four days to visit Army tactical units and Army depots. This provides industry representatives a unique opportunity to interface directly with the soldiers and maintainers and to get their perspective on how the equipment is used and maintained.

And finally, I have to mention our AMC ombudsman, Lew Ashley. He serves as the command focal point for business-industry activities. He concentrates on the way AMC does business and communicates with industry. I rely on him to review reported complaints and provide assistance as needed.

Q: What is AMC's relationship to the Battle Labs?

A: AMC has a partnership with the Battle Labs. As the Battle Labs shape and execute their warfighting experiments, AMC provides expertise in technology, acquisition, testing and logistics. This is accomplished in a cooperative way that makes it difficult to distinguish between AMC personnel and TRADOC personnel.

The partnership was initiated in 1993 by pairing up each Battle Lab with one of the AMC centers for research, development and engineering based upon the functional area of the Battle Lab and the commodities associated with the AMC center. This has grown to where AMC has engineers and scientists on site at each Battle Lab. AMC also has focal point personnel who act as gateways for Battle Lab personnel to use the expertise in the many AMC organizations.

A good example of how well our partnership is working is the Advanced Concept and Technology II (ACT II) Program. ACT II is a contracting mechanism designed to allow the Battle Labs to solicit from industry mature and emerging technologies that the Battle Labs can experiment with as they sort through building capabilities for Force XXI. AMC's Army Research Office (ARO) in Research Triangle Park, NC, is the Battle Labs' administrator for ACT II. ARO guides the Battle Labs through the acquisition process from solicitation to award. After ACT II contracts are awarded, the AMC centers carry out the procurement responsibilities for the Battle Labs, following through to the completion of each effort. All the AMC centers participate in the selection process by providing a technical evaluation of each proposal.

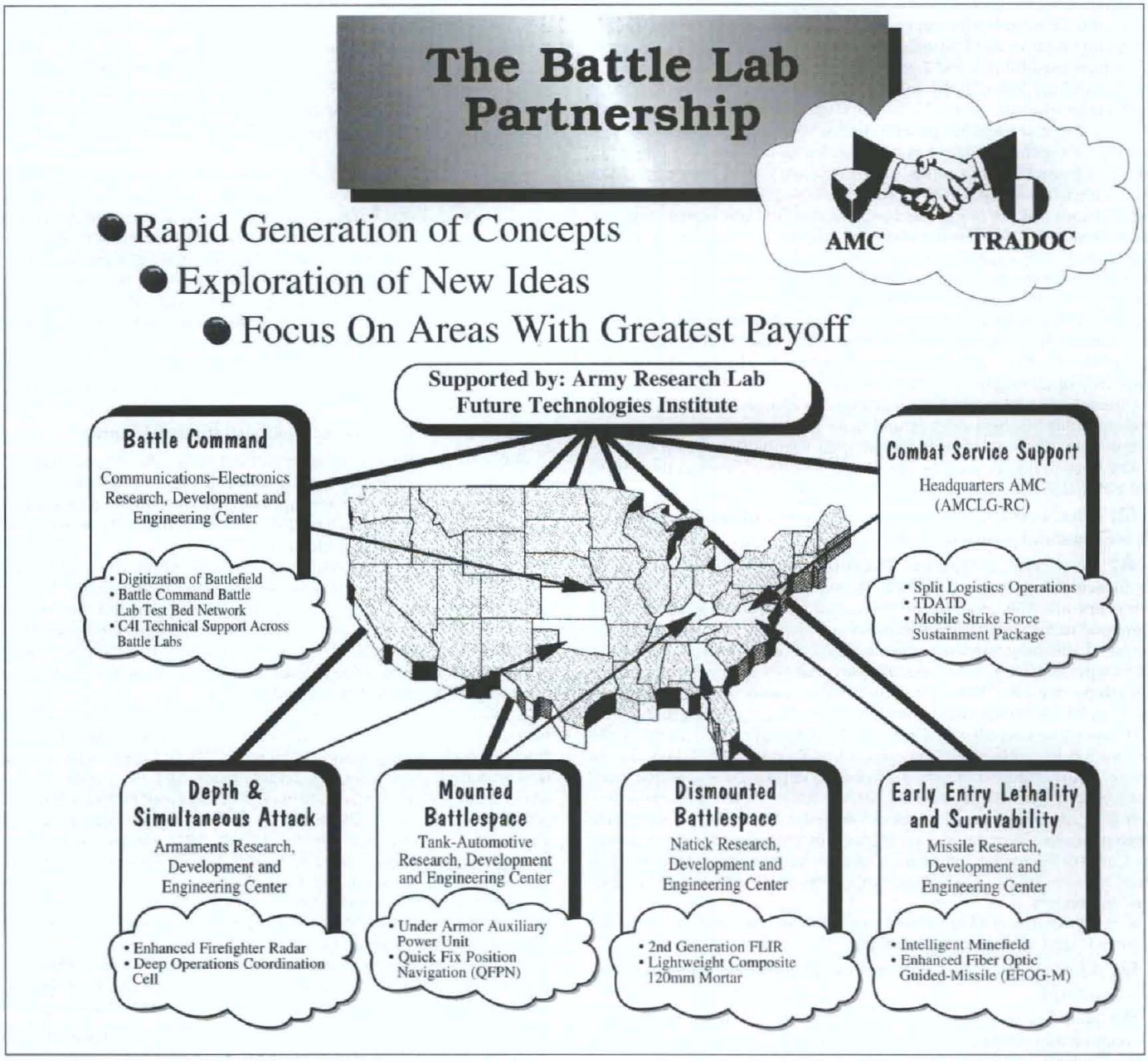
ACT II and many more efforts are carried out in a partnership that allows a free exchange. The goal is to help shape the Army of the future through experimentation, and I believe we are achieving our goal.

Q: What advice would you offer someone considering a career in Army materiel acquisition?

A: I would strongly encourage persons to enter the materiel acquisition career field when they are "turned on" by technology generation, application and program management. The Acquisition Corps may offer you just the future you've been seeking. Corps members are tomorrow's leaders in the continuing work of developing, buying, delivering, and sustaining the materials required for our national defense.

The Army Acquisition Corps is a diverse area with opportunities for people with many different skills and backgrounds. It's an area full of challenges and opportunities. The process of developing and acquiring the equipment our soldiers need is vital to our country. We have a moral obligation to put world-class equipment into the hands of the soldier in both the near term and the far term.

Acquisition Corps membership means opportunities for training, education, and advancement. We know that education and training of our work force is essential to high quality and efficiency, which is the key to the future. The Defense Acquisition Workforce Improvement Act ensures that appropriate career paths for civilian and military personnel who wish to pursue careers in acquisition are identified in terms of education, training, experience, and assignments necessary for career



progression of civilians and members of the armed forces to the most senior acquisition positions.

There is also full reciprocity among the Acquisition Corps. Members can transfer between agencies within the Army, Navy/Marine Corps, Air Force, and OSD/Defense.

If you serve in a designated critical acquisition position, review your options. You may remain in your present position without becoming a member of the Acquisition Corps, since the Department of Defense has decided to "grandfather" all incumbents in critical positions. As you continue to serve in your present job, you may discover attractive advantages to becoming a Corps member. Promotion into another critical acquisition position, for example, requires Corps membership.

The bottom line is that the materiel acquisition field is exciting and will interest a wide range of people. It offers tremendous potential for individuals to improve the Army's ability to provide land warfare dominance.

Q: What is the biggest challenge facing AMC during the next decade?

A: Certainly it is to continue to provide those things that we do in support of the readiness and sustainment of the Army. Technology generation and application, acquisition excellence, and logistics power projection support are the values we add to the Army. We must provide these in an integrated basis so that we will provide both effective and efficient life cycle support to our forces.

AMC's vision is to be the leader in equipping and sustaining America's Army through superior technology and responsive support, assuring worldwide power projection and decisive victory. We owe it to our soldiers to continue to achieve this vision in a period of dramatic downsizing and reshaping. AMC must remain "America's Arsenal for the Brave."

THE 1994 ARMY SCIENCE BOARD RECOMMENDED TECHNICAL ARCHITECTURE FOR THE DIGITAL BATTLEFIELD

By Dr. Michael S. Frankel

Editor's Note: The following views and opinions are those of the author and do not necessarily represent official Army Science Board or Department of the Army positions.

Introduction

Earlier this year, the Army Science Board (ASB) Summer Study Panel (see Table 1) completed a study of an Army technical architecture (TA)—requested by former Director of Information Systems for Command, Control Communications, and Computers LTG Peter A. Kind (USA ret.). Panel participants were tasked to define and assist in the development of a TA, and associated technologies, to support the Army's goal of establishing Force XXI. Members on the panel were selected to ensure that we had in-depth expertise on TA concepts, familiarity with Army battle-command development and procurement programs, and specialized knowledge of the civilian information technologies now ushering in the global information age.

The Army's Vision

The basis of this study was to examine the Army's vision of the future, including combat doctrines, organization, material, and the growing need for information management to support the Army in the 21st century. The concept of the digitized battlefield, embodied in Force XXI, is a vital element of this vision. The information-management-related implications of the Army vision are profound and far-reaching.

The "Third-Wave Army" will emphasize knowledge-based operations, including information-warfare capabilities. This information-age Force XXI must, and will, be organized around the effective use of battlespace information that is prompt, reliable, and secure. The information infrastructure to support the real-time collection, transport, and management of battlespace information is important to the success of the Army's operations today; it will be vital for the success of future operations.

To achieve the vision and goals of Force XXI, interoperability and flexibility are imperative across all battle-command systems. The ability to structure a force rapidly and efficiently to meet any future contingency must be facilitated, not encumbered, by the supporting battle command information infrastructure. Furthermore, given the requirement for the evolution of a force-projection Army, and the concomitant need that the Army support split-based operations, interoperability and flexibility will be required among tactical systems; post, camp, and station information systems; and Standard Army Management Information Systems. However, the need for interoperability and interconnectivity of battle-command systems is not just an intra-Army issue. The need to conduct joint and coalition operations imposes yet a greater demand that all armed forces provide open, flexible, and interoperable information infrastructures to all our fighting forces.

The ability to structure a force rapidly and efficiently to meet any future contingency must be facilitated, not encumbered, by the supporting battle command information infrastructure.

Technical Architecture

To achieve this flexibility and interoperability, a technical architecture must be established to guide the definition, design, and development of Army/DOD battle-command systems. The TA is the framework that provides the definitions, standards, and protocols (i.e., the building code) for all system and/or subsystem design and acquisition.

To place the TA in perspective, we identify three types of architectures that are important to information systems in general, and specifically to the Army, for achieving its Force XXI objectives: These are the operational architecture, the system architecture,

Table 1.
Army Science Board Summer Study Panel Members.

Army Science Board (ASB) Members	Government Consultants
Dr. Michael Frankel (Chair)	
Dr. Phil Dickinson (Vice-Chair)	Mr. Bob Brynildsen (PEO CCS)
Dr. John Cafarella	Dr. Cass DeFiori (DISA)
Dr. Wm. Peter Cherry	LTC Chris Fornecker (AFCEA)
Dr. Gerald Godden	Col. Robert Forrester (SIGCENTER)
Mrs. Iris Kameny	Mr. Tom Hendrick (DISC4)
Dr. William Neal	Mr. Peter Kidd (SIGCEN)
Dr. Tom Rona	Mr. Paul Sass (CECOM)
Mr. Marty Zimmerman	
DSB Consultant:	**Army Staff Assistants:**
Dr. Don Latham	Mr. Errol Cox
	Mr. Tom Rogers

and the TA; and are defined as follows:

- ***Operational Architecture:*** *a description, often graphical, of the required connectivity between force elements: operations facility (OPFAC) to OPFAC, OPFAC to weapon systems, sensors to OPFAC/shooters, and the like. This description also includes the types and frequency of the information sent between those elements.*
- ***System Architecture:*** *a description, including graphics, of the technical characteristics and the interconnection of all parts of an information system. This description includes the identification of all system elements (radios, telecommunication switches, computers and the like); provides the specification of the bandwidth required between each element; the electrical interfaces on each element; schematics for hardware, software specification, and so on.*
- ***Technical Architecture:*** *a minimal set of rules governing the arrangement, interaction, and interdependence of the parts or elements that together may be used to form an information system, and whose purpose is to ensure that a conformant system satisfies a specified set of requirements. The TA is analogous to the building code for homes: It doesn't say* ***what*** *to build (user-> operational architecture), nor does it say how to build (developer—> system architecture); but it does say that when you build you must adhere to the set of rules/standards that it specifies—the standards the "building inspector" enforces.*

Several significant Army initiatives are aimed at establishing common standards and protocols for the Army Battle Command System (ABCS), including the ABCS requirements definition; the definition of the Army's Common Operating Environment (ACOE); Army Global Command and Control System (AGCCS) procurement; and the director of Information Systems, Command, Control, Communications, and Computers (DISC4) data-modeling initiatives.

Supporting experimentation as well as research and development (R&D) efforts are underway in the Battle Labs and in the Army Advanced Technology Demonstrations (ATDs). However, all these efforts lack a well-defined technical framework (architecture) and a management focus that will lead to the timely realization of the Army's requirement for a fully integrated (horizontally and vertically), robust, stable battle-command infrastructure—the infrastructure required for rapid, decisive victories in future operations.

The necessary framework must be established through the development of an Army TA. As we define it, the TA includes four elements: a human-computer interface (HCI) style guide; information standards; an information-processing profile; and an information-transport profile. These elements are defined as follows.

- ***An HCI style guide*** *is a specification that defines how the user-computer interface to applications feels, looks, and behaves. The purpose of the guide is to ensure that the interface to different applications on the same platform, or the same application hosted on different platforms, appears, and acts the same to a user. The look and feel includes sequence control (the actions taken by the user to direct the computer); data entry (the user action of entering data to the computer, and the computer response); data display (the display of data entered by the user, and the user's ability to control the display); and user guidance (feedback to the user for unsuccessful sequence attempts, or guidance on unfamiliar features). The development and use of an HCI style guide will ensure that the warfighter experiences a consistent interface to the ABCS irrespective of where he or she is on the battlefield.*
- ***Information standards,*** *derived by means of formal process modeling and data modeling techniques, include standard data definitions, a data dictionary to hold standard data definitions, and message standards. Process or activity models describe the ways in which an enterprise (for example, a force structure) conducts its business or mission. Data models, often developed in concert with process models, model the enterprise's data entities, attributes, relationships between entities, and the like, that are shared and common across the battle command infrastructure. Establishing these standards would ensure that ABCS elements are able to exchange and use information automatically. Thus, for example, information could be sent and processed from the Maneuver Control System (MCS) to Advanced Field Artillery Tactical Data Systems (AFATDS), and between or among the many other battle-command elements that the ABCS comprises.*
- ***The Information-Processing Profile*** *includes standards, conventions, interfaces, and methods to be used for the design, implementation, operation, and configuration management of domain-specific application software, generic application software, and commercial-off-the-shelf (COTS) open-system products. The Technical Architecture Framework for Information Management (TAFIM) Technical Reference Model (TRM), which is similar to the National Institute of Standards and Technology (NIST) Application Portability Profile (APP), shown in Figure 1, presents a*

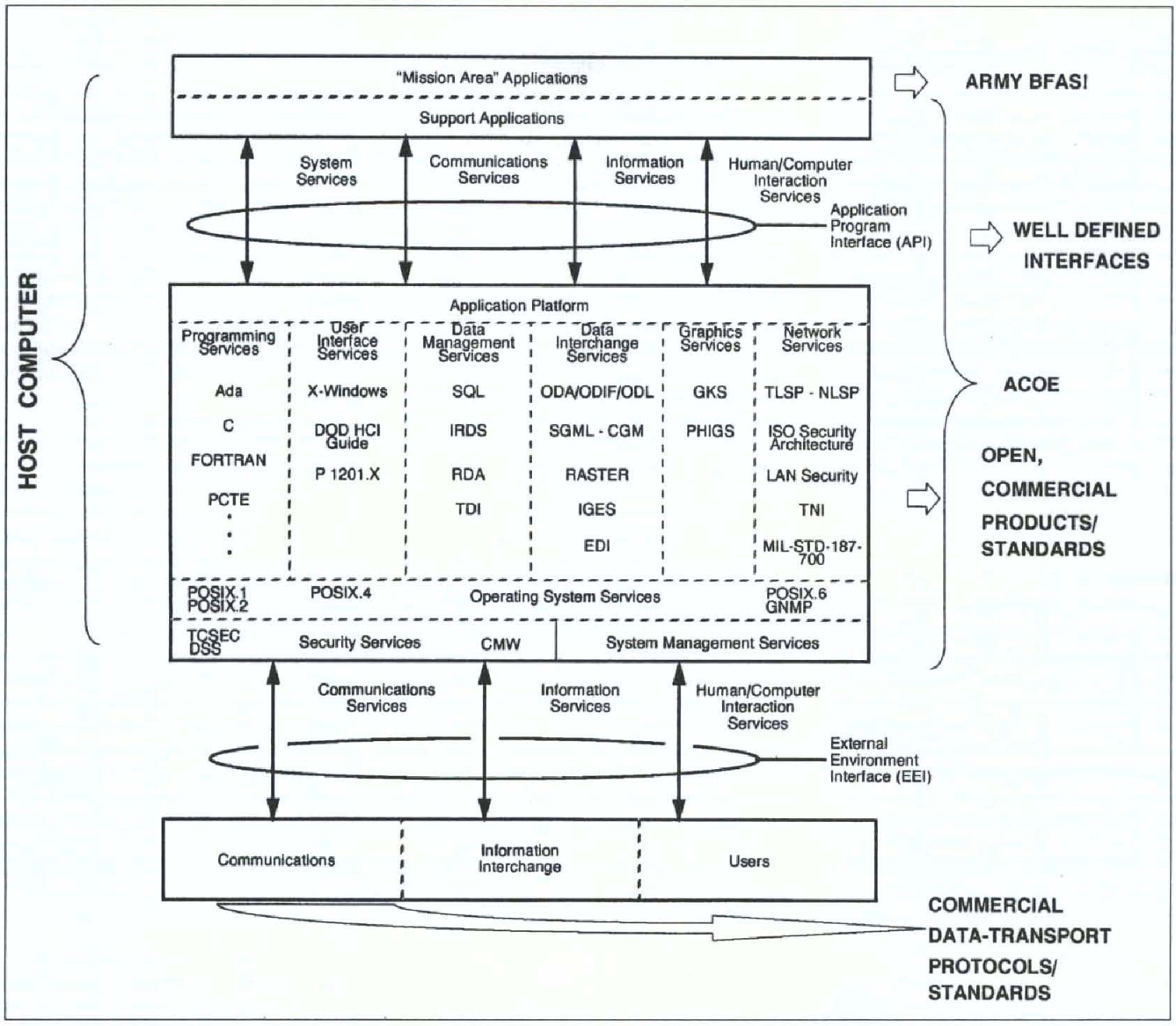


Figure 1.
Information Processing Standards for Technical Architecture.

layered view of appropriate software products and standards. The Defense Information Systems Agency (DISA) is identifying lists of COTS products that are conformant to the software standards at each level defined by the NIST APP. The information processing profile of the TA would include the ACOE as well as specific COTS subsystems drawn from the APP and TAFIM.

- ***The Information-Transport Profile** includes communication and network conventions and protocols to support the transport of bits across heterogeneous communication systems and between heterogeneous computing systems. If common transport protocols are used, the Mobile Subscriber Equipment/Tactical Packet Network (MSE/TPN), Enhanced Position Location Reporting System (EPLRS), Single Channel Ground and Airborne Radio System (SINCGARS), Joint Tactical Information Distribution System (JTIDS), Tactical Satellite Communications (TACSAT), and the like can be integrated into a seamless network of networks wherein data is automatically and dynamically routed from sender to recipients.*

The Army does not now have a TA. As a result of the Summer-Study Panel's interaction with senior representatives from the Training and Doctrine Command (TRADOC), the Army Materiel Command (CECOM-RDEC), and the PEO community, significant progress has been made in defining and establishing the architecture. Additional work remains, however, before the TA is documented and implemented.

The need for the TA is evident within the Army. Today, there is a multiplicity of message sets and mutually incompatible data elements across the ABCS elements in the battlefield. The Integrated Vehicular Information System (IVIS) concept, which demonstrated the value of making available intra-weapon-platform status information and the dissemination of real-time tactical situational information, is in fact a closed "stovepipe" solution that paid scant attention to commercial standards or compatibility with other Army battle-command systems. Similarly, the Army's aviation community is developing a mission planning system which does not utilize the ACOE. The aviation community must work closely with PEO-CCS and PEO-Communications to insure integration

of the mission planner with the ACOE.

Several other similar examples are cited in the panel's Summer Study report, which should be available from the ASB Office in early 1995. The cumulative conclusion drawn from these examples is that the lack of a TA, and central management to enforce it, has resulted in the multiple stovepipe systems and the ad-hoc interoperability solutions that exist today.

The current ABCS development process, the pressure to "Digitize a Brigade by 1996," and the lack of a TA will result in the achievement of short-term goals, but will surely fail to achieve the long-term Force XXI integrated, flexible, battle command system objectives. Earlier studies (ASB 1986, AF-SAB 1993, NSIA 1991, ASB 1992) have all reached similar technical and management conclusions for the Army, Air Force, Navy, and DOD as a whole. Their findings clearly support those presented in the next section.

Findings and Recommendations

Key findings of this study are as follows: (1) the conceptual and technical elements for developing a technical architecture are at hand and have been demonstrated in the private sector; (2) some elements have already been incorporated into DISA's TAFIM and the DOD data standardization program; (3) these elements can be applied to the Army technical architecture without significant security or availability risks; and (4) an Army TA can be developed and implemented at minimal expense within months.

We also found that success in institutionalizing the technical architecture will require the full commitment and support of senior Army leadership, as reflected in specific, urgent management actions. Urgency is important to avoid the continuing development "stovepipe" systems that will result from the current unfocused approach to ABCS definition, development, and acquisition.

The private sector invests tens of billions of dollars each year to develop protocols, standards, and technology for developing large, complex information infrastructures that are flexible and can accommodate thousands of users with widely diverse needs. The Internet is an egregiously successful example of such a system, tying together millions of users subscribing to many thousands of individual networks as shown in Figures 2 and 3. This rate of private investment is expected to continue in the foreseeable future; the Army should leverage its own efforts by adapting the conceptual and technical advancements being developed and used in this sector.

Internet protocols, standards, and technology have already been selected as the basis for the Defense Data Network (DDN) Mobile Subscriber Equipment Tactical Packet Network (MSE TPN), Defense Information Systems Network (DISN), Defense Secure Network (DSNET) and Defense Simulation Internet (DSI). They have not, however, been accepted for most ABCS elements. The reason for non-acceptance might be lack of management direction; the rationale for doing so—interoperability and interconnectivity at minimum risk and cost—is uncontestable.

The study's near-term recommendations (most of which are achievable in three months) are that the Army should: develop a technical architecture that exploits concepts and technologies from open-system commercial standards, protocols and products, and exploits the DOD TAFIM and DOD data-standardization program; that the TA be mandated in procurements for all elements of the ABCS. In our report we provide examples of specific protocols and standards that should be included in the Army's (DOD) TA. The TA will facilitate the realization of the Army's Force XXI by reducing risk, cost, and complexity in procuring ABCS elements (e.g., the Brigade 96 Applique, IVIS V2, AFATDS V2, AMPS, and the like); and by capitalizing on investments and rapid progress being made in developing information technologies in the private sector.

Our recommendation for immediate management action is that the Army designate a technical architect and establish this function as the single point of responsibility for the development and implementation of the TA. This responsibility, we recommend, should lie with the Army Acquisition Executive (AAE). The AAE should require all program elements associated with the ABCS to be built in accordance with the TA.

An Army system engineer and engineering staff should be assigned to support the technical architect in executing these responsibilities. A standing ASB Panel is proposed to provide periodic independent reviews and recommendations as the TA evolves. These management actions are part of a broader recommendation to streamline the management structure for the acquisition of *all* Army information systems. A flattened procurement executive officer (PEO) structure can facilitate the acquisition of systems in compliance with the TA.

With this focused commitment by senior Army leadership, up to 80 percent of the technical architecture could be in place within three months, and the remaining 20 percent available within a year when the definition of all battle-command data elements, and their associated dictionary, are established.

Given the thrust of Brigade 96 and the Force XXI vision, the Panel recommends that the Army take immediate action on current procurements. Specifically, the Tactical Multinet Gateway (TMG) and the SINCGARS Network Controller (INC) should be made Internet Routers and be required to adhere to Internet protocols and standards. All new-version builds for IVIS and the AFATDS, and, more generally, all the Battlefield Functional Areas (BFAs) and communication improvement programs, should be directed to be fully compliant with: Internet protocols and standards, the Army ACOE, the DOD TRM, and the evolving Army/DOD data-standardization programs. Further, the study team recommends that the Battle Labs and RDECs should require the use of the technical architecture for all C3I research, development and demonstration activities.

For the longer term (one to three years), the Army should evolve the TA to support

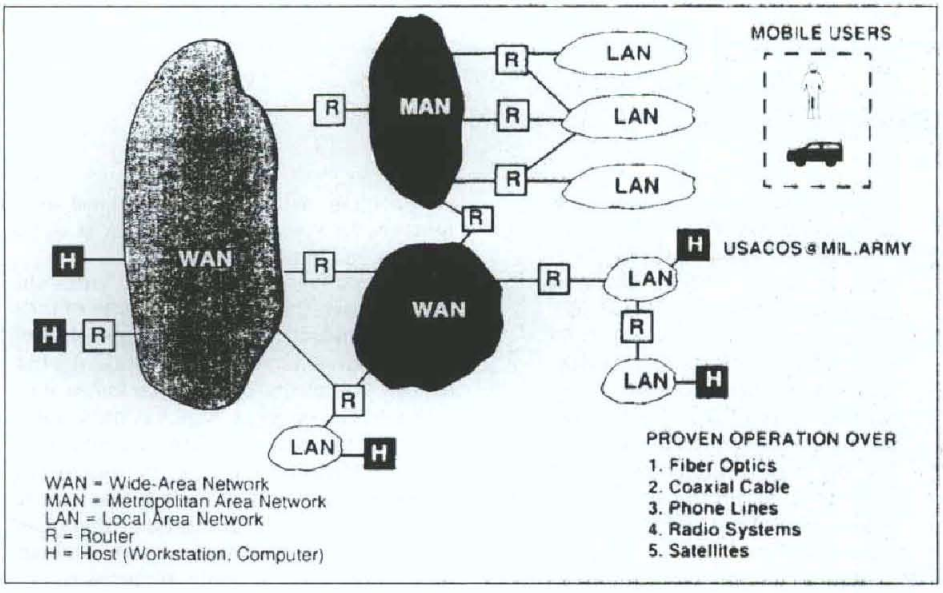


Figure 2.
The Internet Model.

object-oriented technology, distributed computing services, cellular communications, asynchronous transfer mode (ATM) telecommunications and direct broadcast satellite (DBS) systems—technologies that the commercial sector will integrate into the National Information Infrastructure in the near future.

Conclusion

The Army vision for Force XXI can only be fulfilled by developing, implementing, and enforcing a technical architecture, the framework necessary for realizing the digitized-battlefield concept and for exploiting the information technologies developed in the public sector.

Through the implementation of the TA and by establishing a management function to implement, enforce, and evolve it, the Army will benefit from having a battle command infrastructure that is flexible (facilitates force-structure planning and dynamic reconfiguration); interoperable (within the Army, with joint/coalition systems, and with the DISN, DSI and DSNET); extensible (can support many users and many different systems); cost effective (makes maximum use of common Army software and takes advantage of commercial information technologies through adherence and use of open standards, protocols, and products); and state-of-the-practice (can incorporate new private-sector technologies as they mature).

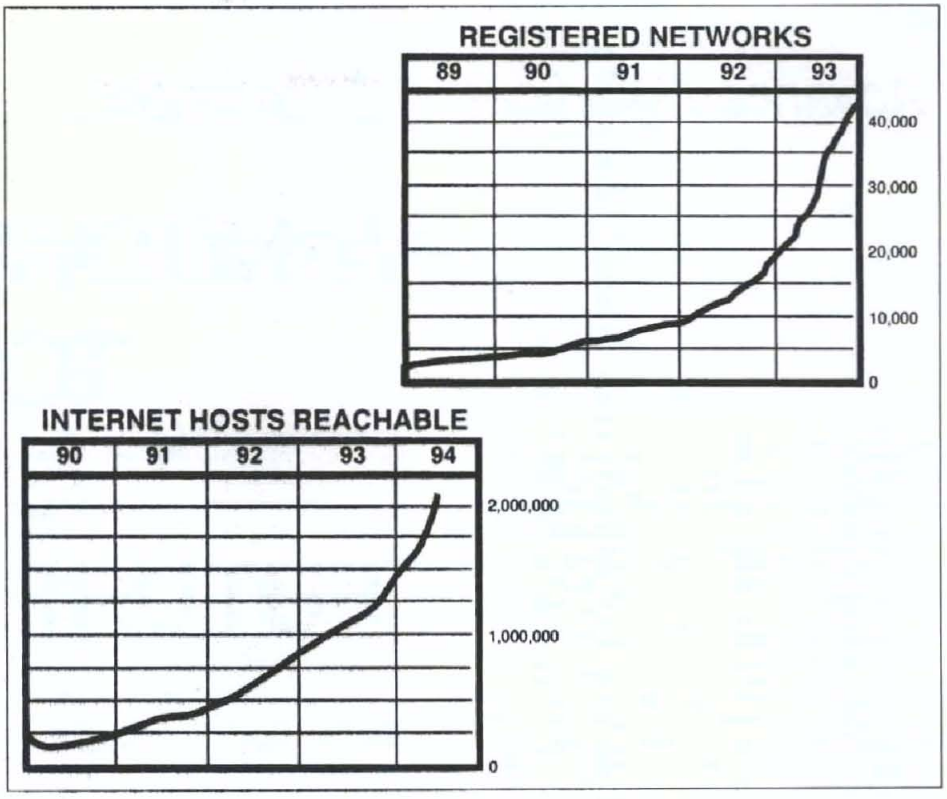


Figure 3.
Internet Success.

The Army vision for Force XXI can only be fulfilled by developing, implementing, and enforcing a technical architecture, the framework necessary for realizing the digitized-battlefield concept and for exploiting the information technologies developed in the public sector.

Implementation of and adherence to the technical architecture is possible without significant up-front cost and with substantial future cost avoidance. The time for action is now, before we commit scarce resources to acquire system upgrades and new products to support Brigade 96. The TA can lead to a successful digitized Brigade experiment with many products, technologies, and warfighter concepts that will support Force XXI vision. If we do not act now, the Army will remain in the information-processing backwaters, building unique stovepipe systems and continuing to attempt interoperability between them by buying costly, complex, closed black box solutions.

Author's Note: The reader is referred to our ASB Summer-Study Report entitled "Technical Architecture for Army Command, Control, Communications, Computers and Intelligence (C4I)" for an in-depth discussion of the many issues and recommendations presented above. The author is indebted to the many outstanding individuals who supported and/or interacted with the Summer-Study Panel, including LTG Peter Kind (DISC4), MG Bill Campbell (PEO-CCS), George Singley (SARDA), Robert Giordano (CECOM), Gene Famolari (CECOM), and Dr. William Evers (ASB).

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Advanced Warfighting Experiment . . .

WINDOW TO THE FUTURE

By BG Lon E. Maggart

In a world struggling with post Cold War concepts and a new national military strategy, the U.S. Army has been moving toward the 21st century for four years in a deliberate, but thoughtful, fashion. We have moved steadily from AirLand Battle doctrine to a force projection doctrine best described as "Full Dimensional Operations." The use of information age technology, techniques and procedures is key to this successful transformation. In fact, we can accomplish this transformation only by acknowledging the necessity for new organizations and new methods for accommodating change. We must leverage the strengths of people and technology in the process of change, and we must ensure that modern information technology, state-of-the-art simulations and realistic training are exploited to meet the requirements of soldiers and commanders in the field.

We must also recognize that training development qualifies as an equal to materiel development in this process. Because today's soldiers—at all levels—are the most educated and most disciplined we have ever had, the quality of their training becomes even more important.

Advanced Warfighting Experiment (AWE) 94-07, conducted in April of this year at the National Training Center (NTC) was a unique amalgamation of training and materiel development, tactics, techniques and procedures, and operational testing. Perhaps as importantly, AWE 94-07 was the catalyst for demonstrating how the Army must change the *way* it changes. This significant experiment in change was developed to test the hypothesis that advanced electronics capable of moving information rapidly around the battlefield will result in significant increases in lethality, survivability and tempo. In conjunction with current doctrine, tactics, and existing organizations, on a competitive battlefield, this experiment opened a small window from which we were able to view the future in a way never before possible.

We selected TF 1-70 Armor, from the 194th Separate Armor Brigade, as the experimental unit largely because of the large numbers of simulators and the technical and tactical expertise available at Fort Knox. Additionally, the Mounted Warfighting Battlespace Laboratory responsible for the experiment was located at Fort Knox. This combination of simulators, soldiers and experimenters most clearly describes the reason for the establishment of battlefield laboratories two years ago. At inception, battle laboratories were envisioned to combine experimentation, tactical and technical expertise, simulations, industry, academia and real soldiers and units at a single location to conduct experiments and develop concepts relevant to the needs of the Army. As a by-product, battle labs also provide an avenue to field equipment more rapidly, at reduced costs, and to devise force structures that can fight and win decisively on any battlefield.

In preparing TF 1-70 for the experiment, Fort Knox's virtual simulators were used to meet unit training requirements, in part because the experiment sought to determine differences in training outcomes between live and virtual simulations. As a result, TF 1-70 drove only 316 actual miles in preparation for the NTC compared to an average of 749 miles for the two rotations prior to and the rotation following AWE 94-07 that were designated as the baseline control group. By comparison, TF 1-70 fired 2,200 120mm tank main gun rounds in preparation versus 4,146 rounds for baseline units.

The goals of the AWE were to digitally link the entire battalion combined arms team; identify battlefield operating system (BOS) insights across DOTLMS for use in developing a manageable framework for Force XXI; and to determine the implications of information age technology on doctrine, tactics, techniques and procedures, training methods, and organizational structures.

The specific focus of the experiment was to identify information destinations required for a field commander to successfully conduct tactical operations. In addition, the AWE evaluated the impact of other advanced technology to include 2d Generation FLIR, telemedicine, Paladin and, through Operation Desert Capture II, the All Source Analysis System (ASAS). An elaborate data collection and evaluation plan was devised to assess both technical and warfighter insights on the "digital" battlefield. These insights were collected and formatted according to battlefield operating systems, with Battle Command as the overarching concept.

While AWE 94-07 provided enough thought provoking ideas to keep the entire Army busy for the next five years, there are several points worth special mention. The experiment revealed the necessity to identify information networks, dissemination and management requirements, and priorities for future study. It also helped us identify requirements for hardware design, and the software necessary to accommodate the needs of commanders on future battlefields.

Success on the battlefield is a function of understanding the total tactical environment, or situational awareness as it has become known. The experiment demonstrated that improved situational awareness significantly reduces the time to make more precise, timely, and tactically sound decisions.

Significantly, data from AWE 94-07 indicated that reduced casualties and greater force protection result from better tactical decision-making and situational awareness. For example, better situational awareness and the shooter to sensor linkage established between air defense radar and the task force Stingers allowed TF 1-70 to triple the number of enemy aircraft killed. By comparison, TF 1-70 lost only 1.7 systems to enemy air in each battle, while baseline units lost an average of 28.

AWE 94-07 provided the opportunity to evaluate IVIS, POSNAV, and other navigation aids. As a result of this equipment, TF 1-70 was able to get 7 percent more tanks and 28 percent more Bradleys into direct-fire battle than baseline units. TF 1-70 was able to fire slightly more artillery and mortar missions than the baseline as well. Despite these increases; however, battle outcomes were not decidedly superior to non-digitized units.

Clearly, there is more to success on the battlefield than firepower. We learned unequivocally that maneuver units must be expert in tactical fundamentals before the full impact of advanced information systems is realized!

The experiment illustrated the necessity for future system designs to provide more rapid access to accurate information from both higher and adjacent headquarters and that horizontal and vertical integration of data and systems compatibility are not just key, but essential. Future digital systems must permit an increased ability to conduct parallel or "collaborative" planning at each subordinate echelon. The near instantaneous sharing of common, but not necessarily the same, information at all levels is a critical factor in reducing the time consumed in decision-making.

In AWE 94-07, digitization increased the time available for planning at company team and platoon levels by nearly 30 percent as a result of their capability to do simultaneous and parallel planning instead of the sequential planning of baseline units. We also learned that the commander needs a hard print capability down to company level to give him both the capability of operating with non-digitized units, and back-up data.

The AWE demonstrated that the commander can better adjust the tempo of operations to match actual battlefield situations through the intelligent use of machines to manage information and share it with the right leaders at the critical times. AWE results described the ability to manipulate tempo through improved integration and synchronization of direct and indirect fires and combat multipliers, but only if the commander has the correct information. Overall mission planning time can be reduced accordingly.

There was considerable concern at the outset of the experiment that the task force commander, and perhaps others, would be overwhelmed with information. Because all of the object systems were not available at the time of the experiment, and communication networks often were lashed together, some nodes were overloaded from time to time. The potential for this to occur must be factored into future systems engineering. However, the volume of information potentially available to the commander will make it absolutely critical that we continue to develop information management systems, and provide information to the commander in a format that is no more difficult to use than current systems. This integration should span all of the battlefield operating systems and must facilitate tactical decision making in non-tactical environments like training, maintaining, and deployment operations as well. Clearly, linking systems digitally promises a synergistic battlefield effect.

The experiment demonstrated that task force information systems must be robust, redundant, and retain a conventional voice capability. Tasks associated with analyses, wargaming, route planning, and rail and air loading must be built into the software so that staff officers not necessarily trained in these disciplines can perform the functions easily and without special expertise. This capability will not totally eliminate the requirement for analysis at the brigade and battalion level, but may reduce the number of specialists necessary for success on the battlefield. This capability also may help reduce the size of staffs at all levels, a significant benefit in an era of rapid deployments.

Considering only the few points made above, it is clear from AWE 94-07 that with greater situational awareness, brigades, battalions, companies and platoons will know their locations and better understand their relationship to one another. Most importantly, they will know how all this relates to the enemy better than anytime in the past. As technological advances in information flow become a reality, situational awareness, tempo and force protection will increase. As these increase, parallel planning will improve to the point that sequential planning will become obsolete. The conventional allocation of the "one-third/two-thirds" rule for planning time will disappear as the entire force shares a common view of the battlefield.

AWE 94-07 showed that rapid decision-making will enhance the commander's ability to mass fires and forces at the decisive point in time and space. Improved situational awareness will reduce fratricide and allow for greater flexibility in formations, dispersion and maneuver. Indeed, initial efforts in training and situational awareness have already reduced fratricide incidents at the combat training centers by 40 percent.

Synchronization will become more visual through intervehicular information systems that allow the commander to see the entire battlefield quickly and accurately. Electronic map sheets will allow leaders at all levels to perform terrain analysis, develop operational graphics, and support dismounted, as well as mounted operations. Commanders will no longer be slaves to sporadic voice communications and the attendant inaccuracies that accompany them. Battlespace will be expanded at every echelon, allowing commanders to see, think and visualize beyond lines of sight. In addition, advanced information technology also offers significant potential for precision logistics. Automated reporting will provide for complete asset visibility and the movement of specific items and quantities when needed. Less and less of the commander's precious mental energies will be consumed with housekeeping chores.

Success on the battlefield is a function of understanding the total tactical environment, or situational awareness as it has become known.

In the final analysis, AWE 94-07 provided a glimpse into future battlefields where battle command, the art form, truly will supplant command and control, the science. On the next battlefield, all of the commander's mental skills can be used to defeat his enemy while information systems keep an eye on the management of things.

BG LON E. MAGGERT is the deputy commanding general, U.S. Army Armor Center and Fort Knox, and assistant commandant, U.S. Army Armor School. He holds a degree in political science from Kansas State University and an M.S. degree in industrial management from the University of Utah.

COMMAND AND CONTROL WARFARE AND INTELLIGENCE ON THE FUTURE DIGITAL BATTLEFIELD

By MG John F. Stewart Jr.

Introduction

We have entered a new era of third wave warfare in which information becomes a "currency of victory." Technology has taken us to the point that it is now possible to have a common view of the battlefield across all echelons and commands from which informed operational decisions can be made rapidly and conveyed to commanders to execute. Such visibility and enhanced command and control provides significant advantages which can be further leveraged if you can deny your adversary similar capabilities. Protecting your own command and control (C2) and countering your adversary's C2 are the two key elements of command and control warfare or C2W. Draft JCS Pub 3-13 describes these two elements as follows:

C2 Protect: "Seeks to deny or negate adversary efforts to destroy, disrupt, and/or deny information to U.S. and allied/coalition C2 systems."

Counter C2: "Seeks to prevent the effective command and control of adversary forces by denying information to, influencing, degrading, or destroying the adversary C2 system." Clearly, an effective C2W strategy is more than the ability to obtain more information and move that information more rapidly on the battlefield. As we look to the future and envision the battlefields in which U.S. forces will be engaged, we must keep in mind that there are two sides to the C2W equation. New doctrine, called information operations (IO), is being developed to integrate the many aspects of information into applicable military operations. Components of IO include: friendly and adversary battle command systems, C2W, intelligence, and the global information system. Success on the battlefields of the future will result from how well we integrate these components. We must consider friendly information operations as well as our adversary's information capabilities. We must not overlook the adversary's side of the information equation. We must be capable of engaging adversaries whose information systems may range from unsophisticated to state-of-the-art technology. We cannot assume that an overmatch in information systems technology will directly equate to success on the battlefield.

Critical Components

There are two critical components necessary to translate our technological advantage into military advantage on the battlefield. The first component is the capability to protect and use our information systems to obtain a knowledge based military advantage on the battlefield. The second component is the ability to understand the adversary's information capabilities in the context of the cultural and military use of information and therefore, effectively target that use of information. Intelligence has a major role in both components needed to transform the technological capabilities of the information age into military superiority on future battlefields.

We must be capable of engaging adversaries whose information systems may range from unsophisticated to state-of-the-art technology.

To support commanders, digitization of the battlefield presents a vertically and horizontally integrated picture drawn from tactical to national level information systems. The intelligence system provides the enemy portion of the digitized battlefield and plays an important role in protecting the friendly information system (FIS). Intelligence provides commanders with indications and warnings of the adversary's information attack capabilities and intentions. These indications and warnings allow him to focus and economize his protection efforts to ensure that we maintain the capabilities of the digital battlefield.

Additionally, the intelligence system provides the operational understanding of the value and use of information by the adversary. This fundamental understanding of the adversary is the most critical element in developing effective plans that enable commanders to attack the enemy's military and combat capabilities through his use of information. The ability to conduct C2W is not predicated upon the reliance of the adversary on technology, but on an operational understanding of his information system at a cultural and technical level. As warfare evolves in the information age, we must be careful not to trivialize IW and C2W simply as the ability to enhance or decrease the speed at which information is transmitted and displayed on the battlefield.

Digitization and Intelligence

The digital battlefield is a technical keystone in the capability of the U.S. Army to maximize its conventional combat power and operational effectiveness on the future battlefield. Military intelligence, as both a user and contributor to the digital battlefield, is evolving doctrine, organizations, training, leaders, material and soldiers (DOTLMS) to optimize digitization on the battlefield. The need to have this parallel evolution of DOTLMS actions outside the immediate scope of the digital battlefield is based on the understanding that information can confuse as well as clarify the situation. Therefore, we must develop methods, tools, and organizations outside the purview of the digital battlefield that allow us to effectively manage the mass quantity of information to produce focused intelligence for commanders. That focus is achieved by placing the commander at the center of the process in defining what information is required to clarify his knowledge of the situation and to make critical operational decisions. The commander drives intelligence. The connectivity that is achieved through digitization is then exploited to obtain answers to the commander's information requirements, and to provide him that information when he needs it to support operational decisions. Connectivity and access to national data bases will not lead to enhanced knowledge on the digitized battlefield unless we can effectively focus our resources on meeting the commander's critical information requirements on time and melding that information with operations. Thus, IEW synchronization melds intelligence with operations and force protection.

Protecting Friendly Information

As meaningful as it is for us to understand how to optimize the management of information on the digital battlefield, it is becoming increasingly important to protect this capability. The need to protect information and the digital battlefield will increase as the Army's dependence on information continues to grow, and information and knowledge become a military center of gravity.

The information systems and signal communities are largely responsible for the protection of the common elements of the infrastructure, or the backbone of the system. Each user is responsible for the protection of their component pieces of the system and the information within the system. The intelligence system supports the protection effort by identifying threat capabilities, intentions and actions to attack our information and information system. Intelligence will identify the capabilities of an adversary to conduct attacks on the FIS, and seek to predict how and where he will attack the FIS. The indications and warning of possible attacks on the FIS can then be used to prepare ways to defend against the attack, respond to the attack, or to exploit the attack when it occurs.

As we design our information systems to become more interoperable we must design safeguards into our information systems to prevent this connectivity and interoperability from being used against us to attack the commander's knowledge base. We must develop solutions across DOTLMS that give us the capability to identify when our information systems are being attacked, and allow us to respond to these attacks. The indications and warning that the intelligence system can provide, will only be effective if we develop ways to respond to the threat. The FIS must be capable of graceful degradation of functions (versus catastrophic failure), and must have the ability to isolate and repair information or information systems that have been attacked on the digital battlefield.

Information Attack

The second component of information warfare and C2W is the ability to effectively attack the military capability of the adversary through its knowledge base. Currently, intelligence capabilities, methods and organizations are being developed and implemented to meet the expanding demand for information and the increased operational role of intelligence in C2W. The intelligence system must be capable of performing intelligence preparation of the adversary information system (AIS) in terms of understanding the cultural nuances of information as well as technical aspects of the information infrastructure.

Information system intelligence preparation on the battlefield will identify how the adversary uses information to acquire knowledge, employ his military forces, and direct his combat power. Based on a thorough understanding of the AIS, the commander can then develop operations plans to attack the adversary's military capability through his knowledge base. It is important to again note that the concept of attacking an adversary through his use of information is not predicated on his dependence on modern technology to manage and distribute information.

The commander's intelligence staff will be in a unique position to develop plans for attacking the AIS and make recommendations on the appropriate attack system based on their understanding of the AIS at an operational and technical level.

The capability to conduct a detailed analysis of the AIS will require new research and development of analytical tools as well as the data base structure to support the increased requirements for technical information on C2 type targets. Detailed analysis of C2 targets will also drive requirements for specific attack capabilities and capabilities to conduct battle damage assessment on C2 targets.

The fundamental understanding of the role of information in military operations is the catalysis to developing effective C2W plans and developing the tools to support the execution of those plans to achieve decisive victory in the 21st century. Intelligence will play a vital role in the ability of the commander to exploit the digital battlefield and win the information war.

Conclusion

The digital battlefield will continue to evolve as the technological centerpiece of the U.S. Army in the 21st century. As the digital battlefield becomes a fundamental element of the commander's knowledge base, requirements to use and protect this capability will become critical to the success of military operations. In addition to the role of intelligence as a provider of information on the digital battlefield, intelligence will also provide critical indications and warnings to protect the use of this capability. As we have seen in the past, the efficient operations of the FIS is insufficient to guarantee success in C2W, if we fail to understand and effectively target the AIS. Intelligence will provide the commander with the ability to understand the AIS, develop effective plans to attack it, execute the attack, and assess the impact of the attack.

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A Turning Point in Modernizing the Army...

ACQUIRING THE DIGITIZED FORCE

By MG Joe W. Rigby

Information exploitation involves: minimizing the "fog of war" through the use of situational awareness information, decreasing decision-making timelines, optimizing the flow of command and control information, enhancing the orchestration of maneuver forces, and streamlining the target acquisition and engagement process.

The effective employment of precision strike weaponry depends on timely collection, interpretation, and distribution of information. To ensure land force dominance requires enhanced battle command systems, an improved ability to synchronize direct and indirect fires, better and faster access to intelligence data, and improved situational awareness leading to greater force protection. A smaller, continental, U.S.-based, force projection Army will be required to conduct high-tempo battlefield operations around the clock, over extended ranges. This force needs an environment in which all friendly forces share a relevant, common picture of the battlefield while communicating and targeting in real- or near-real time. Digitization will enable the Army to rapidly collect and exploit battlefield information to meet these needs. Information exploitation involves: minimizing the "fog of war" through the use of situational awareness information, decreasing decision-making timelines, optimizing the flow of command and control information, enhancing the orchestration of maneuver forces, and streamlining the target acquisition and engagement process.

Digitization is the integration of digital information technologies across the battlefield among combat, combat support, and combat service support systems and units. Such integration of information will allow the warfighter to maintain a clear, accurate, and relevant picture of the battle-space to support both planning and execution. The application of digital technologies can be tailored to the needs of each commander, war-fighter, and supporter, and allow commanders and staffs at all echelons to maintain a clear, accurate, and relevant picture of the battlespace.

Operationally, digitization will provide enhanced situational awareness with friendly and enemy force tracking; a common battlefield view; fratricide reduction; self-location and navigation; horizontal information exchange; target hand-over; and facilitation of force synchronization.

Organizationally, digitization applies within a platform and among platforms, throughout the combined arms team. The Army Battle Command System (ABCS) will provide vertical and horizontal command and control functionality at all levels from brigade to corps. Below brigade level, Force XXI, battle command, brigade and below (FBCB2) will be the primary command and control system which will provide situational awareness and operational command and control from the platform level up to, and interfacing with the ABCS system.

As part of the Army's digitization effort, there is an immediate need for a computer appliqué which can be applied to platforms which have not been digitized (e.g., M1A1, M2), or will not be digitized in the near future. The appliqué is a subset of the FBCB2 concept and consists of hardware and software elements.

The Army's Digitization Program is structured in two principal phases. Each phase will

be covered by a separate appliqué contract. During Phase 1, the initial program planning will be accomplished and a technical architecture defined which will support digitization of an armor heavy brigade task force. A designated brigade with a division control/support slice will then be equipped and trained for experimentation with enhanced digital communications and automated command and control systems culminating in an experiment identified as Brigade 96 (BDE-96). Some embedded command and control systems will be product improved while other platforms will be equipped with an appliqué.

Following the BDE 96 assessment, the appliqué system will be upgraded and deployed, under the same contract, to the remaining brigades and parent division headquarters. A division wide operational assessment will take place in FY97 which will constitute the final exercise prior to launching Phase 2.

Phase 2 will consist of equipping and training a complete corps package which will be awarded under a separate contract. The appliqué system will be recompeted and will include improvements based on lessons learned from the previous experiments, and will further provide a fielded, go-to-war capability. The program will then expand to include digitization capabilities to echelons above the corps.

The appliqué hardware will consist of, as a minimum, a computer processing unit, a display, and a data input device. Provisions have been made for the incorporation of peripheral devices such as printers and remote displays to accommodate user desires. An installation kit will also be provided, allowing the appliqué set to be mounted in or on a variety of platforms. The installation kit will provide for mounting, power, communications and interface cabling necessary for system operation on various platforms.

Three types of appliqué hardware will be procured, which include commercial off-the-shelf (COTS), ruggedized COTS and militarized versions. The proper mix in terms of quantity and platform requirements of these variants will be determined during the early experiments.

Maximum use of commercial standards vice military specifications and standards will be a major feature of this acquisition. This permits industry to provide quality products without going through the expense of using sometimes outdated requirements and allows the military to acquire the latest technologies that industry has to offer.

The appliqué software will be developed from baseline lower echelon command and control capabilities provided in the Brigade and Below Command and Control (B2C2) software system. This software package will provide the basis for the functionality as described in the FBCB2 Operational Requirements Document (ORD). Fundamental capabilities will include: situational awareness, execution of battle command, communications, and network management.

Operationally, digitization will provide enhanced situational awareness with friendly and enemy force tracking; a common battlefield view; fratricide reduction; self-location and navigation; horizontal information exchange; target hand-over; and facilitation of force synchronization.

The acquisition strategy for procuring the appliqué systems will be streamlined in both form and function. From a form standpoint, the appliqué acquisition will include limiting the proposal page count, keeping evaluation criteria to a minimum, relying on contractors to meet the minimum requirements, using highly qualified personnel as evaluators and using electronic media interchange for issuing the RFP and managing the proposal evaluation process. The use of existing military specifications and standards will also be minimized, allowing contractors to use commercial standards and common commercial practices, thereby cutting the cost in terms of time and required resources.

From a functional perspective, the acquisition will be streamlined by: significant use of modeling and simulation throughout the process; use of integrated (government and industry) product development teams; incorporation of dual-use technology; use of best value in source selection; and use of risk management vs. risk avoidance.

The contract strategy for this procurement action will be a full and open competition. Teaming will be encouraged due to the broad nature of the digitization requirement. Full service will be expected from the winning contractor(s). Single or multiple awards will be made based on "range bids." The winning contractor will also be responsible for the overall systems engineering and integration of the appliqué system onto a variety of platforms. The Source Selection Evaluation Board will consist of personnel with expertise on all platforms involved in the experiments and all PEOs will be represented.

The digitization program represents a turning point in modernizing the Army. Rather than procuring exotic hardware built from the ground up using military specs and standards, we are relying on industry, using the best commercial practices and standards, to provide our combined arms force with a capability never before demonstrated in modern warfare. The ability to pass a multitude of information rapidly, accurately, horizontally and vertically throughout the battle area will allow commanders to prevail at the decisive place at the proper time.

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ARMY AVIATION TECHNOLOGY AND CONCEPTS

By MG Dewitt "T" Irby
and Thomas House

Introduction

The Aviation Research, Development and Engineering Center (RDEC) and the program executive officer (PEO) aviation are the primary agents to forge the capabilities of Army aviation through the foreseeable future. The Aviation RDEC's (AVRDEC) R&D activity nurtures advanced concepts which may bear fruit in the future for the Army. The PEO aviation, on the other hand, takes emerging technologies and turns them into capable warfighting systems. The direction we both pursue rests on three foundations—the users' requirements, the Army chief of staff's vision, and the capabilities of our industrial base.

We match user requirements by working closely with our TRADOC user community at the Aviation Warfighting Center at Fort Rucker, AL, to insure that our soldiers get the equipment needed to fight and win. The "best" equipment to take to the battlefield is identified by looking not only at the lessons learned from Desert Storm, but also by looking ahead to the global environment toward which we are moving. Anticipated combat scenarios are developed and evaluated based on our current capabilities and future threats.

Our future fleet of Apache and Comanche aircraft, plus our digitization projects for navigation, command and control, and aircraft survivability provides real increases in combat capability for our soldiers and the combined arms team. Yet, as we went through these "what-if" exercises, our greatest frustrations were twofold: how do we get critical tactical data from its various sources to the commanders who need to use it in real-time, and how do we effectively share this information horizontally among the members of the combined arms team. Overcoming these two hurdles will allow the combat commanders to see the complete battlefield and to out-think the enemy by planning and executing before he can react to our actions.

5 Modernization Areas

Our efforts have become more focused as we work toward the chief's vision for modernization. In order for our combined arms team to achieve land force dominance, we must focus our efforts on five modernization overmatch areas: project and sustain, protect the force, win the battlefield information war, precision strike, and dominate maneuver battle. We see aviation as having a significant role in all five of these areas, especially winning the information war. GEN Sullivan has further defined his vision in what is called the "Force XXI" Army. He sees the future task force to be comprised of smaller building blocks where the combat edge will be leveraged from the people and the technology available. But the chief of staff has also said "... small is not better—better is better."

The keys to victory will lie not just in a smaller force with better weapons, but with a team which has uninterrupted command and control channels, superior operation planning, and synchronized application of power. These three concepts, which comprise "battle command," must operate efficiently in an extended high operational tempo environment as it controls forces which possess overwhelming lethality. Besides their high lethality, these forces will possess superior survivability and a real-time sense of situational awareness by seeing through the "fog of battle," i.e. maintaining a knowledge of battlefield positions for friendly and enemy forces and clear communications with the command and control structure. We read the Force XXI objective as: know where the enemy is, and where he is not—then press the fight to him at the places of our choosing and out-plan him while insuring he can't see what we're doing.

Fulfilling the chief's vision will provide the combined arms team with a decisive combat edge. In today's environment this will be an exceptional challenge. As defined, the force must be deployable, thus light, yet must counter an enemy with access to state-of-the-art equipment. We must use the existing communications and logistics infrastructure of the theater in which we're operating and we can-

not anticipate a new weapon system that will guarantee victory. Thus, the Army today is like a football team: slated to play all away games, where it is expected to win lopsided victories against equally matched opposing teams, receive no injuries to our players during the games and get everyone home fast.

Historically, on a milestone chart of system deployment, the AVRDEC and PEO aviation could be thought of as a single acquisition function. While the RDEC looked into the future to investigate and develop those technologies which may be applicable to aviation's interest, PEO aviation took those that were emerging from the concept stage and developed them into prototypes and fielded systems.

Long-Range Efforts

The AVRDEC's long-range digitization efforts are focused on development and integration of emerging technologies which take advantage of the tremendous computing power expected to be available to satisfy the aviation customer's needs. The Rotorcraft Pilots Associate Program is developing a cognitive-decision aiding capability to allow the aviator of the future to take full advantage of all of the information which will be available to him in the cockpit. Integrated fire and flight control will integrate the weapons firing and flight functions of the aircraft together through the use of advanced processing to reduce the pilot's workload, increase his weapons firing accuracy and reduce his engagement timelines.

Developments in the areas of advanced displays will provide the capability to present more information in a more usable form through the use of lightweight, highly reliable color displays with increased resolution. Image fusion techniques which allow the best image qualities of both FLIR and image intensifiers to be displayed simultaneously are now being developed, using the emerging increases in processing power.

Simulation capabilities which allow us to model the performance of these new systems in the constructive and virtual environments are being developed and matured today. Furthermore, as the vision of the distributed interactive simulation is realized, these same systems will be integrated and evaluated in live simulations (field exercises) prior to embarking on costly development programs.

The AVRDEC is working closely with the Communications-Electronics Command as well as the other Services' development activities to identify and embrace those technologies which have a high potential pay-off on the digitized battlefield. Examples of technologies being developed by other commands in support of aviation include high frequency radios, multi-function radios and antennas and mission planners. High frequency radios will allow long-range non-line-of-sight communications essential for aviation to take advantage of the information available on the modern battlefield while operating at nap-of-the-earth altitude.

Multi-function radios and antennas provide more communication capability at significantly less weight, allowing aviation to carry more processing capability or mission equipment. Mission planners will allow aircrews to quickly plan their missions prior to take-off and to quickly and automatically update those mission plans in flight as new threat or mission data emerges.

Within the PEO, we are moving forward on a multitude of fronts. The top effort continues to be the Comanche—the quarterback of the digitized battlefield. When this aircraft begins fielding in 2003, it will provide vast capability increases in the armed reconnaissance and command and control taskings which are assigned to aviation. The Apache Longbow will be our key weapons platform in the attack role relying on the target acquisition capabilities of the Longbow fire control radar and the "fire and forget" freedom of the Hellfire II missile. To maximize the effects of these weapon systems and achieve our goals in battlefield digitization, we are placing increased emphasis on six avionics projects:

- Global Positioning System inputs for position, heading, and communication timing,
- Improved high frequency radios for long range communications,
- Have Quick II improvements for secure and digital message capabilities for UHF air-to-air communications,
- The Improved Data Modem for target handover by digital messages through the Combat Network Radios,
- The Army Airborne Command and Control System to be installed on UH-60 aircraft for commanders from corps to brigade, and
- The Aviation Mission Planning System for rapid and effective mission initiation and mission rehearsal with digital map capabilities.

These projects, managed under traditional acquisition methods, are being shown as meeting the users' requirements, and this concept has worked well over the years as typified by composite materials, Doppler radar, and laser designators. When we look more closely at digitization technologies however, the "traditional role" can no longer satisfy the needs of the user in the future. This role change is necessitated by the reduction of time between successive releases of new and better technology.

While the DOD once was the primary consumer for advanced electronics, new generations are now being rushed into commercial production due to the competitive demands of commercial industry. The 14-year sequence of events from concept exploration to fielding falls apart in an environment such as personal computer processors, where three increments in capability have been introduced within the last year. Thus, a potential concept development project in an area such as advanced electronic miniaturization gets developed and offered commercially before our R&D funds even have time to get approved. If we keep the same acquisition paradigms, we are destined to always field yesterday's technology tomorrow—not fulfilling the overmatch goal to use tomorrow's technology today.

The TRADOC Battle Lab approach, evaluating the concepts of combat systems while they are still in the prototype phase, takes us in the right direction for shortening acquisition lead times while insuring the necessary DOTLMS changes are made so that the full potential of our technologies is realized by the user. Testing evolving concepts and

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experimental equipment under operational conditions provides invaluable insight into the real contribution of systems being planned for fielding.

The AVRDEC and PEO aviation plan to take advantage of this atmosphere of "try before you buy" and work as a combined team to accelerate our initiatives. This teamwork approach does not stop at St. Louis, but also extends to Fort Rucker where the user community will also be involved at all stages to insure that what is fielded meets the users' requirement.

Teamwork Concept

The teamwork concept between AVRDEC and PEO aviation has already begun and the connectivity with other organizations and agencies continues to grow. The scope of work ahead of Army aviation requires utilizing a multitude of diverse, specialized groups in working arrangements never considered before.

For example, during the recent NTC 94-07 exercise, the AVRDEC, PEO aviation and the Naval Research Laboratory (NRL) combined resources and skills to design, develop, prototype, install and demonstrate a digitized command and control console in the back of a UH-60A Blackhawk helicopter. The AVRDEC community worked in close cooperation with PEO aviation and NRL to document and integrate the prototype console. During the process, PEO aviation provided direction for programmatic issues, and acted as a direct interface with the NTC personnel, Fort Rucker, and AVRDEC.

The PEO aviation role was to ensure the system would meet the goals of the test and demonstrate the advantages of rapidly prototyped, and fielded technologies. NRL was a team member who had a uniquely designed and operating command and control console, as well as extensive working knowledge of digital communications.

The engineers at NRL worked closely with AVRDEC to resolve technical issues of integration, and connectivity between aviation assets. The AVRDEC worked as the system integrator to pull these diverse groups together. They provided personnel experienced in rotorcraft test engineering and test support, detailed engineering analysis for the physical integration and installation of the console onto the Blackhawk, and the Airworthiness Substantiation Document (ASD) development. This combined team brought to NTC 94-07 an airborne command and control system that had connectivity with modified AH-64 Apaches and OH-58D Kiowa Warriors never before experienced on the battlefield. This coordinated aviation team gave the warfighter decision-making tools and situational awareness information that will be crucial on the battlefield of tomorrow.

After the NTC 94-07 exercise, the combined team met with the users to analyze the lessons learned. This information is being disseminated to the growing team of governmental and industry members to provide insights as we move forward with the digitization process.

This fast-paced effort for NTC 94-07 reaffirmed the need to develop and strengthen the team atmosphere. As a result, we worked as a team in aviation to develop a "campaign plan" to reach the Force XXI vision. Planned technologies were evaluated and their impact on the aviation fleet in the year 2003 was our target. The result was the identification of Comanche and Apache technologies which may have additional benefits to the rest of the fleet, the importance of pressing for the fielding of the key avionics projects, and a need to strengthen aviation training and simulation efforts.

Conclusion

Even as we completed our plan, we knew that the other five functional areas were also developing their respective plans. We further knew that as the individual plans were executed, their effect would *not* be a combined arms team campaign plan. Rather, the campaign plans would need to be merged together before Force XXI would be achieved. To make this happen, a grass roots effort among the intelligence, armor, artillery and aviation functional areas was begun to develop a consolidated plan toward Force XXI. The "Team Battle Focus" Executive Steering Group had its first meeting in July 1994. The group brought many of the players of the combined arms team together for this united purpose. The meeting was composed of user representatives, Acquisition Corps, RDEC engineers, and Army headquarters staff. The members are committed to a cooperative effort to make Force XXI a reality.

Now is the time to begin. There is an atmosphere of cooperation among the combined arms team members that will result in combat systems which are successful in linking the force horizontally. The Aviation RDEC and PEO aviation will continue to push the envelope of technology and streamline the process by which it is acquired—to bring to the table the latest that industry has to offer. In this way, not only will aviation users be satisfied, but the combined arms team community will achieve Force XXI.

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ENABLING TECHNOLOGIES AND ADVANCED CONCEPTS FOR THE DIGITIZED FORCE XXI

By MG(P) Otto Guenther
and Robert F. Giordano

"The world isn't run by weapons anymore, or energy, or money. It's run by little ones and zeros, little bits of data. It's all just electrons . . . There's a war out there old friend, a world war, and it's not about who's got the most bullets. It's about who controls the information. What we see and hear, how we work, what we think, it's all about the information."

—Rooftop Scene Dialogue from 1992 Universal City Studios Film Release "Sneakers"

Introduction

Win the information war and digitize the battlefield are popular terms used to describe many things but, in general, these concepts mean the use of digital technology to exchange information in battlefield environments. This technology will be applied to automatically tailor the information to the needs of each decision maker (commander), shooter and supporter. The overall goal is to shorten the sensor-to-shooter cycle using a robust command and control system and seamless communications to enhance the commander's ability to make decisions in a timely manner.

High-tech sensors will be employed to see the enemy in all conditions, day or night. Sensor data will be fused, processed, correlated and compressed to create information which can then be distributed using digital communications technology and appropriately presented by command and control systems to effect decisions. The timeline from the sensor to the decision "to shoot" will become a critical factor in determining the outcome of battles.

Scenario

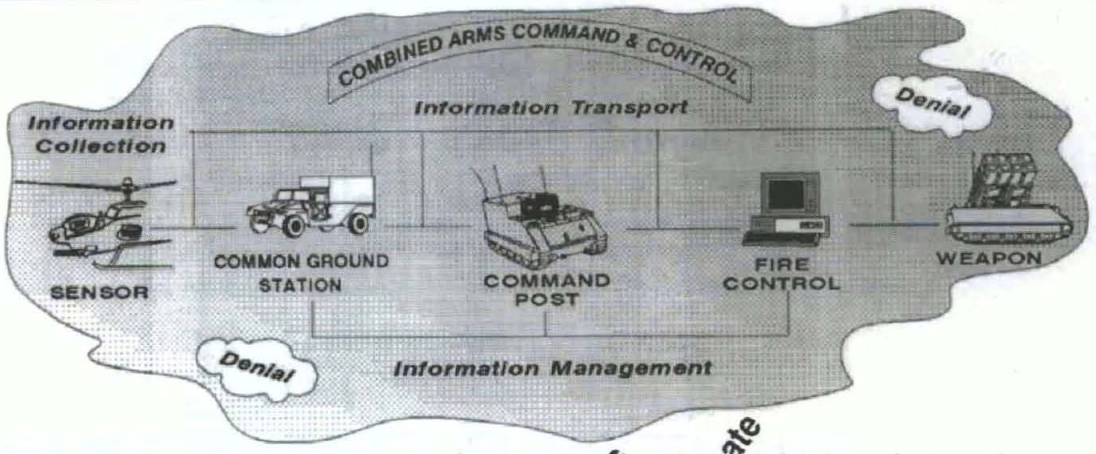
Consider the following real Jayhawk scenario from Desert Storm. On Feb. 26, 1991, the detection of an SA-2 surface-to-air missile site was determined to pose a threat to B-52 aircraft that were preparing to interdict the enemy on the "highway of death." Although Jayhawk Thunder resulted in the destruction of the intended SA-2 site, analysis of timelines showed that sensor-to-shooter time could be reduced markedly by assured seamless communications.

Information must be shared among those users who have a prioritized need for it and its flow must be seamless, integrated and transparent to that user. Jayhawk Thunder points out not only the need for seamless communications within the Army but also for joint seamless interoperability.

During Jayhawk Thunder there was an exhibited need for Joint Stars, the Army ground commander, fire support elements and the AWACS to be sharing information in a seamless manner. In Jayhawk Thunder, the sensor-to-shooter time was approximately 80 minutes. A goal was set to reduce this time to two minutes.

In April 1994, during the National Training Center Desert Hammer VII exercise, the Army combined Task Force 1-70 Armor and 3d Brigade, 24th Mechanized Division linked with digital technology across multiple battlefield functional areas. The Army learned about the power of the digital battlefield to enable commanders to synchronize actions on the battlefield by linking intelligence, fire support and ground and air maneuver. An example of this enhanced synchronization saw Paladin and mortars putting steel on target in less than three minutes with a one-minute projectile flight time.

Does this mean we've reached our two-minute objective in a mere three years? Of course not. We're talking about different echelons, different weapon systems, different



	Collect	Process	Disseminate	Display	Protect	Deny
Information Collection	X	X				
Information Transport			X		X	
Information Management		X		X	X	
Information Denial					X	X

Figure 1. Notional sensor-to-shooter link with functional information areas.

sensors, and joint operations versus Army only. Does it show the power that digitization brings to the Force XXI commander to exercise control over the battlespace, environment and tempo?—you bet.

Let's examine a notional sensor-to-shooter link and compare it with an information/decision cycle. Although the battlefield situations to be faced by the Force XXI commander will vary greatly in scope, battlespace, and intensity, two vital components are leading and deciding. To a great extent the somewhat simplistic detect, decide, destroy loop will still be valid. The Force XXI commander will gain the advantage over his adversary by assembling the best information in the shortest time and making the proper decision before his adversary.

Advanced Concepts

As the 90s wind down, the digital brigade and digital division experiments will become a reality, and the Army will start the evolution toward Force XXI. An advanced concept developed in 1988 by AMC, TRADOC, industry and academia at the Johns Hopkins Applied Physics Lab called Battlefield Information System (BIS) 2015, bears a revisit. The update of this concept to BIS 21 for the 21st century is remarkably current for Force XXI and the digitized battlefield. The BIS 21 concept is used by the information R&D community to describe the integrated (system of systems) digital battlefield of the 21st century. It consists of four main areas/functions: Information Collection (Intelligence/Sensors/Targeting), Information Management (Processing/Decision Making/Displays), Information Transport (Seamless Communications) and Information Denial (Electronic Combat and Electronic Protection).

Advanced concepts for the information collection, for example, include Aided/Automatic Target Recognition for air and ground platforms for improved, faster, more accurate target recognition and identification, during all weather, day/night operation. Enabling technologies include: forward looking infrared imaging multisensor fusion algorithm, synthetic science generation and radar return classifications.

Information management will encompass distributed systems providing automated information storage and retrieval from a common data base architecture and replication/display of real-time situational awareness and the battlefield picture. Enabling technologies include, data compression (fractal, MPEG/JPEG, wavelet), data base architecture/update/query techniques, decision aid algorithms, standardized icons, soldier machine hands free interfaces, high resolution flat panel displays.

The transport functional area will include numerous schemes for the communications links and networks that provide global, seamless, multimedia (voice, data, imagery, video) for all user (foxhole to White House notion) on the battlefield. Systems will be modular, mobile, survivable and adaptive. Features will include software waveform generation and re-programmability, self-learning, self-protecting, automatic routing and re-configuration and autonomous operational capability. Enabling technologies include tactical multinet gateways, commercial standards and technologies (e.g., SONET/ATM), high capacity local area networks, personal communications systems, small satellite platforms and ground terminals, direct broadcast satellite technology surrogate satellite technologies, interactive multimedia, video teleconferencing, wide band, mobile, efficient antennas, small efficient mobile power sources, mobile cellular technologies and component technology.

The information denial concept is comprised of signal detection and interception, signal counter-countermeasures (friendly protection), jammers and other electronic combat devices mounted on a variety of air/ground platforms aimed at denying the enemy's use of the spectrum and ensuring friendly use when desired.

For additional details, please refer to the article entitled, "Command and Control

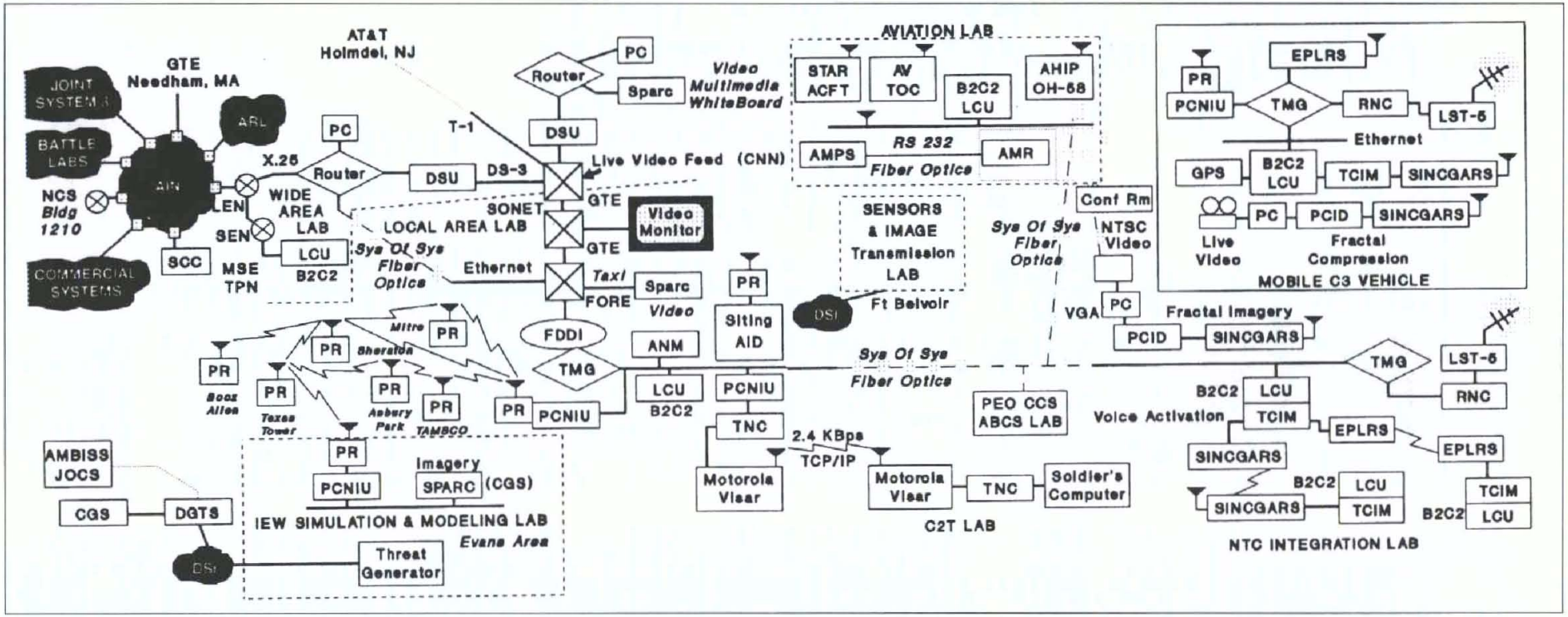


Figure 2.
CECOM Integrated Lab—Schematic.

Warfare and Intelligence on the Future Digital Battlefield," also in this issue.

In our simplified sensor-to-shooter example depicted in Figure 1, collection is carried out by single or multiple sensors. The information is correlated or fused at a location depicted here by the Common Ground Station. The information is distributed or transported to intended locations via a seamless network. Finally, management of the information allows data to be converted to knowledge by decision aids and presented to the commander to facilitate his decision-making capability. It is also important that we secure our sensor-to-shooter information cycle from the enemy and deny him access.

Implementation of the BIS 21 concept will provide commanders with the advantage of an integrated information service for the future battlefield.

Additional Information

Technology alone is not enough to ensure that the digital battlefield of Force XXI will become a reality. New management initiatives are being implemented in the R&D community involving the PEOs, CECOM, and ARL among others, which break down some of the existing stove pipe, paradigms and serial approaches to putting new technology in the field. Team Fort Monmouth has been formed consisting of CECOM, PEO Communications, PEO Command and Control Systems, PEO Intelligence and Electronic Warfare, Information Systems Management Agency and the Joint Interoperability Engineering Organization to capitalize on the synergism and technical expertise existing within the immediate geographic area. The formation of Team Digitization ("D") expanded the concept to include PEO ASM and PEO Aviation.

The C^3 research and development community has recognized that consumer/commercial electronics have increased in volume to the point that consumer needs vice military needs are the primary fuel of innovation. Our challenge is to capitalize on the opportunity to satisfy military needs with commercial products. To this end, the CECOM RDEC is aggressively pursuing strategic alliances with premier labs in industry and academia (e.g., AT&T, Sarnoff, GTE, Stevens Institute of Technology, Princeton, Etc.). Some key areas being addressed include: image compression, video processing and analysis, multimedia, direct broadcast satellite, wireless communications, data distribution, and asynchronous transfer mode switching. Note that many of these areas have direct "dual-use" applicability.

The basic research community in the Army is taking a similar approach with the formation of the Army Research Lab (ARL) Federated Lab and Information Sciences and Technology Directorate. The Federated Lab will link ARL, industry, academia and other government labs through open labs and personnel exchanges. The move toward commercial technology is further evidenced by the recent endorsement of the Army Science Board's recommendation to use Internet compliant commercial protocols to exchange information on the digital battlefield.

With its ability to rapidly prototype new C^3I architectures and interface with the Battle Labs, the CECOM Integrated Lab will provide realistic evaluations of new concepts in a timely manner.

One of the highest payoff initiatives is the creation of the CECOM Integrated Lab/Test Bed. The CECOM RDEC, with the support of the PEOs, has developed this dynamic, first-class integrated facility by electronically linking several key distributed RDEC lab facilities, selected industry, ARL and the battle labs. The facility can be rapidly reconfigured to replicate diverse existing and evolving tactical capabilities in communications, command and control, electronic and night vision sensors, and system integration. By capturing specialized expertise from industry and government, the lab will allow testing and evaluation of new prototypes and concepts in a simulated tactical environment. With its ability to rapidly prototype new C^3I architectures and interface with the Battle Labs, the CECOM Integrated Lab will provide realistic evaluations of new concepts in a timely manner. It is envisioned that this facility will become the technology test bed for the Digital Battlefield/Force XXI. See Figure 2 for a schematic of the test bed.

Conclusion

Force XXI will be organized around information. For the Army to win in the Force XXI environment, the technologies discussed above must be matured, harnessed and directed toward products useful to the commander. Continued investment by both industry and the military in new information technologies is the key to success. Battlefield information is rapidly becoming the most valued asset.

As Chief of Staff of the Army GEN Gordon R. Sullivan articulated on his March 1994 message on "Building the Force for the 21st Century," information will become the new "High Ground." He continues on to say, " . . . the main effort must be the development of concepts and designs for the Information Age Force. The supporting operation—which cannot fail—is the acquisition and assimilation of the technology to enable those concepts and designs."

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Military Deputy to the ASA(RDA) and Director, Acquisition Career Management
LTG William H. Forster

Deputy Assistant Secretary for Procurement
Joseph R. Varady (Acting)

Deputy for Systems Management and International Cooperation
MG Ronald V. Hite

Deputy Assistant Secretary for Plans, Programs and Policy
Keith Charles

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MG Thomas L. Prather

Deputy Director Acquisition Career Management
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George T. Singley III

Director Assessment and Evaluation
Dr. Herbert K. Fallin Jr.

Deputy for Ammunition
BG William R. Holmes

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M1A1 Abrams Tank System
Warren, MI
Product Manager
LTC John L. Gross

M1A2 Abrams Tank System
Warren, MI
Product Manager
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Designee
LTC George B. Patten

ARMORED GUN SYSTEM (AGS)
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Armored Gun System, Armaments (AGS ARMT)
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Product Manager
LTC George E. Mausen
Designee
LTC Foster G. Nickerson

BRADLEY FIGHTING VEHICLE SYSTEMS (BFVS)
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COL Joseph L. Yakovac Jr.

Bradley Fighting Vehicle Systems Command and Control Vehicles (BFVS-C2V)
Warren, MI
Product Manager
LTC Paul M. Wilson

M2/M3 Bradley Fighting Vehicle Systems
Warren, MI
Product Manager
LTC James C. Adams Jr.

COMBAT MOBILITY SYSTEM (CMSYS)
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COL Jack M. Paul

Heavy Assault Bridge (HAB)
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Product Manager
LTC Kenneth R. Dobeck

Improved Recovery Vehicle (IRV)
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LTC Joseph P. Murray
Designee
LTC Robert B. Lees Jr.

M1-Breacher
Warren, MI
Product Manager
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Gary Nenninger (Acting)

APACHE Modernization
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AVIATION ELECTRONIC COMBAT (AEC)
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Project Manager
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Avionics
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Product Manager
LTC Joseph T. Boylan

AVIATION LIFE SUPPORT EQUIPMENT (ALSE)
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Product Manager
John K. Shannon (Acting)

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COL James R. Snider (Acting)

T800/T800 Engine Growth Program
St. Louis, MO
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LTC Terrance L. Reininger

Comanche Crew Support System (CCSS)
St. Louis, MO
Product Manager
LTC Richard H. Langhorst

KIOWA WARRIOR
St. Louis, MO
Project Manager
COL Edwin P. Goosen

LONGBOW (AH-64D)
St. Louis, MO
Project Manager
COL Robert C. Atwell

Fire Control Radar (FCR)
St. Louis, MO
Product Manager
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Longbow Apache (LBA)
St. Louis, MO
Product Manager
LTC Robert T. Gunning Jr.
Designee
LTC Richard R. Ryles

UTILITY HELICOPTERS (UH-60A/L BLACK HAWK/EH-60A QUICK FIX)
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COL Chester L. Rees Jr.

COMMAND AND CONTROL SYSTEMS (CCS)
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Project Manager
COL Daniel L. Montgomery

Extended Air Defense Command and Control (EAD C2)
Redstone Arsenal, AL
Product Manager
LTC James R. Moran

Forward Area Air Defense Command and Control (FAAD C2)
Redstone Arsenal, AL
Product Manager
LTC Edward M. Siomacco

INTELLIGENCE FUSION (IF)
McLean, VA
Project Manager
COL Richard W. Johnson

ASAS/Software (ASAS SFT)
McLean, VA
Product Manager
LTC Edward M. Vigen
Designee
LTC Michael K. Hainline

Forward Sensor Interface Control (FSIC)
McLean, VA
Product Manager
LTC Robert C. Raiford

ARMY WORLD-WIDE MILITARY COMMAND AND CONTROL SYSTEM INFORMATION SYSTEM (AWIS)
Fort Belvoir, VA
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James H. Bray Jr. (Acting)

Strategic Army Command and Control Software (SACCS)
Fairfax, VA
Product Manager
LTC David J. Kirks

Standard Theater Army Command and Control System (STACCS)
Fort Monmouth, NJ
Product Manager
LTC(P) Barry E. Wright

COMBAT SERVICE SUPPORT CONTROL SYSTEM (CSSCS)
Fort Belvoir, VA
Project Manager
COL James R. Steverson
Product Manager Designee
LTC Stephen E. Broughall Jr.

COMBAT TERRAIN INFORMATION SYSTEM (CTIS)
Fort Belvoir, VA
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Digital Topographic Support System (DTSS)
Fort Belvoir, VA
Product Manager
David Thacker

Quick Response Multicolor Printer (QRMP)
Fort Belvoir, VA
Product Manager
MAJ William G. Foshay (Acting)

COMMON HARDWARE/SOFTWARE (CHS)
Fort Monmouth, NJ
Project Manager
COL Clarence B. Mitchell

Common Software (SW)
Fort Monmouth, NJ
Product Manager
Vacant

Standard Integrated Command Post System (SICPS)
Fort Monmouth, NJ
Product Manager
LTC Richard B. Allen
Designee
LTC Terence Fong

COUNTERNARCOTICS COMMAND MANAGEMENT SYSTEM (CN/CMS)
McLean, VA
Product Manager
LTC Stephen A. Monks

FIELD ARTILLERY TACTICAL DATA SYSTEMS (FATDS)
Fort Monmouth, NJ
Project Manager
COL Steven W. Boutelle

Advanced Field Artillery Tactical Data Systems (AFATDS)
Fort Monmouth, NJ
Product Manager
LTC Steven C. Moore

OPERATIONS TACTICAL DATA SYSTEMS (OPTADS)
Fort Monmouth, NJ
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COL Carl L. Lambeth

COMMUNICATIONS SYSTEMS
Fort Monmouth, NJ
Program Executive Officer
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TACTICAL RADIO COMMUNICATIONS
Fort Monmouth, NJ
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Enhanced Position Location Reporting System (EPLRS)
Fort Monmouth, NJ
Product Manager
LTC Steven A. Frith

GLOBAL POSITIONING SYSTEM (GPS)
Fort Monmouth, NJ
Project Manager
COL Sammie G. Young

JOINT TACTICAL AREA COMMUNICATIONS SYSTEMS (JTACS)
Fort Monmouth, NJ
Project Manager
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Communications Management Systems (CMS)
Fort Monmouth, NJ
Product Manager
LTC Robert A. Kirsch II

Communications Switching Systems (CSW)
Fort Monmouth, NJ
Product Manager
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MILSTAR (ARMY)
Fort Monmouth, NJ
Project Manager
COL William F. Jaissle

SATELLITE COMMUNICATIONS (SATCOM)
Fort Monmouth, NJ
Project Manager
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DSCS Control
Fort Monmouth, NJ
Product Manager
Ronald F. Johnson

DSCS Terminals
Fort Monmouth, NJ
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Tactical Satellite Communications (TACSAT)
Fort Monmouth, NJ
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Universal Modem
Fort Monmouth, NJ
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Dale G. Adams

ADVANCED FIELD ARTILLERY SYSTEM/FUTURE ARMORED RESUPPLY VEHICLE (AFAS/FARV)
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Advanced Field Artillery System, Armaments (AFAS ARM)
Picatinny Arsenal, NJ
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LTC Andrew G. Ellis
Designee
LTC Richard G. Kamakaris

Advanced Field Artillery System, Mobility (AFAS MOB)
Picatinny Arsenal, NJ
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LTC Wayne T. Fleming

AFAS/FARV Munitions and Resupply Product Development Team (PDT)
Picatinny Arsenal, NJ
Product Manager
LTC Bernard E. Ellis
Designee
LTC Michael K. McChesney

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Falls Church, VA
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Battlefield Combat Identification System (BCIS)
Fort Monmouth, NJ
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LTC James A. Wells

FIREFINDER
Fort Monmouth, NJ
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Second Generation FLIR Horizontal Technology Integration (FLIR)
Fort Belvoir, VA
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Fort Monmouth, NJ
Product Manager
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Warrenton, VA
Project Manager
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LTC Darell G. Lance
Designee
LTC Charles D. Gemar

Ground Based Common Sensor - Heavy
Warrenton, VA
Product Manager
LTC Stephen V. Reeves

Ground Based Common Sensor - Light
Warrenton, VA
Product Manager
LTC David P. Meriwether

Air Reconnaissance Low (ARL)
Warrenton, VA
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ARROW (ARW)
Huntsville, AL
Project Manager
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CORPS SURFACE TO AIR MISSILE (CORPS SAM)
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GROUND BASED RADAR (GBR)
Huntsville, AL
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Designee
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Fort Lee, VA
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Herb Andressen (Acting)

Objective Supply Capability (OSC)
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Stanford I. Polonsky

Standard Army Ammunition System (SAAS)
Fort Lee, VA
Product Manager
Paul B. Thompson

Standard Army Maintenance System (SAMS)
Fort Lee, VA
Product Manager
LTC Randal G. Tart

Standard Army Retail Supply System (SARSS)
Fort Lee, VA
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Designee
LTC Timothy R. Mallette

Standard Property Book System - Redesigned (SPBS-R)
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Product Manager
Richard J. Weis

Unit Level Logistics System (ULLS)
Fort Lee, VA
Product Manager
Nicholas L. Flaim

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Dr. James E. Tomlinson

STANDARD INSTALLATION/DIVISION PERSONNEL SYSTEM (SIDPERS-3)
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LTC Hugo Keyner

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TACTICAL MANAGEMENT INFORMATION SYSTEMS (TACMIS)
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Rob Ragans (Acting)

Automatic Identification Technology (AIT)
Fort Belvoir, VA
Product Manager
LTC Aaron R. Andrews

Personnel Electronic Records Management System (PERMS)
Fort Belvoir, VA
Product Manager
Mary Gail Martin (Acting)

THEATER ARMY MEDICAL MANAGEMENT INFORMATION SYSTEM (TAMMIS)
San Antonio, TX
Project Manager
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TACTICAL MISSILES
Redstone Arsenal, AL
Program Executive Officer
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AIR-TO-GROUND MISSILES (AGMS)
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Hellfire II
Redstone Arsenal, AL
Product Manager
LTC Richard D. Morris

Longbow Hellfire MissileSystem (Hellfire LB)
Redstone Arsenal, AL
Product Manager
LTC Donald E. Wilbourn

ARMY TACTICAL MISSILE SYSTEM (ATACMS) / BRILLIANT ANTI-ARMOR SUBMUNITION (BAT)
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Improved Army Tactical Missile System (IMP-ATACMS)
Redstone Arsenal, AL
Product Manager
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ATACMS BLK II
Redstone Arsenal, AL
Product Manager
LTC Keith Lenhard

Improved Brilliant Anti-Armor (IBAT)
Redstone Arsenal, AL
Product Manager (Designee)
LTC Robert F. Arnone

CLOSE COMBAT ANTI-ARMOR WEAPON SYSTEM (CCAWS)
Redstone Arsenal, AL
Project Manager
COL Robert E. Armbruster

Improved Bradley Acquisition Subsystem (IBAS)
Redstone Arsenal, AL
Product Manager
LTC William I. Nichols

Improved Target Acquisition Systems (ITAS)
Redstone Arsenal, AL
Product Manager
LTC Thomas M. Harrison

FORWARD AREA AIR DEFENSE (FAAD)
Redstone Arsenal, AL
Project Manager
COL Daniel M. Prescott

Air-to-Air Missiles (ATAM)
Redstone Arsenal, AL
Product Manager
LTC Jerry D. Craig

Ground to Air Missiles (GTAM)
Redstone Arsenal, AL
Product Manager
LTC Jed A. Sheehan

JAVELIN
Redstone Arsenal, AL
Project Manager
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LINE OF SIGHT ANTI-TANK (LOSAT)
Redstone Arsenal, AL
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Richard Paladino (Acting)

MULTIPLE LAUNCH ROCKET SYSTEM (MLRS)
Redstone Arsenal, AL
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Designee
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Multiple Launch Rocket System/Precision Guided Munitions (MLRS/PGM)
Redstone Arsenal, AL
Product Manager
LTC Kelley Griswold

Improved Fire Control System (IFCS)
Redstone Arsenal, AL
Product Manager
Robert G. Wilks (Acting)

NON-LINE-OF-SIGHT COMBINED ARMS (NLOS-CA)
Redstone Arsenal, AL
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COL Louis Kronenberger Jr.
Designee
COL Roy D. Millar

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Warren, MI
Program Executive Officer
COL W. John Stoddart (Acting)

FAMILY OF MEDIUM TACTICAL VEHICLES (FMTV)
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Project Manager
COL Michael W. Boudreau

PALLETIZED LOAD SYSTEM (PLS)
Warren, MI
Project Manager
COL James A. Wank

TACTICAL VEHICLE SPECIAL PROGRAMS (TVSP)
Warren, MI
Project Manager
John D. Weaver

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Program/Project/Product Managers and Commanders

HEADQUARTERS, AMC
Alexandria, VA
Commanding General
GEN Leon E. Salomon

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Designee
COL Andrew J. Fallon

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Redstone Arsenal, AL
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LTC William R. Fast

Test Equipment Modernization (TEMOD)
Redstone Arsenal, AL
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Vacant

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St. Louis, MO
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St. Louis, MO
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COBRA
St. Louis, MO
Product Manager
LTC Joseph E. Planchak

FIXED WING AIRCRAFT
St. Louis, MO
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LTC Randall W. Cason

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COL James B. Cross

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St. Louis, MO
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SOLDIER
Woodbridge, VA
Project Manager
COL William T. Meadows

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BG George E. Friel

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CHEMICAL DEMILITARIZATION
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Program Manager
Richard Misiewicz (Acting)

NBC DEFENSE SYSTEMS
APG (Edgewood Area), MD
Project Manager
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ROCKY MOUNTAIN ARSENAL
Commerce City, CO
Program Manager
COL Eugene H. Bishop

SMOKE/OBSCURANTS
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Product Manager
LTC George M. Birdsong

TECHNICAL ESCORT UNIT
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BG(P) James M. Link

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COL Jeffrey C. Kotora (USMC)

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Deputy to the Commander
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COL James Etchechury

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Designee
COL Walter B. Grimes

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Product Manager
LTC Craig B. Hanford

Close Combat Training Systems (CCTS)
Orlando, FL
Product Manager
LTC James Taylor

Combat Support Training Systems (CSTS)
Orlando, FL
Product Manager
LTC John W. Hoffman
Designee
LTC Stephen J. Kessinger

U.S. ARMY TANK-AUTOMOTIVE AND ARMAMENTS COMMAND (TACOM)
Warren, MI

Commander
BG Edward L. Andrews

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LTC Walter B. Reading

FUZES
Picatinny Arsenal, NJ
Product Manager
LTC Henry C. Keebler III

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Warren, MI
Project Manager
COL James D. Lenard (USMC)
Designee
COL Richard L. Owen (USMC)

M113/M60 FAMILY OF VEHICLES (FOV)
Warren, MI
Product Manager
LTC Audie D. Zimmerman

MORTAR SYSTEMS
Picatinny Arsenal, NJ
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LTC Fred J. Allen Jr.
Designee
LTC James B. Leahy Jr.

SMALL ARMS
Picatinny Arsenal, NJ
Product Manager
LTC William A. Laymon

TRAILERS
Warren, MI
Product Manager
Dennis J. Wend

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Arlington, VA

Commander
LTG Jay M. Garner

EXTENDED AIR DEFENSE TEST BED (EADTB)
Huntsville, AL
Product Manager
LTC James A. Relyea

STRATEGIC TARGETS PRODUCT OFFICE (STPO)
Huntsville, AL
Product Manager
LTC Dennis L. Patrick

THEATER TARGETS PRODUCT OFFICE (TTPO)
Huntsville, AL
Product Manager
LTC Edmund W. Libby

U.S. ARMY INFORMATION SYSTEMS COMMAND (ISC)
Fort Huachuca, AZ

Commander
MG Samuel A. Leffler

U.S. ARMY INFORMATION SYSTEMS ENGINEERING COMMAND (ISEC)
Fort Huachuca, AZ

Commander
BG Robert E. Wynn

ARMY INFORMATION SYSTEMS (AIS)
Fort Huachuca, AZ
Program Manager
BG Robert E. Wynn

Defense Communications and Army Switched Systems (DCASS)
Fort Monmouth, NJ
Project Manager
COL Dennis M. Moen
Designee
COL Kevin J. Cogan

Defense Data Networks (DDN)
Fort Monmouth, NJ
Product Manager
LTC Gregory H. Swanson
Designee
LTC Ronald P. Heuler

Small Computer Program (SCP)
Fort Monmouth, NJ
Product Manager
LTC Charles G. Schwoebel
Designee
LTC Laurianne R. Dubia

DEFENSE COMMUNICATIONS AND ARMY TRANSMISSION SYSTEMS (DCATS)
Fort Monmouth, NJ
Project Manager
COL Paul E. Wolfgramm

Defense Satellite Communication Systems Installations (DCSI)
Fort Monmouth, NJ
Product Manager
LTC Wellsford V. Barlow Jr.

Fort Belvoir Information Mission Area Modernization (IMA MOD)
Fort Belvoir, VA
Product Manager
LTC James H.W. Inskeep
Designee
LTC William D. Miller

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Pentagon
Project Manager
COL John W. Barnes Jr.

THEATER AUTOMATED COMMAND AND CONTROL INFORMATION MANAGEMENT SYSTEM (TACCIMS)
Republic of South Korea
Project Manager
COL Dean R. Nakagawa
Designee
COL Lawrence G. Arrol

U.S. ARMY INFORMATION SYSTEMS SOFTWARE CENTER (ISSC)
Fort Belvoir, VA

Commander
COL Ronald Burton

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Fort Detrick, MD

Commander
BG Russ Zajtchuk

USAMRMC UNIT COMMANDERS

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ARMORED SYSTEMS

By MG John Longhouser,
Wayne Wheelock,
COL James Barbara,
Elio Divito,
and Curt Adams

Introduction

The Tank-automotive and Armaments Command (TACOM) and the Program Executive Office—Armored Systems Modernization (PEO ASM), with support from an extensive industrial base, are responsible for the research, development, production, fielding, life cycle support and sustainment for most of the Army's tracked and wheeled vehicle fleet. With this responsibility has come an extensive background in the development of digitization technologies and automated command and control concepts, as well as a unique technical and programmatic understanding and expertise in the application of those technologies and concepts to ground combat vehicles.

History

Digitization of the battlefield for ground combat vehicles has its roots in the Battlefield Management System (BMS) concept, as developed by the U.S. Army Armor Center and School during the mid-1980s. The Armor Center's Directorate for Combat Developments at Fort Knox, in conjunction with TARDEC, CECOM and ARI, experimented with the application of digital data processing for the collection, analysis, synthesis and transmission of battlefield information over Combat Net Radios.

Concurrent with the BMS concept work was the development of the M1A2 Abrams Main Battle Tank, which included the Inter-Vehicular Information System (IVIS), a more limited version of the original BMS. At the same time, an R&D program was initiated as a potential pre-planned product improvement for the M1A2 which would implement the full BMS functionality. The program was called the Combat Vehicle Command and Control (CVC2) program.

Enhancements to the IVIS starter package were defined by the CVC2 program. They were: a larger message set with more detailed data elements; a full-color display with digitized Defense Mapping Agency (DMA) map information; and interfaces to other C2 networks, such as the Maneuver Control System (MCS) and the German counterpart to CVC2, *Integriertes Fuhrungs and Information System* (IFIS, Integrated Command and Information System).

The M1A2 IVIS implementation and the CVC2 program provided the foundation for the current revolution of "Winning the Information War" through digitization for the Army's ground maneuver forces. Refinements to the command and control system baseline laid out by the CVC2 program have provided critical information for the IVIS system in the M1A2 tank, the definition of the Brigade and Below Command and Control (B2C2) system, and the creation of a Combined Arms Command and Control (CAC2) program and Force XXI Battle Command - Brigade and Below (FBCB2). In addition, the CVC2 message set was used as the starting point for the current effort to define an Army-wide C2 variable message format.

Digitization: The Enabler

• **Weapon System Performance and Sustainability**—A weapon system does not consist solely of command and control. Its other functions—lethality, survivability, mobility and sustainability—must also be accounted for when technical capabilities are designed to satisfy system warfighting missions. Digitization has far-reaching impacts to the internal workings of a combat vehicle. It can enable capabilities such as: precision engagement of targets, control of engine and transmission functions, built-in test and reduction of off-vehicle support requirements, and automatic detection of and response to threats. Overall it enables automation of functions and increasing levels of combat vehicle capability and sophistication while maintaining manageable soldier workloads. It enables the soldier to be a warfighter rather than a hardware controller.

Combat vehicle digital hardware and software must control many on-board systems in real time and be able to meet performance levels and prevent failures that can have life and death consequences. This results in a very unique development paradigm, far removed from the Automatic Data Processing (ADP) world of most computer applications. A weapon system's total digitized capability is an amalgamation of real-time control systems and information processing needs. As such, it would be most analogous to a complex factory automation process, improved to operate faster and respond to unique events, and packages in a box so it can be mobile.

Meeting system level performance and supportability requirements, addressing space and cost constraints, and insuring soldier manageability of the system has created an interdependency among the vehicle subsystems. This interdependency results in a need for electronic integration. Effective electronic integration requires the vehicle subsystems to share electronic hardware resources and to share information among subsystem processes.

Sharing electronic hardware resources insures that only the minimum resources are employed to meet system requirements. This is critical to meeting space and cost constraints. Sharing information between subsystem processes contributes to improvements in warfighting capability. For example, digitization within the tank has allowed for automatic target handoff between the commander and gunner. This results in a dramatic improvement in lethality independent of direct enhancements to the lethality components (i.e. weapon, fire control, etc.). Also as a result of digitization, the commander can now plan a route and the driver receives it automatically with a steer-to-indicator. This reduces the need for subsequent interaction.

Providing the framework for electronic integration is the job of the electrical/electronic system architecture. The resultant combat vehicle architecture identifies a compatible and interoperable set of hardware and software elements. These elements can include the following: features—i.e. fault tolerance, open system; functions—i.e. data distribution, computer resourcing; partitioning—i.e. data buses, processor modules; relationships—i.e. software application user interfaces, backplane standards; and performance—i.e. data rates, data latencies. The electronic architecture is the infrastructure or "glue" for integrating the hardware and software. TACOM will be publishing a handbook which identifies and provides usage guidelines for electronic architecture standards compliant with the Army command, control, communications, computers and intelligence technical architecture. This handbook will be utilized by the ground vehicle community.

• **Automated Command and Control**—There is no question as to the value of accurate, timely battlefield information to a vehicle commander. Vitally important, however, is that some degree of automated filtering, or tailoring, of the information at each echelon of operation be performed. This will

assure that a commander is not overloaded with too much information, or given the wrong type of information. A commander is not a clerk at a data processing terminal.

An obvious benefit of digitization is the ability of a commander to create and disseminate battle plans and orders without having to physically bring commanders together. Communication during and after the battle is greatly enhanced also by the ability to transmit messages and reports quickly and accurately.

The seemingly simple notion of having a current, accurate tactical situation display showing friendly and enemy positions with map information will yield improvements in target identification and hand-off, reductions in fratricide, and savings in fuel and ammunition consumption.

Less obvious are the synergistic benefits created by the use of digital technologies from other vehicle subsystems. Inputs from the fire control system and laser rangefinder supply information for placement of obstacle and enemy locations on the tactical display. Linkage with the vehicle navigation system allows accurate friendly position information to be broadcast over the radio network at regular intervals. Access to detailed map information is provided through a mass memory storage device and is presented on a color flat panel or heads-up display. Human interaction with the C2 system can be accomplished through a keypad, cursor control, touch panel, or voice recognition and synthesis. All of these systems enable many sophisticated modes and states (not at all similar to PC Windows) and require careful MANPRINT considerations.

For example, a call-for-fire can now be sent via one touch with the following automated inputs: the sender and destination identification/frequency from on-board memory, position from the Pos/Nav, heading from the heading reference unit, off axis from the turret azimuth drive system, and range from the laser rangefinder.

A commander who knows precisely where his next destination is, and can accurately navigate there, will use less fuel during faster and more survivable maneuvers. The vehicle will accrue fewer miles of operation for a given mission, requiring less frequent maintenance. Logistical supply lines for vehicle maintenance will be reduced accordingly.

Improvements in day and night target identification can overwhelm one vehicle's ability to engage and fire on targets. A commander can now efficiently acquire targets and hand them off to nearby vehicles forming a coordinated, rapid paced assault with great improvements in combat effectiveness. A result of enhanced conduct-of-fire is reduced consumption of ammunition, thereby reducing logistical burden.

The use of automated logistical reporting can now become a reality for many of the supply needs of waging war. Sensors and built-in test (BIT) capabilities can monitor the levels of ammunition and fuel consumed, as well as general vehicle health. Troubleshooting of propulsion and weapons systems can be performed automatically, to a large extent, with spare parts being ordered by vehicle computers over the command and control network. Ideally, spares would be waiting at a maintenance point upon vehicle arrival.

An automated ground vehicle C2 system should collect, organize, display, prepare, and disseminate battlefield information to assist a commander in performing his mission. Database management and automation allow accurate display of the positions of friendly and enemy forces and obstacles, incoming and outgoing orders and reports, and immediate notification of warnings and alerts. Effective use of automation will result in a reduction of the routine workload placed on a commander allowing him to concentrate on creative and rapid decision making.

Message selection and symbology to be used are a function of the particulars of battle for a given user, with some degree of commonality required for interaction with other combatants. Message routing and filtering is largely predetermined with some exceptions for unusual circumstances. Incoming messages are prioritized according to urgency and importance since a commander's workload demands efficient use of time. Similarly, outgoing messages are sorted and placed in a queue until access to the radio network is attained. Those messages which can be generated and received automatically are processed transparently to the commander and are available for review as his schedule allows.

Digitization is truly the enabler for the warfighting machine. Battle command is not data processing. The use of digitization throughout the vehicle's subsystems yields improvements beyond the contributions of each individual subsystem. These benefits are multiplied yet again when individual vehicles are tied into a digital radio network capable of passing the proper type and quantity of information around the battlefield.

Meeting the Challenges

TACOM and PEO ASM have begun to meet the digitization challenges with innovative tech base and vehicle development programs. Programs such as the Crewman's Associate and AgileLOGS (Agile Logistics) are developing concepts that unburden the soldiers while expanding the vehicle digitization capabilities. Vehicle development programs like the M2A3 Bradley Fighting Vehicle upgrade and the M1A2 Abrams Tank upgrade are enhancing digitization capabilities while providing the core electronic capabilities needed to provide automatic and synergistic benefits to warfighting effectiveness. If the soldier is turned into a data input device for a computer, we will clearly have failed our mission. TACOM and PEO ASM are uniquely positioned to employ digitization in ground vehicles while maintaining a focus on the warfighter.

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MANPRINT AND THE DIGITIZED BATTLEFIELD

By MG Wallace C. Arnold

Introduction

Recent analyses have suggested that a revolution is taking place in the nature of warfare. These analyses are variously called Third Wave Warfare in *War and Anti-War* by Alvin and Heidi Toffler, or Cyberwar in "Cyberwar is Coming!" an article by John Arquilla and David Ronfeldt published in the April-June 1993 issue of *Comparative Strategy*. These analyses conclude that the explosion in information technology and its applications have changed the fundamental character of warfare.

In this new age, the outcome of warfare is increasingly dependent on the acquisition, control and effective utilization of knowledge. This includes gaining knowledge about the enemy and their disposition, maintaining knowledge concerning friendly forces and their status, using this knowledge to effectively target critical enemy nodes (e.g., with precision weapons) or to mass fires on selected targets, and controlling the information which the enemy has regarding friendly forces. Such knowledge is essential to maximize the effectiveness of massed firepower, troops and support resources, when needed. Other key characteristics of this new era include the increased speed of operations and decision making and the need to effectively distribute information both vertically and horizontally throughout the force.

The confluence of this information revolution and the changes in Defense force structure associated with the end of the Cold War have led the Army to adopt a force modernization strategy which is heavily dependent on advances in computers, communications and intelligence technology. Chief of Staff of the Army GEN Gordon R. Sullivan has established five strategic objectives to guide this modernization which are:

- Win the Information War;
- Dominate Maneuver;
- Execute Precision Strike;
- Protect the Force; and
- Project and Sustain Combat Power.

Achieving each of these objectives will depend directly on the application of evolving information technologies. A key part of this process is the recently established initiative for digitization of the battlefield.

Definition of Digitization

Digitization of the Battlefield involves the insertion of digital technologies across the battlefield among combat, combat support, and combat service support systems and units. The intent is to support the acquisition, exchange and utilization of information to allow the creation of a common, relevant picture of the battlefield. This will allow commanders and staffs at various echelons to maintain a clear, accurate and appropriate picture of the battlespace, using a common database, and operate with a shortened decision cycle. It will also provide warfighters and supporters with relevant, real-time information which allows them to more effectively conduct operations. Some potential benefits of digitization are listed in Table 1.

In terms of technology, digitization depends upon the effective integration of computer processing, advanced software, displays, man-machine interfaces, sensors, communications, combat identification, and position/navigation components. It will involve the movement of streams of digital data among force elements and across tactical, theater and national grids. It will take advantage of the continuing evolution of state-of-the-art information technology to aid the Army in maintaining a strategic and tactical advantage over potential adversaries.

Much of the emphasis to date in the digitization initiative has focused on the hardware and software required to support it. However, of equal, if not more, importance is the effective integration of the digital subsystem(s) with the soldiers who will operate and maintain it. Failure to address soldier-system integration issues early in the digitization program will result in sub-optimal or even negative effects in operations and/or maintenance of the systems being "digitized." These concerns fall within the purview of the Manpower and Personnel Integration (MANPRINT) program.

Table 1.
Potential Benefits of Digitization.

- Enhanced situational awareness
- Common battlefield view
- Accurate self-location/navigation
- Enhanced target handover capability
- Strengthened command, control, communications & intelligence
- Reduced fratricide
- Enhanced mission planning
- Improved force synchronization
- Enhanced asset management
- Improved target acquisition

MANPRINT Domains and Issues

The MANPRINT process focuses on integrating the system with the soldier, based on analyses and tradeoffs within and across seven domains which are: manpower, personnel, training, human factors engineering, system safety, health hazards, and soldier survivability. Implementation of the digitization initiative will require careful analyses across these domains to maximize benefits and minimize any negative impact on individual operators, maintainers, supporters, the fighting unit, and the force as a whole. Table 2 presents some representative issues associated with digitization for each of the domains.

There are also issues which involve tradeoffs between domains. One such issue is that of software complexity. In order to minimize operator requirements, the digital subsystem(s) can be designed to be highly "user friendly" (e.g., through use of menus, intelligent decision aids, etc.). This approach can reduce operator skill requirements and minimize training impacts. However, the additional software complexity to support such capabilities has clear implications for maintainers, in terms of skill and training requirements. The goal of the MANPRINT process is to balance such tradeoffs to achieve optimal overall system performance and effectiveness and minimize life cycle costs.

Lessons Learned

Although the digitization initiative is relatively recent in origin, emerging observations from the recently completed Desert Hammer VI Advanced Warfighter Experiment (AWE) at the National Training Center (NTC) offer some relevant insights into areas of potential interest for MANPRINT. This AWE, involving Rotation 94-07, attempted to demonstrate the potential contributions of digitization. All the elements of the friendly task force were digitized, to varying degrees. In some cases, this involved the use of existing, embedded system capabilities (e.g., the Inter-Vehicular Information System in the M1A2). In other cases, it involved the use of add-on computer/display/communications equipment to allow systems to acquire and exchange information in digital form.

Although there were some technical problems, in general the AWE validated the potential of digitization in terms of information availability. That is, commanders, staffs, crews and support personnel had access to increased amounts of information. The soldiers who participated were generally able to operate the digital subsystem(s) and to leverage their capabilities. There were specific examples of effective digital target handoff within the maneuver forces and productive use of enhanced situational awareness by the air defense artillery. Also notable was the availability of timely and accurate intelligence data. Most of the issues which emerged focused instead on information utilization. These issues can best be considered in the context of procedures, information management, leadership and training.

- **Procedures.** In many cases, the digitization subsystem(s) used in the AWE were new, developmental or experimental in nature. As such, standard operating procedures (SOPs) and tactics, techniques and procedures (TTPs) were lacking or limited. As a result, utilization of the available information was less than optimal. Further experimentation and analyses should provide the basis for the development of effective procedures. There is a clear opportunity here for the use of distributed interactive simulation (DIS) to support the development and validation of such procedures.
- **Information Management.** Given the volume and variety of information involved and the evolving structure of the information distribution network, it is not surprising that information management issues would arise. Problems were encountered such as failure to enter key information into the system, delays in transfer of critical information due to overloading of the network, failure to process information due to backlogs or to lack of prioritization, and inability to adapt to loss of key nodes. These shortfalls could be addressed in a variety of ways, including use of cues to alert crews to priority messages or to indicate network loading, development of SOPs to ensure relevant information is entered into the digital subsystem(s), and training commanders and crews to provide redundant capabilities to manage information in the event of loss of specific nodes.
- **Leadership.** The emergence of knowledge-intensive warfare has significant implications for the tactical commander. Accurate, effective situational awareness is a powerful tool. However, the challenge is that the commander must now develop skills in information management (e.g., knowing who needs the information, what information they should have, and when they need it) and battlespace visualization in order to take advantage of these revolutionary capabilities. One of the concerns emerging from the AWE is that the commander must be able to "fight

Table 2.
Representative MANPRINT Issues in Digitization.

MANPRINT Domain	Representative Issues
Manpower	• Impact on manning requirements for operations and maintenance • Potential for use of automation to reduce manning requirement for selected functions
Personnel	• Compatibility with existing military occupational specialty (MOS) skill requirements • Potential for system MOS requirement changes due to reallocation of functions
Training	• Minimizing requirements for additional, unique training for operators/maintainers • Common computer skill requirements
Human Engineering	• Effective presentation of information in presence of vibration, noise, movement, etc. • Impact of digitization on soldier workload • Effective "solder-information interface" (cognitive engineering of information)
System Safety	• Ensuring that integration does not compromise safety (e.g., effect of add-on equipment to ease of egress in an emergency) • Use of alerts, system status information, etc. to enhance safety
Health Hazards	• Ensuring that integration does not introduce potential health hazards (e.g., electrical shock) • Inclusion of appropriate warnings
Soldier Survivability	• Potential benefits of increased situational awareness, including fratricide reduction • Effects of digital subsystem(s) on system signatures

the war" as opposed to being a computer "junkie." Until commanders have sufficient experience with these emerging capabilities, there will be challenges in striking a balance between these functions and in avoiding potential workload problems. The solution here will involve a mix of training, improved ways of presenting information, and ensuring that commanders have appropriate, but not overwhelming, information available to them.

• **Training.** As in the case of procedures, the relative newness of the digital subsystem(s) and the limited exposure which the crews had received, constrained the amount of training which they had accomplished. This limited the soldiers' proficiency in operating the systems and in gleaning the maximum value from their availability. Training will clearly be a key element in optimizing the benefits gained from the digitized battlefield. Beyond familiarization training with standalone systems, DIS should provide a critical tool for gaining experience with digital subsystems in complex, unpredictable combat environments. For those systems where digitization is an "add-on," soldiers will also need to maintain proficiency with the older, analogue systems and the newer, digital systems. This will require additional training, at least until systems are upgraded to a fully digital status. Commanders and staffs will also require increased training on the variety of intelligence products available to them and their utility.

Conclusions

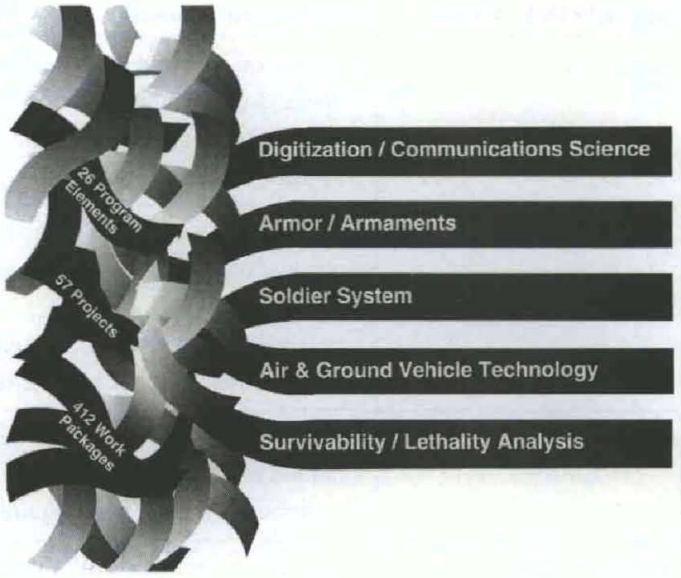
Digitization of the battlefield offers significant promise and challenges for the soldier. Application of the MANPRINT process is critical to ensure that the maximum benefit is achieved as the technology to support digitization is developed and implemented. Domain analyses will be required to identify and address critical issues. Research will also be needed in specific areas to support recommendations for solutions to key challenges such as effective interface designs, avoidance of information overload, adaptation to the changing organizational and operational environment, and development of effective training strategies.

The Army deputy chief of staff for personnel is committed to ensure that MANPRINT is an effective part of the digitization program. Optimal use of these emerging capabilities will depend upon the availability of quality soldiers who are prepared for the knowledge-intensive battlefield. Implementation of the MANPRINT process in digitization will ensure an effective balance between technology and the soldier in the growth toward Force XXI.

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The Army Research Laboratory . . .

A NEW FEDERATED LABORATORY PARADIGM



By John E. Holmes and Cynthia L. Tootle

Historical Background

The Army Research Laboratory (ARL) was originally conceived to be the corporate technology base laboratory for Army materiel with a predominantly in-house focus. This original ARL construct focused on the Army's vision, strategy, and objectives as captured in the Army Science and Technology Master Plan (ASTMP) at that time. Since then, the Army chief of staff's Force XXI vision and the ASTMP have increased the emphasis on information and the digital battlefield. This change in emphasis, along with funding and personnel reductions, necessitated a look at alternative means for conducting research and developing technology to support future soldiers.

The challenge for ARL is to capitalize on changes in the external environment and to focus on the research and technology areas that are unique to future land warriors, while re-engineering its processes and ways of doing business to gain flexibility and to become more business-like in laboratory operations. One study, conducted by the National Research Council Board on Army Science and Technology at the request of the commanding general of the Army Materiel Command, specifically looked at additional improvements for ARL.

The National Research Council report (The Army Research Laboratory-Alternative Organizational and Management Options) analyzed four organizational options:

- The ARL Enhanced option;
- The National Institute of Standards and Technology (NIST) option;
- The ARL Multicenter option; and
- The Government-Owned, Contractor-Operated ARL option.

These options and recommendations aligned very well with other forces for change such as the Government Performance and Results Act (GPRA) of 1993.

GPRA requires that the entire federal bureaucracy, by the year 2000, shift to a system of planning, performance accounting and budgeting based on measurable outcomes. Organizations will have to concentrate on effectiveness with a requirement to provide quantifiable measures of performance. Performance measurement in research and development is notoriously difficult. It has been studied for decades with only minimal success. Yet, the requirement for such measures has only increased in recent years with the GPRA bringing the issue to a head. Recognizing that such a radical change in how the many federal agencies conduct their business will be difficult, the GPRA authorizes pilot projects to experiment with this type of performance measuring and reporting. Beyond this, the act allows for pilot projects in which management flexibilities can be granted by waivers to various administrative regulations and procedures in order to measurably improve performance.

ARL has been approved by the Office of Management and Budget as a GPRA pilot project. With this approval, ARL became a unique addition to the more than 50 other pilot projects as it is the only research and development organization to accept the challenge and scrutiny that the GPRA brings. ARL will be breaking new ground in this role for all government research and development organizations to follow. As a GPRA pilot project, ARL is preparing a performance plan for FY 95 and a proposal for a set of waivers to be granted in order to increase the effectiveness of laboratory operations.

As a result of the National Research Council study, ARL's selection as a GPRA pilot, and many follow-on discussions among retired generals, and personnel from the Army Materiel Command, the Office of the Assistant Secretary of the Army for Research, Development and Acquisition, the Defense Science Board, and the Office of the Secretary of Defense, a decision was made to take one more bold step and convert the ARL into a federated, more open laboratory.

The New Paradigm

The federated laboratory concept—a new paradigm for ARL—is designed to meet the realities of the post-Cold War environment. The downsizing of the Department of Defense and the resultant increase in excess capacity in government, industry and university research and development sectors provide an opportunity for ARL to collaborate with external centers of technical expertise in new and unique ways. The basic construct of a federated laboratory is: to continue strong in-house involvement to meet Army-unique requirements where there is little external expertise in the technologies; and to forge direct associations with industry, not-for-profit, and university laboratories with recognized competencies in specific technology areas where the centers of expertise are outside of the government and where the potential of the technologies has a much broader, dual-use application.

When operating within the new paradigm, ARL will:

- Rely heavily on partnerships with universities, not-for-profit organizations, and industry where they have the lead and commitment, integrating their work with ARL in-house capability to effect transition to the Army and to ensure that the Army will be a smart buyer and user of the technology;
- Utilize this opportunity to achieve flexibility in getting into or out of different technical areas;
- Maintain a strong in-house capability for Army-unique areas where there is little investment or interest outside;
- Create an open laboratory where government researchers work at industry and academia sites and vice versa;
- Expand routes of technology transition to a wider set of users, i.e., all of the customers of the external elements, both public and private;
- Utilize the Training and Doctrine Command Battle Laboratories to help prioritize ARL's technical program; and
- Increase the ARL funding in the private sector.

The federated laboratory concept will result in three significant changes to ARL and radically alter the way it conducts its business. The first, and most far-reaching change, is the formal creation of a multicenter external operation which links the government and the private sector in an ARL federation. Second, the ARL organizational structure will be modified to more clearly address the problems associated with digital telecommunications and battlefield command and control by establishing an additional Directorate for Information Science and Technology. The third significant change is that ARL will focus its resources on five specific thrust areas. (See accompanying figure at the top of page 42.) The group of the ARL directorates at Aberdeen, MD, will maintain a predominantly in-house program focused on armor and armaments and soldier systems technologies due to their unique Army requirements and internal expertise; the group of directorates located at Adelphi, MD, will have a predominantly external program focused on digitization and communications science for digitizing the battlefield. The remaining directorates, focusing on air and ground vehicle technology and survivability/lethality analysis, remain essentially unchanged.

Competitive Processes

Competitive processes will be utilized to select from the nation's best industry, university, and not-for-profit laboratories that will become external components of the ARL under this new construct. It is likely that a combination of contracts, cooperative agreements, and grants will be used as vehicles to bind these external components into the federation. The external laboratories will be considered as an integral part of the ARL program, participating in partnership with the internal government elements. One goal of the open laboratory is that about 20 percent of the government science and technology staff will be serving tours of approximately one year in the private-sector laboratories and vice versa.

Major Changes

Two major changes are being made to the internal organizational structure of ARL. The first is the creation of the Information Science and Technology Directorate. This directorate seeks to provide the fundamental science necessary to exploit the information technology explosion, close the opportunity gap that exists between military and commercial information systems, and support the Army chief of staff's modernization strategy to digitize the battlefield and win the information war.

The primary customers of the new directorate's efforts will be the Communication-Electronics Command's Research, Development, and Engineering Center which is the lead materiel developer for digitization technology and the Simulation, Training, and Instrumentation Command which is responsible for modeling and simulation.

The second new directorate is the Physical Sciences Directorate. This directorate will focus on basic research in areas such as optoelectronic hybrids, optical interconnects, electrochemistry, microelectromechanical structures, nanofabrication, and others, that provide the foundation for leap-ahead technologies. The creation of these two directorates will be accomplished within existing manpower limits by realigning personnel.

Directorates with primarily an external program include: Information Science and Technology, Advanced Simulation and High Performance Computing, Sensors, Battlefield Environment, Vehicle Structures, and Vehicle Propulsion Directorates. These directorates will place about 60-80 percent of their resources outside with the remainder used to maintain an in-house core competency and perform the smart-buyer role. The emphasis for these directorates will be on multicenter external modes of operation with substantial personnel exchanges with their partners in the private sector.

The directorates at the two National Aeronautics and Space Administration sites (Vehicle Structures and Vehicle Propulsion Directorates) are also highly leveraged in that they have a 30-year-old agreement for the shared use of National Aeronautics and Space Administration facilities, cooperative research, and people.

Directorates with primarily an in-house program include: Weapons Technology, Survivability/Lethality Analysis, Human Research and Engineering, and Materials Directorates. These directorates will utilize about 60-80 percent of their resources in-house because of their recognized internal expertise, capabilities relative to other laboratories, and the uniqueness of their work and relationship to the Army. Under the new paradigm, these directorates will also be linked to industry, academia, and other government laboratories (although to a lesser degree) and also gain greater leverage through open laboratory programs and personnel exchanges.

Conclusion

The general plan is to make the changes as fast as possible. This means immediately starting to change the culture of ARL; conducting procurement activities to select the external laboratories; and crafting personnel plans (for hiring, training, and reductions) that meet the needs of the future federated laboratory. The implementation of a multicenter, federated lab—the heart of this concept—is expected to take place during FY 95.

The end result, a federated Army Research Laboratory, will be a unique entity within the Department of Defense. It will draw upon the best of the public and private sectors to produce the research and technology needed for present and future Army land warfare systems.

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TRAINING FOR FORCE XXI TECHNOLOGIES

By Dr. Kathleen A. Quinkert
and Dr. Barbara A. Black

Force XXI synthesizes the science of modern computer technology, the art of integrating doctrine and organization, and the optimization of quality people with the goal of creating new combat formations operating at even greater performance levels in speed, space, and time.

Introduction

The end of the 20th century has ushered in the information age, an age characterized by an explosion of technological capabilities in search of applications. The central focus of these new technologies is the application of knowledge, and it drastically changes how the Army views terms such as: information, intelligence, and command and control (Battle Command). Futurists such as the Tofflers refer to this age as the "Third Wave" and indicate that, even though it is already underway, full implications are far from understood. Nowhere is this statement more profound than in its implications for Army training.

Army Chief of Staff GEN Gordon R. Sullivan has stated that while the Army is undergoing constant change, the basic vision remains firm— "America's Army, Trained and Ready, Serving the Nation at Home and Abroad, A Strategic Force Capable of Decisive Victory, into the 21st Century." But what does the 21st century hold? Army leaders, determined to achieve this vision, have developed a campaign plan incorporating major advances in information technology, called digitization, under combat, combat support, and combat service support vehicles and systems into a program called Force XXI.

Force XXI synthesizes the science of modern computer technology, the art of integrating doctrine and organization, and the optimization of quality people with the goal of creating new combat formations operating at even greater performance levels in speed, space, and time. Goals such as this require a change in how the Army does business. Digitization will provide capabilities for automated tactical reporting, enhanced position location of friendly and enemy forces, and improved target acquisition and surveillance.

The potential for improved situational awareness and the enhanced capability to issue rapid commands should ultimately allow commanders to operate inside the enemy's decision cycle and thereby disrupt his operations. However, information technologies are double edged swords. They have the potential to greatly enhance and improve combat effectiveness or to overload and cripple unit operations.

A challenge facing the Army is to ensure these technologies enhance combat effectiveness—they should not be purchased simply because they are available. This challenge can be better met through the consideration of the soldier in materiel design and by developing appropriate training in time to determine any new system demands on human operators and ultimate system effectiveness. These determinations require a solid research foundation. The Army's intended application of information technologies to battlefield systems in Force XXI cuts across a diverse number of systems and battlefield functional areas.

To understand both potential benefits as well as potential pitfalls it is necessary to "tinker" with these capabilities before they are put on the battlefield. These tinkering efforts are described in the Force XXI campaign plan as intermediate objects or Advanced Warfighting Experiments (AWEs). They include constructive and virtual simulations, as well as field trials designed to evaluate system performance using prototype or applique equipment and to determine their effects on doctrine, organization, training, leaders, materiel, and soldiers (DTLOMS).

AWEs impose changes to the normal way of doing Army business. To date, they have focused on materiel, leaving units with the responsibility to not only train fundamental warfighting skills but also to figure out how to utilize a large number of components for which there is no training program or previously established tactics, techniques, and procedures (TTPs).

Training is the glue that holds the Army together and has continually been demonstrated as a major contributor to the success of battles of the past. Training was responsible for the edge that led to victories in

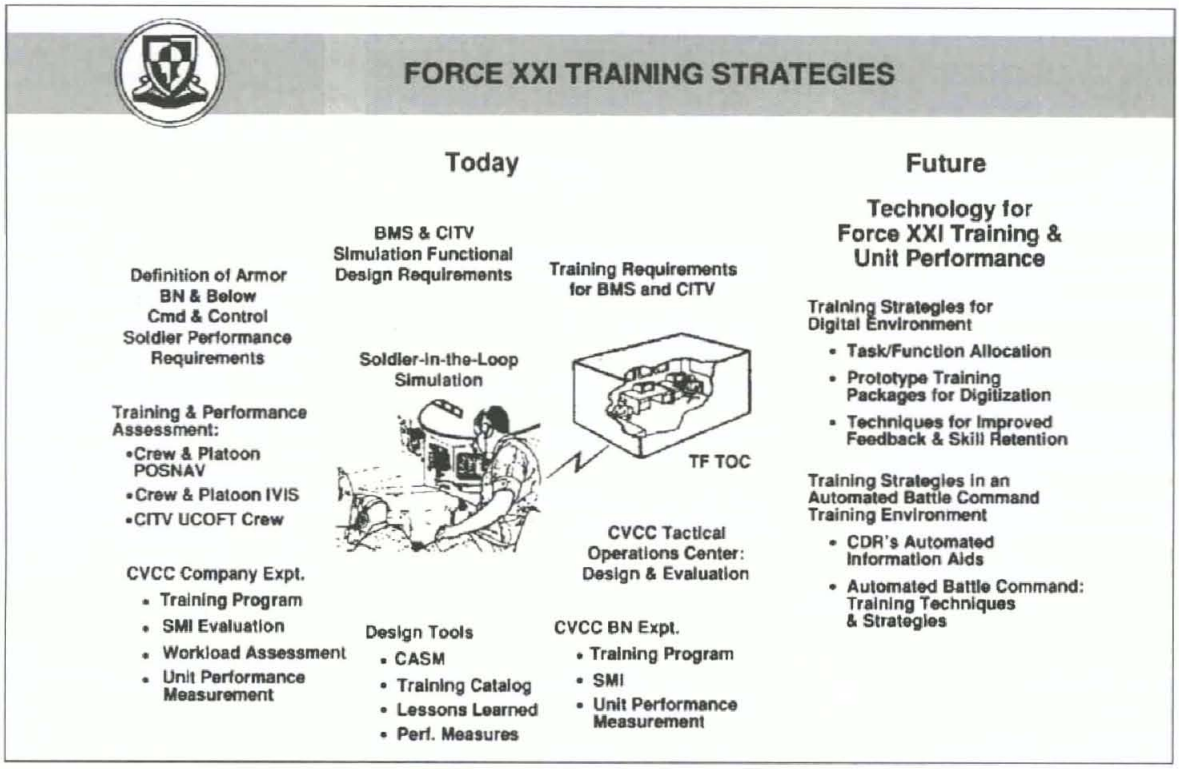


Figure 1.

Panama and the Gulf. The challenge is to continue that quality training for Force XXI. To meet this challenge, additional training research and development is required.

Research Foundation

A significant foundation for the AWE Operation Desert Capture VI, conducted by the Mounted Warfighting Battlespace Lab was provided by completed and ongoing research and development (R&D). These efforts were conducted by the Tank Automotive Command, the Communications and Electronics Command, the Armor Center's Directorate of Combat Developments and the Army Research Institute (ARI) at Fort Knox.

ARI began utilizing the simulation networking (SIMNET) capability at Fort Knox as part of their R&D efforts concerning training and soldier issues with future information technologies in the '80s. These early efforts and those that followed are reflected in Figure 1. Initial efforts focused on position navigation technologies provided to an armor platoon. Training requirements and effect on unit performance were determined. Later, similar experiments were conducted for a prototype Intervehicular Information System (IVIS) and for a sensor system called the Commander's Independent Thermal Viewer (CITV). These early R&D efforts provided preliminary training requirements and defined for the Army how simulation could be used to incorporate soldiers' views into the design of the system well in advance of "bending metal," thereby providing information on benefits and drawbacks of proposed systems.

ARI-Knox continued the research with a series of simulation-based R&D efforts on a future command, control, communication (C3) system configuration, called Combat Vehicle Command and Control (CVCC). Evaluations compared the performance of CVCC-equipped units using digital C3 systems with conventional units using voice radio, grease pencils and acetate overlay sheets. These evaluations were conducted using an iterative approach at platoon, company and battalion levels which included the development of an automated tactical operations center (TOC).

Training is the glue that holds the Army together and has continually been demonstrated as a major contributor to the success of battles of the past.

At each echelon, operational effectiveness, training, and soldier-machine interface (SMI) requirements were determined and lessons learned were documented. These formed the basis for enhancements at the next echelon in a spiral development approach. Results from the simulation-based battalion level evaluation demonstrated that a CVCC-equipped unit was significantly more effective in conducting defensive and offensive combat operations than conventional units. These findings can be directly linked to the training program that trained individual and collective skills required to utilize automated battle command systems and to an interface designed to consider the operator's workload in an operational environment.

Products from these R&D efforts were readily available (e.g., hardware, software, training programs, and automated measures of effectiveness) and were quickly integrated into the early demonstrations for the Louisiana Maneuver Board of Directors as well as the Mounted Battlespace Battle Lab's AWE efforts. In addition, lessons learned from the R&D efforts formed a basis to guide AWE planning and execution efforts (Figure 2).

Major lessons learned indicated a need for not only fundamental warfighting skills, but also training that is more comprehensive, and more systems-oriented. These were recently reinforced by observer controllers at the National Training Center, during Operation Desert Hammer VI (the Digital Rotation).

LESSONS LEARNED	
Training	**Soldier-Machine Interface**
▸ Train the conceptual underpinnings of the entire automated battle command system	▸ Principle of "designing for simplicity" is more important than ever
▸ Establish TTPs and disciplined SOPs that make automated battle command systems work	▸ Interface should be tailorable to individual needs, and intuitive to reduce the potential for skill decay
▸ Train basic tactical skills and knowledge about the position/function before training automated technology	▸ Interface design is directly related to the operator's workload and training requirements
▸ Embedded training tools such as the Concept of the Operation (electronic rehearsal) provide foundation for situational awareness	▸ Appropriate feedback regarding system operation is important to the operator
▸ Embed information management training	▸ Color, digitized terrain "maps" improve performance
▸ Use operational vignettes that focus training objectives and negate the need for large numbers of soldiers used as training aids	▸ Alternate input mechanisms required
▸ Determine proper training mix that underscores where tasks are best taught	▸ Helmet-mounted or heads-up displays should be incorporated
	▸ Filters and aggregates for messages should be incorporated

Figure 2.

They pointed out that digital skills were "higher order" in nature, perished easily and required new training techniques. They further suggested that any future training strategy must provide for increased training to maintain skill proficiency. For example, knowing what information is available, where to get it, and how to use it to make timely battlefield decisions is crucial. This requires training beyond knowing how to push the right "procedural buttons." These issues are indicative of the need for a training R&D program that parallels and complements AWE efforts into the 21st century.

Future Training R&D Requirements

The Army's *Draft Training XXI Plan (1994)* attempts to describe the training objectives required for the next century. An increased use of virtual environments is suggested as the medium to provide a series of structured training events that: "enable a higher entry level into live (CTC type) events; execute automated assessments; provide an efficient means to train assessed deficiencies; retrain demonstrated weaknesses; and expose units to different environments with limited safety constraints." In addition, Force XXI training looks to maximize all facets of networked simulation-local area, wide area and long haul. This should provide an environment to train tomorrow's commanders today on a "context correct" battlefield, rich in information technologies where a "systems" approach becomes second nature.

It should be noted that simulation cannot totally replace training on the ground. Simulation will however, permit training on tough tasks too dangerous to execute in peacetime, or tasks which are ecologically unsound. Additionally, simulation provides a means to prepare for more efficient training in the field by bringing to a mastery level those maneuver and C3 skills whose tasks are simulated with high levels of fidelity.

The Force XXI classrooms will not be the classrooms of the past. Rather, they may include fully portable linkages to vast data bases of multi-media training materials. Distance learning should become common place, and personnel will need to be able to train on demand. While these characteristics are often discussed, a wide disparity still remains between the application of technology to support these requirements and the training technology research base to meet this need. This too is an area which requires further research.

The training technologies, if properly designed, will provide user-friendly support tools to relieve requirements for extensive rote procedural training. These same tools will support the creation of constructive and virtual environments in which soldiers will practice and hone skills and ultimately test and fight new doctrine/concepts. This approach may bring us to a similar educational emphasis evidenced prior to WWII. That era provided training for commanders who successfully adapted new technologies of their day and became creative in their mixes of old technologies. As GEN (Ret.) Gorman points out, they were not tied to "old ways" which included rote implementations, tactics or doctrine. The training issues associated with the information age are as compelling and challenging as any of the materiel technology issues.

Training must ensure that soldiers have the requisite knowledge and experience from basic concepts through practical applications to fully advantage new weapon system and information technologies. New training approaches that maximize distance learning, networked simulation, virtual reality, and seamless simulation will require major changes to the methods and strategies used to train soldiers of the 21st century.

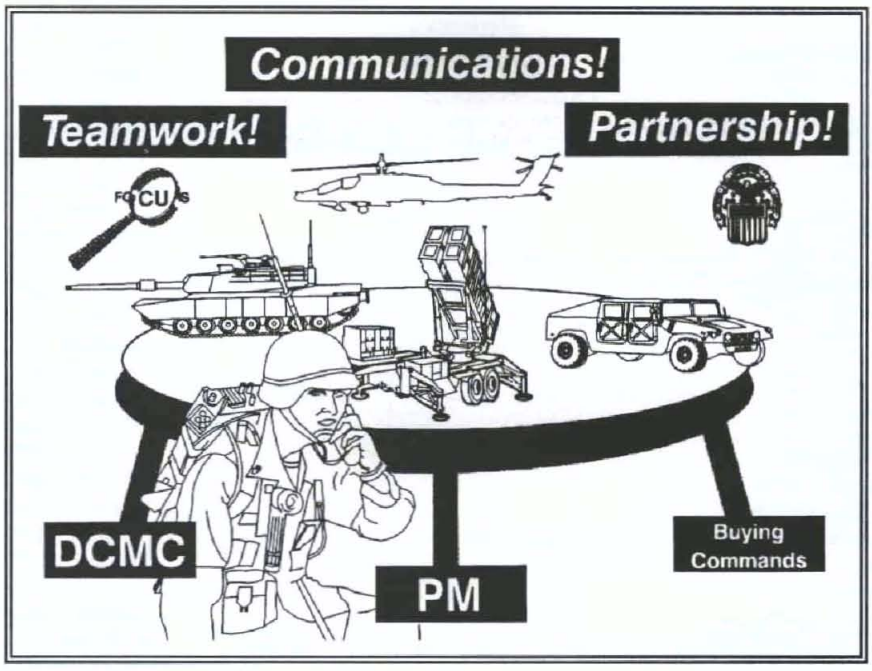
Conclusion

Information age technologies are not "business as usual." Their potential can only be realized through development of new training methods and strategies combined with an increased emphasis on the role of the commanders and soldiers in the system. Army leaders must meet the challenge to provide tough and realistic training in the 21st century, because the ability to fight and win on the technology rich battlefields of the future will depend directly on the quality of training provided to the force.

Authors' Note: A listing of ARI's CVCC documentation is available from the Armored Forces Research Unit at Fort Knox, commercial phone (502) 624-3450 or DSN 464-3450.

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Functional Area 97 Officers in DCMC . . .

TOOLS IN THE ACQUISITION KITBAG

By COL Lee Thompson
and MAJ William C. Zolp

Winning the "Information War" is a major objective for our Army's modernization, acquisitions, and improvements. However, fighting the information war is not a new concept. Program executive officers (PEOs), program managers (PMs), and buying commands fight battles in this war every day. To win these battles and successfully execute their programs, PEOs, PMs, and buying commands use and synchronize their available assets. Functional area 97 (contracting and industrial management) officers assigned to the Defense Contract Management Command (DCMC) are the "tools in the kitbag" that PEOs, PMs, and buying commands can use to enhance their programs.

Army program and product managers can take advantage of Army contracting and industrial management officers assigned to DCMC by understanding DCMC's mission and its available skills and functions. The contracting and industrial management officer can provide PMs support not readily available through the program office or the buying command's matrix management system. The matrix management system provides support by assigning its available officers from inside the PM and buying command structure.

DCMC can supplement the buying commands' matrix management systems. DCMC provides officers who maintain contact with contractors on a daily basis. These officers are dedicated to provide information and customer support. By including FA 97 officers early and throughout the life cycle, PMs can improve their chances of having successful programs and emerge victorious in the information war.

The Mission of DCMC

DCMC is a "purple suit," or joint, organization. Its mission is to provide contract administration services in support of Department of Defense (DOD) components, the National Aeronautics and Space Administration, and other designated federal and international organizations. DCMC supports all of the Army's major weapons systems acquisition programs.

Army officers assigned to DCMC work with Marine Corps, Navy, and Air Force personnel on a wide variety of Defense programs. The Army FA 97 officers assigned to DCMC are not directly in the Army's chain of command. This is because of the joint nature of their assignment to a DOD organization. However, PEOs, PMs, and buying commands can "reach out and touch" these officers through the DCMC chain of command.

The Federal Acquisition Regulation (FAR) lists specific contract administration tasks and responsibilities of DCMC in part 42.302(a). The FAR lists 67 areas of responsibility that the procuring contracting officer for a particular system delegates to

Table A.
Functional Area 97 Education Requirements.

Level	Contracting	Quality Assurance	Manufacturing & Production	Program Management
Entry LEVEL I (Captain)	Baccalaureate Degree or Completion of 24 Semester Credit Hours in any one of the following disciplines: Accounting Business Finance Law Contracts Purchasing Economics Industrial Management Marketing Quantitative Methods Organization and Management	*Baccalaureate Degree	*Baccalaureate Degree	*Baccalaureate Degree
Intermediate LEVEL II (Major)		Same as Level I	Same as Level I	Same as Level I
Senior LEVEL III (LTC/COL)		Same as Level I	Same as Level I	Same as Level I

* Not required for Career Field Certification. The Baccalaureate Degree is required for Military Branch Qualification.

Table B.
Functional Area 97 Experience Requirements.

Level	Contracting	Quality Assurance	Manufacturing & Production	Program Management
Entry Level I (Captain)	12 Months Acquisition Experience	12 Months Acquisition Experience	12 Months Acquisition Experience	12 Months Acquisition Experience
Intermediate Level II (Major)	24 Months Contracting Experience	24 Months Quality Assurance Experience	24 Months Acquisition Experience of which 12 Months were in Manufacturing and Production, Engineering, or Quality Assurance	24 Months Acquisition Experience
Senior Level III (LTC/COL)	48 Months Contracting Experience	48 Months Quality Assurance Experience	48 Months Acquisition Experience of which 12 Months were in Manufacturing and Production, Engineering, or Quality Assurance	48 Months Acquisition Experience

DCMC. The contracting and industrial management officers assigned to DCMC actively plan and execute many of these tasks and responsibilities.

One of the goals of DCMC is to respond to its customer's needs throughout the product life cycle. We want to serve the PEOs, PMs, and buying commands the best we can in the contract administration areas they delegate to us.

To respond well, DCMC must understand the program objectives and areas of emphasis for contract administration. We do this by using a memorandum of agreement signed between the contract administration office and the program manager. We also communicate often with the buying commands and PMs.

DCMC provides the ability to avoid duplication of the services provided the PM through his office or his matrix support organization. DCMC eliminates duplicity and unnecessary redundancy in performing engineering and production surveillance, program support, quality assurance, and most other functions related to the program. DCMC is now providing PEOs, PMs, and buying commands with updated briefings on its capabilities and functions. These briefings will allow the PM or buying command to choose the responsibilities and functions it wants to delegate to DCMC.

Assignment and Functions

The Army currently assigns 124 FA 97 officers to DCMC. These officers perform more diverse missions than just administering contracts. Most Army officers assigned to DCMC work at Defense Contract Management Districts, Defense Contract Management Area Operations (DCMAO), and Defense Plant Representative Offices (DPRO). Districts provide command and control for subordinate DCMAOs and DPROs and support DCMC. As of July 1994, DCMC had three district headquarters: Northeast, South, and West.

The DCMAOs provide contract administration services for government contracts over large geographic areas. The DCMAOs generally manage many low dollar value contracts for piece parts and spares. They are in the readiness business. The DPROs provide contract administration services for large programs and are located at the contractor's facility. DPROs generally have a small number of highly complex, high dollar value contracts to administer. These contracts cover the entire product life cycle from concept exploration to disposal.

Two types of positions exist in DCMC for Army Acquisition Corps officers. The first type of position is a "4Z," or acquisition critical. This position requires highly qualified, highly experienced officers in the procurement field. This position can only be filled by an officer who is Level III certified and is a LTC or above.

The Army assigns 28 colonels to DCMC into positions that are all designated as acquisition critical. Two colonels command the two districts that closed in June 1994 because of Base Realignment and Closure Commission recommendations. Four colonels are activity directors or department chiefs and 22 colonels command DCMAOs or DPROs. Of the 35 lieutenant colonels assigned to DCMC, 19 command DCMAOs or DPROs and 16 lieutenant colonels are assigned as deputy division, department directors, or activity chiefs.

The second type of position is designated as "4M," or "developmental" positions. These positions, although not listed as "acquisition critical" are extremely important to the professional development of out Army contracting and industrial management officers. DLA and DCMC have the only assignments where FA 97 officers can get significant training in the pre- and post-award elements of contract management. This experience is key in our preparation to become program managers or heads of contracting agencies.

Additionally, DCMC provides the ability to hone our skills in preparation for deployment on contingency contracting missions. The contracting and industrial management officers within DCMC are soldiers who are deployable 24 hours a day.

The Army assigns 41 majors in these developmental positions within DCMC. These officers direct Defense Contract Management

Offices, perform the duties of Program Integrators (PI), administer contracts as administrative contracting officers, and perform critical staff functions. These staff functions include program and technical support, cost and schedule control systems criteria analysis, quality assurance, production officers, and flight operations officers. Twenty Army captains assigned to DCMC perform similar duties as PIs, production officers, and contract administrators.

FA 97 Skills

Functional area 97 officers require formal schooling to reach prescribed levels of certification. The Defense Acquisition Workforce Improvement Act prescribes the necessary academic and experience levels. The courses concentrate on contract administration, pricing, and contract law. The Army Logistics Management College, Air Force Institute of Technology, and the Defense Systems Management College are the primary institutions that offer these courses. Table A shows the course necessary for certification at the specified levels. Table B shows the required experience levels.

Although most of the Army officers assigned to DCMC are functional area 97 officers, only a few are assigned as contracting officers. Their positions, as commanders, program integrators, and special staff officers require significant levels of experience and training. These requirements ensure that FA 97 officers can support PMs from a position of experience and knowledge.

Using the Tools

The FA 97s assigned to DCMC are the PEOs, PMs, and buying commands' cavalry—we deal in information and results. The FA 97s can give our customers the edge in information because we in the DCMAOs and DPROs know the contractors. These officers work with the contractors daily and see the products these firms produce. They have daily contact with our highly qualified DOD civilian workforce which consists of quality assurance inspectors, industrial specialists, and contracting personnel. The FA 97 officers use these people as the cavalry uses its scouts. They become the eyes and ears of the program manager inside the contractor's facility.

The DCMAO and DPRO commanders are valuable sources of information. They have extensive databases from which to draw information concerning contractor and subcontractor delivery timeliness and accuracy. Commanders are familiar with the contractor's labor rates and labor issues, overhead rates, and the factors that influence these rates. Using this data can help the buying commands and program offices in the pre-award stage of contracting. Early involvement of DCMC is one tool in the kit bag that should be used regularly.

Commanders can track material costs and find information quicker than someone located far from the contractor's facility. Because they are located with the contractor, they have quick access to information, can identify potential schedule delays, and become aware of technical problems that arise during integration of systems. Commanders make things happen. The Army commanders assigned to DCMC are no exception. They encourage customers to call them when they have a potential problem or require information concerning contractors.

Program integrators provide detailed information to PMs. The DCMAO and DPRO commanders assign them to programs that require extensive monitoring, which are usually major acquisition programs. The memorandum of agreement states the duties and responsibilities of the PI to the PM. The PI is responsible to lead the program support team, which includes contract administration, engineering, production, and quality assurance personnel. The PI provides the PM recommendations, assistance, representation, and contract administration services for the system. The PI provides the PM integrated communication concerning the program's cost, schedule, and performance. The PI remains in close contact with the contractor and provides all necessary, current, and accurate information to the PM.

Special staff officers provide support to DPRO and DCMAO commanders, PMs, and Program integrators. They produce products such as guides and reports based on information concerning the programs. These officers respond to requests for information that they can tailor rapidly to fit a user's needs.

DCMC has wartime missions as well as peacetime requirements. Each of the Contracting and Industrial Management officers assigned to DCMC can deploy on contingency contracting missions. The DCMC environment serves as the primary training ground to write, award, and administer contracts.

This valuable training enables the officers assigned to DCMC to be among the most proficient when operating in a contingency operation.

Summary

The greatest value the Army FA 97 provides to the PEO, PM, and buying command is the information necessary to make decisions. We can provide the "early warning" and surveillance necessary for decision makers to make decisions regarding cost, schedule, and technical performance. We deal with vast amounts of information that can be tailored to the individual program's needs. We come from the user's environment. We understand the importance of on-time delivery of goods and services.

Remember that DCMC is a joint organization. Army officers do not command all the DPROs and DCMAOs. Officers from the Navy and Air Force may command a DPRO or DCMAO where they oversee the manufacture of critical parts for Army weapons systems. Program managers and buying commands must know that they will receive professional, high quality service from all commands within DCMC no matter what branch of Service.

Program managers that use the officers and DOD civilians available in DCMC have an advantage. The advantage is having highly skilled and motivated soldiers and civilians cooperating to provide quality weapons systems to support the troops in the field. The DPRO and DCMAO commanders encourage PMs to use the talent and experience of the Army officers and DOD civilians assigned to DCMC. We are the "combat multipliers" PMs and buying commands can use to win the information war.

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MAJ WILLIAM C. ZOLP is the assistant chief, Contract Management Division, Chicago. He is an armor/procurement officer with a B.B.A. in production management from Loyola University of Chicago and an M.S. in administration from Central Michigan University. He is also a graduate of the U.S. Army Command and General Staff College.

ON-THE-FLY POSITIONING REVOLUTIONIZES SURVEYING

By Mark K. Ross

In a scene from the film, *Until the End of the World*, made in 1991 and set in 1999, a driver is shown in Paris checking her actual position in real time on an electronic map while driving a car. Though the film was science fiction, that particular technology it displayed now exists.

Scientists at the U.S. Army Topographic Engineering Center (TEC), Alexandria, VA, led the effort to develop a system that uses the Global Positioning System (GPS) to record extremely accurate positions of moving platforms on-the-fly (OTF). This technique, developed for hydrographic surveying and dredging, will revolutionize the way surveyors do their work. The spin-off applications are just beginning to be realized.

The system provides real-time, three-dimensional accuracies better than one decimeter over ranges up to 20 kilometers from a single reference station without static initialization. Initialization is the redundant gathering of satellite data required to determine the starting position of the survey. It can now be done while the vessel is moving—that is, on-the-fly.

Currently, TEC is demonstrating this OTF breakthrough around the country. It was first demonstrated to mostly Corps of Engineers personnel at the Corps Wilmington District in early October 1993. "We felt that the Corps developed this system, so Corps personnel should be the first to see it demonstrated," said Sally Frodge, the principal investigator for the OTF system. After Wilmington, the next demonstration was on the Columbia River near Astoria, OR, in mid-November.

"The goal of the demonstrations is to convince the potential users within the Corps that this is a useful technology for them. It was funded by the Dredging Research Program, and so the primary targeted users were the dredgers. However, direct spin-off applications will greatly interest hydrographic surveyors and engineers, since the accuracy is so high," Frodge said.

The reaction to the components has been overwhelmingly positive. "The development of this technology will revolutionize many of the ways surveying is conducted," Frodge said.

Both the Wilmington and Astoria demonstrations were made up of two separate demonstrations. The first part was a land-based test using a mobile platform going back and forth over known control points. The surveyors in attendance could see for themselves the agreement between the real-time positions determined by the OTF system and the previously surveyed positions. "They could see for themselves that it only deviated by centimeters," Frodge said.

The other part of the demonstrations was conducted aboard survey vessels. During the Wilmington demonstration, the OTF positioning system supplied positioning (x,y,z) data to the ship's navigation system along side the positioning system the ship normally uses. Both sources for positioning ran simultaneously, providing input for the navigation system. Input for depths was determined from the same Fathometer.

"The positions should agree very closely, and they did. Observers could see for themselves by just looking from one monitor to the other," Frodge said.

Also, part of these demonstrations was to have the survey vessels go under a bridge and lose contact with the GPS satellites. Before this technology breakthrough, static initialization was required if contact with the satellites was lost. The vessel would have to go back and initialize again. This usually meant going back to the dock, which could take hours.

"During both demonstrations, we traveled under a bridge on the way down and on the way back up. We told them to watch the system to verify that our claims would hold true. We didn't want them to have to make a leap of faith. We forced the ship to lose lock with the satellites. It reacquired the integers it needed, and we were back on-line within 15 seconds," Frodge said.

"Sometimes it can take two 15-second intervals to re-establish initialization, but this system has done it in one second," Frodge said. But even that remarkable time has been improved. Now, if the first 15-second interval fails to establish OTF initialization, rather than starting from ground zero to begin another 15-second interval, the system processes backwards. "If a second attempt is required, it generally takes less than five additional seconds."

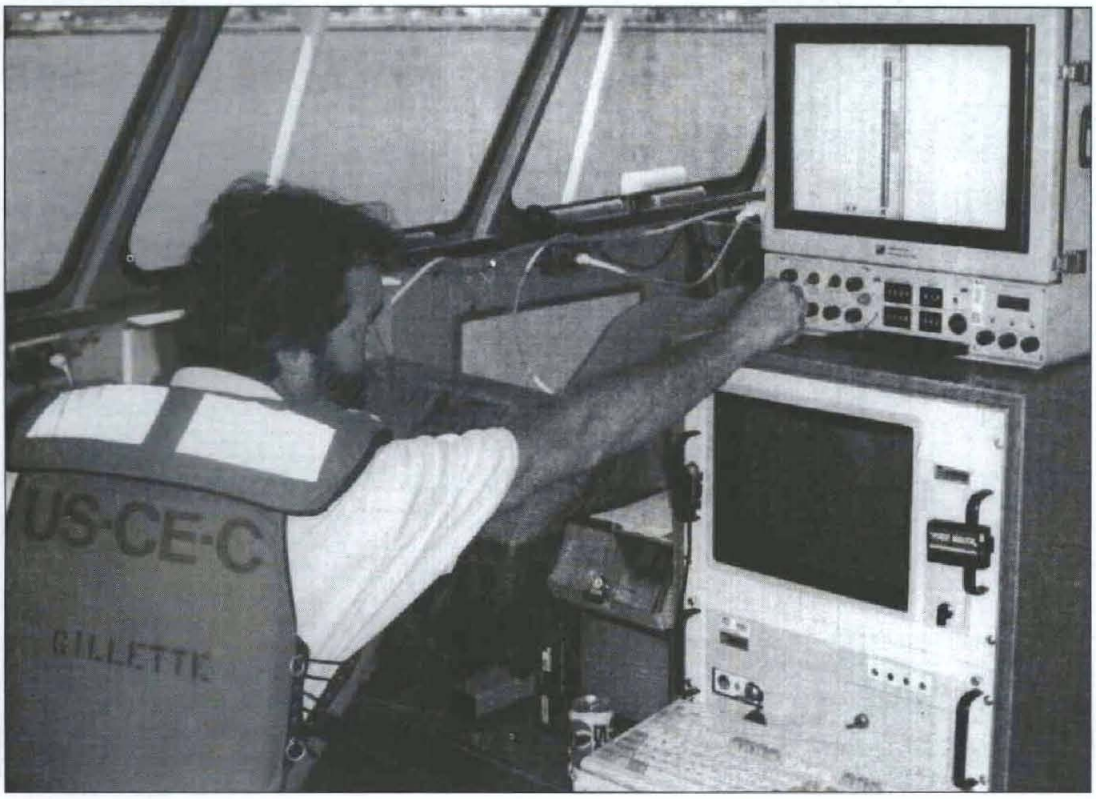
This is, for the most part, an automatic, hands-off system. "We didn't want someone to have to be very involved or have to learn a lot to operate this system. The surveyors have better things to do than babysit the system," Frodge said. "It's meant to be a robust tool—something which you don't even need an implementation document for unless you're interested. It's designed to be almost intuitive, and to survive in the surveyor's environment.

"If the system operator needs or wants to know what is going on, they can just look at the screen. Some of the screens are diagnostic, and are a very useful tool for a knowledgeable user," Frodge added. The Corps districts seem to agree. There are nine, so far, in line that want this implemented.

"There are many districts out there poised and ready to implement it because TEC went out and showed them what we were developing, convincing them that they wanted this as soon as it was available," Frodge said.

The system has already been used in an operational capacity by the contractor that helped develop it, John E. Chance Associates, Lafayette, LA. The company was conducting a stake-out survey of some 8,000 points for an oil company, and finished in less than three weeks. "If you would do that conventionally, it would only be possible to do a fraction of those points in that time," Frodge said.

"What also is great is that you know the accuracy level immediately. You don't have



Jeff Marlow, a surveying technician in the Wilmington District, operates the survey vessel *Gillette's* onboard navigation system during the on-the-fly demonstration.

to go through the calculations and reoccupy sites, or wonder if maybe there was a blunder or bust in the survey. You know right away that your positions are accurate," Frodge said.

Another advantage to this OTF system is that it uses the GPS Coarse Acquisition (C/A) code instead of others that would offer only restricted use, such as the Precise (P) code. Though the wavelength of the C/A code is 300 meters (compared to 30 meters with the P code), the longer wavelength is still capable of being used to determine position within centimeters.

The development of this system, which began in 1988, was accomplished in three phases. The first phase involved research in developing new signal processing algorithms and testing necessary to determine the feasibility of the concept. The algorithms were developed by Dr. Benjamin Remondi, of the National Oceanic and Atmospheric Administration/National Geodetic Survey for TEC, and are an integral part of the system's success.

Phase two saw the beginning of extensive field tests. It was during this phase that a reliable statistical acceptance criteria was developed by TEC scientists. This was a major step toward the creation of a real-time system. It showed that OTF software could determine if the correct solution had not been obtained.

It was found during phase two that most of the data collected for baseline surveys under 20 kilometers were successfully initialized using the OTF software. Also, during phase two, kinematic GPS delivered accurate positioning and two independent systems verified that the design goal accuracy of less than one decimeter could be achieved. It was determined that vessels could be positioned accurately in real, operational conditions, even in higher sea states.

TEC currently is in phase three of the program, which is the demonstration of the prototype. In addition to the demonstrations already conducted, the technology will be demonstrated at the Institute of Navigation Meeting in San Diego, CA, on Jan. 24-26, 1994. Plans also include a demonstration at the Corps Survey Conference in New Orleans, LA in August.

Although the on-the-fly system is referred to as a prototype system, it has far exceeded the original design specifications. It can be used today as a reliable working system for applications that require real-time, horizontal positioning with extreme accuracy.

The other possible uses of the system are almost unlimited. "The spin-offs are limited only by imagination," Frodge said. Just one example is the monitoring of large structures, such as dams, for any deformation or movement. "You can push this technology to measure at the real-time, millimeter level and place it into any deformable body monitoring," Frodge added.

This isn't limited to dams, but can include almost any large structures, such as monitoring high-speed rail systems for track movement, thus possibly avoiding future derailments. Many applications require accurate, real-time vertical measurements—more so than horizontal measurements. This system also can provide this vertical measurement capability.

With the success of the project and the public demonstrations ongoing, Frodge is hopeful that the research will continue to improve and that development of systems with wider ranges and more accuracy will occur. "Right now, the range of the system is 20 kilometers, or about 12 miles from the base reference station. From the research completed to date, we are confident that we can double or triple that range," Frodge said.

MARK K. ROSS is a public affairs specialist with the U.S. Army Topographic Engineering Center. He received his bachelor's degree in mass communications from Towson State University.

From The AAC Career Manager...

Product Managers

Congratulations to the following acquisition officers selected by the FY95 lieutenant colonel level product manager/acquisition command selection board.

Selectee	PEO/Program
Arnone, Robert F.	Improved Brilliant Anti-Armor
Broughall, Stephen E. Jr.	Combat Service Support Control Systems
Drabczuk, Jan S.	Combined Arms Assessment Network
Dubia, Laurianne F.	Small Computer Program
Fong, Terence	Standard Integrated Command Post System
Gage, Bruce E.	ARSOF Materiel and Mobility Systems
Gemar, Charles D.	Aerial Common Sensors
Gross, John L.	M1A1 Abrams Tank Systems
Hainline, Michael K.	All Source Analysis System - Software
Heuler, Ronald R.	Defense Data Network
Horner, Stephen C.	Tactical Endurance Synthetic Aperture Radar
Kamakaris, Richard G.	Advanced Field Artillery Systems - Armaments
Kaura, Mary A.	THAAD Project Battle Management/Command, Control, Communications and Intelligence
Kelly, Thomas P.	Information Warfare
Kessinger, Stephen H.	Combat Support Training System
Leahy, James B. Jr.	Mortars
Lees, Robert B. Jr.	Improved Recovery Vehicle
Mackin, Joseph P.	Second Generation FLIR Horizontal Technology Integration
Major, Edward B.	Special Project Office #1
Mallette, Timothy R.	Standard Army Retail Supply
McChesney, Michael K.	Advanced Field Artillery Systems - Munitions
Miller, William D.	Fort Belvoir Information Mission Area Modernization
Moran, James R.	Extended Air Defense Command and Control
Nelson, Ronald J.	ARSOF, C4I
Nickerson, Foster G.	Armored Gun Systems
O'Reilly, Patrick J.	Anti-Tactical Missile Defense
Patten, George B.	M1A2 Abrams Tank/Abrams Upgrade Program
Ryles, Richard R.	Longbow Apache
Webster, Cecil R.	THAAD Launcher

Acquisition Commands

FA 51	FA 53	FA 97
Clifford, Michael R.	Greaney, Kevin J.	Brown, David Jr.
Payne, Gary E.		Dronka, Paul J.
Walsh, Thomas P.		Dykstra, Robert L.
		Frye, Jan R.
		Garrett, Johnny L.
		Jones, Duwayne W.
		King, Edward C.
		Owens, Carl D.

Civilian Product Manager Board

We are pleased to announce the first HQDA centralized selection board for civilian product managers (PMs). The board was held in October 1994.

Two PMs were selected: MLRS Improved Fire Control Radar, GS-301-14, PEO Tactical Missiles; and Strategic and Theater Command and Control System, GS-854-14, PEO, Command and Control Systems.

It is anticipated that a civilian project manager selection board will be held in the January 1995 time frame. This board will consider those project manager positions at the GS-15 level.

PERSCOM Notes . . .

Staying Competitive

Many officers think that being accessed into the Army Acquisition Corps (AAC) puts them in another category of officers. This is not true. AAC officers compete for promotion and schools in the Army Competitive Category (ACC). You still compete against the officers from your basic branch and all the other branches.

As of publication of this bulletin, the AAC has promotion floors to ensure a certain number of AAC officers are selected for promotion each year. One must understand the reasons for the floors. The floors are to ensure the Army will have enough AAC officers to meet the requirements at the higher grades (LTC and COL). Without the floors, the AAC would have to be one of the largest branches. The Army could not afford the number of officers required to be out doing acquisition assignments if some adjustment was not made to keep the population relatively small (i.e. enhanced promotion rates). The bottom line is that you should not think the promotion floors will get you promoted. Promotion for AAC officers is just as competitive as the rest of the Army.

Remember, AAC officers compete for promotion and schools in the Army Competitive Category. Officers sitting on these selection boards come from all the branches. These officers are often unfamiliar with what an acquisition officer does. Officers sitting on boards are looking to promote outstanding performers who have done traditional Army jobs—leadership positions, positions of great responsibility. Many of these traditional jobs are instantly recognized no matter the branch—commander, XO, S3. While most of the acquisition jobs are leadership positions and positions of great responsibility, they are not instantly recognized by basic branch officers.

When you write the job title and duty descriptions for your support forms and OERs, clearly state your duties and responsibilities. Use program or item names, number of people you supervise, and dollar figures. Simply stated, write it in Army language. Don't change the way OERs are written just because you are in the AAC. There is only one AAC officer on the selection board. Every combat arms, combat support, and combat service support officer must be able to read your OER and know, without having to ask any questions, what you do for the Army and why it is important.

The things that get officers promoted within their basic branches are the same things that will get officers promoted in the AAC. Seek out the tough jobs and do well in every job you have.

Pre-Command Course

Pre-Command Course (PCC) is a program conducted at the direction of the chief of staff, Army, to assist LTC and COL command-designees to acquire the knowledge and proficiency they will need to command. As such, Army Acquisition Corps (AAC) officers chosen for product/project manager (PM), or for one of the acquisition commands, will attend the PCC. PCC is an important part of the preparation of assumption of PM or acquisition command (battalion or brigade equivalent command).

PCC consists of three phases: Self-study phase administered by CGSC; Branch/specialty phase which is an intensive refresher, update and systems proficiency training conducted at the branch (specialty) school; and a Leavenworth one-week PCC.

Attendance at PCC is mandatory. Command/PM-designees will attend PCC prior to assuming command/PM. Requests for exception from PCC will be approved only under exceptional circumstances, when the benefits to the Army are clear and substantial. Requests will be submitted through CDR, PERSCOM to the DACM (ATTN: SARD-AC).

Active Duty Written Agreement

Colonels and lieutenant colonels in the AAC are required to sign a written agreement to remain on active duty prior to being assigned to a critical acquisition position (sec. 1734 (a)(2)). The Defense Acquisition Workforce Improvement Act states all lieutenant colonel and higher positions are critical, so in effect, with every new assignment lieutenant colonels and higher must sign a written agreement to remain on active duty for three years (four years for ACAT #1 PMs).

PERSCOM would like to have the officer sign the agreement one time and then reference it when issuing an RFO. The agreement will be maintained in the officer's career management file at PERSCOM. Within the next two months MAJ(P)s and above can expect to receive a letter with the written agreement. The officer will sign the agreement and mail it to PERSCOM.

Tour Length Policy

An interim policy has been signed by the director of military personnel management regarding the tour length for critical acquisition positions and overseas, hardship, or short tour areas. The interim policy states "AAC tour length policy for acquisition critical positions, including Centrally Designated Position List commands, to overseas, hardship, and short tour areas will be consistent with DODD 1315.7 and the same as Army tour length policy for all other duties in the geographical area of the assignment, including Title 10 joint duty."

This policy simply states the Army Acquisition Corps will not assign an officer to a geographical region and require that officer to remain in that region for three years while all other duty assignments are of a lesser time period.

The Army Acquisition Corps has a requirement, directed by the Defense Acquisition Workforce Improvement Act, for lieutenant colonels and colonels to sign a written agreement to remain on active duty for three years when assigned to an acquisition critical position. Since all Army Acquisition Corps lieutenant colonel and colonel positions are acquisition critical, all lieutenant colonels and colonels must sign the agreement. This agreement was mailed to all lieutenant colonels and colonels in 1993 and is mailed annually to all newly promotable majors. Signing this agreement prior to being assigned to a critical acquisition position is a requirement of the Defense Acquisition Workforce Improvement Act.

The following are some of the questions that have been asked about the three-year agreement:

Q: Do I have to sign the agreement?

A: Yes. Signing the agreement is required by law. The law clearly states "a person may not be assigned to a critical acquisition position unless the person executes a written agreement to remain on active duty in that position for at least three years."

Q: Does this mean I will not be able to retire for the next three years?

A: No. This does mean that, along with your retirement request, you must also submit a request for waiver of the assignment period. The waiver form is found in *DoD 5000.55*. The form is to be processed through PERSCOM and forwarded to the director, acquisition careet management. *DoD 5000.58* states waivers may be granted in the following circumstances:

(a) Humanitarian reassignment, discharge, or retirement,

(b) Relief of duties and reassignment in the interest of the Department of Defense,

(c) Promotion, where promotion in place is not allowable.

The authority to grant the waivers is delegated to the director, acquisition career management.

Q: Does this agreement mean that I can be sent to an overseas short tour area for three years?

A: PERSCOM will continue to assign officers in accordance with current assignment policies. The Military Acquisition Management Branch will not assign officers to short tour areas for tour lengths that are not consistent with the current policies.

Q: I signed an agreement when I became a PM. Do I have to sign this one also?

A: Yes. This agreement is for your next assignment. The agreement you signed previously was for your current assignment. The first agreement does not apply to future assignments; however, the new document does.

SUMMARY OF DOD 5000.52M CAREER LEVEL REQUIREMENTS

LEVEL	EXPERIENCE	EDUCATION	TRAINING
PROGRAM MANAGEMENT (Career Field A) pg A.1-7			
1	12 months		Fund of Sys Acq Mgt
2	24 months		Acq Basics Course
3	48 months with 24 in prog off		–
CONTRACTING (Career Field C) pg B.1-6			
1	12 months	Bach deg or 24 bus hrs	Mgt of Def Acq Cont (Bas); Prin of Cont Pricing
2	24 months *	Bach deg or 24 bus hrs	Govt Contract Law **AND ONE OF THE FOLLOWING:** Mgt of Def Acq Cn (Adv) **OR** Adv Cont Admin **OR** Quan Tech Cost/Price **OR** Def Cont for Info Res
3	48 months *	Bach deg or 24 bus hrs	Def Acq Cont Exec Sem **AND ONE OF THE FOLLOWING:** Mgt of Def Acq Cn (Exc) **OR** Contract Admin (Exec) **OR** Advanced Cont Pricing **OR** Sys Acq for Cont Pers
INDUSTRIAL PROPERTY MANAGEMENT (Career Field D) pg B.3-4			
1	12 months		Def Contract Property Admin; Mgt of Def Acq Cont (Bas); Def Cont Prop Disposal; Def Cont Prop Sys Anal
2	24 months *		Adv Def Cont Prop Admin; Govt Contract Law; Adv Contract Admin; Exec Cont Prop Mgt Sem
3	48 months *		Def Acq & Cont Exec Sem; Contract Admin (Exec)
PURCHASING (Career Field E) pg B.2-1			
1	None		Mgt of Def Acq Cont (Bas)
2	12 months *		–
3	36 months *		Mgt of Def Acq Cont (Adv)
MANUFACTURING AND PRODUCTION (Career Field G) pg D.1-4			
1	12 months		Production Management I; Mgt of Def Acq Cont (Bas)
2	24 months *		Production Management II; Def Manufacturing Mgt Crs; Mgt of Def Acq Cont (Adv)
3	48 months *		Def Acq & Cont Exec Sem; Def Acq, En, Man, & QA Sm
QUALITY ASSURANCE (Career Field H) pg D.2-6			
1	12 months		DoD Acq Qual Assur Fund; 2 weeks OJT
2	24 months *		DoD Qual Assur Course
3	48 months *		DoD Acq QA Management Crs; Def Acq EN, Man, & QA Sem
BUSINESS, COST, ESTIMATING, AND FINANCIAL MANAGEMENT (Career Field K) pg F-4			
1	12 months *		Fund of Sys Acq Mgt
2	24 months *		Sys Acq Funds Mgt Course; Cont Perform Measure Crs
3	48 months *		–
ACQUISITION LOGISTICS (Career Field L) pg E4			
1	12 months		Fund of Sys Acq Mgt **AND ONE OF THE FOLLOWING:** ILS Basic **OR** ILS Overview **OR** Acq Planning and Analysis
2	24 months *		Mgt of Acq Log; Def Bas Log Spt Anal
3	48 months *		Acq Basics Course **OR** Cont Mgt for PM **AND ONE OF THE FOLLOWING:** Reliability & Maintain **OR** Intro to Config Mgt **OR** Provisioning Mgt
COMMUNICATIONS AND COMPUTER SYSTEMS (Career Field R) pg A.2-4			
1	12 months		Fund of Sys Acq Mgt; AIS Fundamentals
2	24 months *		Acq Basics Course; Intermediate AIS
3	48 months with 24 in prog off *		AIS Procurement Strat
SYSTEMS PLANNING, RESEARCH, DEVELOPMENT, AND ENGINEERING (Career Field S) pg C.1-3			
1	12 months *	Bach deg in science or engineering	Fund of Sys Acq Mgt
2	24 months *		Sys Engineering Mgt Crs
3	48 months *		–
TEST AND EVALUATION (Career Field T) pg C.2-3			
1	12 months	Bach deg w/24 hours in science or engineering	Fund of Sys Acq Mgt; Intro to Acq T & E
2	24 months *		Test & Eval Mgt Course; Inter Test & Eval
3	48 months *		Exec Test & Eval
AUDITING (Career Field U) pg G-1			
1	None	24 semester hours in accounting	Tech Indoctrination
2	Auditing exper	24 semester hours in accounting	Statistical Sampling **OR** Graph, Comp & Imp Cur **OR** Inter Cont Auditing
3	US OPM Qual	24 semester Standards hours in accounting	DCAA Supervisory Skills

**indicates that the number of months includes specific types of experience within that career field*

AAC ELECTRONIC MAIL POINTS OF CONTACT

CHIEF, AACMO	CLAWSONO@HOFFMAN-EMH1.ARMY.MIL
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ADV CIVIL SCHOOL	HAMILTOR "
SEPARATIONS	ELLERBYC "
CHIEF, CAMB	BROWNJ2 "
CHIEF, MAMB	BAILERR "
AAC COLONELS ASSIGNMENTS	LEES "
FA51 LTC ASSIGNMENTS	GAULTC "
FA51 MAJ ASSIGNMENTS	DOWLINGE "
FA51 CPT ASSIGNMENTS	RHODESW "
MIL PERS SPEC (MAM, PM)	YAGERR "
FA53 LTC/MAJ ASSIGNMENTS	REYENGAR "
FA53 CPT ASSIGNMENTS	LIPSCOJ@ "
FA97 LTC/MAJ ASSIGNMENTS	OWENSC "
FA97 CPT ASSIGNMENTS	WOMACKJ "
AAC COMPUTER ENGINEER	MUNOZD "
AAC STRENGTH MANAGER	HAMILTOR "
FA51	TAPCOP51 "
FA53	TAPCOP53 "
FA97	TAPCOP97 "
NEWSLETTER	TAPCOPBE "

Q: I've been in my current job for two years. Does this agreement mean I have to stay in this job for another three years?

A: No. The agreement sent to you in the mail covers your next assignment. It does not lock you into your present job for any additional time.

Q: Once I sign the agreement and move to the job, can my assignment officer move me prior to completion of the three years?

A: Yes, with a waiver signed and approved by the director, acquisition career management.

Q: I won't sign and you can't make me!

A: It is important for everyone to understand that the three-year agreement is the law. We can't make you sign it and we don't want to force anyone to do something they don't want to do; but we must comply with the law.

Requests for orders processed after Oct. 1, 1993, state, "this officer has previously signed an agreement to remain on active duty for a period of three years when assigned to a critical acquisition position. This assignment is to a critical acquisition position and therefore the previously signed agreement is in effect for this assignment." The agreement is now a condition for assignment. If the officer refuses to sign the agreement, he is failing to meet a condition of the orders, and is refusing an assignment. In this circumstance, the officer would have to retire or resign as per AR 614-100, paragraphs 6-30 and 6-31.

Photographs

Look over your photo very carefully prior to sending it to MAMB. Take the time to have the photo retaken if you are not pleased with the results. Keep the photo updated. Update your photo at least every three years and upon promotion. It is also a good idea to update your photo for each board. This ensures your most current data goes before the board.

Color or black and white? Get a color photo! Color photos have been used by DA board since February 1992. This goes along with keeping your photo updated. Have a new photo taken when promoted or for an upcoming board so that you have a current color photo.

ATTENTION: BLACK AND WHITE PHOTOS PLACE AN OFFICER AT A DISADVANTAGE AND ARE PROBABLY MORE DAMAGING THAN NOT HAVING A PHOTO AT ALL!!!

When you take your photo remember that the Acquisition Corps is not a branch. *DO NOT PUT AC AS YOUR BRANCH!* You retain your basic branch affiliation, and your basic branch goes on the footboard.

Tips on taking photos: Take a color photo for the board!; Ensure your trousers and sleeves are the correct length; Check for creases along the crotch and shoulders; Put your basic branch, NOT AC, on the footboard; Wear only official awards and decorations; Use edge dressing on the shoes to include the toe bottom; Have a proper haircut; We recommend no moustaches; and take a friend with you to double check your uniform.

Summary of DoD 5000.52M Requirements

DOD has established 12 acquisition career fields for acquisition officers. Officers may be categorized in one or more of the following areas: Program Management; Communications—Computer Systems; Contracting; Purchasing; Industrial Property Management; Systems Planning, Research, Development, and Engineering; Test and Evaluation Engineering; Manufacturing and Production; Quality Assurance; Acquisition Logistics; Business, Cost Estimating, and Financial Management; and Auditing.

An officer's qualifications are also categorized within three career levels. In general, level 1 positions are held by CPTs and level 2 positions by MAJs. Critical positions, requiring a LTC or above, are considered career level 3. Each career level requires 12 months of acquisition work experience as well as a variety of education and training requirements.

Officers achieve career levels through a certification process. Certification authority for levels 1 and 3 have been delegated to the chief, Army Acquisition Corps Management Office (AACMO), Total Army Personnel Command. The chief, AACMO submits names of officers recommended for career level 3 certification to the director of acquisition career management for approval. Officers must meet the certification standards for the career level corresponding to their rank in order to be eligible for higher levels.

Each acquisition position is filled based on a field and career level requirement. Officers should meet these requirements prior to assignment; However, officer's assigned to critical positions have six months and officers assigned to non-critical positions have 18 months to meet the requirements.

The experience, training and education requirements for each career level within each of the 12 career fields are summarized in the accompanying chart.

Army Acquisition Corps Reserve Component

Under the guidance and at the direction of MG Robert L. Menist, assistant military deputy to the assistant secretary of the Army (RDA) and Dr. Bennie H. Pinckley, deputy director for acquisition career management, OASA(RDA), COL William Hanna, director, reserve affairs, OASA(RDA), has been assigned responsibility for building the Army Acquisition Corps Reserve Component.

A staff study has been initiated to validate the total Reserve Components' Army Acquisition Corps requirements by TDA/MTDA and TOE/MTOE documents. The following Functional Areas (FA) will be reviewed for both the Army National Guard and the U.S. Army Reserve: 51 (Research, Development and Acquisition), 53 (Systems Automation), and 97 (Contracting and Industrial Management). Finally, the study will examine the current training AAC curriculum and formulate recommendations to modify course scheduling to accommodate Reserve Component "unique" training needs. Due to obvious time constraints, RC personnel may require AAC courses of instruction to be offered in combinations of resident and non-resident training packages.

There is a concurrent effort to establish a new DA Board to review the entire RC applicant population and determine the qualifications of each for their ultimate inclusion in the Army Acquisition Corps. Tentatively, the board will convene in late 1994 or early 1995 at the U.S. Army Reserve Personnel Center in St. Louis, MO.

Upcoming Article

As a result of numerous requests, an article on the Army Acquisition Corps Scholarship Intern Program will be published in the January-February 1995 issue of *Army RD&A Bulletin.*

On the Horizon . . .

• ***DOD 5000.52-M:*** The revised *DOD 5000.52-M (Acquisition Career Development Program)* dated January 1995 has been completed and is in final review. This significantly revised document prescribes DOD-wide certification standards and will more succinctly define and/or increase the requirements for certification in the majority of acquisition career fields.

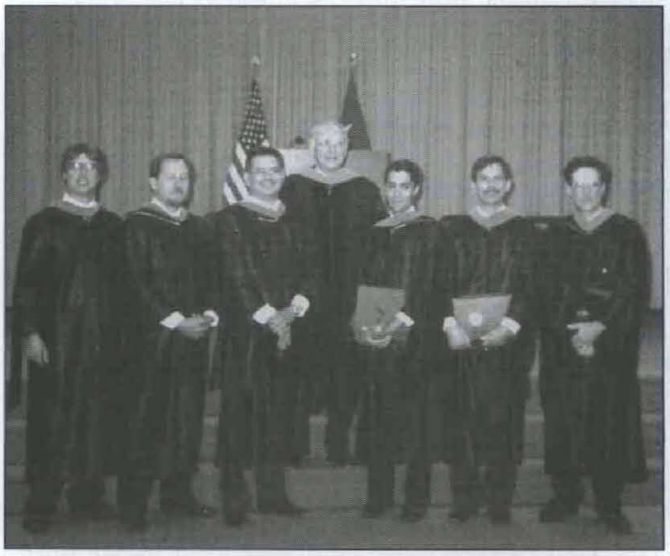
• **Executive Program Management Course (EPMC/PMT 303):** The pilot offering of EPMC began on July 18, 1994. EPMC is an individually tailored four-week course designed to meet the specific needs of PEOs and ACAT I/II PM or DPMs. After Oct. 1, 1996, both the 14-week Advanced Program Management Course (PMT 302) and PMT 303 will be required to meet DAWIA's statutory training requirements for PEOs and ACAT I/II PMs and DPMs.

• **Military Acquisition Position List (MAPL):** A mid-course review of the FY95 MAPL was conducted on June 22-23, 1994. The purpose was to review administrative corrections and COL/LTC positions where the requirement for an AAC officer was not readily apparent. The revised FY95 MAPL along with a list of "weak" COL/LTC positions was distributed on July 11, 1994. The FY96 MAPL Council of Colonels is planned for first quarter FY95.

For additional information on any of the above subjects, please contact MAJ(P) Mark Jones, Army Acquisition Proponency Office, DSN 225-7264 or commercial (703) 695-7264.

Army Employees Graduate From Gateway University Program

Six Department of the Army employees recently received master's of science degrees in engineering management as the inaugural graduates of the Gateway University Program for engineers. Pictured at right with Dr. Bennie H. Pinckley, deputy director for acquisition career management, Office of the Assistant Secretary of the Army (RDA), are (left to right): Rusty L. Weiger, Advanced Attack Helicopter (AAH) Program Manager's Office, PEO Aviation; William T. Reese, AAH Program Manager's Office, PEO Aviation; Jose O. Gomez, Aviation Research, Development and Engineering (RD&E) Center, Aviation and Troop Command (ATCOM); Louis T. DiGuiseppe, Aviation RD&E Center, ATCOM; William J. Smith, Aviation RD&E Center, ATCOM; and Eugene M. Mergel, Aviation RD&E Center, ATCOM.

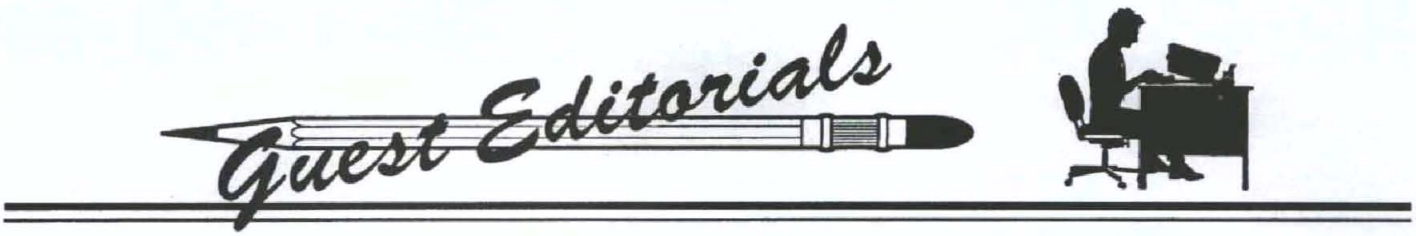


The Gateway University Program is a cooperative effort between the U.S. Army Aviation and Troop Command (ATCOM), the Program Executive Office, Aviation, and participating universities. The intent is to provide an innovative and effective approach to meet employees' educational needs, especially those of members of the Army acquisition workforce and Army Acquisition Corps.

Gateway University Program students receive a master of science degree in engineering management from the University of Missouri (Rolla), or a bachelor of arts degree in business management through Webster University. On their own time, participants attend classes which are offered on-post and fully funded by the Army. The program is administered by the ATCOM Training and Development Division of the Civilian Personnel Office.

Graduation ceremonies for the initial Gateway University engineering graduates were held at the Federal Center with opening and closing remarks delivered by MG Dewitt T. Irby, program executive officer, aviation, and MG John S. Cowings, ATCOM commanding general. A special ceremonial address was provided by Dr. Pinckley.

Representing the University of Missouri (Rolla) were: Dr. Robert Mitchell, dean of the School of Engineering Management; Dr. Raymond Kluczny, program coordinator; and Dr. Daniel Babcock, senior engineering management professor.



ARMY SCIENCE BOARD CONTRIBUTION TOWARD ACHIEVING THE ARMY'S FORCE XXI VISION

By Dr. Michael S. Frankel

Vice President and Director of the Information Telecommunications, and Automation Division, SRI International
Chairman, ASB C^3I Issue Group and Chairman ASB 1994 Summer Study

Many activities are underway in the Army that are developing concepts, doctrine, and technology in support of its Force XXI vision. The Army Science Board (ASB) became intimately involved in the processes associated with achieving this vision and, more specifically, its early (albeit limited in scope) realization in the Brigade 96 experiment. This association was a result of our 1994 Summer Study entitled "Technical Architecture for Army Command, Control, Communications, Computers and Intelligence (C4I)."

The goal of our study was to assist the Army in establishing a framework, called a technical architecture (TA), that would be the basis for the design, development, and acquisition of all Army information systems (tactical, strategic, or post/camp/station). The TA will enable the Army to (1) achieve interoperability and interconnectivity among all of its battle-command systems, thus meeting its knowledge-based operations objectives; (2) achieve interconnectivity with joint and coalition forces who are enforcing standards and protocols that are part of the Army TA; and (3) exploit the rapidly accelerating information technologies being developed in the private sector. The TA will allow the benefits to be accrued, while minimizing the risk, complexity, and cost, of acquiring elements of the Army's battle-command infrastructure.

During the five months we spent in defining the TA, many meetings were held throughout the Army community. These meetings spanned the spectrum of intellectual endeavors from concept and/or doctrine discussions, to requirements definition, to in-depth technical debates related to information-system technologies. As a result of these discussions, many ideas were exchanged or changed. These exchanges caused the TA to support many of the initiatives related to information technology that are already underway in the Army and DOD. Conversely, the TA study has had a major impact on the direction, planning, and procurement of information systems and technologies to support the Force XXI vision and the upcoming Brigade 96 experiment.

The study has already had a very positive impact. Furthermore, this impact will be long lasting. The TA, when completed by the Army, will provide the framework that has been needed, and will continue to be needed to design and procure information systems. The benefits of this study, however, would not have been realized had not the Army community and the ASB worked as a team to define and begin the development of the TA. Although many viewpoints were expressed and in some cases hotly debated, in the end, agreement was reached and appropriate actions were taken.

Of course, timing is critical. The Army's focus on digitization and knowledge-based operations has heightened the long-standing need for a TA. However, it was the team effort, and the respect and trust established between the ASB and Army communities, that have made such remarkable progress possible toward establishing the TA and migrating Army systems to comply with it, in such a short time.

The relationship between the Army and its independent study group, the ASB, has grown and continues to grow strong over time. The Technical Architecture Summer Study is only one example of the value of this relationship. We who participate on the Army Science Board look forward to our continuing support of the Army community.



Yuma Proving Ground Welcomes Armored Gun System

A group of testers from a private firm in San Jose, CA, visited southwestern Arizona's U.S. Army Yuma Proving Ground (YPG) in June 1994 to conduct pre-production firing tests on the Armored Gun System (AGS). Only six prototypes of the vehicle currently exist.

United Defense officials initially planned to conduct the firing tests at nearby Camp Roberts, CA. But when the facility became unavailable, officials chose to transport the system to YPG for the tests. Several of the testers had previously worked at the proving ground and had been favorably impressed with its people and facilities.

The AGS is a lightweight, air-transportable armored vehicle which will replace the old M551 Sheridan light tanks used by airborne forces and will provide direct fire support in light contingency operations. It will meet other light operational requirements including rapid strategic mobility through air transportability.

The AGS carries a crew of three. It mounts a powerful 105mm main gun equipped with an automatic loading system enabling it to fire 12 rounds per minute. It is capable of firing all standard NATO ammunition. The AGS is also equipped with a 7.62mm machine gun in the turret and another machine gun on top. Though the standard AGS comes equipped with basic armor protection, two additional levels with increasingly more protection are available for specific applications.

The AGS will undergo further extensive testing before it is fielded with U.S. forces. Testers plan for it to return to YPG in 1996.

Tanks For the Memories

The U.S. Army Tank-automotive and Armaments Command (TACOM) in Warren, MI, is in the process of retiring thousands of obsolete tanks from the Army inventory. Most of these tanks are from the post-Korean/post-Vietnam era and have been stored at Anniston Army Depot, Anniston, AL, for a number of years.

TACOM, in conjunction with the Army Materiel Command, the Department of the Army, the Defense Logistics Agency (DLA), and the Defense Reutilization and Marketing Service, devised a number of low-cost, innovative approaches to dealing with these old dinosaurs. The most effective new approach is to sell these tanks for scrap value.

Initial estimates for the Army to demilitarize these tanks were $25 million. Neither TACOM nor the Army had that level of funding available. The alternative was to have commercial scrap contractors bid on the rights to the steel and have them perform the demilitarization as part of the conditions of sale. Jerry Zalc, chief of the Combat Vehicle Division of the National Inventory Control Point (NICP), TACOM, stated, "This is a win-win effort for everyone involved. The contractor receives large amounts of scrap steel; the Army gets rid of old, unsellable tanks at minimal cost. There is a net profit to the U.S. Treasury of nearly $2,000 per tank."

To validate the concept, a pilot program of 125 M48A1 tanks commenced in May 1993 and was completed in February 1994. The success of this pilot demonstrated that commercial contractors were interested in bidding, and that the tanks could be turned into scrap in an economical fashion. This program, in turn, paved the way for a much larger effort during 1994.

On April 26, 1994, a contract was let by the DLA National Sales Office in Memphis, TN, to demilitarize 1,000 tanks with the possibility of exercising options for up to 2,000 more. Based on lessons learned from the pilot, this program will be even more cost effective than the pilot program.

The chief of the M60 Tank Branch (NICP) at TACOM, William L. Guess, said, "This program is not only good for the Army, but the taxpayer as well. We've worked real hard with the DLA to minimize the amount of work that government personnel have to perform and thereby kept the costs down."

Zalc added in closing, "These tanks were a key deterrent during the cold war. It's only fitting that they are now primary examples of the re-invested government." This tremendous effort was primarily accomplished with a two-person team composed of Ken Hiltunen and Michelle Spisak.



Dausman Retires

Secretary of the Army Togo D. West congratulates Deputy Assistant Secretary of the Army (Procurement) George E. Dausman on his retirement after 39 years of government service.

RD&A NEWS BRIEFS

Army Research Lab Develops Holographic Microscope

The Army Research Laboratory (ARL) has developed a real-time transmission holographic microscope with special imaging capabilities for largely transparent phase objects such as unstained tissue sections.

The basis of the design is the aberration-correcting capability of phase-conjugate illumination. The diffracted light from a laser beam transmitted through the object is recorded in real time as a hologram within a crystal of barium titanate. The phase conjugate of this beam is reconstructed from the hologram and passed back through the object.

Because of the aberration-removal properties of phase-conjugated illuminating, this back-propagating beam does not contain intensity patterns due to diffraction by transparent phase modulating elements in the object. For this reason, a microscope image of a phase-conjugate illuminated object does not contain phase structure details.

To produce phase details, the phase object is displaced. The original holographic reconstruction of the transmitted beam is passed back through the displaced object.

As a result, aberration removal is incomplete and intensity patterns now appear in the back-propagating beam that then can be imaged. The phase-conjugate microscope permits viewing of transparent features of specimens used in biomedical applications such as cancer and forensic research.

Commercial industrial applications include quality control inspection of optical lenses, the study of the combustion process, and semiconductor materials research.

For technology transfer information, contact Norma Vaught at ARL on (301) 394-2952.

BOOKS

Global Paradox: The Bigger the World Economy, The More Powerful Its Smallest Players

By John Naisbitt, William Morrow and Company, Inc., New York, NY,1994

Reviewed by MAJ Thomas B. Gilbert, an Army Acquisition Corps officer at the U.S. Army Signal Center and School, Fort Gordon, GA. Gilbert is a frequent contributor to *Army RD&A Bulletin.*

Let's see. My trusty U.S. Army dictionary has this to say about paradox: "Paradox - 1. a statement or proposition seemingly self-contradictory or absurd, but in reality expressing a possible truth. 2. a self-contradictory and false proposition. 3. any person, thing, or situation exhibiting an apparently contradictory nature. 4. an opinion or statement contrary to commonly accepted opinion."

John Naisbitt is renowned for looking beyond the obvious and deriving substantial trend analysis at the macroeconomic level. He is the author of the best sellers *Reinventing the Corporation, Megatrends* and the more recent *Megatrends 2000.* His forte is the analysis of worldwide events and their relationships to projected future behavior. He postulates these trends and makes predictions of future trends. He has been surprisingly consistent in a majority of his predictions stated in his past books.

In this tome, John Naisbitt looks at the dynamic forces changing the world economy. The centerpiece is the telecommunication industry that is, in his words, "Powering the paradox."

Telecommunications is the driving force that is simultaneously creating the huge global economy and making its parts smaller and more powerful.

The author cites four complimentary thrusts that underscore his thesis:

• **Blending of Technologies.** The old days of the dedicated telecommunications media are passing. These merged technologies will yield personal communications systems (computers, telephones, and televisions) that will significantly enhance the power of the small user. We have witnessed the birth of the blended technology in our own home offices. Your home computer may now answer your telephone, show interactive video displays, communicate on-line with other users across the world, and, of course, use multiple applications as a computer is expected.

• **Strategic Alliances.** The successful companies of the future are the ones that will merge technology today. We are already seeing the birth and creation of companies that are capitalizing on this convergence of technology. The web of blended technologies are expanded across traditional corporate boundaries.

• **Creating a Global Network.** As the author says, we are "creating a seamless, global, digital, network of networks." It sounds almost as if he was restating the Signal Center's evolving communications concepts. As interconnectivity options grow, the future will permit the user to communicate, through multiple media, to anywhere on the globe.

• **Personal Telecommunications for Everyone.** We can all see where this is leading. As the user gains the power, interconnectivity, and access to information, the world will become intertwined in an ever tightening web of telecommunications. This web is what will power the Global Paradox simply because it will make no difference where you are or how large an organization may be. Everyone will have, to a large degree, mutual access to vast stores of information and the capability to reach each other.

To those of us working with telecommunications, John Naisbitt has stated what we could see coming for some time. Several questions now arise.

• How will we, as military communicators, seize the technological watershed that is about to take place?

• How will we integrate the commercial technologies into our military communications pipes?

• How will we placate the user with his growing, insatiable demand for access?

• How will we maintain our secure, hardened communications systems in the face of growing throughput demands while being mandated to use more commercial means at every turn?

• With commercial imagery and satellite access available to all nations and militaries, how will we overcome our demising competitive advantage?

Yes, telecommunications is powering the Global Paradox. Yet it has created a situation where the military now has a paradox of its own. As the fast-paced telecommunications opportunities grow exponentially, the military's options may be inversely proportional to the opportunities presented. That is, the more options we have to choose, the less we can afford to dedicate toward any one technology. Historically, we have procured systems for the long term, and now the life cycle of a given telecommunications product in measured in months vice years.

As the paradox unfolds, this will be an interesting time to be an Army communicator.

Medical R&D Command Renamed

Shortly before this issue of *Army RD&A Bulletin* was put to press, the bulletin's editorial office was informed that the U.S. Army Medical R&D Command has officially been renamed the Army Medical Research and Materiel Command. The name change is the result of the command's additional responsibilities for medical logistics and health facilities planning for the Army.

Corrections

A small portion of copy was inadvertently dropped from the concluding sentence of the article "Fielding of Paladin M109A6" on page 55 of the September-October issue of *Army RD&A Bulletin*. The sentence should have read "The system is nicknamed Paladin after the medieval knights who roamed Charlemagne's empire in defense of noble causes."

The captions for the two figures on page 12 ("A Critical Step in the Production of Quality Composite Parts" by Diane S. Kukich) of the same issue were transposed. Our apologies for these errors.

U.S. Postal Service
STATEMENT OF OWNERSHIP, MANAGEMENT AND CIRCULATION
Required by 39 U.S.C. 3685

1A. Title of Publication	1B. PUBLICATION NO.	2. Date of Filing
Army RD&A Bulletin	0 8 9 2 8 6 5 7	31 August 1994
3. Frequency of Issue	3A. No. of Issues Published Annually	3B. Annual Subscription Price
Bi-Monthly (Every Other Month)	6 (Six)	$11.00 domestic $13.75 foreign

4. Complete Mailing Address of Known Office of Publication (Street, City, County, State and ZIP+4 Code) (Not printers)
DEPARTMENT OF THE ARMY, ARMY RDA BULLETIN, 9900 BELVOIR RD SUITE 101, FT BELVOIR VA 22060-5567

5. Complete Mailing Address of the Headquarters of General Business Offices of the Publisher (Not printer)
DEPARTMENT OF THE ARMY, ARMY RDA BULLETIN, 9900 BELVOIR RD SUITE 101, FT BELVOIR VA 22060-5567

6. Full Names and Complete Mailing Address of Publisher, Editor, and Managing Editor (This item MUST NOT be blank)
Publisher (Name and Complete Mailing Address)
DEPARTMENT OF THE ARMY, ARMY RDA BULLETIN, 9900 BELVOIR RD SUITE 101, FT BELVOIR VA 22060-5567
Editor (Name and Complete Mailing Address)
MR HARVEY L BLEICHER, EDITOR-IN-CHIEF, DEPARTMENT OF THE ARMY, ARMY RDA BULLETIN, 9900 BELVOIR RD SUITE 101, FT BELVOIR VA 22060-5567
Managing Editor (Name and Complete Mailing Address)
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The purpose, function, and nonprofit status of this organization and the exempt status for Federal income tax purposes (Check one)
N/A
(1) ☐ Has Not Changed During Preceding 12 Months
(2) ☐ Has Changed During Preceding 12 Months (If changed, publisher must submit explanation of change with this statement.)

10. Extent and Nature of Circulation (See instructions on reverse side)	Average No. Copies Each Issue During Preceding 12 Months	Actual No. Copies of Single Issue Published Nearest to Filing Date
A. Total No. Copies (Net Press Run)	30,943	30,989
B. Paid and/or Requested Circulation 1. Sales through dealers and carriers, street vendors and counter sales	0	0
2. Mail Subscription (Paid and/or requested)	1,074	1,074
C. Total Paid and/or Requested Circulation (Sum of 10B1 and 10B2)	1,074	1,074
D. Free Distribution by Mail, Carrier or Other Means Samples, Complimentary, and Other Free Copies	29,814	29,880
E. Total Distribution (Sum of C and D)	30,888	30,935
F. Copies Not Distributed 1. Office use, left over, unaccounted, spoiled after printing	55	54
2. Return from News Agents	0	0
G. TOTAL (Sum of E, F1 and 2—should equal net press run shown in A)	30,943	30,989

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ARMY RD&A BULLETIN
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