ARMY

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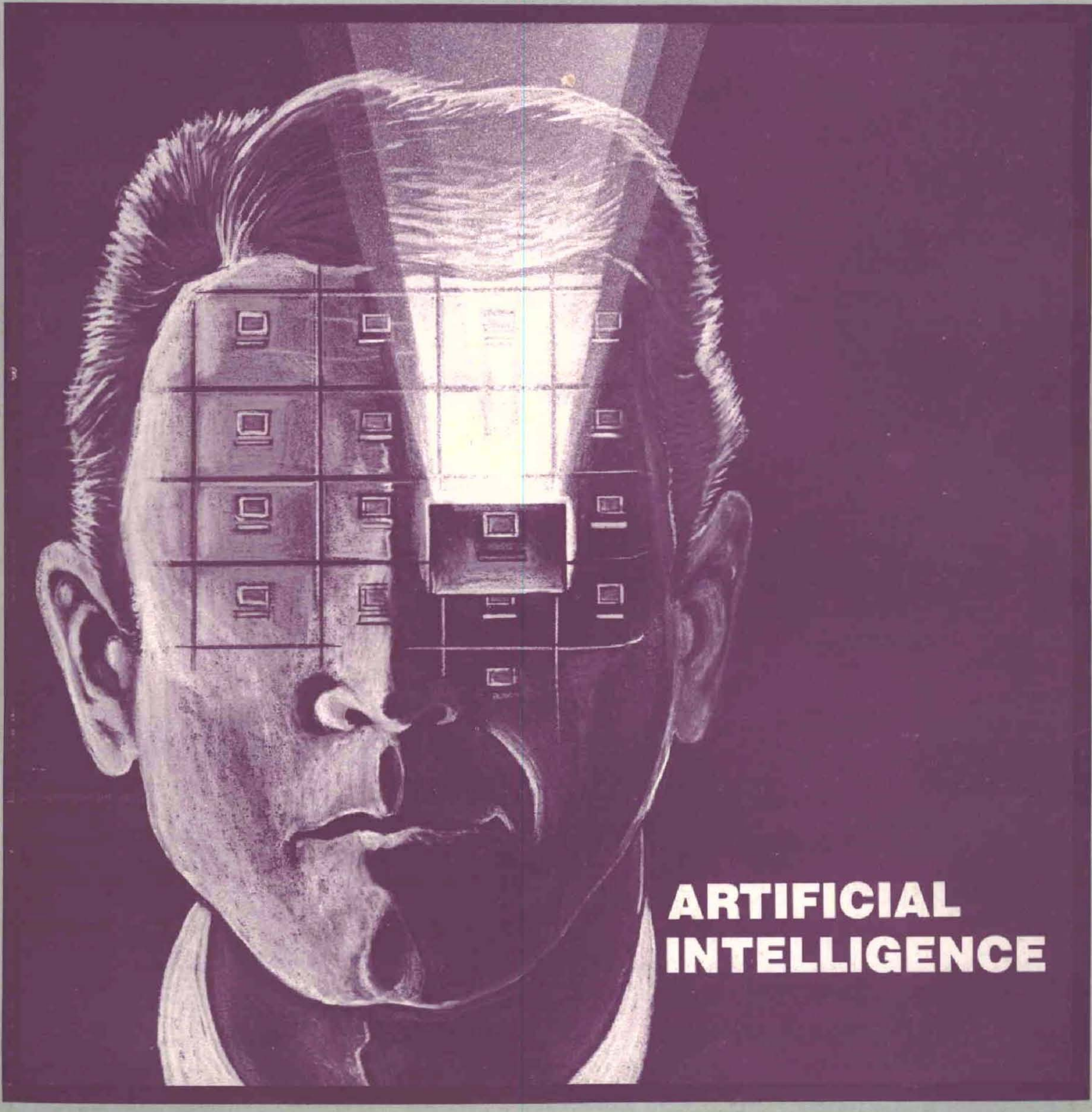
NOVEMBER - DECEMBER 1985



ARTIFICIAL INTELLIGENCE

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FEATURES

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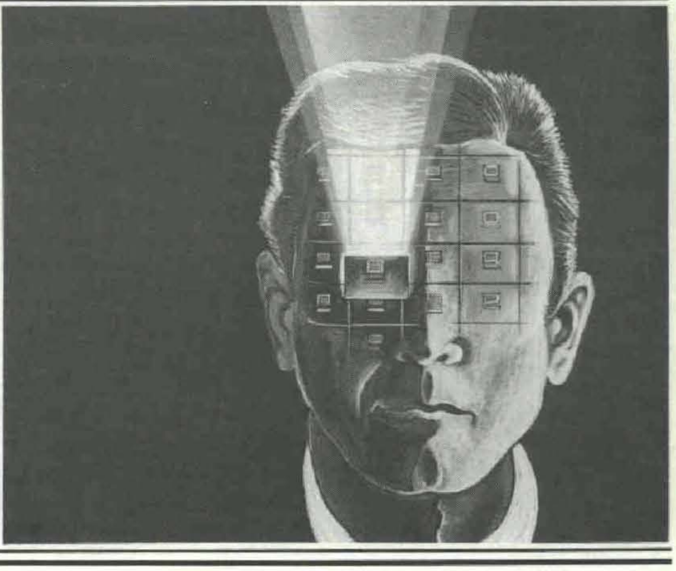
Artificial Intelligence for Executives



By MAJ Richard Allen and Dr. Joseph Psotka

Introduction

This paper was written by use of an experimental tool developed at Xerox Palo Alto Research Center, making use of the Interlisp-D environment. This experimental tool, which will be discussed later, helps researchers organize complex ideas and knowledge into simple tree structures. In helping write this paper, this tool automatically extracted relevant ideas from existing text, stored as a much larger hierarchy or tree.

The first fully-fledged conference on artificial intelligence (AI) took place at Dartmouth in 1956, 29 years ago. Yet, one can hardly pick up a journal these days without encountering yet another story about the newest miracle of technology to explode on the scene as if it were invented yesterday. AI may still be a baby in terms of its potential for growth, but it is a mature technology ready to be exploited by the Army for training, command and control, logistics, intelligence, and to provide the brains for active robots. AI will undoubtedly be exploited in many ways on the battlefield, but it can also make the Army run more efficiently behind the lines.

The goal of AI (AI is best defined by its goals and objectives rather than its description) is to make computers and other machines smarter so that they are more useful. In order to make machines smarter, AI researchers deal with a core set of topics, such as learning, language, reasoning, perception, manipulation, and computer environments. Since this is an enormous range of topics, very few people can encompass them all, so research work typically involves teams of experts from several disciplines. Computer science generally provides the nucleus surrounded by logicians, psychologists, linguists, and others.

Expert Systems

Although the definition of AI covers many areas of research, the widespread excitement about it stems almost exclusively from the commercial applications of expert systems. Expert systems use rules to codify the knowledge of experts so that a computer can act as an expert to do the job or provide expert consultation to others. Rules are written in the form of a condition that needs to be met (If . . .) in order to take a certain action (Then . . .). The focus is on rules as a knowledge base of expertise. Structuring these rules uniformly provides the foundation for the inference engine (usually a relatively simple set of programs) to search the knowledge base and determine the best course of action. Understanding expert systems holds the key to understanding the potential of AI for the Army. Understanding expert systems in turn hinges on knowledge about the three key components: the Lisp machine environment, the activity of knowledge engineering, and case studies of the current capabilities of expert systems.

One of the first "products" to come out of the Dartmouth conference, from MIT Professor John McCarthy, who probably coined the term artificial intelligence, was the computer language Lisp (LISt Processing language). Lisp has become the lingua franca of AI because all of the significant milestones in the history of AI have been etched in Lisp.

Powerful computers, known as Lisp machines, are designed to capitalize on the strengths of Lisp. As a rough comparison, these machines have the storage and memory of 2,000 personal micro-computers, and a display with sufficiently high resolution to hold 10 to 15 micro-computer screens.

Putting all this programming power in one person's hands means posing the problem of how to create a human interface that lets someone deal with a highly complex matter in a very simple way. The current answer turns out to be a high-resolution graphic display with inspectable windows and tree structures, and an intelligent computer-based assistant that helps interpret all these aids. Future answers are likely to support other symbolic systems, especially natural language.

The plummeting price of hardware has seen the price of dedicated, single-user machines needed for Lisp processing drop from half a million dollars four or five years ago to under $20,000 today. The number of companies making these machines is increasing steadily. Hardened machines for Army use are currently available, and portable machines at the cost of today's micro-computers are probably only a year away.

Knowledge Engineering

The creation of expert systems involves a unique blend of skills to extract the structure of knowledge that experts have and impose it onto the symbolic formalisms a computer needs. These demands have created a new profession of knowledge engineering. Generally, knowledge engineers have come from the computer sciences and they are intimately aware of what the computer system needs in order to function. Given this knowledge, they have approached an expert in the narrow area they wanted to encode and gradually teased from the expert the set of rules that best cover the domain. Because of the complexity of the process, they have usually been forced to become experts themselves. However, this picture is rapidly changing, and other professionals (often psychologists) are learning to use the powerful knowledge engineering environments available to perform this task.

Central to the process of knowledge engineering is the formation of knowledge structures that create a semantic network of the kind shown in the accompanying diagram. Although these knowledge structures are not required for the operation of the expert system, they are needed if the expert system is to provide the kinds of explanations and justifications that someone would ask of it in its role as an assistant, trainer, or decision aid.

Developing an expert system through the process of knowledge acquisition is still much closer to an art than a science. Trial and expensive error have yielded the following general but useful advice about the kind of knowledge that works best:

- It should be based on facts covering a well-defined body of knowledge.
- It should require human judgement.
- It should not be a physical skill, like juggling.
- It should have well-recognized experts.
- It should be taught routinely in courses or apprenticeships.
- It should be complex enough that a simple computer algorithm cannot deal with it.
- It should cost a great deal for humans to learn it, because certainly, the expert system will be expensive to develop.

Expert systems can do anything a human expert can do, within limits. Usually, their knowledge base is narrower than an expert's. They have limited explanation capabilities, virtually no natural language, and they break down completely when a question falls outside their area of expertise. Even more telling is that they can only effectively deal with a uniform knowledge base. If there are any conflicts in the knowledge base (such as the opinions of multiple experts) the system will collapse.

Within these limits, if there is an expert on a subject, it is probably safe to bet that an expert system of some kind exists or can be constructed. The following general tasks offer some illustrative examples that try to cover the range of possible systems: interpreting and monitoring sensor data; diagnosing faults and troubleshooting; controlling the overall behavior of a system; designing and configuring systems; planning actions, routes, and tactics; predicting outcomes of dynamic systems; forecasting the implications of models; training technical knowledge and skills; and solving problems and making executive decisions.

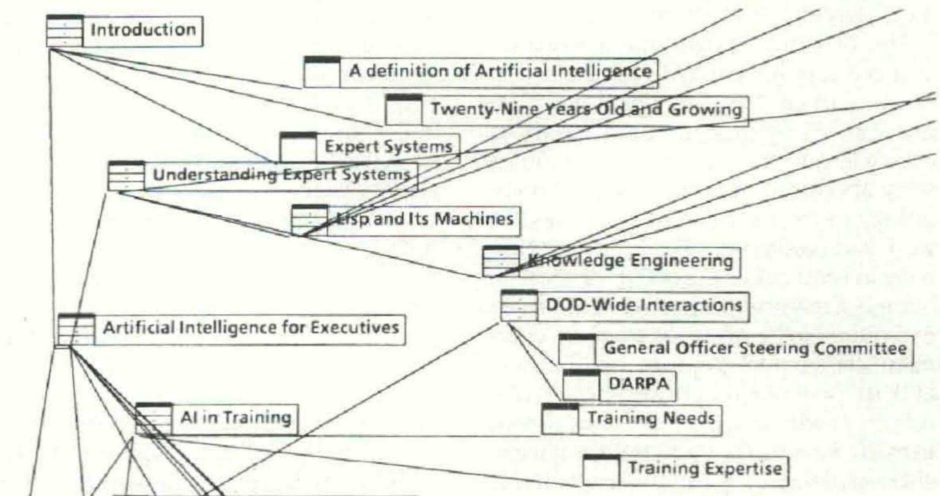
Most expert systems handle a part of each of these tasks, but are designed to deal best with problems in only one of the above areas.

Executive Assistants

People often say that an executive does not need to know anything, only how to find it when it is needed. Usually that means a smart assistant who can track down the information at a moment's notice. The developments in expert systems and powerful computers are making it increasingly easier to provide powerful assistants (not just assistance) for executives and professionals. Programmers on Lisp machines already have these assistants since the machines take care of much of the housekeeping aspects of programming. More recent expert systems in medicine act like invisible robots, helping and tidying up whenever they can.

For example, watching a medical doctor interact with these systems, one might not realize the intelligent, expert system is operating. It has carefully been made subservient to the doctor's initiative. The system provides him with an identical version of the form normally used. As it is filled out, the system may enter suggested values, or display windows next to the form with a profile of the current patient (that it has extracted from the form as the doctor was filling it out) with suggested diagnoses and doses of medicine. The doctor is free to ignore the advice, but if it is accepted, the form is automatically updated and completed, at considerable savings of time and effort.

These kinds of assistants can act as unobtrusive consultants to executives and professionals in many areas. They take advantage of expert systems' strengths in limited areas of knowledge, but keep human expertise in the loop to prevent catastrophic miscalculation by limited expert systems.



This tree graph shows the structure of this article.

Increasingly, executives must have expertise in areas where they have no experience or training. Computer technology constitutes a prime example of this phenomenon, particularly within DOD. More and more weapons are turning into walking or moving computers. A brief (say week-long) executive training session helps, but it cannot provide answers to straightforward questions when they are needed. An expert assistant can. Similarly, the rules of law and bureaucracy an executive lives by can be entered into the knowledge base of an expert assistant and made ready at a fingertip's command. These kinds of consultants are being developed in all areas of business, such as law, banking, insurance, real estate, and accounting.

A general officer steering committee has been set up to develop a management action plan to apply AI and robotics to many Army areas. An Army AI group is also creating an effort to develop them for logistics. It should only be a short step beyond these efforts to create expert general officers and Senior Executive Service assistants for distributed communication, wargaming, and tactical and strategic analysis.

AI in Training for the Army

Our work within DCSPER naturally focuses our interest on manpower and training issues within the Army. Currently, the Army's training system is strained as a result of reductions in training time and an increased need for highly skilled performance. Future Army doctrine identifies the need for skilled operators and specialized technicians to repair and maintain complex, high-technology weapon systems. Short tours of duty and lengthy training combine to dilute the Army's expertise.

The distributed battlefield of the future will also make unprecedented demands on the cognitive decision-make skills of its soldiers. They need to be prepared intellectually to make fast, appropriate decisions and use complex strategies and technologies. The best way to train soldiers is to use the same smart technology they will use on the battlefield. At some point in the future, battlefield systems may even have intelligent training systems embedded in them.

An example of a mature technology which is ready to be applied to the training problem is Intelligent Tutoring Systems. The past decade has seen the development of several of these systems that provide the kind of individualized training and interactive instruction that leads to the acquisition of expertise which might otherwise require years of on-the-job experience. The Army Research Institute for the Behavioral and Social Sciences (ARI) has capitalized on this technology by cooperating with Xerox in the development of intelligent maintenance training systems to create improvements that are ready to be applied to Army systems.

A Prototype Trainer for HAWK

The U.S. Army Air Defense Artillery School and ARI are conducting research that will establish the effectiveness of new, intelligent computer technology for training in an Army school setting. The effort will adapt existing artificial intelligence technology to reduce the time-to-field "expert" air defense artillery officers and technicians. A sophisticated AI-based maintenance tutor is being designed for HAWK (MACH-III) radar fault diagnosis and an intelligent Conduct of Fire Trainer will be developed for Patriot. The high technology environment of the missile school, with its advanced radars and virtually automatic targeting devices, has created a skilled corps of soldiers well prepared to evaluate these new ideas.

The core of these trainers is an "articulate expert" capable of performing problem solving tasks and explaining its performance to soldiers and novices so that they may rapidly acquire its "expertise." The systems will tailor instruction to individual trainees' needs, structuring their training in the way a good personal mentor would.

The articulate expert will prepare trainees with appropriate background information; demonstrate the maintenance or command and control task; carry out in-task monitoring and guided practice; and conduct a thorough post-task debriefing, just like an expert. The building of these systems is an attainable goal that will be a signal contribution to training technology.

Given practical constraints of implementation and funding, the role of these systems in the overall program of instruction at a school will gradually increase and spread to fielded systems, but there are many training tasks that are better carried out with live instructors or with the real equipment or three-dimensional simulators. AI technology at this time is but one important component of a continuum of training techniques, and much remains to be done to explore how best to integrate all these components.

Conclusions

In many senses, the future is now. Unraveling all the many threads of possibilities in existing exploratory systems creates the whole cloth for what the future will look like. Computer hardware devices will become more intelligent, smaller, and cheaper. They may become part of every piece of equipment, from clothing to rifles to missiles. They will assist in training and in executive decisions. Expert systems with limited knowledge bases will act as assistants and consultants in all Army areas where intelligent decisions need to be made clearly and quickly.

Larger systems with more autonomous decision-making power are more problematic because they will still be difficult and expensive to construct and to maintain; so their role will be drastically more limited.

Natural language capabilities and speech understanding and generation are somewhat clearer prospects for rapid development and deployment. Along with the sophisticated graphics environments that will make computers more like books to read and browse, (but with intelligent assistants to help in the browsing) natural language facilities are what executives need most of all from AI systems. With careful planning, funding, and executive decisions by the RDA community, this future should emerge from the present in the next decade.

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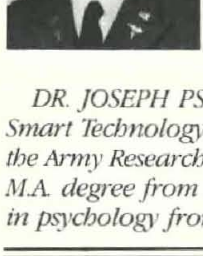

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Navy Applications of Artificial Intelligence

By Leslie E. Gutzmann and Sharon M. Hogge

Introduction and Background

Throughout its history, the U.S. Navy has been manpower intensive in most of its systems. The combination of demographic changes (fewer young men), changed battle scenarios, and advanced technologies in artificial intelligence (AI), computers, and robotics suggests both a need and an opportunity to multiply the effectiveness of Navy personnel. Not only can these technologies reduce manpower requirements, they can also replace personnel in hazardous areas, multiply combat power, improve efficiency, and augment capabilities.

Current AI efforts are being performed at several of the Navy's R&D laboratories. The Navy Center for Applied Research in Artificial Intelligence at the Navy Research Laboratory in Washington, DC, has been chartered as the main center for AI research in the Navy.

Other laboratories performing significant work include the Naval Ocean Systems Center, San Diego, CA; the Naval Surface Weapons Center, Silver Spring, MD; and the Naval Personnel Research and Development Center, San Diego, CA.

Major areas of AI research in the Navy laboratories are command, control, communications and intelligence (C^3I), training, expert advice for decision making, message processing, and control of robotic systems.

The definition of artificial intelligence can be thought of as simply an attribute demonstrated by any system which has a dynamic data base of facts, a reasoning mechanism that exchanges information with the data base, and a static knowledge base as shown in Figure 1. Theoretically, this basic intelligent system should be able to make decisions concerning an unknown situation in which it has no prior knowledge. The problem with this structure is that the knowledge base is static i.e., does not learn. An example would be a mobile robot with the attribute of artificial intelligence that suddenly senses an obstacle in its path that it previously mapped as clear. The robot must make the decision to avoid collision and if it is possible to go around the obstacle. However, if it has limited sensing processing and information capabilities, then it will have no ability to learn and no means to reach a logical decision.

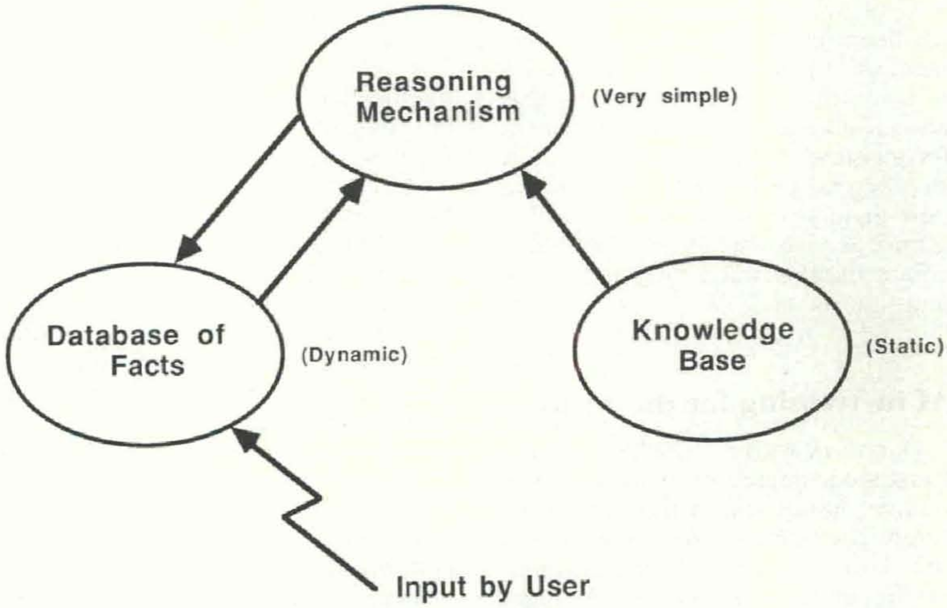


Figure 1. Model of a basic intelligent system.

In the area of C^3I, RADM Albert J. Baciocco Jr., director of research, development, test and evaluation, Office of the Chief of Naval Operations, comments in *Applications in Artificial Intelligence* on the military need for AI:

> In the case of C^3I, the necessity for intelligent automation can be attributed to the steadily increasing requirement for more responsive intra- and inter-task force interactions driven by expanding demands imposed by ever more sophisticated surveillance and weapons systems of both friendly and hostile forces. While the application of conventional automation on the command, control, and communications arena has been somewhat successful to date, it has not really kept pace with improvements in weapons systems and surveillance capabilities which drive it. Artificial intelligence, I believe, affords new opportunities, not simply for catching up, but for getting ahead.

In the area of control of robotic systems, the physical actions of a mobile robot might not seem to require a great deal of intelligence. Even small children are able to navigate successfully through their environment and to manipulate items, such as light switches, toy blocks, and eating utensils. However, these tasks, performed almost unconsciously by humans, require many of the same abilities used in solving more intellectually demanding problems when performed by a machine.

Consequently research in robotics has helped to develop many AI ideas. It has led to several techniques for modeling "states of the world" and for describing the process of change from one state to another. It has led to a better understanding of how to generate plans for action sequences and how to monitor the execution of these plans. Complex control problems have also forced us to develop methods for sensor integration.

Current Efforts

Currently underway in the Navy's R&D labs are projects in three-dimensional (3-D) vision, decision support for fire support, command and control, C^3I, and computer-aided training. The results of these projects will be beneficial to not only the Navy but to the other services as well.

3-D Vision and Image Processing

Three-dimensional vision has applications in manufacturing processes i.e., welding, machining, paint spraying, where the work environment will change with time. Also, with the navigation of a mobile vehicle, 3-D vision and image processing are critical. At the Naval Surface Weapons Center, the Robotics Project Office is engaged in the development of a passive, near real-time 3-D sensor for obstacle avoidance for a robotic device and rough positioning of a robot end effector with respect to the workpiece in a robotic arc-welding system.

The approach to the 3-D vision is to exploit the inherent characteristics of a wide aperture lens, varying the focal length, thus "seeing" only a slice of space, eliminating foreground and background clutter. Analog processing of the image is used to simplify the 3-D information used in the image understanding expert system that "recognizes" the image.

Decision Making Aid

Timely decision making during warfare is critical. However, with the sophistication of today's weapons systems and large quantity of pertinent information concerning a scenario, decision makers may find themselves reaching the limit to the information that they can retain.

Efforts at the Naval Research Center are dealing with this problem by development of an expert consultant system for weapon allocation. This system combines two important tools of AI to generate improved weapon allocation plans for the Marine Integrated Fire and Air Power Support System, based on information provided by forward observers using digital communication terminals. First, the effectiveness of each individual weapon against each prospective target is computed using a computation network. The networks used in battle are generalized to allow non-probabilistic reasoning and to use a criterion called "merit" for efficient direction acquisition.

After the calculation of individual effectiveness values, a weapon allocation tree is constructed to determine good allocation plans for the set of weapons. The individual effectiveness values are used to direct the traversal and pruning of this allocation tree and to select the best allocation plans. This method of search succeeds in finding a globally optimal weapon allocation plan.

C^3I

The Naval Ocean Systems Center is addressing the issue of information and data sharing in the C^3I arena. Earlier investigations of Navy data fusion problems and techniques are being examined in three areas. The first investigation, from a single site and platform, is extended to a global network of systems. The problem of sharing information among subsystems of a command and control system is expanded to that of sharing information of mutual interest with other units and battle groups. The second investigation concerns a reconstruction and post-analysis system. The reconstruction process is simply data fusion after all data are in. After reconstruction, AI techniques may be used to interpret and help analyze the event records. The third area concerns information storage and retrieval in novel mediums. Throughout all this research, the main emphasis is on the application of AI tools.

Computer-Aided Training: Steamer

Computer-aided training, training devices, simulation, and training cost benefit analysis are being addressed in work sponsored by the Naval Personnel Research and Development Center by Bolt, Beranek, and Neuman Inc. The name of this project is "Steamer." The main objective of the Steamer effort is to develop and evaluate advanced knowledge-based techniques for use in low-cost, portable training systems. The project is focused on propulsion engineering as a domain in which to investigate these computer-based training techniques.

An important component of the Steamer system is a detailed mathematical simulation of a propulsion plant. This simulation model describes the engine room portion of the propulsion plant and has interactive user capabilities. This portion of the model may be used alone or with other modules. Facilities to smooth interaction with the system are available, also an on-line data base of variables containing information about their units, range, the models in which they occur, and their role in the simulation e.g., internal constants or as values sent to the real-time interface.

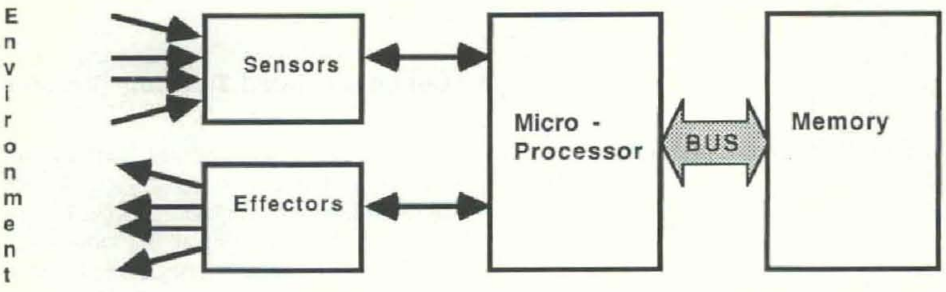
Future Efforts

The Navy is also looking toward the future needs of the fleet and the requirements for research efforts to meet these needs. Below, potential applications of AI are described which have been identified by a study at the Naval Surface Weapons Center.

Expert System for Replenishment Logistics

An expert system for replenishment logistics would assist and speed supply operations at sea. An underway replenishment (vertical replenishment via helicopters, or alongside via span wire from the replenishment ship) is an operation requiring 50 percent or more of the crew. Depending on the ship size, two to eight hours are required for the replenishment. Ships are vulnerable

Figure 2. Processing architecture for a mobile robotic device.



during this period because both crews are involved in the transfer of supplies. In addition, handling the cables is hazardous.

Danger is also present among winch operations and overhead wire breakage is possible. As materiels are brought aboard, lines of men are formed to break down palletized loads and transfer those materials below decks. However, some materials cannot be stowed immediately and are stacked where space permits. The order in which supplies will arrive is sometimes not known. The typical choke points in underway replenishments are work parties that must physically handle material. An objective during replenishment is to minimize the time required to complete the process, thereby minimizing the vulnerability of a ship.

A computer system could be used to support the logistics of the transfer of materials. Software with knowledge rules based on the arrival order of materials, flow paths to proper storerooms, ship layout, number of crew members available, expected time for tasks, and available space could optimize arrival order, flow paths, and crew usage. This information could be coordinated with a similar system on the replenishment ship. The optimized material flow patterns would minimize the time ships are alongside as well as the time needed to stow the material.

Intelligence Data Correlator

Just before a ship is deployed, a large amount of written information is received concerning pertinent intelligence that may affect the mission of that ship. This information must be reviewed, requiring numerous manhours. Tactics, threat assessments, maps, and charts for the ship are then prepared from this information and the resulting analysis.

A rule-based expert system could be quite useful for this task given the large amount of information to be analyzed and correlated. The system could assist in the above mentioned tasks as well as with the monitoring and analysis of tactical, political, and intelligence information on a continuous basis to detect developing patterns, provide warnings or requests, project scenarios, and recommend possible actions. This system could provide input as a decision making aid used by the commanding officer.

Expert Mobile Sentry

Watch standing requires 20 percent to 25 percent of the crew's time while at sea. The watch may involve monitoring dials and recording readings regularly, observing machinery in operation, roving the ship and checking locks on storerooms, freezers and lockers, disbursing, ship's store, scanning the sky and sea for objects, monitoring radars, message traffic and communication equipment. Also, watch tasks may include the guarding of special weapons. Many vital operations of a ship are monitored constantly. Since watch standing requires an enormous amount of manpower, the automation via robotics and AI of many of the tasks above would mean manpower savings.

A mobile sensor platform with the ability to detect fire, smoke, toxic fumes, infrared radiation, flooding, and other critical conditions could perform a mobile watch standing task. Figure 2 contains a processing architecture for a typical mobile robotic device. Sensors are available today but are not sufficiently reliable or robust for a naval environment. Further, even though numerous permanently installed remote sensors could do the sensing function as a permanent system with wiring running through the ship and back to a main monitoring station, it would be very susceptible to damage.

The Defense Advanced Research Projects Agency has the Autonomous Land Vehicle Program which is generating technology that would apply to this application. In addition, the Naval Ocean Systems Center and the Defense Nuclear Agency have ongoing programs in intelligent robotic systems.

Summary

Today, the discipline of artificial intelligence appears to realistically address a wide range of military concerns. Current efforts include C^3I, training, expert advice for decision making, message processing, and control of robotic systems. We are facing declining availability of manpower and rising costs. Such manpower issues, coupled with the increasing complexity of our decision environment and our hardware systems, is one driving force behind DOD interest in AI.

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Air Combat Expert Simulation

By Dr. Timothy E. Goldsmith and Dr. Roger W. Schvaneveldt

Introduction

Air Combat Expert Simulation, or ACES for short, is a computer simulation of the cognitive skills pilots employ in air-combat maneuvering (ACM). ACM occurs when two or more opposing pilots attempt to obtain an advantageous position over one another.

The problem domain of ACM offers much of the complexity found in traditional tasks studied by cognitive psychologists. For example, in performing ACM, a pilot must predict what his opponent will do next, plan a course of action, execute the actions in a timely manner, and continuously evaluate and update his plan of action.

ACES attempts to model the cognitive performance of expert fighter pilots in performing ACM. At present, the computer simulation is directed primarily at selecting maneuvers to perform under a given set of airspace conditions. Maneuver selection is guided by a model of the decision-making skills of expert pilots.

Represented within ACES is an airspace environment occupied by two opposing aircraft of equal capabilities (AT-38s). ACES displays changes in this airspace by showing sequences of static airspace states. Each airspace state is a snapshot in time description of the positions, orientations, and airspeeds of the aircraft.

ACES also contains flight equations to describe the aerodynamic characteristics of high-performance aircraft. Each maneuver known to ACES is described as a sequence of inputs to these equations. ACES currently works with 18 basic flying maneuvers, including both offensive and defensive maneuvers. Some example maneuvers include low yo yo, barrel roll, quarter plane, and break turn.

A typical session with ACES consists of a user selecting maneuvers for one aircraft with ACES selecting maneuvers for the other aircraft. The goal for each participant is to maneuver his aircraft into a position for deploying weapons. A user begins a session by choosing conditions for an initial airspace state. The user and ACES then select maneuvers that appear most appropriate for their aircraft under the existing conditions. It is also possible to let ACES select for both aircraft, in which case the user simply observes the engagement.

After selection is complete, ACES uses the flight equations to realistically execute each aircraft through its maneuver. During this time, the user sees a series of airspace states depicting the aircraft performing their maneuvers. The last state shows the resulting conditions in the airspace after the maneuvers have been completed. A new set of maneuvers are then selected for this state, and the cycle continues.

The airspace environment is described to an ACES user in both tabular and graphic forms. A table provides information specific to each aircraft, such as heading, airspeed, and altitude and also information relative to both aircraft, such as range and closure rate. A graphics display depicts a three-dimensional image of the two aircraft. The reference point for viewing the airspace can be changed by the user to allow various viewing orientations and distances. It is even possible to pick a viewpoint from within one of the aircraft's cockpits. This allows the user to see what the pilot would see when looking straight out of the cockpit windscreen. The information table and graphics are displayed simultaneously.

ACES employs a production system architecture for representing its knowledge of ACM. A production system is a programming technique used extensively in artificial intelligence (AI) work. The data base of the production system contains information that pilots find useful for selecting maneuvers such as aspect angle, angle off, and closure rate. ACES' production rules are if-then statements that describe conditions for performing particular maneuvers. ACES is written in the programming language PROLOG.

We have employed techniques of knowledge engineering in AI and expert-novice research in cognitive psychology to understand the cognitive skills underlying ACM. From discussions with expert pilots, primarily from the 479th Tactical Training Wing at Holloman Air Force Base, NM, we have identified information critical for selecting maneuvers, local and global strategies for maneuvering against opponents, and means for evaluating relative positional advantages. Scaling procedures have been used to identify and represent the conceptual structures of pilots with various levels of expertise. Much of our current effort in this area is directed at understanding how pilots form and evaluate plans of action.

The ACES project is currently funded by the Air Force Human Resources Laboratory at Williams Air Force Base, AZ, through the Computing Research Laboratory at New Mexico State University.

Project Goals

The ACES project is designed to achieve several interdependent goals. A primary objective is a better understanding of the cognitive skills underlying performance in complex tasks such as ACM. We are particularly interested in pilots' planning and decision making abilities. We hope to learn how these skills are acquired and what distinguishes an expert pilot from a more mediocre performer.

A second goal is to develop a computational model for representing and employing expertise in ACM. In this sense, ACES is an attempt to create an expert system. There are some important differences, however, between ACES and other AI type expert systems.

First, expert systems to date have dealt primarily with static tasks; that is, the particular problem at hand does not change much over time. In contrast, ACM occurs in a dynamic environment, so it is likely that existing methods for representing knowledge in expert systems will prove inadequate in the ACM environment. Second, unlike expert systems, ACES is not currently aimed at aiding or replacing the human expert. ACES does not consider the perceptual motor skills that are so critical in real-time performance of ACM. Instead, its sole focus is cognitive. Third, an important goal of the project is to consider the psychological validity of certain aspects of its computational method. In contrast, expert systems are motivated primarily by performance criteria and are not intended to be psychological models.

A third goal of ACES is to teach student pilots the cognitive skills required to perform ACM. We envision ACES serving as a desk-top training system to supplement students' academic training. Students can learn much about ACM by observing expert pilots perform the task. To the extent that ACES successfully models the decision processes of an expert pilot, it offers an excellent tool for teaching maneuvering skills to student pilots. However, ACES is not intended to teach the perceptual motor skills required to actually maneuver aircraft. Instead, its teaching potential is its ability to demonstrate to students appropriate maneuvering actions under a variety of air-combat situations.

Future Directions

One future direction of the ACES project is to begin to incorporate strategic planning into the model. Currently, the decision making ability of ACES is aimed at the maneuver level. Although the maneuver is an important aspect of air combat, pilots clearly plan sequences of actions that are more global than the maneuver. We hope to incorporate into the model higher-level goals and plans for achieving those goals.

Although the ACES project has focused solely on air-to-air combat, it appears to have relevance to other areas. The approach taken in ACES might be applied to represent the cognitive skills required of people in other dynamic task environments. Adapting the basic framework of ACES to similar domains, such as helicopter-helicopter or tank-tank engagements, would be another interesting direction for future work.

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New Smoke Vehicle Type Classified

The M1059 Smoke Generator Carrier will be fielded to Army units in Korea and Europe in October 1986.

A new smoke vehicle has been type classified by the Army and designated the M1059 Smoke Generator Carrier. This action took place as a result of a type classification in process review held last April at the Edgewood Area of Aberdeen Proving Ground.

The review was hosted by project manager (PM), smoke/obscurants, and the briefing conducted by the Chemical Research and Development Center (CRDC). Attending were representatives from the Office of Project Manager, M113 Family of Vehicles, the U.S. Army Training and Doctrine Command, the U.S. Army Materiel Command, the Logistics Evaluation Agency, and other activities.

The vehicle is managed jointly by the PM, M113 family of vehicles and PM, smoke/obscurants. Each conducted simultaneous product improvement programs (PIPs) on the two sections of the M1059.

PM, smoke/obscurants managed the M157 Smoke Generator Set, which was designed by the Munitions Directorate's Smoke Division of CRDC. PM, M113 family of vehicles developed the M1059 Smoke Generator Carrier on which the system is mounted.

Full scale production of the vehicle is expected to begin in June 1986. In October 1986, fielding will begin to units in the U.S. Army Forces Command, the United States Army Europe, and the Eighth U.S. Army Korea. A total of 195 vehicles will be fielded.

The combination of an M113A2 Armored Personnel Carrier, with an M157 Smoke Generator Set, makes the M1059 Smoke Generator Carrier the first vehicle with large area mobile smoke generation capability. Six M1059s will be provided to each chemical company in the Army's heavy divisions, due to requirements of the Division 86 force structure.

The M1059 can produce smoke continuously for one hour without refueling. The vehicle is operated by a three-man crew consisting of a vehicle commander, a driver, and a smoke generator operator. The system is remote controlled, allowing the crew to be protected by the vehicle's armor during smoke operations.

The M157 Smoke Generator Set will also be applied to the High Mobility Multi-purpose Wheeled Vehicle, schedule to be fielded in FY87 in all smoke generation units not equipped with M1059s.

COL Morton S. Brisker, project manager, smoke/obscurants, is the life-cycle manager for the M157 Smoke Generator Set, and LTC Lawrence J. Becker II, project manager, M113 family of vehicles, is the life-cycle manager for the M1059 Smoke Generator Carrier. The M1059 Smoke Generator Carrier will fielded to Army units in Korea and Europe in October 1986.

The HAWK Institutional Training System

By Bennie H. Pinckley, Dr. William C. Wall Jr., and J. D. Kirkland Jr.

An integrated approach to HAWK institutional training will result in significantly improved school-based soldier proficiency and in substantially reduced life cycle training costs. This is the conclusion of a recently released HAWK Project Office Study. The study—a comprehensive system engineering evaluation involving the combat developer, the materiel developer, and the training developer—recommends the introduction of computer-based instruction (CBI) and CBI simulation as the central thrust of this integrated approach. Classroom instruction and practical exercise on HAWK tactical equipment will be maintained as integral elements of total school curriculum, but with revised emphasis.

Integration is a key factor in the HAWK Institutional Training System (HITS) in two major ways. First, the study team represented an integrated effort of the combat developer, the materiel developer, and the training developer, operating together as a HAWK Training Committee. The association of the first two groups was not unusual in such an endeavor. However, the integration of the third group on the basis that the concept-based requirement methodology applies as much to the training developer as it does to the combat developer was a first—if not for the Army—then certainly for HAWK. Second, the study team was chartered to evaluate the total institutional training requirement both for operator and maintenance training at the U.S. Army Air Defense Artillery School and the U.S. Army Ordnance Missile and Munitions Center and School. In both instances, the emphasis on integration paid handsome dividends resulting in more than just modest payoffs.

Background

HAWK is the U.S. Army and U.S. Marine Corps primary low-altitude, all-weather air defense missile system. Designed for particular effectiveness at low altitude, HAWK uses a continuous wave radar homing guidance to discriminate against ground clutter and achieve intercepts against the lowest flying aircraft targets. Improved HAWK is effective against the full spectrum of aircraft at all tactical speeds, altitudes, and in a heavy electronic countermeasures environment. The system is highly mobile, helicopter transportable, and will operate under rugged weather conditions.

Basic HAWK—originally deployed in 1960—is deployed with U.S. forces around the world. As hostile threats increased, HAWK was modified to meet these threats and to take advantage of the rapid increase in technology. A major update to HAWK was fielded in 1972 when Improved HAWK was deployed. This included such improvements as solid state electronics, digital data processing, counter-countermeasures improvements, rocket motor and warhead improvements, improved reliability, increased built-in test equipment, and easier maintenance.

A second major update occurred in 1979 when the phase I product improvements were fielded. These improvements included a new solid state transmitter for the Continuous Wave Acquisition Radar, a new digital moving target indicator for the Pulse Acquisition Radar, and provision for the Army Tactical Data Link—an automated interface with the AN/TSQ-73.

A third update occurred in 1983 with the fielding of the phase II product improvements. This update provided the system with an optical tracking system as an adjunct mode and provided a major update of the High Power Illuminator for reliability, maintainability, and for improved performance. In the same time frame, the missile was updated with new performance improvements and shelf-life components were replaced. The next major update will occur in the mid-1980s when the phase III product improvements are fielded. This significant update includes an additional modification of the High Power Illuminator and the Continuous Wave Acquisition Radar, a new computer and fire control display system, a new integral operator training system in the Platoon Command Post (a field proficiency trainer) and provision of a new system capability for low-altitude simultaneous engagements.

These major update cycles have allowed HAWK to continue to be the most effective air defense weapon in the world. HAWK has proven itself in thousands of flight tests against every type of threat, including actual combat application. Improved HAWK is used by the Army, the Marine Corps, and 21 allied nations.

Although significant changes have been made to the HAWK tactical equipment, the institutional training methodology for the most important people piece of the system equation has remained unchanged for 25 years, relying totally on classroom lecture coupled with practical exercise on tactical equipment. While this method certainly has stood the test of time and has been effective, it has several limitations in today's environment in HAWK institutional training:

- Inadequate training at the institutions is highlighted annually by the user as the major system problem found in the field.
- The electronic countermeasures environment the HAWK operators will undoubtedly face, should a combat situation occur, cannot be simulated with existing HAWK facilities. As a result, the air defense mission training for operators contains a significant void.
- Classroom lecture is a "passive" mode of training that fails to capitalize on the quantum advances in "active" processes made possible by computer-based instruction. In its current methodology, only 30 percent of organizational maintenance critical tasks and 50 percent of intermediate critical tasks are taught at the schools, while the balance are exported to the field commander.
- The HAWK training base has always suffered from a deficit of tactical hardware. Foreign Military Sales customers

and Direct Sales customers just add fuel to the fire in this regard because the training base is primarily sized for U.S. students only.

• Maintenance of school tactical hardware is a constant problem due to high usage rate and repair parts shortages. As a consequence, hands-on practical exercise is reduced far below expected levels.

• Full accomplishment of training exported to the field for on- the-job training is suspect because the air defense mission properly takes first priority in deployed HAWK units. The bottom line is that there just is not sufficient time to complete the exported training through on-the-job training.

HAWK Institutional Training System Study

Prompted by this harsh reality, the HAWK PM with the full support of the Air Defense Artillery School commandant and the Ordnance Missile and Munitions Center and School commandant chartered a HAWK Training Committee in mid-1983 to develop the architectural concept for institutional trainers for both operator/organizational maintenance training and support maintenance training. Further, the committee was to perform a cost and benefit analysis with regard to the recommended solution and provide a compatible program approach. The HAWK Training Committee was assisted in the analytical aspects of the analysis by the Raytheon Co., the HAWK prime contractor, and Raytheon Services Co. and WCW Associates, Inc., Raytheon subcontractors.

As a first step in our study methodology, the existing approach to HAWK institutional training was examined in order to provide a baseline for such critical issues as current training philosophy, existing MOS structure, identification of available training resources, and identification of other recent training studies and analyses. The statements of training needs and training constraints of both the artillery school and the Missile and Munitions Center and School were examined and integrated with the 8,258 specific tasks to be taught for the system hardware requiring training.

This data base provided a detailed description of training requirements that, when coupled with the priority objectives developed by the training committee, provided a comprehensive framework for evaluation, assessment, and final selection of a training system. Of interest is the fact that the requirements thus defined reflected total system requirements, thus the selected training system was analyzed in terms of total requirements.

A key to this study was the analysis conducted to determine the broad spectrum of generic instructional delivery approaches available to insure that all logical alternatives were properly considered and evaluated. This phase of the analysis resulted in the identification of 39 separate and distinct approaches ranging from traditional lecture and laboratory instruction to CBI full-media simulators and the identification of 49 individual systems and components associated with one or more of the identified generic systems. Each of the identified systems and their related components were applicable in some manner to the HAWK institutional training environment for either operator or maintenance training or both.

The many alternative solutions thus developed were then compared against the requirements. Alternatives not meeting this go no-go test were eliminated. Surviving alternatives were ranked using a weighted scoring model and a cost-benefit analysis was conducted. The final recommended solution for HAWK institutional training was then selected. Since there was no attempt at any point in the study to drive the solution to any particular method of instruction, the final conclusion was the one generic solution that best met requirements and that was most cost effective.

Systems Integration

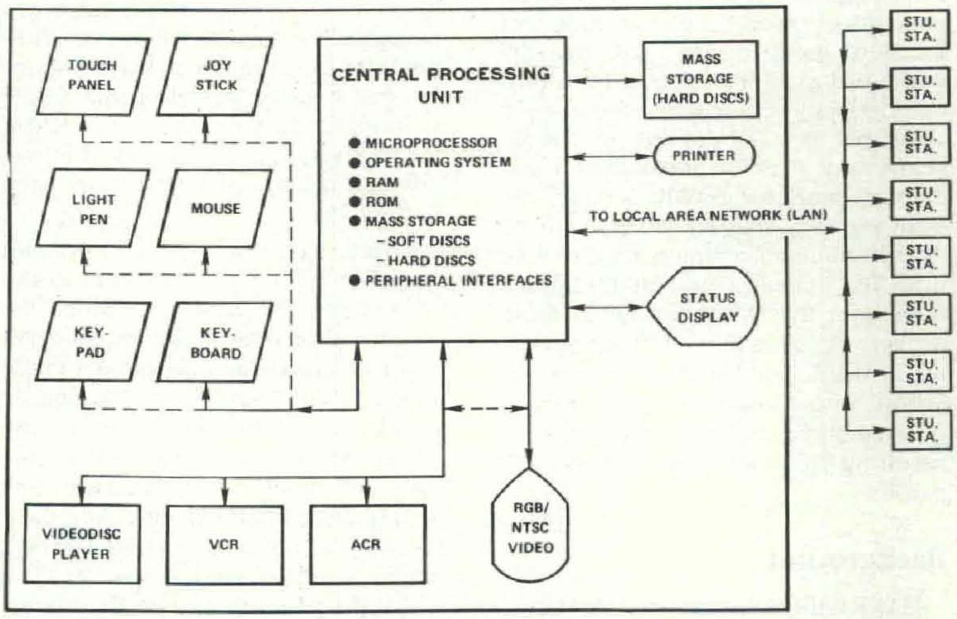
The exhaustive analysis of the training environment and many available alternative solutions led the training committee to the conclusion that the best technical approach was an integrated systems approach to HAWK institutional training that requires the following four interrelated components be present:

• Conference. Composed of tutorial lecture instruction, group testing, and administrative instruction in the classroom, this mode accounts for approximately 10 percent of total instruction.

• Computer-Based Instruction. This includes tutorial, drill and practice remediation, reinforcement, 2-D simulation, and testing delivered via a computer-based instructional system enhanced with all appropriate media. This mode is approximately 50 percent of total.

• Computer-Based Instruction Simulations. This component is the CBI system enhanced by 3-D simulators of HAWK tactical hardware This component provides the "touchy-feelies" of actual tactical equipment, but is still 3-D simulation. Approximately 15 percent of total training time is devoted to this mode.

Figure 1. CBI instructor station functional diagram.



VCR .... **Video Cassette Recorder**
ACR .... **Audio Cassette Recorder**
RAM .... **Random Access Memory**
ROM .... **Read-Only Memory**
RGB .... **Red, Green, Blue**
NTSC .... **National Television Standard Code**

• Practical Exercise. This mode accounts for approximately 25 percent of total training time and involves hands-on testing of selected HAWK tasks utilizing HAWK tactical hardware.

HITS Major Items

The institutional training system consists of CBI instructor stations, CBI student stations, four CBI simulators, and the courseware.

The computer-based instructor stations are full-media systems capable of using all existing capabilities in terms of training/trainer systems interactivity, performance measurement and recording, and systems management. A functional diagram of the CBI instructor station is depicted at Figure 1.

The following four CBI simulators are planned: Continuous Wave Acquisition Radar, High Power Illuminator, Platoon Command Post, and Tactical Display Engagement Control Console. The CBI simulator student station functional diagram is depicted at Figure 2. The remaining HAWK major items do not require 3-D simulation for training since the combination of 2-D simulation plus practical exercise is considered satisfactory.

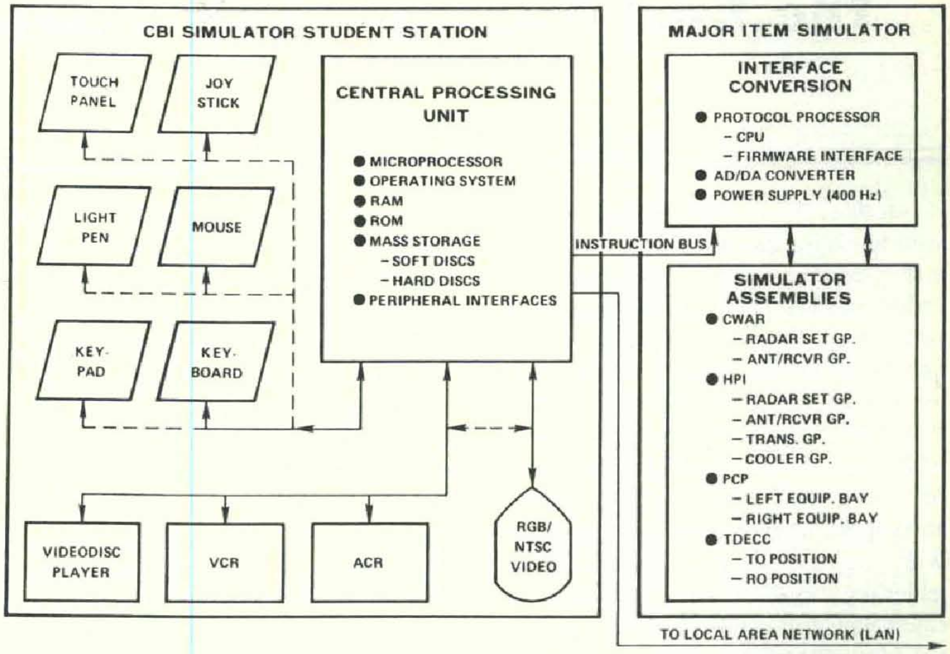
Cost and Benefits

Perhaps the icing on the cake is that in addition to being the best technical approach, HITS will save the Army $58 million over a 10- year period. Conducting all institutional training on tactical hardware is both inefficient and expensive. With HITS implementation, tactical equipment requirements are dramatically reduced at the two schools and the cost of maintenance is similarly reduced.

In addition, proper implementation of HITS will result in a dramatic increase in the numbers of tasks trained in each HAWK MOS and will provide for a teaching capability that cannot be achieved even on tactical hardware. This improvement reflects TRADOC Commander GEN William R. Richardson's direction that all TRADOC schools incorporate as much institutional instruction as possible and minimize exported training in order to reduce the training pressures on the field company commander. The result will be a better trained and more competent soldier emerging from institutional training.

While not tabulated in the cost benefits analysis, downstream benefits should appear in the field in terms of improved mean-time-to-repair, decreased repair parts usage, and overall improved system readiness. At the bottom line, the implementation of HITS will eliminate the weakest link in the HAWK system chain.

Figure 2. CBI simulator student station functional diagram.



CBI ..... **Computer-Based Instruction**
CPU ..... **Central Processing Unit**
CWAR ... **Continuous Wave Acquisition Radar**
AD/DA ... **Analog Digital/Digital Analog**
HPI ...... **High Power Illuminator**
PCP ...... **Platoon Command Post**
TDECC ... **Tactical Display Engagement Control Console**
TO .... **Tactical Officer**
RO .... **Radar Operator**

Summary

HITS is the much needed upgrade of the HAWK training base. It is a cost-effective solution and is enthusiastically endorsed by the PM HAWK, TRADOC, the Army Air Defense Artillery School, and the Army Ordnance Missile and Munitions Center and School. Planned for implementation consistent with HAWK phase III tactical hardware fielding, HITS will significantly improve school-based soldier proficiency with attendant increased effectiveness in the field.

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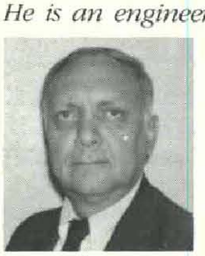

The authors acknowledge the significant contributions of the following individuals for the analysis that formed the technical basis for the preceding article: Gene Stapher and Jim Hendley, U.S. Army Air Defense Artillery School; SFC Steve Pleva, U.S. Army Ordnance Missile and Munitions Center and School; and Bill Morgan, Jim Ross, and Jim Berry, Raytheon Co.

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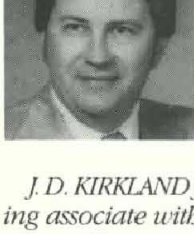

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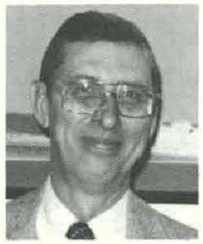


The Total Package—Unit Materiel Fielding Way

By Maxine Richter

Success! We started at milestone I, with funds in place for the development and acquisition of the new product. All milestones were met and the system is in production. Now we can sit back on our laurels, or go on towards the development of a new system. Or is the job really done? What about the overall objective, which has always remained the same, namely; getting operationally effective and supportable equipment to the field? With the new weapon systems being generally more complex and sophisticated than the equipment they are replacing, getting an operationally effective and supportable end item to the field now requires a coordinated effort on the part of the logistics community, the materiel developer, and the gaining command.

The need to improve the force modernization materiel fielding process (getting supportable equipment to the field) has been voiced by virtually all major Army commanders. Under the current method of materiel fielding, the gaining command is charged with the responsibility of budgeting for initial repair parts support; requisitioning special tools and test equipment; associated items of equipment; test, measurement, and diagnostic equipment; and a myriad of other actions in preparing for the receipt of the newly developed system.

The current method of fielding new equipment has placed a burden on the user, as the user is often budgeting for support of the system without having any technical familiarity of the equipment to be supported. This unfamiliarity has often led to understandable oversights involving the authorization and supportability of required associated items of equipment or test, measurement, and diagnostic equipment, as well as over estimations or under estimations of the dollars required to assure initial support.

Other problems for the gaining commands have been associated with the current method of fielding, and thus, have contributed to the need for improving the materiel fielding process. Under the current force modernization fielding technique, initial repair parts would quite often be individually shipped to the gaining unit. This individualized flow of materiel has resulted in some materiel losses, and in some instance, the materiel was not identified as being associated with the new end item being fielded. In the latter case, there was a real and justifiable concern that the initial repair parts would prematurely be declared excess and sent to disposal. In addition, considerable time and effort was required by the gaining command to track the percent of fill of these parts and justify to the materiel fielder that sufficient support was available to have the new weapon system delivered.

In any gathering of materiel fielders, the classic horror stories are told and retold to the point of their taking on a legendary aura. The materiel fielder and the gaining unit may change from story to story, but the basic theme remains the same. That is, the supply support is not available at the gaining unit as the fielding date of the end item approaches. The most often cited scenario goes like this: The gaining unit requisitioned the initial repair parts for support of the end item in time to meet a projected fielding date. The items were received, but the fielding date slipped which caused a lack of demand for these parts. Because of the lack of demand for the repair parts, these items were prematurely declared excess by the gaining unit and were either sent to disposal or back to the wholesale system. As the new date for fielding approached, these same items had to be requisitioned again by the gaining unit and the entire process of attaining supply support for the system being fielded had to be repeated.

Background

An Army Materiel Command (AMC) initiative was undertaken in December 1982 that resulted in the development of the Total Package/Unit Materiel Fielding (TP/UMF) concept. This concept was designed to alleviate many of the problem areas associated with the traditional force modernization method of fielding and relieve the gaining command of the unnecessary burdens associated with this method of fielding. The gaining commands would therefore be able to devote the time, effort, and resources, heretofore devoted to materiel fielding, to their main mission or "raison de etre."

The Total Package/Unit Materiel Fielding concept was tested in fiscal year 1984 with the fielding of six systems. Because of the success of the test fieldings, the Army vice chief of staff directed further expansion of the TP/UMF method of fielding during the Functional Area Assessment on Aug. 17, 1984. AMC's plans for expansion include fielding 24 systems under this method in fiscal year 1985, 81 systems in fiscal year 1986 and all AMC fielded systems in fiscal year 1987 and thereafter.

The Process

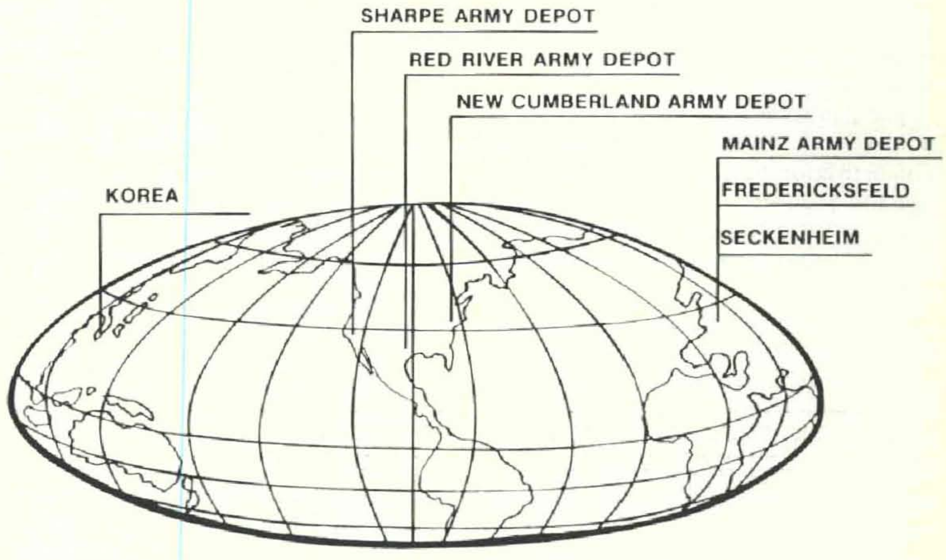
Under TP/UMF, AMC fielding commands assume the requisitioning burden for fielding systems and thereby relieves the gaining commands of much of the initial burden associated with force modernization fielding. Fielding under the TP/UMF process shifts many of the responsibilities previously placed on the user to the AMC fielding command, and thereby reduces the gaining unit and major command workload. TP/UMF is defined as a materiel distribution and control process to provide a consolidated package of end items and support materiel for that end item to the gaining unit.

Total Package/Unit Materiel Fielding allows the materiel fielder to distribute the system and its support package to the field in a single step. The support package includes everything from initial repair parts and test equipment to publications and special tools. Under TP/UMF, the fielding command identifies, funds, assembles, packages, and ships the weapon system as a total package. This reduces the workload of the gaining unit and smooths the transition of the weapon system to the user.

The materiel acquisition process remains unchanged until the materiel fielder receives the gaining command's Mission Support Plan. At this point, the materiel fielder develops a complete or comprehensive Materiel Requirements List for the gaining command. This list identifies all of the items of supply which are required to field, operate and maintain the end item. This list is all-inclusive. That is, it contains items that need to be requisitioned by the gaining command, as well as those items that AMC will requisition. The Materiel Requirements List is then fully coordinated with the gaining command, and agreements are reached during the initial coordination visit of the materiel fielder as to the requisitioning responsibility of both the gaining command and the fielding command. Any support items for which the gaining command can apply available assets are deleted from the list of items to be requisitioned by AMC in order to avoid the generation of excesses.

The AMC fielding command then requisitions the required items. Major end items and associated support items of equipment are sent to a staging activity, while repair parts, special tools and test equipment, and publications are shipped to a Unit Materiel Fielding Point (UMFP). There are three UMFPs in CONUS: New Cumberland, Red River, and Sharpe Army Depots. The UMFPs receive and consolidate the items into unit packages and, upon notification form the materiel fielder, ship the package to the staging activity.

PACKAGE PROCESSING POINTS AND OCONUS CENTRAL STAGING AREAS



At the staging area, which may be an OCONUS central staging activity or an area designated at the gaining unit location, the end items and all supporting items are assembled, and the end items are processed for issue. Representatives from the gaining units, according to a previously arranged schedule, arrive at these sites, and an inventory of the package to be handed-off is jointly conducted by the unit representatives and the hand-off team. Accountability for the contents of the total packages is then transferred to the gaining unit. Generally, the hand-off site for OCONUS fieldings will be the central staging area. The hand-off points for CONUS fieldings are locations agreed upon by the gaining and fielding commands.

Categories of Fielding

There are three categories of fielding associated with the total package method of fielding. The first category encompasses end item or weapon system fieldings. The second type is a unit activation, in which a new unit is being formed because of the introduction of a system. The third category is a unit conversion in which a unit changes modified table of equipments. This last type of TP/UMF fielding is directed by the Department of the Army, and presently applies only to the AH-64 Apache.

The package contents for an end item or weapon system fielding includes the major end item, initial repair parts for the end item, associated items of equip-

Categories of Fielding/Package Contents

AMC Weapon System Fielding to Existing Units E.G., PADS/M1	Unit Activations E.G., MLRS/LACV-30	DA Directed Unit Conversions E.G., Apache
• End Item • Associated Items of Equipment • Special Tools & Test Equipment • Test, Measurement & Diagnostic Equipment • Authorized Stockage List/ Prescribed Load List • Manuals • ADP Cards	• Organization of Support Equipment	• Unit Authorization Differences

TP/UMF

ment, special tools and test equipment, test measurement and diagnostic equipment, a starter set of publications, and a user level documentation package for establishing accountable records in the retail computer system.

The difference between package contents of a system fielding and that of a unit activation package is that the package for a unit activation also contains organizational support equipment such as tents, field kitchens or camouflage nets.

The TP/UMF of the Apache units was directed by Army Vice Chief of Staff General Maxwell Thurman as a test. The fielding command is responsible for requisitioning the differences between the old and new modified table of equipments including organizational support equipment.

These are the package contents for systems being fielded under full release conditions, i.e. where full supply and maintenance support is available. The package contents for those systems being fielded under interim contractor support will largely depend upon the extent to which the contractor support entails. The development of full in-house support capability will constitute another Total Package/Unit Materiel Fielding effort. Thus, TP/UMF is flexible enough to accommodate fieldings under full release conditions, as well as those being fielded under less than full release conditions.

Some specialty items of supply are excluded from the AMC prepared package. Those items which are not included in the package to be handed-off to the gaining command/unit are: Class III, (bulk petroleum, oils and lubricants); Class V, (ammunition); Class VIII, (medical supplies); and communications security items. The requisitioning responsibility for these items of supply remains with the gaining command. The AMC materiel fielding role regarding these items is that of coordination with the gaining command to assure that these items are identified and are available by the time of hand-off. As AMC has budgeted for, and requisitioned all of the items required for support of the system being fielded, hand-off then is "free issue" to the gaining command.

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- ***Length.*** Articles should be about 2,000 words. Shorter or longer articles are acceptable, depending on what is required to adequately tell the story.
- ***Photos.*** Include any photographs or illustrations which complement the article. Black and white or color are acceptable. We cannot promise to use all photos or illustrations and they are normally not returned unless requested.
- ***Biographical Sketch.*** Include a short biographical sketch and a photo of the author(s).
- ***Clearance.*** Articles must be cleared by author's security/OPSEC Office prior to submission.

Articles may be submitted by regular mail or by "electronic mail." OPSEC clearances and photographs must still be sent by regular mail if articles are submitted electronically. Mailing addresses are:

Regular Mail. HQ, AMC, Army RD&A Magazine (ATTN: AMCDE-XM), 5001 Eisenhower Avenue, Alexandria, VA 22333-0001.

Electronic Mail: amcde-xm @ amc-hq.

Telephone: AUTOVON 284-8977, Commercial 202-274-8978.

Exclusions to Package Contents

- **Class III, bulk petroleum/oils and lubricants**
- **Class V (ammunition)**
- **Class VIII, medical systems**
- **Communications security**
- **Personnel**

Summary

The TP/UMF method of fielding will be the standard method of fielding for AMC weapon systems. Our goal is to field all of AMC's systems using this method in fiscal year 1987. The procedures have been incorporated in DA Circular 700-85-2, and changes to existing Army regulations to incorporate TP/UMF as the standard method of fielding are currently being staffed Army-wide.

Accomplishment of a Total Package/Unit Materiel Fielding, no less than as in the current method of fielding, is dependent upon close coordination with all parties involved in the fielding process; that is, the materiel developer, the project manager, the gaining command, the AMC fielding command, DA, the new equipment trainers, and the non-AMC fielding commands which have impact on particular fieldings.

Yes! Success is definitely involved when the newly developed system is in full production. But, the job is not quite done at this point and RDA involvement is still of paramount importance.

Increased dialogue between the RDA community and the logistics community will maximize the efficiency of "getting operationally effective and supportable equipment to the field and into the hands of the soldiers when it is needed." The bonds between the two communities have been established through other programs such as Log R&D and will become stronger and more fruitful to the user through the coordination of new equipment fieldings under the TP/UMF procedures. The fieldings accomplished thus far have been successful. It is up to us all to assure maximum efficiency and dedication to support an Army of Excellence.

MAXINE RICHTER is a logistics management specialist in the Readiness Analysis Division, U.S. Army Communications-Electronics Command. She was previously associated with the TP/UMF project at HQ, U.S. Army Materiel Command. She has a B.A. degree from Pennsylvania State University.

BRL Studies Ramjet Concept

The Ballistic Research Laboratory (BRL) is reviving interest in ammunition technology that dates to the American Civil War. In hopes of developing a new, safer and less expensive training round for Army tank crews, BRL researchers are restudying the potential of solid-fuel ramjet-powered projectiles.

According to William Mermagen, BRL's principal investigator for this project, the first experimental work with tubular projectiles dates to 1863. German engineers sent shells to the Union Army that used tubular projectile principles. It is not known, however, if they were ever used.

"Some additional work on the ramjet projectile concept was done during World War I and again during World War II," Mermagen said. The most famous ramjet weapon ever developed was the German V-1 "Buzz Bomb," which used an intermittent ramjet motor.

In the late 1940s, Continental Aviation received a contract from BRL to study air-breathing projectiles, Mermagen said, but development was abandoned because high velocities and efficient burning of fuel could not be achieved.

Interest in ramjet propulsion was revived again in the early 1970s when the Army Chemical Systems Laboratory (CSL) (now the Chemical Research and Development Center) at the Edgewood area of Aberdeen Proving Ground and United Technologies began work on its application to aircraft and missiles. In 1975, CSL engineers Donald Olson and Joseph Huerta proposed adding fuel to tubular projectiles to make them behave like air-breathing ramjets.

Their research offered hope of success, Mermagen said, and by 1980, the Defense Advanced Research Projects Agency decided to fund CSL and United Technologies to conduct further research. In 1981, BRL test fired the first solid-fuel ramjet projectile and, in 1982, full-scale applied research began to assess the potential for solid-fuel ramjets and hollow projectiles.

In 1983, Mermagen said, BRL decided to apply the expanding technology toward developing an improved kinetic-energy (KE) round as a training device for tank gunnery. This year, BRL took over the work begun by CSL to evaluate the ramjet concept for possible use in air defense gun systems.

Ramjet rounds may offer significant advantages over current training rounds, Mermagen said. "The two greatest advantages we see in developing this technology lie in the areas of safety and cost," he said. "The hollow projectile is aerodynamically unstable. Once the solid fuel inside the projectile has been consumed, the round rapidly loses momentum and falls to earth. The current kinetic-energy round is very long-ranged and newer KE projectiles are being developed which can travel even greater distances. With the ramjet round, we hope to provide the Army with a training round that emulates ballistically the current KE round, but which has a maximum range of only seven kilometers."

Mermagen added, "Army tank guns are required to be accurate to a range of three kilometers—the maximum distance at which a tank would be expected to engage a target in combat. We are working to provide a ramjet round that will be accurate to that range, but which will fall to earth quickly once it has passed three kilometers.

"Because of the simplicity of the solid-fuel ramjet round, we also feel it will be less costly than the current KE training round," Mermagen said.

Testers must address a host of questions before the round can be accepted for use by the Army. These include: Is dispersion inherently increased such as that experienced with rocket-assisted projectiles? How will the projectile maintain precise alignment of thrust axis, center of gravity, and line of flight? Will the propellant and its bond to the shell body be capable of withstanding the shock of being fired? What are the operating and storage temperature limits? Will smoke form the ram jet obscure target sensing and scoring systems? Will the inlet of the ram jet require some form of protective cover to prevent damage to the nozzle when used under field training conditions?

Some of these questions remain to be answered. Until they are, the ramjet round is far from ready for use by troops in the field. Still, the potential is worth exploring according to Mermagen.

The round is very simple in construction. A steel tube, tapered at one end to form an inlet nozzle for the ramjet, is lined with a rubber compound like that used on automobile tires. An exhaust nozzle, made from a heat resistant epoxy resin impregnated with glass, is at the other end of the tube.

As the round is fired, air rushes into the nozzle at the front of the projectile. Its own friction causes the air to become superheated, which ignites the rubber fuel lining the projectile casing. The hot gases then exhaust from the rear of the projectile, providing a forward thrust. Once the fuel is exhausted, the projectile quickly loses momentum and falls to the ground.

Tubular solid-fuel ramjet projectile with sabot.

"We were given three goals to achieve in this early stage of the concept exploration," Mermagen explained. "The first was to develop a solid-fuel ramjet round with ballistic characteristics that emulate the current KE tank training round. Second, we had to ensure the round had a maximum range of no more than seven kilometers. And third, it had to cost less than the current tank training round.

"I believe these goals will be met," he said. "So far, we've duplicated the ballistics of the current KE round out to 2.5 kilometers. We're working at extending that now to three kilometers—the maximum effective range required of U.S. Army 105mm M68 tank guns. As to the projectile's safety characteristics, work in this area has proven most successful. As to price, we estimate the ramjet round will cost about half as much as the current KE training-round projectiles."

"Tank firing ranges in the United States and Europe face growing problems as more powerful propellants increase the range of tank projectiles. A current tank KE round can travel 20 miles or more, and many firing ranges don't have that kind of safety perimeter around the firing sites," Mermagen said. More powerful guns, such as the 120mm gun which arms the U.S. M1A1 Abrams and German Leopard II main battle tanks, will have even greater maximum ranges. This will further limit the number of training areas available for tank crews to conduct live fire exercises with KE rounds.

The coming years will see further research in ramjet technology as BRL investigators attempt to answer the many questions still present in this program.

The preceding article was authored by Bob Lessels, a public affairs specialist in the Public Affairs Office, U.S. Army Test and Evaluation Command.

AMC Program/Project/ Product Managers

This listing is correct as of October 16, 1985. A list of acronym definitions is on Page 18.

9MM

LTC Richard C. Williams

AAH

MG Charles F. Drenz

ACS

Photo Not Available

Laura Lotkowictz (Act.)

ADCCS

COL Kenneth N. Brown

ARMY TACMS

COL Thomas J. Kunhart

ASE

COL Curtis J. Herrick

ATSS

LTC James Kriebel

AVD

LTC Michael F. McGaugh

AWC

COL James D. Howard

BFVS

COL William O. Coomer

BLACK HAWK

COL Ralph H. Lauder

FATDS

COL Paul T. Wickliffe

FIREFINDER/ REMBASS

COL Ronald C. Baldwin

GFD

LTC Daniel E. Adams

HAWK

COL Samuel N. Liberatore

HEAVY TAC VEH

Photo Not Available

LTC James W. Stryker (Act.)

HELLFIRE/ GLD

COL William J. Schumacher

LAV

COL Billy L. McClain (USMC)

M9/ACE

Photo Not Available

LTC Joseph G. Papapietro

MCD

COL James C. Fields

MED TAC VEH

COL Richard P. Diehl

MEP

COL Charles S. Green Jr.

MICNS

LTC David R. Gust

MLRS

COL Nicholas R. Hurst

MORTAR SYS

Photo Not Available

MAJ Robert Leon Jr. (Act.)

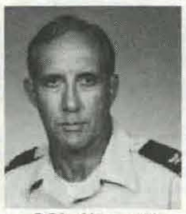
PLRS/TIDS

COL Henry L. Harris

PERSHING

COL Robert A. Brown

PSE



COL Harry V. Daniels

PWS

LTC Andrew Foster (Act.)

REGENCY NET

vacant

ROLAND

James E. Shepard (Act.)

RPV

Photo Not Available

COL David W. Keating

ADS

Raymond C.
Hase (Act.)

AHIP

COL John N.
Tragesser

ALSE

LTC Karl R.
Griffin (Act.)

AMMOLOG

COL Paul L.
Greenberg

AMWS

COL Robert T.
Walker (Act.)

APACHE ATE

LTC David E.
Sullivan (Act.)

ARD

LTC John C.
Gale

CAWS

Photo
Not
Available

LTC James R.
McGinnis (Act.)

CCE/SMHE

LTC Joseph B.
Evans

CH-47

COL Norbert I.
Patla

CHAPARRAL/FAAR

COL Hezekiah
Richardson

CIE

Vivian
McKenzie (Act.)

COBRA

COL John N.
Bertelkamp

DCS (ARMY)

BG Alonzo E.
Short

LCV

BG Claude B.
Donovan

LHX

BG Ronald K.
Andreson

LIGHT TAC VEH

COL Joseph A.
Petrolino Jr.

M1

COL William R.
Rittenhouse

M113

Photo
Not
Available

LTC Robert P.
Klaver

M1A1

COL Joseph
Raffiani Jr.

M60

COL William M.
Kearney

MPG

COL James B.
Welsh (Act.)

MSCS

COL Joseph P.
Fitzgerald

MSE

COL James A.
Frick

NUC MUN

COL Nicholas
Barron

NVD

Kenneth N.
Solinsky

OPTADS

COL Philip S.
Threefoot

PATRIOT

COL Larry R.
Capps

SANG

BG Paul R.
Schwartz

SATCOM

COL Gene A.
Venzke

SEMA

Photo
Not
Available

Jaros
Rickmeyer (Act.)

SGT YORK

COL William S.
Chen

SINCGARS

COL Edward R.
Baldwin

SMOKE

COL Morton S.
Brisker

STINGER

COL Richard C.
Dean

AMC Program/ Project/Product Managers

(Continued)

TAC INTEL/EW

Photo Not Available

COL Alex J. Johnson

TAC VEH

COL James M. Durham

TADS/PNVS

COL David L. Funk

TANK SYS

MG Robert J. Sunell

TEMOD

Photo Not Available

LTC Bruce D. Sweeny

TMAS

COL Donald R. Kenney

TMDE

COL Douglas H. Barclay

TOW

COL James B. Lincoln

TPS

LTC Steven W. Butcher (Act.)

TRADE

COL James W. Ball

TSS

Jerry L. Wilson

UAV

Richard E. Franseen (Act.)

Acronym List of AMC Program/Project/Product Managers

9MM .... 9MM Pistol Program
AAH .... Advanced Attack Helicopter
ACS .... Army Communicative Systems (Provisional)
ADCCS .... Air Defense Command and Control System
ADS .... Air Defense Systems (Provisional)
AHIP .... Army Helicopter Improvement Program
ALSE .... Aviation Life Support Equipment (Provisional)
AMMOLOG .... Ammunition Logistics
AMWS .... Advanced Manportable Weapon Systems (Provisional)
APACHE ATE .... Apache Automatic Test Equipment (Provisional)
ARD .... Armor Training Devices
ARMY TACMS ...... Army Tactical Missile System (Provisional)
ASE .... Aircraft Survivability Equipment
ATSS .... Automatic Test Support Systems
AVD .... Aviation Training Devices
AWC .... Amphibians and Watercraft
BFVS .... Bradley Fighting Vehicle Systems
CAWS .... Cannon Artillery Weapons Systems/ JPM Guided Projectiles
CCE/SMHE .... Commercial Construction Equipment and Selected Materials Handling Equipment
CH-47 .... CH-47 Modernization Program
CIE .... Clothing and Individual Equipment
DCS(ARMY) .... Defense Communications Systems (Army)
FATDS .... Field Artillery Tactical Data Systems
GFD .... Ground Forces Training Devices (Provisional)
HEAVY TAC VEH ... Heavy Tactical Vehicles
HELLFIRE/GLD ..... Hellfire/Ground Laser Designators
LAV .... Light Armored Vehicles
LCV .... Light Combat Vehicles (Provisional)
LHX .... Light Helicopter Family
LIGHT TAC VEH .... Light Tactical Vehicles
M1 .... M1 Abrams Tank System
M113 .... M113 Family of Vehicles
M1A1 .... M1A1 Abrams Tank
M60 .... M60 Tanks
M9/ACE .... M9 Armored Combat Earthmover
MCD .... Mines, Countermines and Demolitions
MED TAC VEH ...... Medium Tactical Vehicles
MEP .... Mobile Electric Power
MICNS .... Modular Integrated Communication and Navigation System
MLRS .... Multiple Launch Rocket System
MORTAR SYS ...... Mortar Systems (Provisional)
MPG .... Mobile Protected Gun (Provisional)
MSCS .... Multi-Service Communications Systems
MSE .... Mobile Subscriber Equipment
NUC MUN .... Nuclear Munitions
NVD .... Night Vision Devices
OPTADS .... Operations Tactical Data Systems
PLRS/TIDS .... Position Location Reporting System/ Tactical Information Distribution Systems
PSE .... Physical Security Equipment
PWS .... Petroleum and Water Systems (Provisional)
RPV .... Tactical Airborne Remotely Piloted Vehicle/Drone System
SANG .... Saudi Arabian National Guard Modernization Program

(Continued on Page 30.)

The 'Proof-of-Principle'

By LTC(P) John B. Alexander

Background

During the past months, the Army Materiel Command (AMC) has undertaken several major changes in the materiel acquisition process. Among these have been the institution of Mission Area Materiel Plans (MAMP), the laboratory realignment and the formation of an Army Laboratory Command (LABCOM), the Army Scientific Assistance Program (ASAP) (which puts scientists in the field with units), the four-year development cycle (from initiation of engineering development to start of production), and the technology integration process which I will discuss in detail below.

Technology integration should be viewed as a bridge between our laboratories and engineering development. The "bridgekeeper" is the Technology Integration Office, designed to evaluate laboratory technologies, evaluate them against system concept, and for those found promising, to concentrate their issuance to soldiers in the field. The culmination of this is a "proof-of-principle" demonstration by operational troops. Once successfully demonstrated, the system will be transitioned to a project manager for accelerated development.

Technology integration requires the Army to change its way of thinking and to break the mold as to how we have done business as usual in the past. This places an increased burden on the tech base to mature technologies and to assist in demonstrating them as prototype systems. We are optimistic enough to believe this can be done in one and a half to two years, after which the Army will move the project to engineering development in 6.4.

The process envisions elimination of advanced development as we formerly knew it and requires that the Required Operational Capability (ROC) and related documentation be completed at the end of the demonstration period. The demonstration process will include proof-of-principle, and completion of the ROC; but more importantly, it will allow the Army to view the system in an operational environment, determine its utility, and commit to its accelerated engineering development.

Details on this program are covered in AMC PAM 1-5, published in May 1985, and entitled the Technology Integration Plan. The plan covers both the generic aspects of technology integration as well as implementation of the earlier New Thrust Program from which technology integration arose.

Technology Integration Plan

The Technology Integration Plan envisions closer cooperation between AMC and the Army Training and Doctrine Command (TRADOC). In fact, both headquarters at this time have formed staff-level Technology Integration Offices responsible for inter-command coordination. Members meet frequently and travel together, both to schools and centers as well as to Army laboratories. The intent is to initiate cooperation as early as possible and to foster direct coordination between TRADOC schools and centers and AMC laboratories while insuring that cross-cutting technology coordination takes place between our major subordinate commands (MSCs).

The plan explains that the role of AMC laboratories is in exploring new technologies and developing early prototypes. The scope of exploration includes work by other U.S. government labs, by industry through their efforts in Independent R&D as well as buys from friendly foreign governments, and consideration of reverse engineering from other foreign materiel. On a continuous basis, TRADOC is in touch with our efforts, developing concepts and doctrine within the context of AirLand Battle and Army 21 or other concepts and plans that are being continuously proposed.

A push-pull process from the tech base is an initial and key element of the plan. Through the MAMP process, mission area managers can put forward candidate technologies that they feel are ready for demonstration in proof-of-principle. The organizations reviewing this area, both at AMC Headquarters and LABCOM, will also be aware of areas that have been funded and can request that certain technologies be proposed for movement into proof-of-principle with troops. These technologies compete with the technologies from industry and friendly foreign governments. The technologies that offer the greatest potential and are sufficiently mature will be those that go forward.

Technology Steering Committee

To adjudicate the process by which technologies will be funded for the proof-of-prinicple phase, a Technology Integration Steering Committee (TISC) has been formed. Membership includes general officers from both TRADOC and AMC. Although the group is small, it will act with input from the schools and centers as well as from the laboratories as to which candidate technologies are ready to be reviewed. During the first TISC meeting, the universe of emerging technologies is examined and the committee determines which subset of these technologies are ready to have a more rigorous systems analysis conducted on them.

The intent of the systems analysis is to ensure that those technologies which are forwarded for the proof-of-principle phase are in fact mature, whether or not additional funds would enhance the capabilities, if the capabilities will give us the largest "delta" in combat, and how the proposed technology fits in with Army systems and projected architectures. We want to insure that we do not derive a series of "stand alone" items but rather ones that will fit in with our objectives and with existing or projected systems.

Once the systems analysis has been conducted by a joint AMC and TRADOC body with input from the Army Forces Command (FORSCOM), the TISC then receives the report from those analyses. The committee then determines which of the technologies will cross the line into the proof-of-principle phase for demonstration with troops. At this time we expect to have a tentative ROC in place.

Demonstration Phase

Next begins Phase II of the Technology Integration Plan; that is, the demonstration phase. You will note that missing from this phase is developmental/operational testing (DT/OT I). This is a conscious decision to have the demonstration phase followed by the DT/OT II in full-scale engineering development. We believe that this is consistent with the Continuous Comprehensive Evaluation as described by the Operational Test and Evaluation Agency (OTEA).

To reach the demonstration, several things must occur. First, funding must be in place not only for the development of the demonstration breadboard or brassboard items, but also for when the item is handed off to a project manager. We want an entire package to go to the PM, including funding, engineering, and test and evaluation. Part of that package includes the initial cost estimates supported by required program funding in the budget. Because of the speed of the process, close coordination with resource management in its initial cost estimates is an extremely critical item.

Systems Engineering

Systems engineering is a key to the effective operation of the Technology Integration Plan. It is envisioned that the majority of the work will still be done at the laboratory and the school and center level, with a small group of experienced systems engineers working at the Technology Integration Office (TIO) level.

The TIO job is to oversee the process and act as advocates where necessary and as a watchdog to insure that the gates are being met. Overall, the systems engineers ensure not only the development of the prototype in a breadboard or brassboard configuration that will be employed during the demonstration, but will also be planning for the full-scale development and an acquisition strategy for the production of the system. To accurately determine the data that are necessary to be derived from the evaluation, it is necessary to ensure that more than a single prototype is ready for the actual conduct of the demonstration.

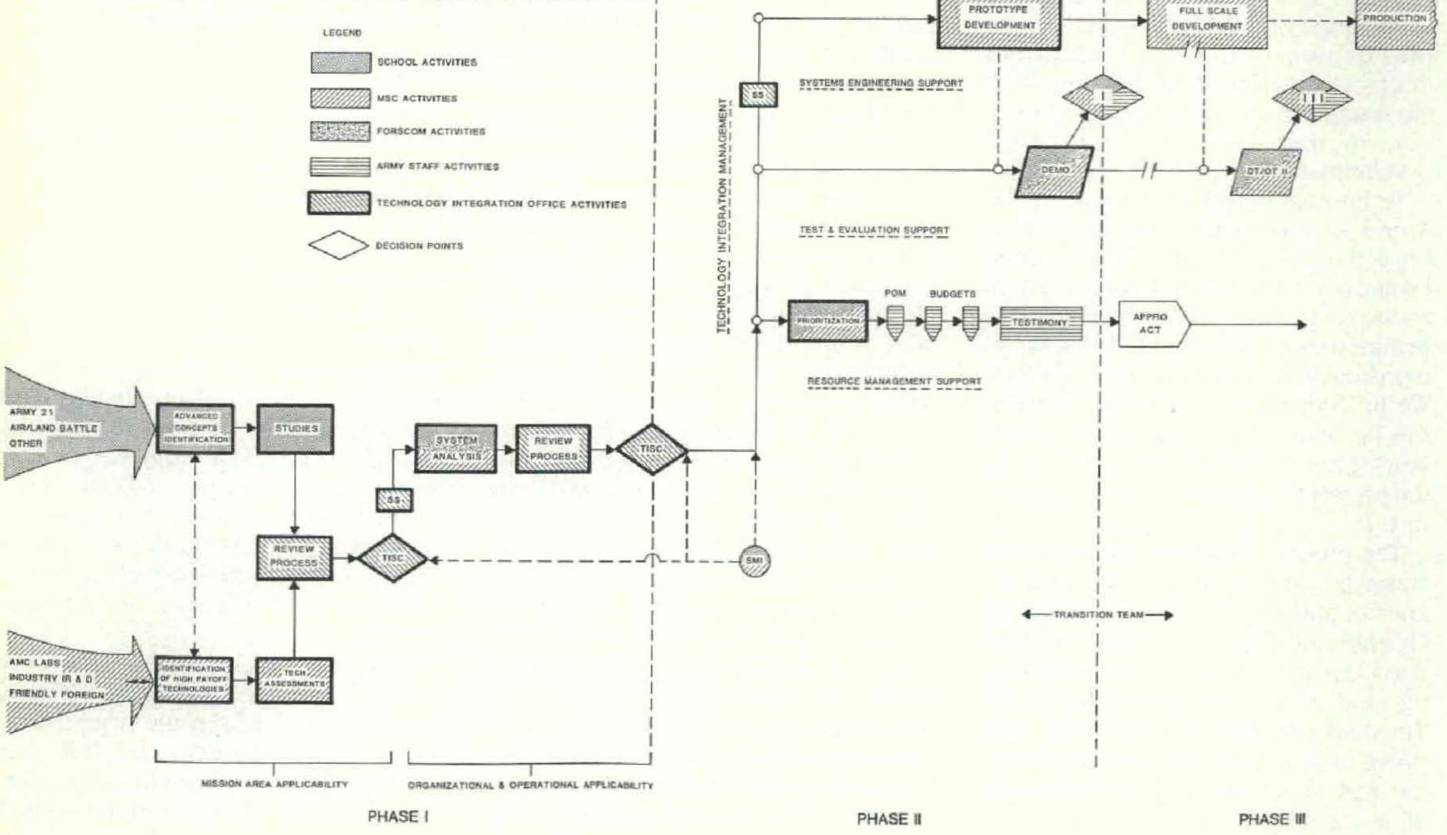
Test and Evaluation

Another major element is test and evaluation. Here again, most of the participants are from the normal test and evaluation community with heavy input from the Army Forces Command and from the TRADOC schools and centers as well as our laboratories. In the development of the demonstration, we must be mindful that the system will be thoroughly tested in DT/OT II and that the test that is conducted at the demonstration phase is in fact compatible with the testing plan for DT/OT II as well as sufficient to determine the data that are necessary to drive the decision to go to development after the Army Systems Acquisition Review Council (ASARC) or In-Process Review (IPR).

We plan to work with the Test Schedule and Review Committee process so that FORSCOM can adequately project the timing and troop requirements that will be required for the demonstration. We envision that we will be heavily involved with the Army Development Employment Agency as one of our primary testbeds. We are all very aware of the concerns and constraints, not only on dollar resources, but on troop time and their training requirements as well.

The project manager is brought into

TECHNOLOGY INTEGRATION METHODOLOGY



the plan as early as possible, probably at least a year prior to the demonstration. For smaller systems, we want the PMs to be totally familiar with the planning that is coming to them so that they will get what we term the total package of funding, an engineering plan, and a test and evaluation plan. We expect that they will then be able to totally coordinate the effort and fit it into their existing program.

A sensitive issue in the development of the Technology Integration Plan has been the definition of what is a demonstration. Our definition is: Under the proposed accelerated acquisition process, AMC and TRADOC will assess the suitability of new systems during a two-year period that replaces former 6.3A and 6.3B development cycles. The culmination of this will be the demonstration of prototypes in the hands of troops. Under this process, new systems will be sent to selected troop units where soldiers will be trained in their use. Over a period of several months, the utility and functionality of these systems, employed by trained troops in realistic field exercises, will be assessed. This phase will replace the former OT I and will be conducted in conjunction with a developmental evaluation that will replace the former DT I.

Purpose

The purpose of demonstrations with troops is to indicate how well the new system should be expected to operate against emerging technical and operational requirements, to provide operational (and developmental) testers an environment in which to validate test parameters (e.g., measures of effectiveness) for incorporation in OT II plans, and to allow for the incorporation of the views of field units in systems development. Together with the developmental evaluation, demonstrations with troops will set realistic reliability, availability, maintainability and durability parameters and evaluate supportability issues for resolution during engineering development (and for testing during DT/OT II).

In those cases where demonstrations with troops appear inappropriate, developmental evaluations will be expanded to include operational assessments, which will incorporate user views as to the functionality and utility of the system.

The culmination of the new 6.3 process will be demonstration reports that will be presented to the appropriate milestone I decision body along with recommendations as to whether the system is ready to proceed into engineering development. The demonstration will be comprehensive, but less rigorous than the DT/OT I requirements and can be tailored to meet the requirements of the particular technology that is under consideration. In order to accomplish this adequately, we must determine, through technical testing before the proof-of-principle phase, that the technology is in fact mature and ready to move forward. Upon completion of the demonstration, the presentation is then made to an IPR or to ASARC to move this system into the four-year development cycle.

Conclusion

If we are to accomplish the objectives set forth by the Technology Integration Plan there are certain key elements that must be adhered to. There is an absolute requirement for close and continuous coordination at all levels between AMC and TRADOC as well as the testing community and the organization where the demonstration will take place. It is also essential that we choose only technologies that are in fact mature and ready to be tested as proof-of-principle. There must be flexibility in the system and in our ability to choose wisely those technologies that will be forwarded for demonstration with troops while insuring that adequate funds are in place at all phases of the process.

As stated in the beginning, we hope to break a mind-set. We need to change the concept of doing business as usual, to get away from tinkering in what was known as the 6.3B or advanced development phase, to cause the user to lock in his requirements as quickly as possible, and to field mature technologies with a minimum of delay. It is only with a concerted effort at all phases of the streamlined acquisition cycle that we will be able to provide the best service and weapon systems to the troops for future combat.

LTC(P) JOHN B. ALEXANDER is manager, Technology Integration Office, Office of DCS for Technology Planning and Management, HQ, AMC. He is a graduate of the Army Command and General Staff College and holds a Ph.D. in education in thanatology.

Army Level Project Managers

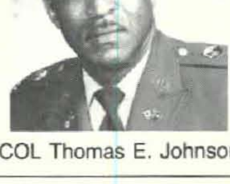
Shown are Army project managers chartered under AR 70-17, who are not assigned to the Army Materiel Command. (See July-August 1985 issue of *Army RD&A Magazine* for additional Army level PMs.)

CAMIS

Continental Army Management Information System

COL Frederick E. Johnston III

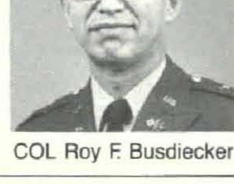
SUPER COMPUTER



COL Thomas E. Johnson

TACMIS

Tactical Management Information Systems



COL Roy F. Busdiecker

VIABLE

Vertical Installation Automation Baseline

COL Jay R. Hern

PM Conferees Address Systems Integration Issues

Far-ranging issues impacting on effective and efficient management of major Army weapon systems and equipment were addressed during general and special sessions at the Army Project Managers Conference in Gettysburg, PA.

Sponsored by the Army Materiel Command (AMC), the meeting drew more that 150 attendees, including PMs and key representatives from HQ, Department of the Army, AMC, and other DOD activities. The conference theme was "systems integration."

Topics during the two and a half day conference included deep battle initiatives, Defense Logistics Agency assistance to PMs, provisioning, Congressional interface, acquisition streamlining, and PM materiel system assessment.

LTC(P) William R. Holmes, chief of AMC's PM Office, called the meeting to order and introduced AMC Deputy Commanding General for Research Development and Acquisition LTG Robert L. Moore who delivered brief opening remarks. Moore noted that the conference was intended to review a number of the initiatives being taken to improve the acquisition process. Moore stated that a further purpose of the conference was to talk about "our" business, and specifically to address the systems integration process and the total force structure.

Deep Battle

A portion of the initial session of the conference was devoted to a series of presentations on "Deep Battle, Systems Integration Problems and Processes." BG Wilson A. Shoffner, assistant division commander, 1st Calvary Division, began these presentations with a lengthly discussion of the deep battle operational concept and system integration initiatives. He spoke about the enemy threat, adding that the way in which forces are positioned on the battlefield can determine how the enemy will react.

Other areas addressed by Shoffner included AirLand Battle imperatives; offensive and defensive objectives relative to rear, close and deep battle operations; and the Soviet employment of forces.

MAJ Harry Lesser, Office of the TRADOC Systems Manager for Deep Battle, followed Shoffner with a discussion of some of the efforts which are necessary to tie the deep battle effort together. He also described some deep attack options and how the Army defines future attack windows. A final deep attack presentation, by Ben Hart from the Office of the PM, Joint Tactical Fusion Program, dealt with the various types of targeting templates being developed for the Deep Battle effort.

Acquisition and Logistics Issues

LTG Moore returned to the podium as the first of four speakers who dealt with acquisition and logistics related topics. Moore specifically addressed the tailored acquisition process and directed attention to establishment of the new Laboratory Command, the new R&D Centers and the importance of engineering development. He emphasized the importance of engineering development as the preparatory stage for production and noted that if we don't do engineering development properly, then we will encounter problems later on during the production phase. Testing of the production prototype will be done during engineering development. Relative to funding, he stated that it is not smart to be programmatic, it is smart to be businesslike. Plan smart and execute smart, he concluded.

LTC(P) John B. Alexander, manager, AMC Technology Integration Office, followed up with a talk on technology demonstrations, which, he said, have become part of the new way of doing business (See Page 19). He also discussed the Technology Integration Steering Committee which was formed to assist in the demonstration process. Included among those who play a role in technology demonstrations are TRADOC, AMC, the Army Forces Command, and government laboratories.

Director of the Defense Logistics Agency (DLA) LTG Donald M. Babers then provided an overview of his agency's assets and how DCA can be of assistance to the PMs. DLA's Technical Information Center handles more than 200,000 inquiries annually and can help with technical solutions to problems. The nine Contract Administration Regions across the nation can also provide assistance to PMs.

Babers called on the PMs to be informed about their contractors. Relative to subcontractors, Babers noted that the Army is paying the prime contractor to properly manage their subs. He added that some improvements are needed in this area. Babers also called on the PMs to make better use of pre-award surveys, to award only to contractors who will "deliver," and to do a better job of finding out the cost of scrap and rework.

AMC Deputy Commanding General for Materiel Readiness LTG Lawrence F. Skibbie, followed Babers with a briefing on some key areas which the PM plays a role. The first of these is quality. Skibbie stressed that more attention must be given to quality early in the acquisition process. He said that quality and productivity go hand in hand and that contractors must be held responsible for quality, not government inspectors. He also appealed to the PMs to read, challenge and understand requests for proposals and contracts and make sure they are sensible and that specifications and requirements are realistic. Other areas he cited as important were competition, audits and PM System Assessments. System assessments, in particular, can provide an early warning of readiness problems.

ASA (RD&A) Address

This year's luncheon speaker, Assistant Secretary of the Army (RD&A) Dr. Jay R. Sculley, stressed the importance of the PMs function, noting that they represent the "front line" of top management, and that they play a key role in achieving the

Competition is not achieved by creating adversary relationships with the private sector.

Dr. Jay R. Sculley, Assistant Secretary of the Army (RD&A)

Army's goals of modernization and readiness. The remainder of his address was devoted to a review of some critical management challenges. With regard to one of these, funding, he said that the DOD and the Army are not exempt from budget cuts and that PMs may be asked to do more with less.

Sculley also touched on the issue of competition, stating that legislative direction is toward more competition. He appealed to the PMs to keep in mind the long-term benefits of competition, not its short-term hindrances. Competition, he added, is not achieved by creating adversary relationships with the private sector. Sculley also called for improved systems quality through collective and cooperative efforts within the Army and with industry. In closing, he applauded the PMs for their efforts during the past year.

Fred Michel, the deputy chief of staff for Manufacturing Technology, HQ, AMC, followed with a discussion of problems related to production and producibility. He has found that, in general, there is a lack of understanding on the part of higher management of what attributes are involved in good manufacturing. This is because Army management is basically R&D oriented. He has also found a lack of institutionalizing lessons learned from past mistakes, a lack of knowledge concerning systems engineering, a lack of understanding of standard repair procedures, and inadequate attention being given to contractor compliance with equipment delivery dates.

One of the most highly informative presentations of the PM gathering was an address by AMC Commander GEN Richard H. Thompson on some key management issues related to the PM program. A discussion of these issues appears on Page 31 (Executive's Corner) of this magazine.

Under Secretary of the Army

The final opening day conference speaker, Under Secretary of the Army James R. Ambrose, reflected on some of the positive and negative aspects of the acquisition process in recent times. He gave sincere credit to the PMs for helping to change things for the better. One problem which continues, but appears to be under control, is DOD's credibility with the public. Said Ambrose: "The perception problem can kill you." The Army and AMC, however, have done a good job of addressing this problem, he added.

One of the bright spots cited by Ambrose is the contract for the T800 Engine. This program, he said, represents a procurement path which is valid and useful and may be applicable to other programs. Other programs which show how a "new way of doing business" can achieve good results are the Single Channel Ground and Airborne Radio Subsystem and Mobile Subscriber Equipment. Ambrose concluded his presentation by calling on the PMs to improve their business acumen.

The perception problem can kill you.

James R. Ambrose, Under Secretary of the Army

The second day of the conference was opened with an overview of the Materiel Readiness Support Activity (MRSA) by Willard F. Stratton. His activity has capabilities to assist throughout the materiel acquisition process. Specific areas where MRSA can assist PMs include acquisition planning, development of acquisition strategies and in preparing integrated logistics support documentation.

COL Edward Lee, the assistant deputy chief of staff for Weapons Systems Production Management, Office of the Deputy Chief of Staff for Production, HQ, AMC, and Thomas J. Moran, chief of the Pricing Branch, Office of the DCS for Procurement, HQ, AMC, followed up with presentations related to cost management. Lee spoke about unit production quantities and their relationship to costs. Moran specifically targeted the area of overhead costs and the importance of the PM in understanding the reasons for significant changes in contractor overhead costs and overhead rates.

The next speaker, Robert Jones, from HQ AMC's Office of the DCS for Procurement, described some of the elements involved in successful provisioning. He defined provisioning as a management process for determining and acquiring the range and quantity of support items necessary to operate and maintain an end item of materiel for an initial period of service. He stressed the importance of adequate documentation and early planning.

Fraud Detection and Enforcement

One of the most engrossing presentations of the Conference—"Defense Procurement Fraud Detection/Enforcement," was provided by Howard Cox, the DOD deputy assistant inspector general for Criminal Investigation Policy. Four primary fraud targets which his office is investigating are product substitution; cost mischarging; defective pricing; and bribery, gratuities, and conflicts of interest. Cox noted that in recent years the Department of Justice has accepted an increasing number of DOD contract fraud cases for prosecution. In addition to criminal penalties for contract fraud, Cox said other remedies should include suspension and debarment. He concluded by stating that the Department of Defense has the best anti-fraud program in the federal government.

B-1B Program

Another highly illuminating conference presentation was on management of the B-1B program by LTG William E. Thurman, vice commander of the U.S. Air Force Systems Command. From an acquisition standpoint, the B-1B program was unusual in several respects. First, very direct guidance was provided by the Secretary of Defense. Additionally, baseline changes were frozen and the Air Force served as the systems integrator for the program. Thurman emphasized that the Air Force expended substantial effort in developing a teamwork relationship with the contractor. He also placed a good deal of importance on having contact with sub-

The Department of Defense has the best anti-fraud program in the federal government.

Howard Cox, DOD Deputy Assistant IG for Criminal Investigation Policy

contractors. Some of the other "lessons learned" which contributed to the success of the B-1B program are:

- On large programs, such as the B-1B, find a simple way of doing business and develop a straightforward organizational relationship.
- Good planning is a must.
- Develop a strong system of control and follow-up.
- Identify those things that are important and those that are not.
- Develop a good cost-reduction strategy.
- Accelerate the identification of spares and support equipment.
- Create an action oriented organization.
- Keep the front office small so that decision makers can be close to potential problems.
- Establish an environment where people are committed.

Another highlight of the PM Conference was an address by Army Vice Chief of Staff GEN Maxwell R. Thurman who provided an overview of some key Army issues and current thrusts. Included among his topics were Army fiscal guidance revisions, personnel inventories, OCONUS deployment training, and war reserve stocks. He praised the PMs for their crucial role in maintaining high public confidence in the military.

Thurman was followed by MG Duard Ball (U.S. Army ret.). He reflected on the progress the Army has made in improving the quality of its weapons systems. He observed that, in general, equipment now being issued to troops in the field is good. However, he stressed that quality demands attention up front and applies to everyone. It is not the sole domain of product, assurance and test. One area which is of some concern is the quality of software. He termed this a big issue which is getting bigger.

Concluding speakers on the second day of the PM conference were J. David Willson, a staff assistant with the House Appropriations Subcommittee on Defense and Roy D. Greene, assistant deputy chief of staff, Development, Engineering and Acquisition—Program Management, HQ, AMC.

Congressional Concerns

Willson discussed some Congressional expectations, concerns and predictions regarding DOD. PMs, he said, should attempt to view things from a Congressional perspective, should inform Congress if they have a problem, and should get the most for the funds allocated to them. He expressed concern for the PM turnover rate and said that he believed there would be fewer problems if PMs remained with programs longer. Some of his other concerns are unrealistic Army budgets, lack of incentives to recognize that a program is a failure and insufficient attention in the development process to manufacturing technology. He predicted that the military may have some future difficulty as a result of new procurement reform measures.

Greene's presentation dealt with some of the actions being taken to incorporate OSD's acquisition initiatives into AMC's acquisition streamlining efforts. He emphasized the "smart business" approach to the acquisition process and stated that one of the biggest challenges is to change mind-sets regarding streamlined acquisition.

The remainder of the second day of the PM meeting was devoted to roundtable discussions among the PMs. These special sessions were chaired by PM for Advanced Attack Helicopter MG Charles Drenz, PM for Tank Systems MG Robert J. Sunell, and BG Claude Donovan, PM for Light Combat Vehicles.

Concluding Session

The concluding session of the PM Conference included a briefing on PM System Assessments by LTC(P) David Morgan, chief of AMC's System Assessment Program Office, and reports from the previous day's roundtable discussions.

A Program, Project, Product Manager/Materiel Systems Assessment (PMSA) is an in-depth AMC review of PM systems and selected high visibility major subordinate command-managed systems. Morgan provided his insights on the PMSA and some of the lessons learned since the PMSA was established. He stressed the importance of including both positive and negative issues in the PMSA. Some of the specific PMSA subjects addressed by Morgan included personnel involved in the PMSA, test and evaluation issues, configuration management, MANPRINT, provisioning, production and delivery schedules, and funding.

Quality demands attention up front and applies to everyone.

MG Duard Ball, U.S. Army, Ret.

Some of the conclusions, concerns and comments resulting from the conference roundtable discussions were:

- There is a need for an integrated management information system with continuing access by the PM, MSCs, AMC and HQDA.
- Recruitment and retention of quality people needs to be addressed.
- Improved communication with DA, TRADOC, the Operational Test and Evaluation Agency and others regarding the shortened acquisition process is needed.
- It is difficult to find out who is in charge of software management.
- Getting small items type classified is too time consuming.
- Benefits of increased competition must flow to the PMs, not just to contractors.
- Legislation might help in getting contractors to close out contracts.
- There are too many unrealistic specifications and requirements.
- PMs must deal with too much trivia.
- Improvements are needed in the AMC Weapon System Staff Manager process.

The PM Conference was concluded with brief remarks by LTG Moore. He called on the PMs to look ahead at potential problems, to give their personal attention to cost trends, and to get contractors to pay for facilitization up front. He was pleased that seven serving or former PMs were on the recent brigadier general promotion list. This, he said, shows that the "business side" of the Army is now being understood. He closed the conference by calling it a great success.

Enhanced Surface Coatings by Ion Plating

By Vince F. Hock and Dr. James M. Rigsbee

Most material failures originate at surfaces through wear, corrosion, and fatigue. One way to control surface-initiated failures in metals is by alloying elements throughout the material to modify the hardness, chemical passivity, or strength. However, this is a costly and inefficient use of strategic alloying materials such as cobalt and chromium. A more cost-effective approach to preventing surface-initiated failures is to simply apply alloying materials onto the surface of susceptible items. Electroplating, plasma flame and arc spraying, and chemical vapor deposition are some of the currently available techniques for coating items with alloying materials.

The U.S. Army Construction Engineering Research Laboratory (CERL), Champaign, IL, in a surface-science center, jointly operated with the University of Illinois, is investigating an innovative technique for depositing alloying materials, called ion plating. CERL research suggests that ion plating will produce electrically-conductive ceramic coatings applicable to anodes used in cathodic protection systems, and for corrosion-resistant, electrically-conductive coatings for gaskets and interfaces used on communication shelters.

Advantages of the Technique

Ion plating offers several advantages over other available surface coating techniques. The process can be used to deposit a variety of coatings, such as metals, alloys, ceramics, and metal/ceramic composites. In addition, coatings can be applied to surfaces having coefficients of thermal expansion greatly different than those of the applied coating. The process also provides excellent adhesion between the coating and the surface, especially in coating ceramic materials with metallic films. Further, ion plating provides a coating with relatively uniform thickness over the entire surface of the item coated. A uniform coating can even be applied to irregularly shaped items without extensive manipulation. Finally, ion plating requires little or no heating of the item to be coated.

How It Works

Ion plating was originally developed in 1963 by D.M. Mattox at Sandia National Laboratories and incorporates characteristics of both sputter etching and ion beam mixing. In ion plating, the item to be coated and the source of the coating material are held in a chamber containing a low-pressure gaseous environment. An inert gas is used during deposition of elemental metal or alloy coatings, and inert gas/reactive gas combinations during deposition of ceramic coatings. The item to be coated is biased to a high negative potential to create an abnormal cold cathode glow discharge. Positive ions from the glow discharge strike the surface of the item to "sputter" atoms off the surface. The sputter etching is critical as it produces a very reactive and atomically clean surface.

Once the surface has been thoroughly cleaned, evaporation of the coating material is begun in conjunction with the continued glow discharge sputtering. A relatively simple experimental ion plating setup is shown in Figure 1. The coating material is evaporated using an electron beam source, which is necessary for materials with high melting points. A small percentage of the neutral atoms evaporated off the coating source are ionized by the glow discharge and are accelerated towards the item surface to form the coating. The rate of deposition of the coating material must exceed the sputtering rate to obtain a coating. This can be controlled by varying the rate of evaporation from the coating source.

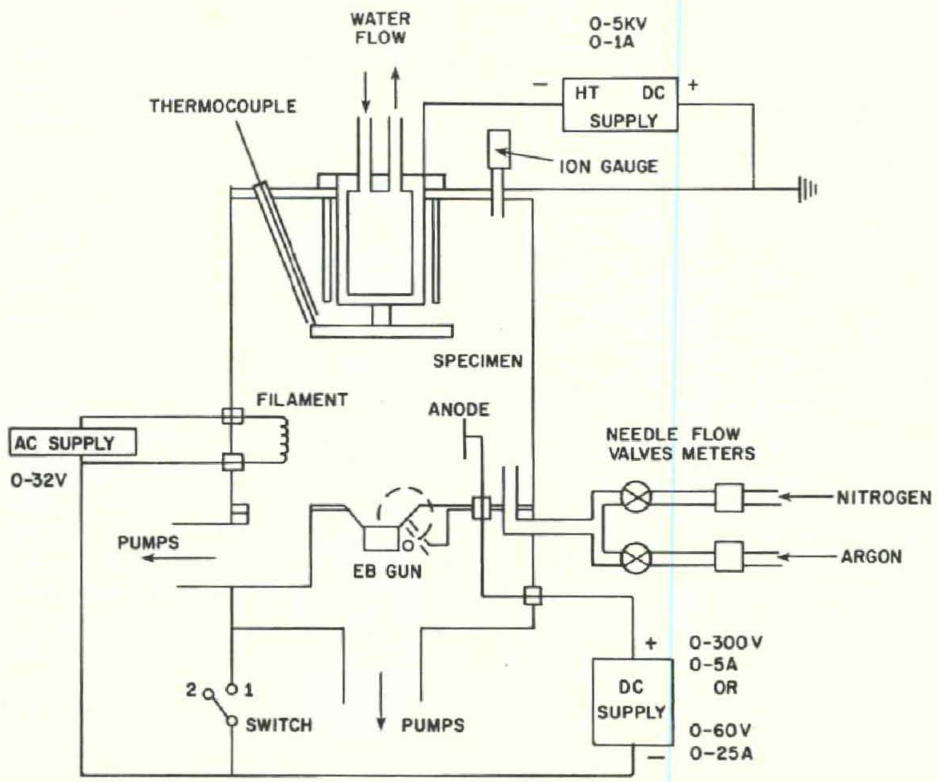


Figure 1. Experimental ion plating set-up.

CERL Research to Date

CERL is working with the University of Illinois to obtain a better understanding of the activities and capabilities of the ion plating process. Several modifications have been made to an ion plating machine obtained by CERL in 1983. The initial system featured twin electron beams and is capable of coating a 6-inch diameter by 10-inch high object. The system has been improved with the addition of various analytical technologies to ensure uniform coatings are reproduced in each application.

CERL research indicates that the ion plating technique provides strong bonds between metallic coatings and ceramic surfaces, whereas conventional deposition techniques typically provide low-adhesion strengths. As an example, deposition of a micron-thick copper coating onto a polished cordierite ceramic by conventional evaporation results in interfacial strengths of less than one Mega Pascal (MPa). In contrast, use of ion plating for the same materials provides interfacial strengths in excess of 75 MPa.

The ion plating process has been used to successfully apply electrically-conductive mixed-oxide coatings of ruthenium/titanium oxide and of niobium/titanium oxide onto oxide niobium substrates for use as anodes in cathodic protection systems. These coatings have excellent adhesion and low-dissolution rates.

As part of a larger effort to develop new technologies for electromagnetic pulse (EMP) shield structures, a series of corrosion resistant copper-chrome and aluminum-molybdenum alloys and conducting ceramic coatings have been ion plated onto aluminum, steel, and copper alloy specimens. These specimens are currently being evaluated for use in electromagnetic interference and EMP shielding applications.

Other Existing and Potential Applications

Several important material properties shown in Figure 2 are strongly affected by the composition and structure of the surface layers of a material to a depth of one tenth of a mil. Ion plating is capable of depositing oxidation/corrosion and or wear resistant thin film (less than two mills thick). Exploiting this capability of the ion plating process will yield a variety of improved corrosion- and water-resistant coatings for the Department of Defense.

The production of corrosion-and oxidation-resistant aluminum coatings on uranium fuel elements was the first commercial use of ion plating. Ion plating effectively provides a uniform thickness

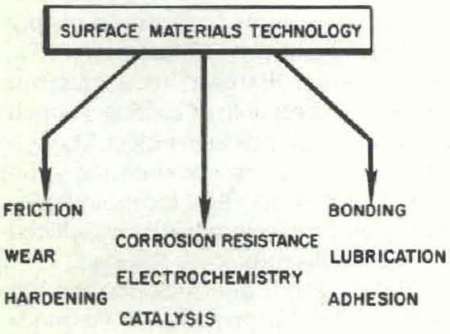
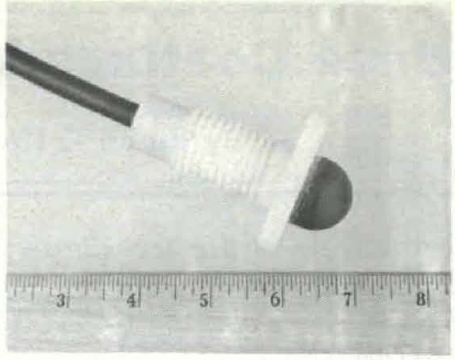


Figure 2. Material properties influenced by ion plating.



CERL is conducting research on the applicability of ion plating on the ceramic anode.

for the coating and excellent adhesion which prevents spalling for even the high temperatures experienced in this application. Ion-plated aluminum coatings are also used commercially in coating titanium and steel fasteners for aircraft and spacecraft. Ion-plated coatings have been found to aid in resistance to stress corrosion. Ion-plated coatings would be well suited for producing oxidation/corrosion resistant coatings, such as nicraly (nickel chrome aluminum yttrium alloys), on turbine components with relatively complex shapes.

Ion plating has been used to produce dry-lubrication, low-friction coatings such as sulfides of gold, silver, and molybdenum for materials operating in vacuums or at very low temperatures. Although the friction coefficients of ion-plated coatings are no lower than for coatings provided by other techniques, the ion-plated coatings have lasted much longer because of their superior adhesion. Low-friction alloy surfaces with reduced galling and fretting have been produced on titanium by aluminum ion plating. Ion-plated coatings of refractory metal carbides and nitrides have been shown to resist erosion well and to increase the operating life of rotary engine parts by up to 10 times.

A modification of the ion plating process using a reactive gas and ion-enhancement system has been used to deposit very wear-resistant titanium nitride and titanium carbide ceramic coatings on tool steels. Increases in tool life of up to 10 times and large reductions in friction and cutting force have been produced, with manufacturing cost increases of less than 50 percent. Because of their extreme hardness, high-temperature strength, and resistance to corrosion/oxidation, these refractory metal ceramic compounds are best used to prevent high-temperature erosion of metal.

The Future Of Ion Plating in the Army

Ion plating was one of four plasma-based coating technologies identified in a 1984 meeting of material specialists as being available for use in protecting metallic and non-metallic components from corrosion and erosion. The Army-initiated interagency workshop on Plasma-based Surface Engineering Technologies was held in December 1984 at CERL. Attendees of this meeting assessed and categorized several plasma-based coating technologies according to their readiness for use in the field. The technologies identified as being well developed were ion plating, laser surface alloying, sputter deposition, and ion implantation.

Some of the specific DOD applications of ion plating and other plasma-based technologies discussed at the workshop include: reduction of gun-tube erosion, lubrication of gas turbine engine bearings, improved corrosion-resistant coatings for compressor blades of gas turbine engines, hermetic coatings for optical fibers and devices, barrier layers for semi-conductor devices, and corrosion-resistant coatings for high-strength structural steels for aircraft components.

VINCE F. HOCK is the principal investigator on the Corrosion and Coatings Team of the Engineering and Materials Division at the U.S. Army Construction Engineering Research Laboratory. He has an M.S. from Pennsylvania State University.

DR. JAMES M. RIGSBEE is the assistant professor of physical metallurgy at the University of Illinois. He holds a Ph.D. from North Carolina State University. His main interests are in surface engineering and applications of microstructural and microchemical analysis techniques.

From The Field. . .

Contract Calls for Inlet Particle Separator

A 32-month, $590,754 contract for an Advanced Integral Engine Inlet Particle Separator has been awarded by the U.S. Army Aviation Systems Command's Aviation Applied Technology Directorate, Fort Eustis, VA, to General Electric.

"The objective of this program is to investigate, both analytically and experimentally, an advanced integral engine inlet particle separator which will demonstrate improved engine protection from sand and dust and develop a better understanding of the scavenge system," said David B. Cale, project engineer. "Potential cost savings due to extended engine life and a reduction in down time for repair would be expected as a result of this contract."

CERL System Protects Against Aerial Explosives

The fiberglass cover provides a base for protecting personnel against aerial explosive rounds. Troops construct the cover and then add a protective layer of soil or sandbags.

The U.S. Army Construction Engineering Research Laboratory (CERL), Champaign, IL, is developing the Sectional Fiberglass Overhead Cover Support System to protect Army troops against aerial explosive rounds. The wide use of aerial explosive rounds against troop fighting positions makes overhead,cover essential. Weapons system like the TOW anti-tank weapon are particularly vulnerable because they are primary targets for enemy fire.

CERL's fiberglass cover system provides the foundation for a 36-inch layer of either soil or sandbags. This protect layer will shield TOW gunners from shrapnel or other shell debris. A minimum of 18 inches of soil or sandbags is required to protect personnel against a 155mm shell detonated 10 feet from the position.

The Sectional Fiberglass Overhead Cover Support System consists of four corrugated fiberglass sections. Each section is 59 and three-quarter inches long, 40 and three-quarter inches wide and weighs 32 pounds. When fastened together, the sections form a complete arch that provides the necessary support. The soil-covered arch can be camouflaged to avoid detection be unfriendly forces.

CERL researchers designed the fiberglass arch so that the sections can be "nested," or closely stacked upon each other, to minimize transportation-space requirements. When stacked, 10 nested sections have a total height of 13 inches.

Future plans include evaluating different materials and designs that will reduce the structure's weight and size, yet increase its load-bearing capacity.

Four of these "nested" sections are used to create the fiberglass cover. Nesting the sections reduces transportation space requirements.

Scientists Evaluate Progress on Receptors

Scientists from the U.S. Army's Chemical Research and Development Center (CDRC), met earlier this year with 30 leading scientists in the fields of pharmacology, biochemistry and biophysics to review the first year of a combined effort aimed at the development of a generic detector for neurotoxic agents.

The Johns Hopkins University Applied Physics Laboratory hosted the meeting, now known as the First Annual CRDC conference on Receptors. Dr. F. Prescott Ward, chief of the Biotechnology Division at CRDC, opened the conference and welcomed the scientists on behalf of CRDC.

The conference was held to evaluate the progress made by the contractors working for the past year on neuroreceptors and artificial membranes in CRDC's effort to develop a mini-detector for the Army.

"We wanted to get scientists, both contractors and outside experts, together to evaluate the first year's progress and plan future directions of the program," said Dr. James Valdes, a neuro-pharmacologist in CRDC's Biotechnology Division and chairman of the conference. "This way we can evaluate the progress and feasibility of their approaches and identify technological aspects of the program which need to be developed," he said.

Researchers from numerous universities and medical schools, and scientists and engineers from CRDC, the Army Research Office, the Naval Research Laboratory and the Applied Physics Laboratory attended eight formal presentations which were followed by an open forum round-table discussion in which different approaches to the problem of generic biodetection were analyzed and debated.

Significant progress has been made since these top people have shown interest in the program, and a laboratory demonstration is being planned for next summer.

The scientists hope to develop a microsensor which can detect many classes of neurally toxic agents without the need to have previous knowledge of their identities. The detector will combine the biological system, i.e., immobilized receptor proteins, with microsensors which will transduce and amplify the response of the receptors to threat agents.

"There are literally hundreds of potential threat agents, including naturally occurring toxins, and synthetics," said Valdes. "But most of the neurally toxic agents react primarily with specific receptor sites.

"If we can isolate and stabilize these targets, we can develop a sensor that will react to the agents with great sensitivity and in real time. Theoretically, the proteins in the system would function as well as proteins in your brain, maybe better," he said.

The laboratory work uses receptors from rats and a specific type of electric fish that has acetycholine receptors and ion channels nearly identical to those in humans. Ultimately, other receptors will be incorporated and cell culture or cloning techniques will be developed to provide for the large amounts of receptors required in a fielded device.

Valdes said a follow-up conference will include more engineers and a greater emphasis on coordination among contractors working on biological and engineering aspects of the project.

Stabilizing The New "Light" Artillery

Putting the "light" into the evolving light divisions is currently an important priority for the Army. Engineers at the U.S. Army Armament Research and Development Center (ARDC) are developing innovative approaches toward that end.

There is a dual challenge in a program to build a lightweight artillery piece with performance characteristics equivalent to the presently fielded M198, 155mm towed howitzer. ARDC engineers are trying to reduce weight to enhance mobility, but also lessen recoil force to maintain stability and safety.

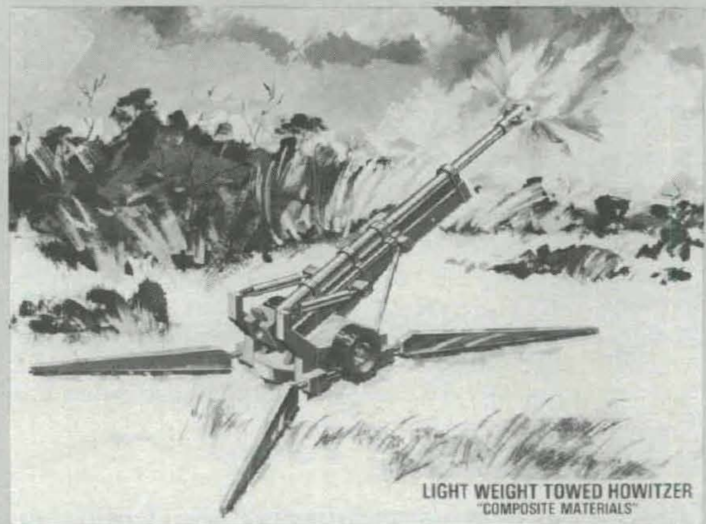
The dual solution is composite materiels and recoil system technology. Furthermore, such a solution could spin off to other artillery, tank and cannon weapon systems.

The present goal is a 9,000-pound towed howitzer that maintains the same range characteristics as the 16,000-pound M198. The weapon must be more than 40 percent lighter, yet must not "hop" or move significantly when fired, which would reduce accuracy and endanger the crew. Composite materiels provide the potential to build lightweight 155mm artillery systems; recoil technology can make the systems usable.

Success would provide the new light infantry divisions with the required firepower and allow airlift capability by a product-improved UH60 Black Hawk light utility helicopter.

Graphite and fiberglass are being explored as alternatives to aluminum and steel. With the support of the Army Materials and Mechanics Research Center (AMMRC) in Watertown, MA, ARDC engineers intend to develop a full-scale 155mm towed artillery weapon incorporating state-of-the-art composites.

Composite materials can be tailored to a specific application with new, more exacting design methodology. Graphite, glass and other fibers possess high strenght-to-weight ratios that make them feasible replacements for aluminum and steel in the "heavyweight" components of a towed howitzer—the carriage, trails and cradle.



Lightweight, long-range artillery weapon makes extensive use of state-of-the-art composite components.

Solution of the composite-materials problems is essential. Equally essential is the mitigation of recoil forces. The present hydropneumatic throttling systems will not do the job. New and innovative ways to manage recoil energy must be developed. One approach the engineers are investigating is the application of electronic feedback control to monitor and optimize recoil energy dissipation.

A full-scale demonstration of this concept is planned at ARDC. An existing 155mm recoil mechanism will be modified and exercised on a test stand to determine feasibility.

If successful, this technology may be applied to a new recoil mechanism specifically designed for a lightweight application. Another possible alternative is "soft" recoil. Soft recoil, in effect, lengthens the recoil stroke via a spring pushing the tube assembly forward just prior to firing.

Such research and development may produce advances across mission area lines. Technology spin-off could be anticipated in all types of large caliber and small caliber weapon systems, including towed artillery systems, self-propelled artillery systems and naval gun systems.

Potential spin-offs for the heavy close-combat area center on tank systems, while light close-combat candidates are infantry fighting vehicles, anti-tank weapons and mortars. Cannon systems for air defense and helicopters are other potential beneficiaries.

The design, fabrication and testing of a lightweight 155mm towed howitzer may cause "lightening" to strike not only throughout the artillery community, but across a spectrum of mission areas.

Field Kit Adds Mine Clearer to M1 Tank

The Belvoir R&D Center has awarded a contract for almost \$1.5 million to General Dynamics' Land Systems Division, Warren, MI, for development and testing of an adapter kit that will allow the Army's recently fielded track-width mine clearing roller to be mounted on the M1 Abrams tank.

Developed by the center, the roller weighs about nine tons and consists of two wheel assemblies which are mounted in front of the tank's tracks to clear pressure-fused mines. A weight drag on a chain between the two assemblies is used to clear tilt-rod mines.

In operation, the the adapter kit will be attached to the tank's towing eyes. The kit will not only allow the roller to be mounted on an unmodified tank in the field, but will also permit the driver to disconnect the roller from inside the tank in less than 15 seconds. The quick-release mechanism will enable him to continue the mission without the roller once the minefield has been breached. Three prototype adapter kits will be built and tested under this contract.

Belvoir Develops Pocket-Size Net

A new "pocket-size" camouflage net being developed by the Army Troop Support Command's Belvoir R&D Center was used successfully in Korea during Exercise Team Spirit 85.

The individual concealment cover is a solid-colored, 5-foot by 7-foot net made of incised, coated nylon. Each unit weighs less than a pound and can be folded to fit in the pocket of a soldier's uniform. The net can be joined together to form a larger cover. In the field, they can be used for concealing fighting positions, weapons emplacements and soldiers. During Exercise Team Spirit, the cover was used for concealment by elements of the 7th Light Infantry Division.

The cover is being developed under a quick response program at the request of the 9th Infantry Division and the Army Development and Employment Agency (ADEA).

Contract Awarded for ACAP T & E

A 29-month, $2,579,784 contract for Advanced Composite Airframe Program (ACAP) Militarization Test and Evaluation has been awarded by the U.S. Army Aviation Systems Command's Aviation Applied Technology Directorate (AATD), Fort Eustis, VA, to Bell Helicopter.

"The objective of this program is to conduct additional test and evaluation of the ACAP airframes," said AATD Project Engineer L. Thomas Mazza. "This effort is to evaluate a variety of military and operational characteristics and systems and subsystems interface issues associated with the use of composite materials which have not yet been fully assessed."

Hughes Gets Contract for AI Applications

Hughes Aircraft Co. has received a 25-month, $401,319 contract from the U.S. Army Aviation Systems Command's Aviation Applied Technology Directorate (AATD), Fort Eustis, VA, to develop artificial intelligence applications to Army aviation systems fault isolation.

"The program is directed at investigating the application of the technology of artificial intelligence, particularly the area of knowledge-based systems for improving the ability to fault isolate and repair Army aviation systems," explained AATD Project Engineer Bruce Thompson. "This program will develop a knowledge-based system which will be applied to the M65 TOW Missile System," said Thompson.

A demonstration of the knowledge-based system's ability to fault isolate and provide recommended corrective action will be conducted.

6th Edition of Corrosion Data Survey

The sixth edition of the *Corrosion Data Survey (Metals Section)*, a convenient and easy-to-use reference book to determine corrosion rates of materials in specific environments, is available from the National Association of Corrosion Engineers (NACE), a technical and professional society concerned exclusively with the prevention and control of corrosion on all materials.

This new edition is an update and revision of the 1974 fifth edition of the *Corrosion Data Survey*, initially published 30 years ago. The book identifies metals that may provide satisfactory corrosion performance in specific environments and gives vital information concerning reactions, other than corrosion rates, that will be valuable to engineers and scientists.

The 192-page hard-bound book lists more than 2,600 corrosive solutions and gases. The data, presented in average penetration rates, are on a matrix of concentration percent in water versus temperature.

Copies are available from NACE Headquarters, P.O. Box 218340, Houston, TX 77218 at $130 per copy for members; $160 per copy for non-members.

Capsules. . .

Army Publishes Series on Vietnam War

The authoritative history of the Vietnam War is currently being published as a multi-volume series by the U.S. Army Center of Military History. These books will be the Army's official account of the war and will vividly record the rising and falling tides of America's involvement in Vietnam.

The books in this series will tell the real story about military decisions made at the highest level: decisions that helped to shape the war's conduct and ultimate outcome—and the effect they had on each American soldier. The series of some 20 books, to be published over a period of 10 years, includes the Army's involvement from its early advisory years to 1973 when the American troops left Vietnam.

Illustrations, maps, charts, and photographs are featured throughout the series. Each book in the series will include a comprehensive index covering personal names, military titles, geographic locations, major Army functions, and commands down to the division level.

Special books will focus on the massive logistical support of the war, its pioneering technologies, Vietnamization, intelligence, and communications.

All of these books will be sold by the U.S. Government Printing Office. To receive timely announcements of each volume's publication, as well as notices of new military history books from all of the armed services, send your name and address to the Superintendent of Documents, Mail Stop MK, Washington, DC, 20401 and ask to be put on Priority Announcement List N-534.

Career Programs

CRDC'S Carlon Selected As Army Fellow

Dr. H. Carlon

Dr. Hugh Carlon, a senior research physicist at the U.S. Army Chemical Research and Development Center (CRDC), has been selected as a Secretary of the Army Fellow in the Army Science and Engineering Fellowship Program.

The program offers Carlon the opportunity to undertake an unrestricted project for one year, at a private, public, or government institution of his choice.

Carlon will study at the University of Manchester Institute of Science and Technology in England from June 1986 until June 1987. He will complete and document studies of electrical properties exhibited by atmospheric water vapor.

A civilian employee assigned to the Army chemical center in the Edgewood Area of Aberdeen Proving Ground for 27 years, Carlon began this study as part of a CRDC In-house Laboratory Independent Research (ILIR) Program in 1978, but was assigned to a new project in 1982.

During the four years of research, Carlon won three first place annual CRDC ILIR ratings, the MG Leslie Earl Simon Award, an Army R&D Achievement Award, and published 25 papers related to his research.

A 1957 graduate of Drexel University, Carlon received a bachelor's degree in chemical engineering. He began his federal career at Edgewood Arsenal in 1958 as a chemical engineer. Carlon later received a master's degree in systems management in 1971 from George Washington University, and a doctoral degree in physics from City University in Los Angeles in 1979.

Personnel Actions. . .

Ferguson Becomes AMC DCS for DE&A

BG Michael L. Ferguson, former deputy commander/chief of staff, U.S. Army Japan, has succeeded MG Robert D. Hammond as deputy chief of staff for development, engineering and acquisition, HQ, U.S. Army Materiel Command. Hammond has assumed duties as director, Nuclear and Chemical Directorate and commanding general, U.S. Army Nuclear and Chemical Agency, Office, Deputy Chief of Staff for Operations and Plans.

BG Ferguson

Ferguson is a graduate of the U.S. Military Academy and has an MA degree in international relations from American University and an MA degree in business management from Central Michigan University. He has also completed the Infantry Officer Basic and Advanced Courses, the Naval School of Command and Staff, and the National War College.

During 1983-84 he served as director of materiel plans and programs, Office of the Deputy Chief of Staff for Research, Development and Acquisition (ODCSRDA), following an assignment as deputy director of materiel plans and programs in ODCSRDA. Prior to this, he commanded the 2nd Brigade, 5th Infantry Division (Mechanized), Fort Polk, LA.

Other key assignments have included assistant deputy director for operations, National Military Command Center, Organization of the Joint Chiefs of Staff; commander, 3rd Brigade, 2nd Infantry Division, Korea; chief, Program Coordination Team, Materiel Plans and Programs Directorate, ODCSRDA; and chief, Infantry Branch, Combat Arms Division, Officer Personnel Directorate, U.S. Army Military Personnel Center.

Ferguson's awards and decorations include the Legion of Merit, Bronze Star Medal with V Device and three Oak Leaf Clusters (OLC), Meritorious Service Medal with four OLC, Air Medal, Army Commendation Medal with OLC, and the Purple Heart.

AMC PM Acronyms

(Continued from Page 18.)

SATCOM	Satellite Communications
SEMA	Special Electronic Mission Aircraft
SGT YORK	SGT York/Division Air Defense Gun
SINCGARS	Single Channel Ground and Airborne Radio Subsystem
SMOKE	Smoke/Obscurants
TAC INTEL/EW	Tactical Intelligence/Electronic Warfare System (Provisional)
TAC VEH	Tactical Vehicles
TADS/PNVS	Target Acquisition Designation System/ Pilot Night Vision System
TANK SYS	Tank Systems
TEMOD	TMDE Modernization
TMAS	Tank Main Armament Systems
TMDE	Test, Measurement and Diagnostic Equipment
TPS	Test Program Sets (Provisional)
TRADE	Training Devices
TSS	Topographic Support Systems
UAV	Joint Unmanned Aerial Vehicles

Executive's Corner. . .

AMC Commander GEN Richard H. Thompson Discusses. . . .

Initiatives to Improve the PM Process

During my assignment as AMC commander, I have undertaken a number of initiatives to improve the materiel acquisition process. Two of these initiatives—the tailored development cycle and the new Army Laboratory Command and RD&E centers—were discussed by LTG Robert L. Moore in the last issue of this magazine. Both initiatives are directed at improving the acquisition process and the organizations involved in that process to get better, more affordable equipment into the hands of the American soldier.

I would now like to share with you the rationale for what we are trying to do to improve the acquisition process in another key area—project management (PM). The PM concept, which I fully support, has served us well over the years. It is a proven technique for intensively managing selected programs, but it can be made to work better.

Core Concept and Matrix Management

We have placed PMs at the major subordinate command (MSC) or commodity level so that most of the functional expertise he or she may require will be immediately available. PMs are considered commanders and are extensions of the MSC commander. They carry, therefore, the authority of that commander in the execution of the PM mission and in the use of the matrix concept.

We also utilize the "lead command" concept for developments (such as Smart Munitions) which may span several commands. This is to ensure coordination among the programs within that area, and provide each individual PM visibility into, and the control needed to coordinate, complementary efforts.

Command policy regarding the PM concept is that the PM should not be a "doer" but an integrator and manager of all activities associated with assigned programs. The "doing" is accomplished by functional specialists external to the project management office, but over whom the PM has tasking authority. The full employment of our matrix management concept will be of great assistance in this area.

Under the matrix management concept, PMs will bring to bear the functional support elements of the AMC major subordinate command in response to workload demands of the weapon system. The MSC will provide functional support to the PM with the PM retaining only management responsibilities. To accomplish this, PMs must articulate needs and the MSC commander must determine how these needs can be provided. This entails early involvement in planning by the matrix components who provide functional support.

"PMs are considered commanders and are extensions of the MSC commander. They carry, therefore, the authority of that commander in the execution of the PM mission and in the use of the matrix concept."

Under the present TDA structure, there is very little flexibility for the movement of personnel to correspond with the workload shifts of a system as it moves through the life cycle. To alleviate this problem, I have directed that the TDA for PM offices be canceled and the resources transferred to the MSC TDA. In accordance with the core concept, personnel will then be provided to PM offices by the MSC, as determined jointly by the PM and the MSC commander.

To facilitate the cancellation of PM office TDAs, steps have been initiated to bring PM chartering and approval under my jurisdiction. I have also directed MSC commanders to develop detailed action plans for implementing matrix management throughout the MSC and PM communities. An alternative and intermediate step to fully implementing matrix management at MSCs, is the capstone or umbrella PM structure.

Unfortunately, there is no magic formula for determining the size of a PM office. Staffing requirements are driven by the functional demands of a program. However, given the current environment of constrained resources, we can no longer afford autonomous, self-sufficient PM structures. I firmly believe that our matrix management and core concepts will help us continue to gain the benefits of project management while more efficiently using AMC's resources.

Termination and Transition Policy

One of the keys to successful project management is knowing when to use it. Within AMC, there are currently 79 PMs. I believe that's probably too many because it dilutes top management attention required for programs that really require it. This is the reason for recent guidance on project transition and PM office termination.

It is AMC policy that the project management approach be maintained but that project management not become a customary method of doing business. Consistent with this policy is our intention to retain PM offices only as long as absolutely necessary. New criteria for determining when PM systems and items should be transitioned to MSC functional management responsibility have been approved. Initial operational capability (IOC) is the life cycle event at which a PM system will be considered for transition.

To transition a PM system, three separate actions are required. First, the initial phase of the fielding process (i.e., achievement of IOC) must be successfully completed. Second, a set of indicators as well as a comprehensive transition plan checklist must be satisfied. Third, AMC must approve the system transition plan in its entirety. Key to the plan's approval is not only the existence of fielding plans and the absence of major production problems at the time of transition, but also the assurance that the MSC is capable of assuming full responsibility for the management of the program after transition.

Transition cannot be effectively completed without extensive planning. Accordingly, the transition plan for each system will be developed, approved and scheduled prior to the IOC date. PM offices will be terminated when all of their systems and items have been transitioned. Transition planning should be initiated at least two years before the actual management transfer is to occur.

For Department of the Army-chartered PMs, Secretary of the Army approval is required prior to termination. A PM office termination plan will be submitted to HQ, AMC for approval at least six months prior to the recommended termination date.

"I totally support the project management system and I encourage everyone involved to seek ways to assist PMs and improve the PM process."

PM System Assessments

Another new AMC initiative to improve the PM process is the PM Materiel Systems Assessment (PMSA) Program. This management tool was developed for all program, project and product managed systems as well as for other selected high-visibility systems. The purpose is to have a more active technique that identifies potential system problem areas early enough in the life cycle process to initiate changes before they impact on fielding and sustainability.

The PMSA, which is required of all PMs, is a "living" document with charts moving in and out of the PMSA packages as the system moves through the life cycle. These PMSA packages must be updated at least quarterly. The PMSA replaces the Command Review.

As part of the PMSA process, there will be two additional reviews: one from the council of colonels/directors; and an MSC commander (or representative) review. I consider the HQ, AMC Weapon System Staff Manager (WSSM) the key player in the PMSA process. I look to the WSSMs to be the HQ, AMC managers for their respective PMSAs and use them as a management tool. WSSMs will provide whatever assistance necessary to PMs, including identification and follow up of issues and actions, development of the presentation, and analysis of data.

The PMSAs that have been reviewed at HQ, AMC thus far have been successful. We are telling a more accurate story, identifying issues in a proactive manner, solving some tough problems, and ultimately improving our support to the soldier. It has been a team effort and shows we are capable of working smarter.

I want all of the AMC community to know, understand, and contribute to the PMSA process. As the PMSA program evolves, several initiatives have been directed:

- We have established a Systems Assessment Program Office under the deputy for management and analysis to manage the PMSA and functional area assessments.
- We are folding the current Program Management Control System into the PMSA.
- PMSA data elements are being expanded to include more critical events in the early stages of the life cycle model.
- The PMSA process will be included in the curriculum of selected schools, such as the Defense Systems Management College, Army Logistics Management Center, and intermediate and senior level schools.
- Current review categories require selected systems to be reviewed at HQ, AMC, others to be reviewed by the MSC commanders, and a PMSA to be presented to me when I visit an MSC. Initially, there was a "30-day notice" category which called for MSC scheduled reviews to be brought into the headquarters to be presented to me. This category has been changed to a "no notice" PMSA which will require a PMSA to be presented to me at HQ, AMC within 24-48 hours of notification.
- We are synchronizing the Materiel Readiness Support Activity (MRSA) logistics systems reviews with my PMSA schedule and insuring that MRSA's assessment is considered during the PMSA process.

The tremendous effort that has gone into the PMSA Program to date is outstanding and those involved are to be commended.

PM Recognition

I totally support the project management system and I encourage everyone involved to seek ways to assist PMs and improve the PM process. I have taken steps to re-energize the role of the Office of Project Management at HQ, AMC. I want this office to be the focal point for PM matters and to serve as a communication channel, both from me to PMs and vice versa.

The AMC PM Office will be more proactive in its oversight of PM activities and will promote the interchange of good ideas among PMs. The office is working closely with the Defense Systems Management College in developing a PM notebook that will serve as a guide to the wide-ranging issues that are within a PM's areas of influence and interest. I expect to add to the responsibilities of the AMC PM Office in the future.

We at AMC are continually seeking to obtain the recognition for PMs that they deserve. The colonel-level PM selection board is now conducted concurrently with command boards, and selection board results are published at the same time. Beginning next spring, lieutenant colonels will be centrally selected for product manager jobs concurrently with the lieutenant colonel command boards.

We are also continuing to work with the Military Personnel Center to improve the Materiel Acquisition Management Program (MAM). Selection of the initial 504 members of the MAM Program was recently announced.

Conclusion

We're getting results. The Army leadership continues to recognize the importance of project management. The most recent brigadier general selection list included seven serving or former PMs. In addition, more than 30 active duty general officers are former PMs.

Project management is indeed a challenging and rewarding job. The AMC staff and I are committed to working toward keeping it that way.

1985 Index of Army RD&A Magazine Articles

The following is a headline list of feature articles published in the *Army RD&A Magazine* during calendar year 1985.

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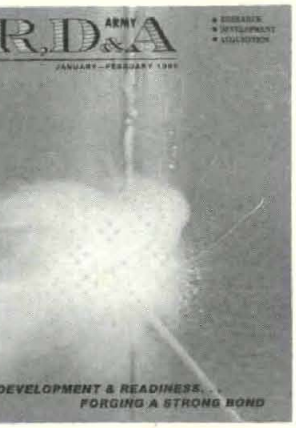

- Interview With AMC Commanding General Richard H. Thompson
- Manpower and Personnel Integration
- Pershing II Deployment Control Center
- Logistics R&D: Strengthening the Bond Between RDA and Readiness
- Designing for Supportability
- ORSA Conferees Address Analysis Excellence
- Innovation: The Tough Requirement
- The Strategic Defense Initiative
- Innovation and Creativity in Army R&D
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- Army Science Board Convenes at Fort Rucker

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- Trends in Armor Materials Development
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- Evolution of M60 Tank Series Continues
- Army Presents Annual Laboratory Awards

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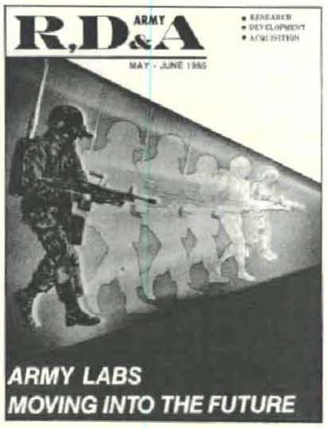

- In Search of Excellent Army Laboratories
- In-House Laboratory Independent Research
- Prescription for Success: WRAIR
- Continuous Comprehensive Evaluation
- Atlanta XI Conferees Address Major Issues
- Army Research and Technology: An Investment in Excellence
- Tandem Computers Inc.: A Culture of Self Management
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- AMC Organizational Changes Announced
- The Surrogate Research Vehicle
- GEN Thompson Discusses Pitfalls & Payoffs of Component Breakout

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- Helicopter Reliability Assessment
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- NBC Collective Protection
- Army M76 Smoke Grenade Ready for Production
- Improved Fire Protection for M60 Tanks
- LTG Moore Discusses The Acquisition Process

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