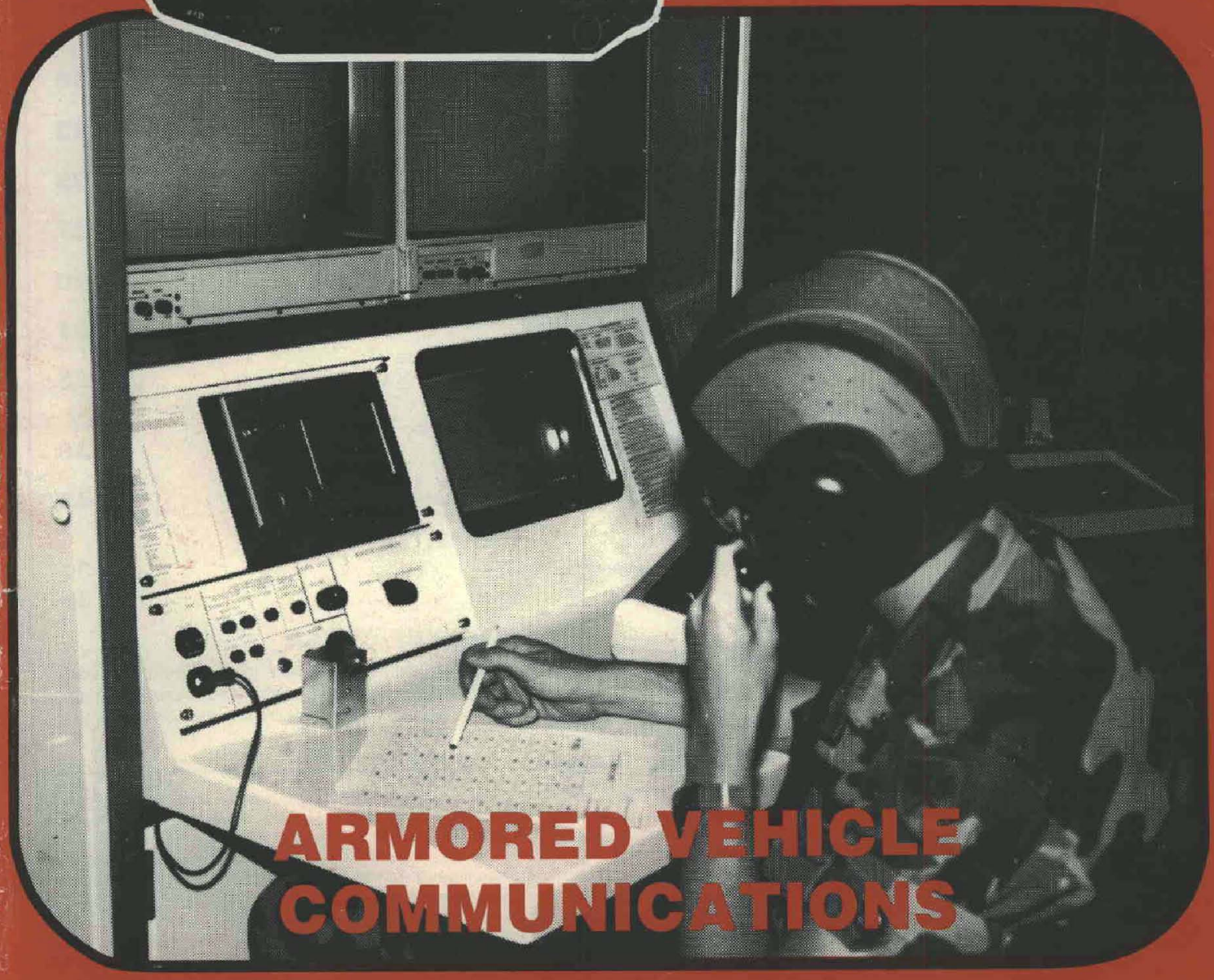
Headquarters Department of the Army
PB 70-90-1

JANUARY - FEBRUARY 1990

ARMY RD&A BULLETIN



ARMORED VEHICLE COMMUNICATIONS

ARMY
Research
Development
Acquisition
RD&A

PB 70-90-1

JANUARY-FEBRUARY 1990

PROFESSIONAL BULLETIN OF THE RDA COMMUNITY

This medium is approved for the official dissemination of material designed to keep individuals within the Army knowledgeable of current and emerging developments within their areas of expertise for the purpose of enhancing their professional development.

By order of the Secretary of the Army:

CARL E. VUONO
General, United States Army
Chief of Staff

Official:

WILLIAM J. MEEHAN, II
Brigadier General,
United States Army
The Adjutant General

Distribution: Special

FEATURES

DEPARTMENTS

ABOUT THE COVER

The importance of communications in armored vehicles is highlighted on the front cover which shows a Conduct of Fire Trainer tank simulator and a crew member conducting a speech intelligibility test. The back cover relates to an article on the Army's long range training plan into the 21st century.

Army RD&A Bulletin (ISSN 0892-8657) is published bimonthly by HQ, U.S. Army Materiel Command. Articles reflect views of the authors and should not be interpreted as official opinion of the Department of the Army or any branch, command, or agency of the Army. The purpose is to instruct members of the RD&A community relative to RD&A processes, procedures, techniques and management philosophy and to disseminate other information pertinent to the professional development of the RD&A community. Private subscriptions and rates are available from the Superintendent of Documents, U.S. Government Printing Office, Washington, DC 20402 or (202) 783-3238. Second class official postage paid at Alexandria, VA and additional mailing offices. POSTMASTER: Send address changes to Editor, Army RD&A Bulletin, 5001 Eisenhower Avenue, Alexandria, VA 22333-0001. Inquiries: (202) 274-8977 or AV 284-8977. Articles may be reprinted if credit is given to Army RD&A Bulletin and the author except where copyright is indicated. Unless otherwise indicated, all photographs are from U.S. Army sources. Approved for public release; Distribution is unlimited.

IMPACT OF COMMUNICATIONS ON ARMOR CREW PERFORMANCE

Investigating the Impact of Noise and Other Variables on Mission Effectiveness

By Georges R. Garinther and MAJ Leslie J. Peters

It is almost axiomatic in military circles that good communication is critical to mission accomplishment. Poor speech intelligibility (SI) affects the interpretation of verbal communication and leads to misunderstandings, errors, accidents, or even failure to accomplish the mission.

A specific example of a problem area is that of communication in armored vehicles. Understanding commands or instructions accurately and quickly can be critical; yet in practice, it is often almost impossible to transmit commands or instructions because of noise, distractions, or hearing loss. Case histories are constantly being cited of instances when a tank commander was unable to direct the driver to take a certain action, or the gunner misunderstood a command and fired at the wrong target.

It seems reasonable to assume that the impact of communications variables on mission performance should be well documented and quantified, but the opposite is true. Evidence is almost all anecdotal with no hard data existing as a basis for evaluating the impact of communications variables on performance or for developing strategies to handle problems that exist. Therefore, the U.S. Army Human Engineering Laboratory (HEL) has initiated a research program to investigate the effects of communications on performance and to identify methods that might be used to reduce this problem.

HEL's initial study was conducted in the Conduct of Fire Trainer (COFT) tank simulator at Fort Knox, KY, using 30 experienced tank crews. The experiment required the crews to conduct gunnery scenarios under communication conditions ranging from very good to extremely poor. Performance measures were recorded for each scenario at nominal speech intelligibility levels of 100, 75, 50, 25, and 0 percent (as measured on the modified rhyme test, a standard intelligibility test). An electronic chopping circuit, inserted in the earphone circuit, was adjusted to create each of the five desired levels of SI.

The specific measures used to evaluate performance as a function of SI fell into the following four categories:

- **Mission Time:** time required to identify the target; time required to complete the mission.
- **Mission Completion:** percent of targets correctly identified; percent of targets hit.
- **Mission Errors:** percent of communication errors; percent of times wrong target was hit.
- **Gunner Accuracy:** percent of times target was hit by the first round; aiming error.

The scenarios consisted of 10 missions, each requiring the commander to instruct the gunner to shoot at one to three targets (21 targets per scenario). Four targets (tank, truck, helicopter, or troops) appeared during each mission, and as is the standard operating procedure for armor operations, it was the commander's task to instruct the gunner to shoot at the appropriate target with the appropriate weapon. A closed set of commands such as GUNNER-SABOT-TANK alerted the GUNNER that he was to find the enemy TANK and shoot a SABOT round at it. Changes and corrections were required throughout

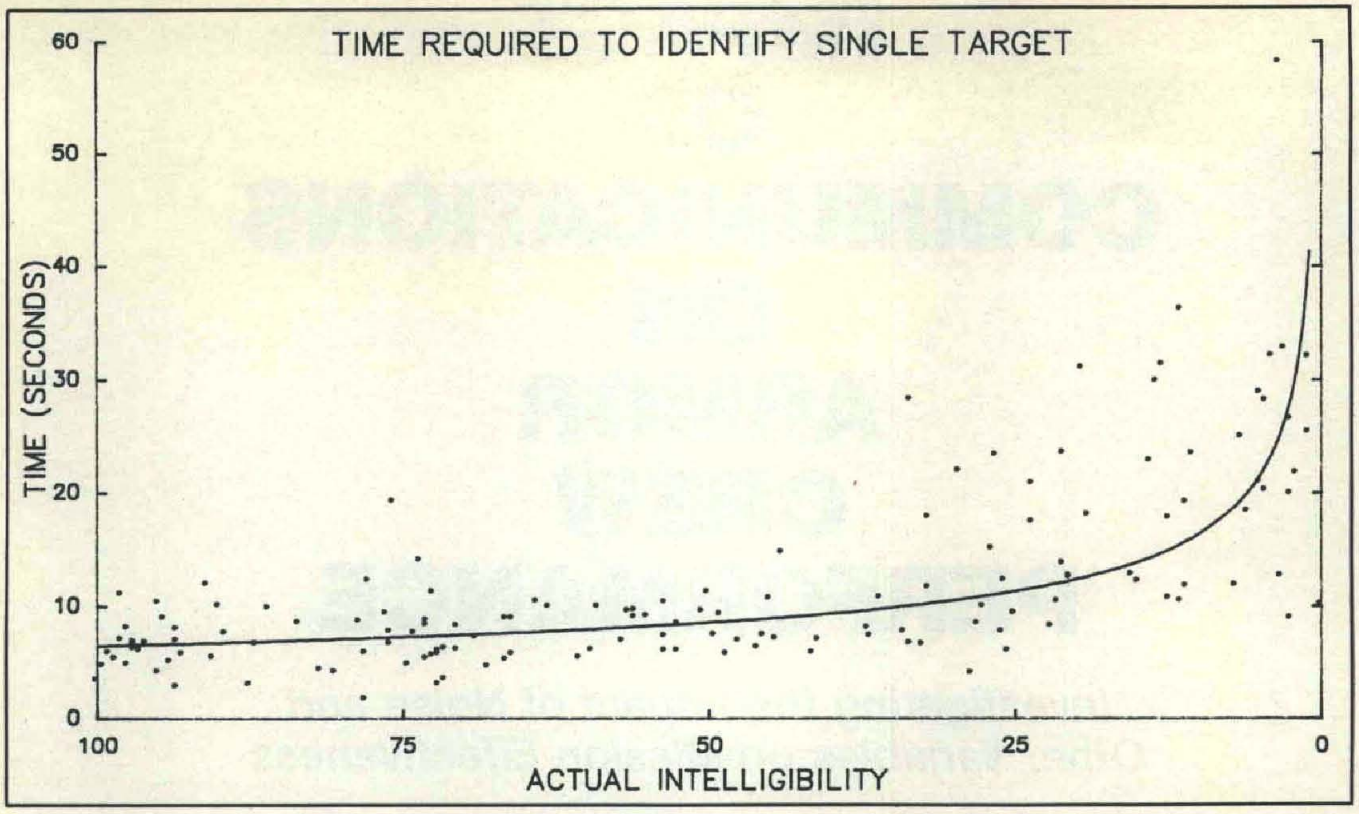


Figure 1.

the missions to increase the crew's need to communicate. It was the gunner's task to shoot only at the specified target, not at the other "friendly targets," and to instruct the driver to move quickly behind a berm after each mission to avoid being "killed" by the enemy.

The commander was directed to repeat instructions misunderstood by the gunner or use other words, realizing that excessive delay and exposure might get him "killed." If he was unable to properly direct the gunner, he could proceed to the next mission.

The experiment produced the following performance changes as a function of speech intelligibility:

Mission Time

The mean time required to identify a single target as a function of SI is shown in Figure 1. Overall mission time varied from 40 seconds at good intelligibility to approximately 90 seconds at poor intelligibility.

Mission Completion

The percent of targets correctly identified varied from 98 percent at good intelligibility to 68 percent at poor intelligibility. The percent of enemy targets killed is shown in Figure 2.

Mission Errors

The percent of commands not correctly communicated to the gunner varied from 1 percent at good intelligibility to 37 percent at poor intelligibility. The percent of time the crew was killed by the enemy varied from 7 percent at good intelligibility to 28 percent at poor intelligibility. The percent of times the wrong target was shot is shown in Figure 3.

Gunner Error

Gunner aiming error was measured and discovered to have varied only slightly, since once the proper target was found, SI had little effect on accuracy. Because of problems in target specification, however, the percent of time the correct target was hit by the first round decreased from 90 percent to 42 percent as intelligibility decreased from good to poor.

Discussion

This study has shown that even for this relatively well defined gunnery task, with a limited vocabulary designed to enhance communication efficiency, mission performance varies as a function of SI. The greatest change in performance was caused by the time required and the difficulty of correctly identifying the target. Once the correct target was identified, the time to fire and hit the targets remained fairly constant among SI levels. At poor SI, however, the percent of targets correctly killed decreased quite dramatically as shown in Figure 2. Also, the percent of time the wrong target was killed increased at poor intelligibility as shown in Figure 3. Furthermore, the number of times the 'enemy' defeated the friendly tank increased four-fold as speech intelligibility worsened.

This study is a first of its kind, with follow-on work presently being conducted to investigate the role of communications in settings that are somewhat more complex. Here, the SIMNET Bradley simulator was used with crews conducting navigational

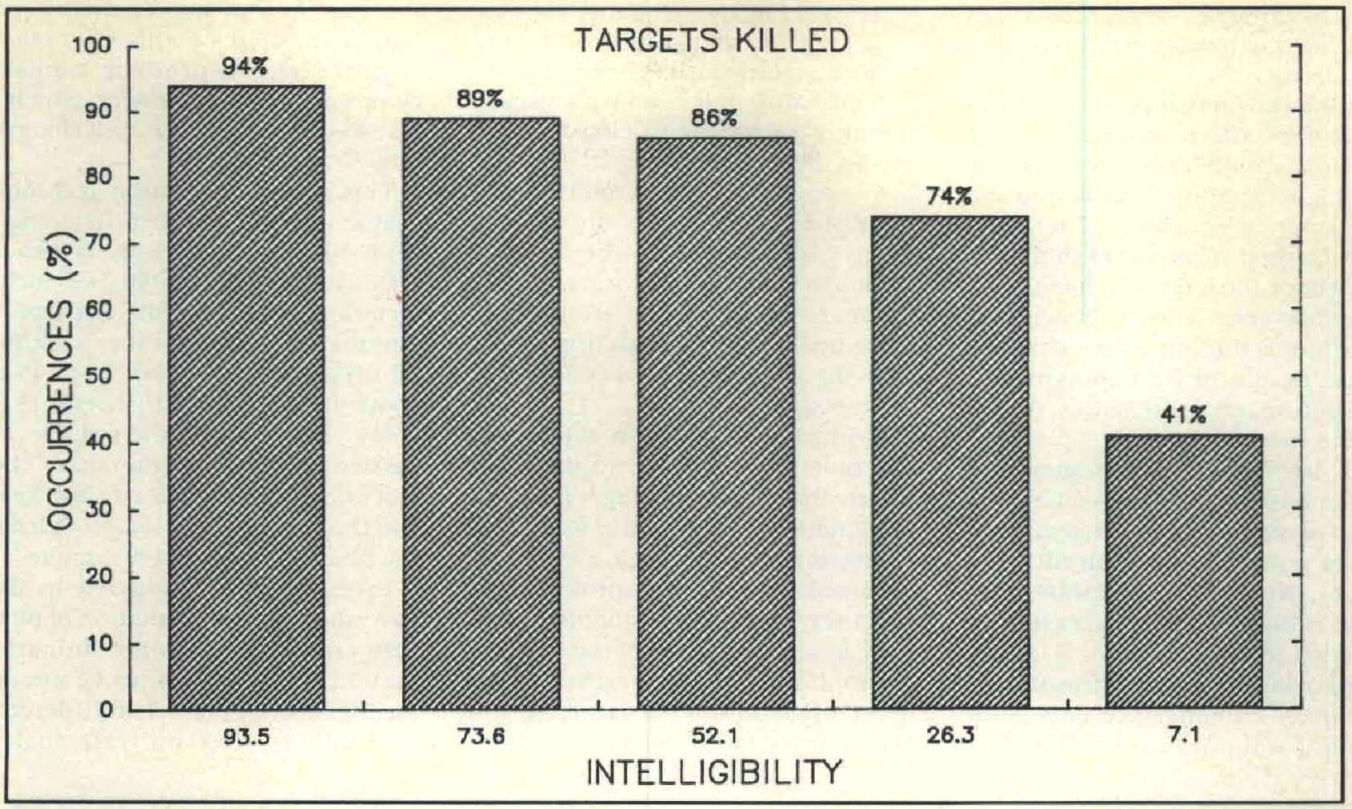


Figure 2.

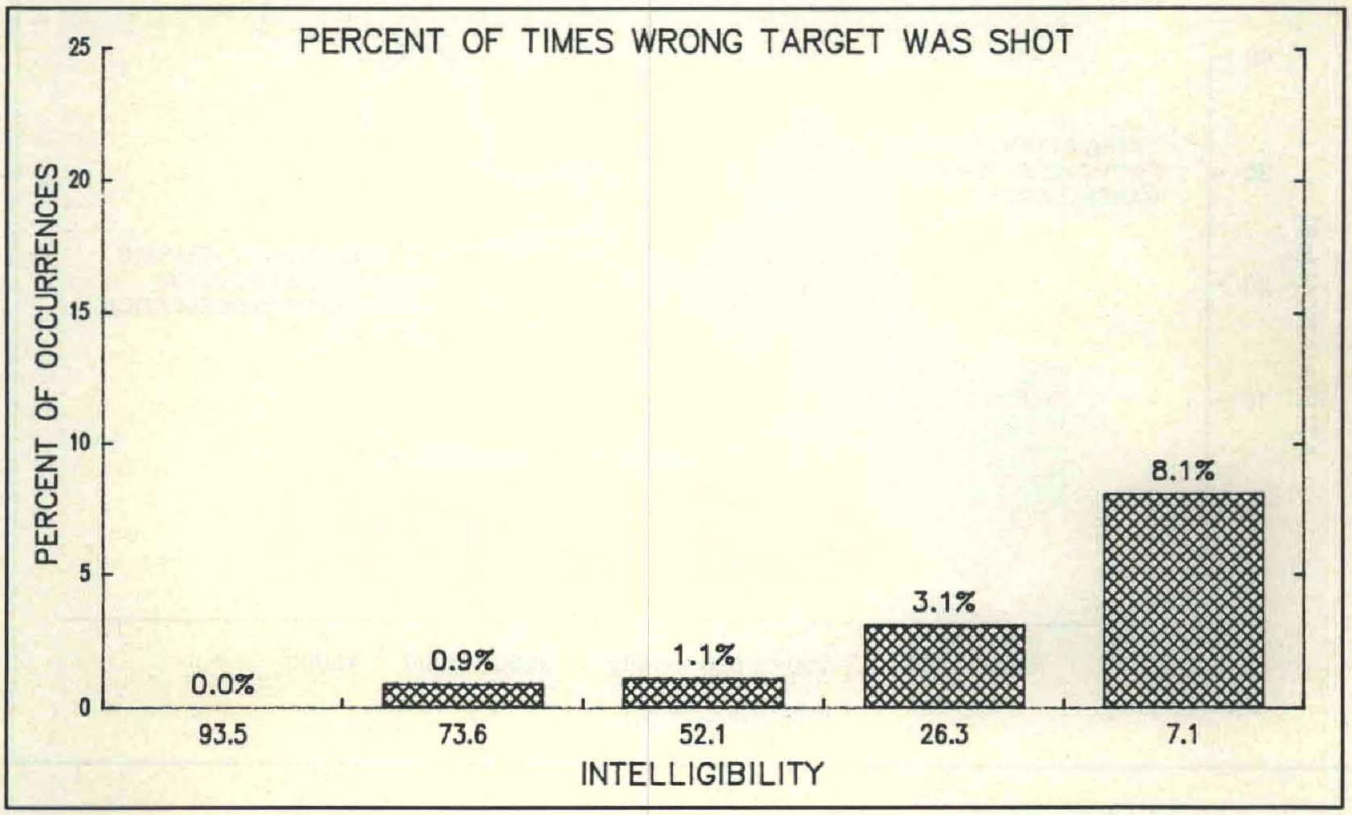


Figure 3.

exercises through several phase lines and firing at selected targets throughout the exercise.

Having shown that poor communication does affect performance, the question which arises is how can speech intelligibility be increased and performance improve. The most direct method of accomplishing this is to reduce the level of vehicle noise at the crew's ears. This can be achieved by either reducing noise through vehicle design or by improving the attenuation characteristics of the tanker's helmet.

HEL has completed a program that has demonstrated that through careful design of the suspension system, track vehicle noise can be reduced by 65 percent. Other studies have shown that track redesign can increase this reduction to 85 percent.

Improving the passive attenuation of the tanker's helmet presents some technical and practical barriers since increasing the low frequency attenuation of a hearing protector would require significantly greater earcup volume. Most track vehicles exceed the Army's noise limits at low frequencies in the 250-Hz range.

A commonly used method of increasing attenuation at the ear is to wear earplugs under the helmet. Although this protects hearing, in most instances, particularly when the user has a hearing loss, the ability to hear over the communication system may be impeded.

A phase-cancellation technique has recently become available for improving speech intelligibility over communication systems, as well as for protecting hearing. Such a system is mounted inside a hearing protector and has a tiny sensing microphone inside the earcup just in front of the ear. This microphone senses both the desired speech signal from the earphone and the undesired noise signal that enters the earcup and masks the speech signal. The output of this microphone is processed to produce a phase-reversed noise component which is reintroduced into the ear, cancelling the undesirable noise.

This active attenuation technique is able to cancel noise at frequencies from 30 to 1000 Hz, with its greatest attenuation being at 250 Hz. Such a technique complements the passive attenuation of the tanker's helmet which has attenuation of 20 to 45 dB above 1000 Hz, but only five to 15 dB below 1000 Hz. Figure 4 shows the passive attenuation of the tanker's helmet (measured with an artificial head) and the extra attenuation provided by the phase cancellation technique.

Investigations conducted to date have shown that the addition of phase cancellation to a communication system is able to improve speech intelligibility by more than 10 percent. Preliminary data indicate that in

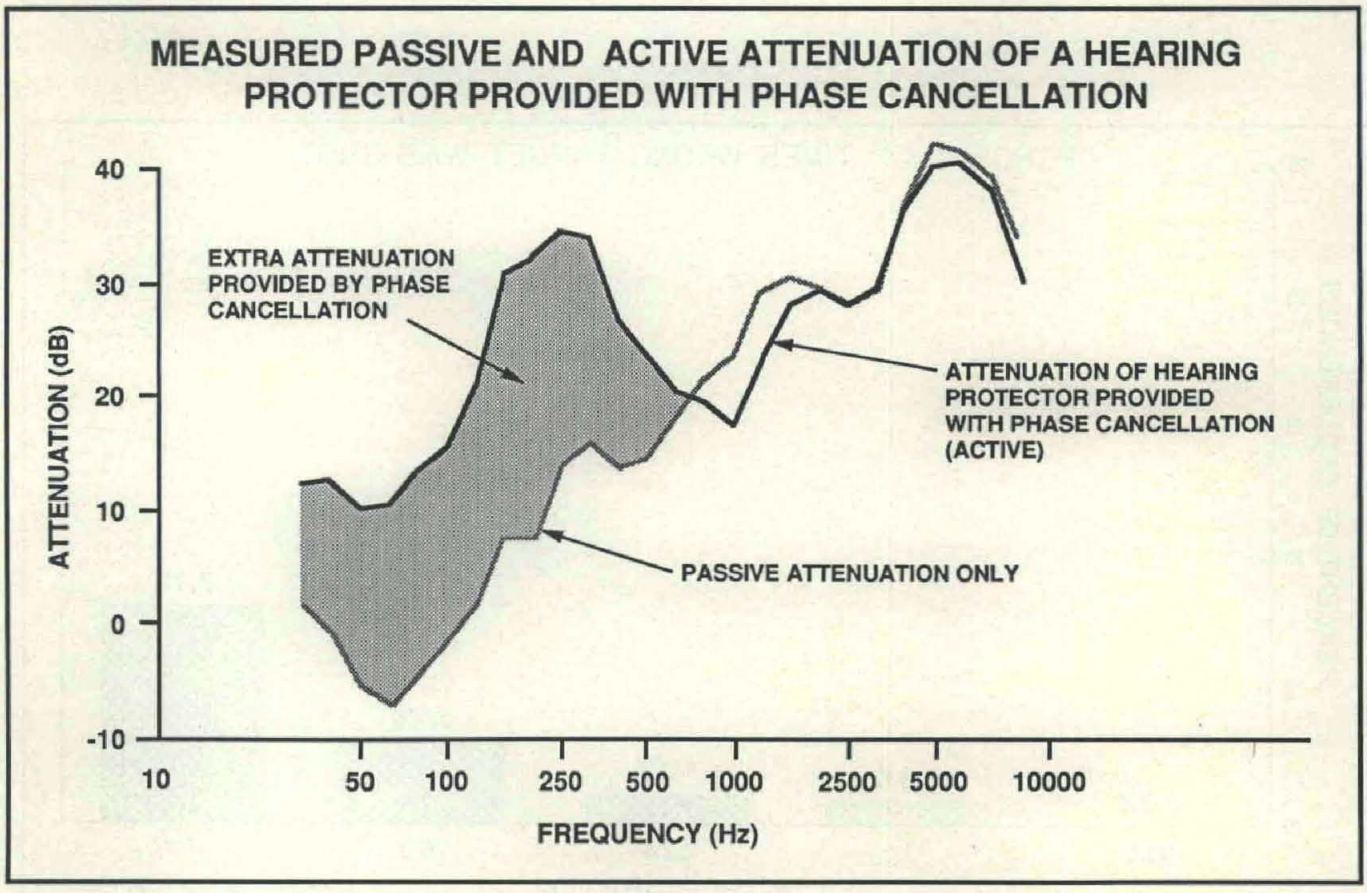


Figure 4.

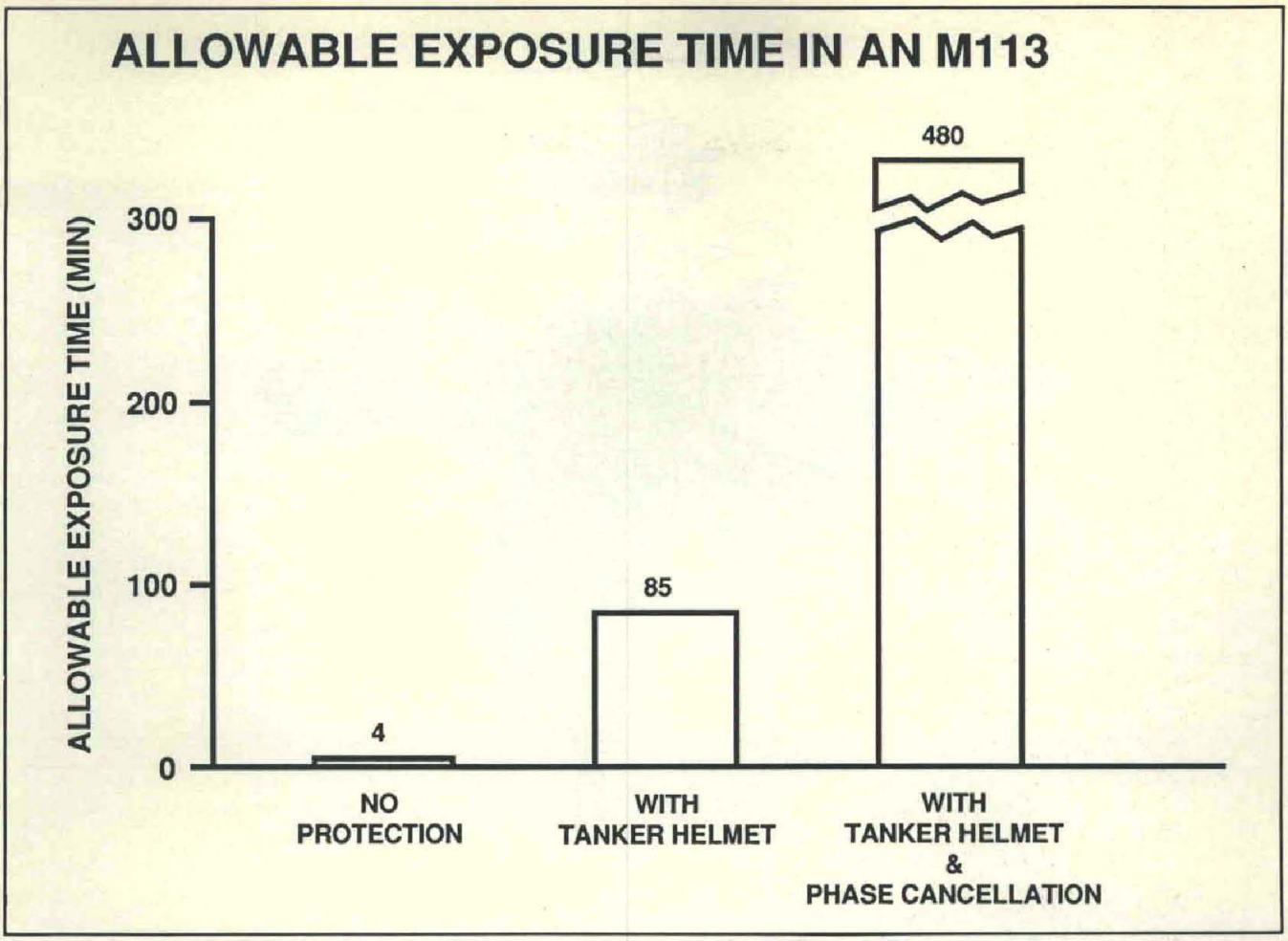


Figure 5.

situations when communication is very poor, SI will be improved by an even greater amount.

In addition to this improvement, the phase-cancellation technique will dramatically increase the exposure time permitted without auditory hazard. Figure 5 shows the computed permissible crew exposure time in an M113 armored personnel carrier moving at 25 mph, with no protection, with only the tanker's helmet, and with the tanker's helmet and phase cancellation.

Also, subjective comments have indicated that listening to speech without the constant low frequency roar of armored vehicles is much less fatiguing and stressful. Although these effects have not been objectively quantified, such improvements could permit longer sustained combat operations at greater states of alertness.

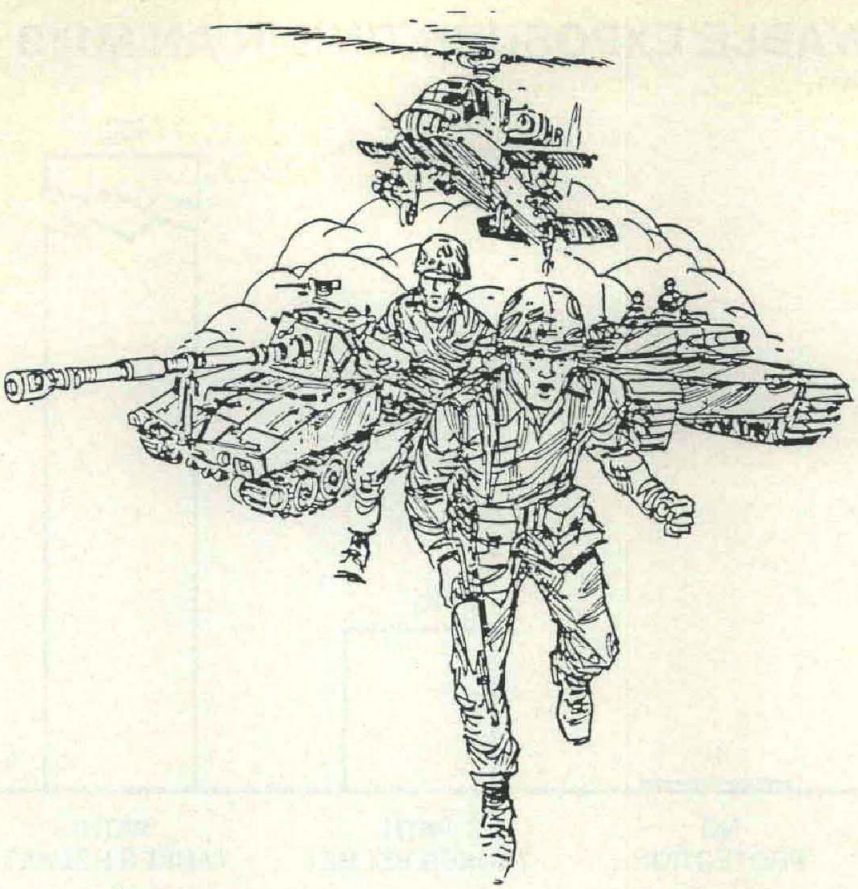
These studies, which are the first of their kind, are intended to establish realistic acoustic limits for Army materiel, guide the design of improved communication systems, and assist operations analysts in better defining those parameters that may affect the performance of personnel and the outcome of a battle.

Summary

We have shown that poor communication in armor units results in prolonged mission times and in a greater number of operational errors. One method of improving speech intelligibility is to use phase cancellation in tankers' helmets. This reduces the noise level at the ear, thereby improving speech intelligibility, reducing hearing hazard, and improving system performance.

GEORGES R. GARINTHER is a research engineer at the U.S. Army Human Engineering Laboratory's Acoustical Research Team. He hold's a bachelor of science degree in electrical engineering from Gannon University and is a fellow of the Acoustical Society of America.

MAJ LESLIE J. PETERS is a research audiologist at the U.S. Army Human Engineering Laboratory's Acoustical Research Team. He holds a Ph.D. in audiology from Penn State University.



Training in the 21st Century. . .

THE ARMY'S LONG RANGE TRAINING PLAN

Future Trends in Developing Meaningful Systems for a Wide Range of Scenarios

By COL Jerry N. Armstrong
and LTC Ron E. Deaver

SGT Williams looks through the gunner's sight of his tank and sees more enemy vehicles than he has seen in any of his previous battles. In the distance he observes tanks from another battalion engaging enemy tanks and personnel carriers. He can see artillery falling and Air Force aircraft firing tank killing missiles, all attempting to stop the enemy attack. The defensive positions of the platoon on his right are coming under enemy fire and he knows that now is the time he will find out if his unit's hard work in training will pay off.

Suddenly, the sergeant's commander issues a fire command. The tank lurches forward. It is SGT Williams' turn to kill the enemy before they kill him. The battle rages. SGT Williams destroys seven enemy tanks; his company many more. However, the enemy has committed a reserve and continues the attack.

There are more enemy tanks firing at him than SGT Williams can count. Suddenly, he feels a shudder, a tremendous noise engulfs him, his sights all go black. He knows what has happened. His tank has been exposed too long. He realizes they should have backed into a more protected position. Too late. He knows he has only seconds more to spend in this great battle.

As he steps out of the gunnery/maneuver simulator, he is thankful that the battle is only simulated. He is even more thankful that the Army has developed training devices that allow him to train in such a realistic and effective way for the job he hopes he will never have to actually perform.

But what will Army training be like in the 21st Century? Will SGT Williams' simulator training be an enhancement to actual maneuver and live fire training, or will it be the primary method of training? The Army attempts to come to grips with this question, and many others, in its recently published Long Range Training Plan.

Preparation by the Army to accomplish the many diverse missions required in the next 30 years provides significant challenges. To assist in meeting those challenges, the Army has developed a Long Range Planning System.

Army Regulation (AR) 11-32, *Army Long Range Planning System (ALRPS)* prescribes policy, responsibilities, and procedures concerning the Army Long Range Planning System. It provides for total Army involvement in the long range planning process and establishes linkages between long range goals, mid-term objectives, and the programming process.

The ALRPS includes the publication of the Army Long Range Planning Guidance (ALRPG) and requires Army Staff agencies, commanders of Army commands, and Army component commanders of the warfighting unified and specific commands to publish long range plans.

The Army Long Range Training Plan (ALRTP) 1989-2018 is one of the functional/special area long range plans. Although it does not attempt to predict exactly how training will occur in the 21st Century, it does provide a vision of the characteristics of that training. It provides an overall azimuth for trainers and training developers to follow as they prepare for the training challenges of the coming years. It identifies future trends in the environment in which training will be conducted; identifies future force characteristics; and makes assumptions concerning areas relevant to training. More significantly, it articulates the Army active, reserve, and civilian component training strategies for the near term (the budget and POM years), and then extends the strategies for the total Army through the turn of the century to the year 2018, to the day SGT Williams fights his simulator battle.

Determining Army training requirements requires an understanding of several functional areas; for example, how the Army will be manned, equipped, structured, and sustained in the future.

Relationship to Other Documents

The ALRTP is linked with other documents which provide conceptual bases for future training requirements. The senior Army leadership vision of the future, found in the ALRPG and Army future warfighting concepts, provides the basis for developing the trends and assumptions used in the ALRTP. While not all functional/special area plans were in final form, the training requirements and implications of those plans were considered in the development of the training plan.

Trends

The training environment envisioned in the long range plan is formulated after considering many variables. Anticipating the direction and impact each will have on training is difficult. However, focusing on the major trends enhances the capability of training planners to develop training plans and programs that more effectively deal with likely training requirements throughout the period.

Major trends considered in the preparation of the ALRTP include the improving military capabilities of other nations, the expansion of low intensity conflict around the world, the fielding of chemical weapons by lesser developed nations, the impact of environmental considerations on training, and an understanding that the cyclical nature of the domestic political environment will continue to affect resources provided for defense and, therefore, for training. Other trends considered include expected changes in U.S. demographics affecting both the military and civilian manpower pool, and the impact of emerging technology on equipment and the way we train.

Assumptions

Determining Army training requirements requires an understanding of several functional areas; for example,

how the Army will be manned, equipped, structured, and sustained in the future. However, because it is not possible to define fully the training environment 30 years in the future, some assumptions must be made.

The ALRTP includes assumptions that Soviet military power will continue to pose a threat to the United States and its interests, that the Army must be prepared to fight across the full spectrum of conflict, that time spent in the training base will not significantly increase (resource utilization will instead indicate a reduction of in-resident institutional training opportunities), and that more individual MOS qualification training will be conducted at the unit/home station, less in the institution.

Training Requirements

The ALRTP identifies, for the first time in a single Department of the Army level document, training requirements for the future. Some requirements remain the same as in the past, while others are new requirements to meet changes in the training environment. Key requirements include exploiting the use of technology in all training activities and systems, focusing training on battle-focused mission essential tasks, and using a systems approach to training based on an analysis of empirical data.

Near Term Strategies

The current active, reserve, and civilian component training strategies in the ALRTP reflect the requirements for training now and in the immediate future. They establish a starting point for the longer range strategies that follow. The goals of the three strategies are:

- **Active Component Training Strategy.** Train the force for prompt, sustained, and successful land combat, with other services and nations where required, across the spectrum of conflict anywhere in the world.
- **Reserve Component Training Strategy.** Produce a reserve component force trained to mobilize, deploy, fight, and win upon arrival in the gaining capstone command, to include the CONUS base.
- **Civilian Component Training Strategy.** Provide a consistently high-quality civilian work force competent in leadership, professional and technical knowledge, and abilities to support, enhance, and sustain Army readiness.

Each strategy identifies specific objectives, and then describes the mechanisms through which the objectives will be achieved. The training strategies address the training requirements for individual/soldier, collective, unit, leader training, and training support. They reflect those activities required in institutional training and those necessary in unit training programs.

Continued use of initial entry training and individual skill development training in institutions is envisioned, with emphasis on implementation of the training management principles of FM 25-100 in the development of unit training activities. The near term strategies reflect an emphasis on leader development, joint and combined training, and the increased use of training devices, simulators, and simulations.

Long Term Strategies

Training strategies of the future will result from an evolutionary, not revolutionary process. The near term strategies will evolve into the long term strategies of the next century. While the impact of technology, environmental constraints and other factors will cause changes in the way the Army trains in the future, those changes will follow a steady path.

The long term goal, like our current goal, will be to produce a force capable of mobilizing, deploying, fighting, and winning anywhere in the world.

The long term goal, like our current goal, will be to produce a force capable of mobilizing, deploying, fighting, and winning anywhere in the world.

The long term strategies to accomplish this goal are once again described in the ALRTP for soldier and leader training, collective training, training support and training management.

Soldier and Leader Training

Training will continue to focus on inculcating the skills, knowledge, and attitudes necessary for soldiers and civilians to perform successfully in a wide range of conflict scenarios. The confidence that springs from proficiency in basic skills will prepare an individual for effective operations in fluid, lethal, tactical situations in which boundaries are ill-defined.

Basic skills will continue to be taught most effectively through dynamic, demanding "hands on" training, and in realistic, simulated combat conditions. However, the extended stand-off capabilities of new weapon systems, the increasing constraints on maneuver space and other resources, and environmental concerns mandate an increased reliance upon simulations, simulators, and training devices to develop proficiency.

Initial entry training (IET) will continue to be used to train newly recruited soldiers and newly hired civilians. However, time spent in the institution will be reduced to the time needed to teach common tasks that apply to all units. Other, more specific tasks will be taught at the unit using distributed education developed by the proponent school.

Advanced education, the Noncommissioned Officer and Officer Education Systems (NCOES and OES), will routinely make use of phased education. The first phase of courses will be "at duty station," followed by a shorter resident phase. Distributed education using communication/computer based/distributed techniques will link students around the world with a single instructor in an institution.

Distributed education and its related technology will require and provide worldwide access to the proponent schools. Reduced course length will reduce TDY for most students, and will allow proponent schools to provide Army wide, instantly available information, enhancing standardization throughout the Army.

Collective Training

Collective training will be oriented on those skills and tasks that contribute to the successful accomplishment of a unit's wartime mission. Critical to this process is the ability to integrate soldier, leader, crew, and collective training requirements derived from wartime mission analysis.

The full range of devices, simulators, and simulations, (DSS) must be utilized to ensure maximum cost-effectiveness in maintaining readiness. The Army will move from the current training strategy that includes live-fire and maneuver enhanced by DSS to a strategy where live-fire and maneuver are combined with DSS. Some live fire and maneuver currently being done in units will be replaced by use of DSS in the future.

Combat training centers (CTC) will become more important in the execution of collective training. Large scale maneuver training will be accomplished at combat training centers or regional training centers while individual, crew, squad, and small unit maneuver will be accomplished at home station.

Distributed education (training) equipment and facilities and other related technological developments will link units training at home station directly to units training at the CTCs or other training centers. They may all participate in the same exercise, for example, but from different locations, and at different levels of involvement.

Home station training will continue to be important, but may become more difficult to accomplish at larger unit level. While resources may decrease, multiple constraints on training, and requirements for larger ranges and maneuver areas will increase. Obtaining sufficient land to support unit maneuver training and new weapons firing requirements will be difficult. However, use of distributed training, and linked simulations, simulators and training devices in conjunction with actual firing and maneuver, will enhance home station training. Collective training, including joint and combined training, will often be effectively conducted using DSS without the unit leaving its installation.

Training Support and Training Management

The requirement to provide the training support necessary to develop individual and collective expertise in warfighting and sustaining base skills remains unchanged. However, the nature of the training programs, strategies, and systems that must be developed to facilitate the acquisition of those skills will be dramatically different.

The full range of technology (human and hardware) must be incorporated into ways to meld soldier and leader during collective training. Examples of emerging technologies that could be utilized to enhance training activities include speech recognition, interactive audio and video, virtual environment, voice technology, and neural systems.

The focus must shift from training soldiers on equipment to training soldiers in systems. Army training developers must become even more intimately involved than ever before in the materiel development and acquisition process.

A device, simulator, simulation hierarchy must be developed to integrate interactive networks of simulators and simulations that support individual and unit training. Training devices for operational and maintenance training systems must be embedded in new as well as current systems, and must include the capability for linkage with other simulators and simulations. DSS systems must provide realistic training, developed as part of a training strategy that supports the user's mission.

"New" learning centers must be developed that support the requirements of distributed education (training) and are accessible to the total Army. These centers may potentially support IET, AC/RC units, joint/combined training, and allow simulated maneuver and weapons firing through use of a variety of devices, simulators, and simulations. Current technology such as computer based instruction (CBI) and satellite education networks must evolve into systems that are integrated with other DSS. Current development of training systems must be an integral part of the development process for all new equipment, not an item to be added at a later date. In some cases, simulators may be developed prior to equipment to allow for effective systems development before production.

Conclusion

The ALRTP, as a long range vision of Army training, and through its articulation of goals, objectives, and strategies, provides long range direction, contributes to prioritization, and sets the foundation for all Army training programs. To be effective, it must be institutionalized in a long range training system used throughout the Army.

The ALRTP will be staffed and revised biennially. Long range training plans will be an agenda item at all annual Department of the Army sponsored MACOM training conferences and will be the sole focus of a separate annual long range planning conference.

As Army trainers develop supporting plans, execute a common training strategy in the near term, and pursue a common strategy in the future, they will ensure that SGT Williams is part of the best trained Army in the 21st Century.

COL JERRY N. ARMSTRONG is chief, Training Operations Division, Directorate of Training, Office of the Deputy Chief of Staff for Operations and Plans, HQDA. He is a graduate of the U.S. Army Command and General Staff College, the Air War college, and holds a B.A. degree in psychology and an M.A. in management.

LTC RON E. DEAVER is a staff officer, Directorate of Training, Office of the Deputy Chief of Staff for Operations and Plans, HQDA. He is a graduate of U.S. Army Command and General Staff College and holds a bachelor's in business and an M.B.A.

EXPERT SYSTEM SIMPLIFIES INTEGRATED LOGISTIC SUPPORT

By Jay Graver

Integrated Logistic Support (ILS) is the management process required to plan and implement all of the logistical requirements performed and delivered throughout the acquisition and fielding of a new weapon system. Army Regulation 700-127, March 1, 1988, *Integrated Logistic Support*, defines the following 12 ILS elements: Design Influence; Maintenance Planning; Supply Support; Training and Training Devices; Support and Test Measurement Diagnostic Equipment; Facilities; Transportation and Transportability; Standardization and Interoperability; Packaging, Handling and Storage; Manpower and Personnel; Computer Resources Support; and Technical Data.

The U.S. Army Materiel Command's (AMC) Materiel Readiness Support Activity (MRSA) performs a prominent role in all aspects of ILS; a role in which MRSA has the opportunity to view and participate in the entire ILS life cycle. MRSA plays a program management role, serving as the preparing activity for Department of Defense (DOD), Department of the Army, and the AMC ILS policy documents. MRSA is involved in the ILS analytical process by serving as the DOD Logistic Support Analysis (LSA)/Logistic Support Analysis Record (LSAR) Support Activity, performing data modeling and managing the Joint Service Automatic Data Processing Program.

The organization has also been involved in the execution of ILS, performing Level of Repair Analysis, Comparative Analysis, and serving as the interim ILS manager for the Heavy Force Modernization Program. MRSA offers assistance to Program Management Offices (PMOs) by participating in ILS management team meetings, LSA review teams, and source selection evaluation boards and by providing help in preparing and reviewing ILS program documentation and associated logistics products.

Recent experience has uncovered several recurring problems in ILS. These problems fall into three main categories: ILS planning, ILS scheduling, and ILS requirements specifications. In the planning area many programs have been discovered with outdated ILS Plans (ILSPs) and some that did not have any plans whatsoever. Programs that did have current plans frequently did not address key ILS considerations and did not perform the integration function they were intended to achieve. In some organizations, it has become a practice to simply copy an old plan and hope it would suffice.

In the ILS scheduling area, MRSA review has discovered schedules which were incomplete, illogically sequenced, and ones that were not in conformance with regulatory policy. Often the schedule was maintained in a reactive rather than a proactive manner (only maintained as a historical record, not a roadmap to the future).

ILS requirements specifications or Statements of Work (SOWs) were frequently fragmented or totally absent from the request for proposal (RFP). When present, the functional ILS elements often asked for redundant information in varying formats, thus causing the government to pay twice for the same analytical effort and resultant data.

The cumulative effect of these problems has led to conditionally released weapon systems, or weapon systems which are sent to the field deficient in one or more of the elements of support, which undermine the system's inherent readiness potential and place an undue logistics burden on the equipment user.

MRSA research into the cause of these problems led to a closer look at the environment of the ILS manager. The cause and effect diagram (Figure 1) shows four primary problem areas the ILS manager must overcome. First there is an enormous volume of knowledge required for an ILS manager to be effective. The ILS manager must be proficient in all of the functional disciplines of ILS as well as the related budgeting and program management processes.

A new ILS manager is frequently knowledgeable in one or two disciplines of support but seldom has sufficient knowledge in all of them (Figure 2). MRSA researched what it would take to obtain the required knowledge and found over 700 policy and guidance documents related to ILS as identified in an AMC ILS bibliography.

There are over nine months of various training courses that are considered prerequisites for ILS competency and over 250 published lessons learned. This is coupled with an average ILS manager turnover rate of 2-3 years. By the time an ILS manager becomes knowledgeable, they often leave, taking the knowledge and experience gained with them.

Not only does the ILS manager turnover, but so does the program manager, his staff, and the contractor personnel. The ILS manager must deal with the knowledge demands and turnover rate and, furthermore, is frequently constrained with an inadequate budget and turbulent schedule. The sum total of the knowledge required, high turnover, constrained budget and turbulent schedule frequently results in ineffective management of the ILS process.

That cause and effect of ILS implementation shortfalls led to a realization that a tool must be developed that can assist the ILS community in overcoming these deficiencies. MRSA has compiled information on ILS policy and procedure, lessons learned, training material, and "expert" ILS experience into an automated system called the Logistics Planning and Requirements Simplification System (LOGPARS) (Figure 3).

LOGPARS takes advantage of a form of artificial intelligence called expert or knowledge based systems. LOGPARS was developed to run on an IBM AT (or compatible) personal computer — the DOD standard Zenith 248 works well. The expert system guides the user through a logical question and answer session presenting him with appropriate guidance and help screens throughout. The results of the interactive session produce specific ILS documentation required in the program.

These products include the ILS Strategy, the ILSP including the LSA/LSAR Plan, ILS SOW for inclusion in the RFP, the ILS milestone schedule, and an associated warranty clause. LOGPARS maintains an audit trail of each session and associated products for reference when the ILS program encounters turnover and turbulence.

LOGPARS is a modular expert system with each module producing a specific product. The current LOGPARS modules include an ILSP advisor, a schedule advisor, an ILS SOW advisor, an ILS strategy advisor, and a warranty advisor.

The user begins by executing the strategy advisor. The strategy advisor will ask key upfront program management related questions such as the type of acquisition program (developmental, non-developmental item, etc.), the life cycle phase, contractor support considerations, and more.

After completion of this interactive session, the strategy advisor will make a series of recommendations for each ILS element. The user can then accept or override each of the recommendations depending on their level of expertise and judgement. LOGPARS will feed the results of the strategy advisor to each of the other modules. If the user comes back and changes the strategy, LOGPARS will identify the impact of each change.

The schedule advisor assists the manager in developing and tracking the acquisition schedule. Based on the results of the strategy advisor and other tailoring considerations, the

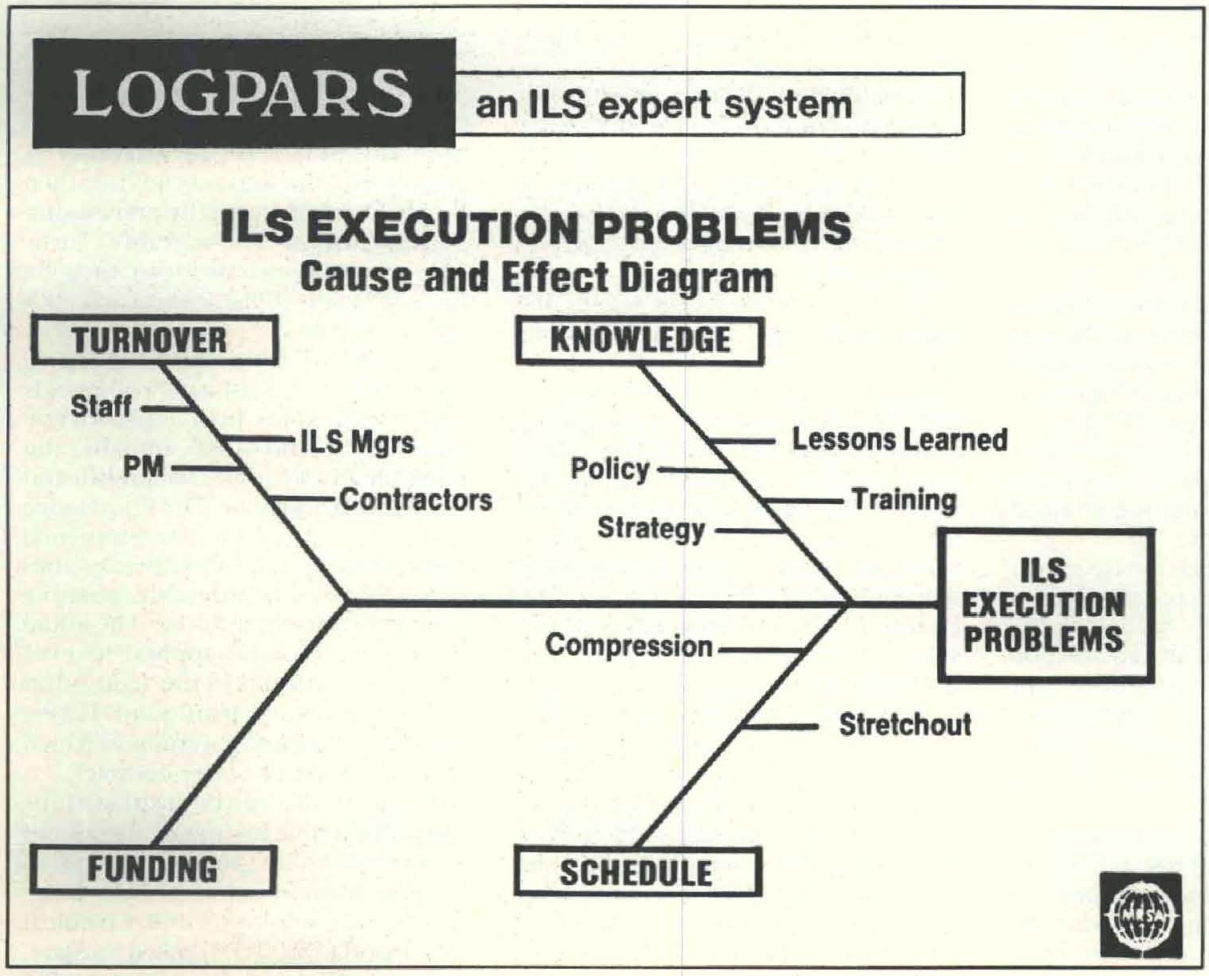


Figure 1.

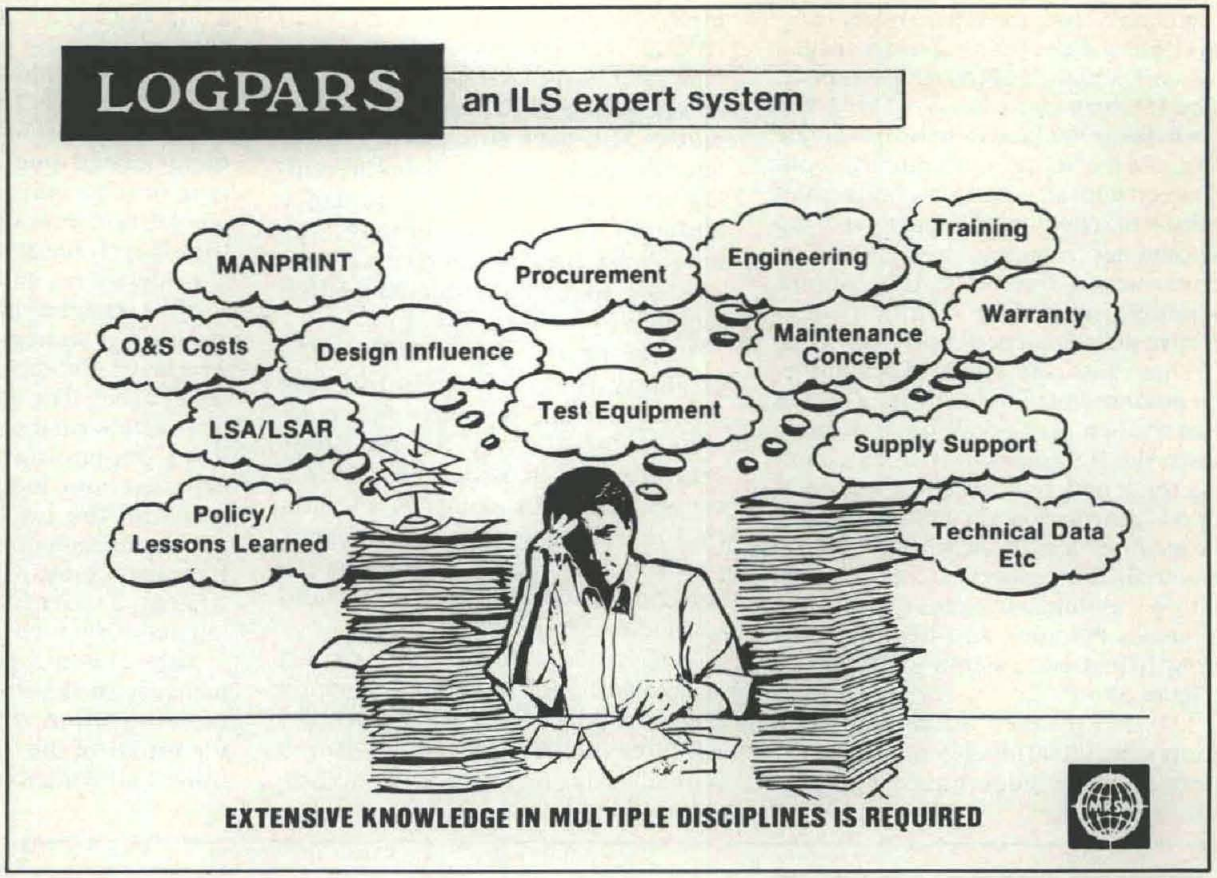


Figure 2.

schedule advisor projects a tailored initial baseline schedule leading from program initiation through initial operational capability. The user will be able to easily maintain, change, or even overhaul the schedule as the program proceeds.

As changes are made, the schedule advisor forewarns the user of associated impacts and offers to automatically adjust impacted milestones. The results of the schedule advisor can be automatically be submitted to the Army's acquisition management milestone system using the commodity command standard system.

The ILSP advisor leads the ILS manager through the preparation of a comprehensive ILSP. A formal ILS program is required for all new weapon systems acquisition programs per *DODD 5000.39*, Nov. 17, 1983, *Acquisition and Management of Integrated Logistics Support for System and Equipment.*

The ILSP is the guiding document from which the ILS program is executed. The ILSP advisor ensures all logistical element considerations are appropriately planned for later execution. Policy, procedures, and lessons learned are interjected by the expert system at the appropriate place. The resultant plan is in full conformance with *DA Pamphlet 700-55*, March 1, 1988, *Instructions for Preparing the Integrated Logistic Support Plan.*

The ILS SOW advisor leads the ILS manager through the considerations and questions required to formulate a tailored ILS SOW for inclusion in the RFP. The SOW advisor identifies the pertinent data item descriptions, LSA tasks and LSA reports, then incorporates the associated requirements into a clear, concise and integrated SOW. All program requirements and deliverables are tailored based on the results of the strategy advisor and subsequent interactive tailoring. The results developed throughout the use of LOGPARS can be downloaded to any word processor for further tailoring of command and system peculiarities.

The warranty advisor performs three tasks. First, the legal requirement for a warranty is determined based on the particular weapon system scenario. If it is not required by law then the expert system determines the requirement based on Army policy documents.

Once it is determined that a warranty is required, either by law or regulation, then the best type of warranty is concluded. The warranty advisor then leads the user through the preparation of the actual baseline warranty clause. The resultant warranty can then be included in the RFP or negotiated with the contractor.

LOGPARS was initially fielded to select major subordinate commands and PMOs. The initial prototype consisted of the ILSP advisor, the schedule advisor, the SOW advisor and the warranty advisor. The knowledge base was tailored for developmental items entering the full scale development phase. Considerable positive feedback has been received. The initial prototype has been applied to over 30 weapon systems in the acquisition process and has produced ILSPs, schedules, SOWs, and warranties which are now in use or under contract.

Many of the initial applications identified a time savings of weeks and even months in the preparation of baseline documentation. The U.S. Army Armament, Munitions and Chemical Command (AMCCOM) stated "a Statement of Work was prepared in 4-5

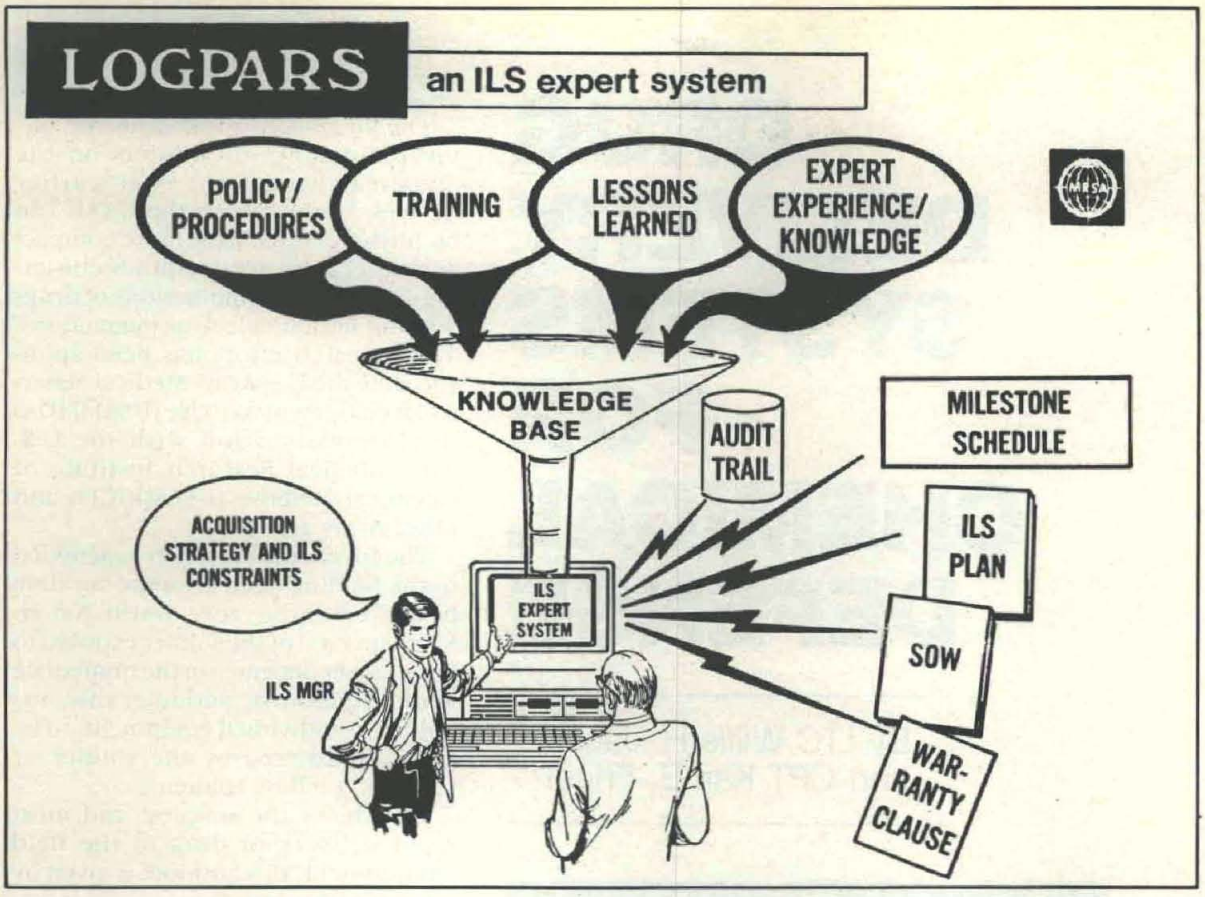


Figure 3.

Hours by a GS-12 using LOGPARS; without LOGPARS it would have taken two GS-12's 2-3 weeks." The U.S. Army Belvoir RDE Center (BRDEC) stated they "could bring a new ILS manager to full performance within six months using LOGPARS, previously it took about two years."

LOGPARS use of expert system technology has enabled it to be an aggressive program. Rapid advancements in LOGPARS have been achieved to date and its future is bright. In fiscal year 90, LOGPARS has received funding through the Office of the Secretary of Defense Productivity Investment Funding program. These funds will enable MRSA to expand the existing knowledge base and add additional modules. Over the next two years, MRSA will be adding a provisioning advisor, ILS cost advisor, transportability advisor, expanded NDI knowledge base, logistic support analysis task submodules, an LSA data element selection module, and an electronic bulletin board.

Many other modules and applications for LOGPARS have been proposed. The expert system shell is a government-developed, government-owned shell written in the PROLOG programming language and a procedural language, commonly termed C language. The shell is adaptable and can be applied to multiple domains where complex decisions are made and documentation must be produced. GEN Louis C. Wagner, former commander, AMC, presented LOGPARS to the Joint Logistics Commander's Conference in July 1989.

The Office of the Deputy Assistant Secretary of Defense (Systems), Air Force, and Navy are currently evaluating LOGPARS as an interservice program, thus standardizing ILS planning and documentation throughout DOD. MRSA has also distributed LOGPARS to the Federal Aviation Administration, the Coast Guard, and the National Aeronautics and Space Administration.

In summary, the LOGPARS expert system approach to logistics planning is a proven alternative to the complex, knowledge-intensive, time-consuming, and error-prone methods of the past. The LOGPARS program opens the door to improved, structured, and streamlined ILS planning. Knowledgeable, trained, and experienced ILS managers are a scarce commodity and we must make a commitment to programs like LOGPARS to fill the void.

Future phases will build on the existing modules to create a comprehensive ILS expert system which will provide guidance and expertise in the accomplishment of each ILS assessment area. The result will significantly decrease current deficiencies in ILS planning and actions critical to the development of effective economical, logistically supportable weapon systems.

JAY GRAVER is program manager of the Logistics Artificial Intelligence Program Office at MRSA, Lexington, KY. He holds a B.S. degree in engineering and is a master's candidate in computer science, specializing in artificial intelligence.

DRUG DELIVERY SYSTEMS FOR CHEMICAL DEFENSE

By LTC Willis H. Jacob
and CPT Karl E. Friedl

The currently fielded nerve agent antidote kit (NAAK) represents a significant step in an ongoing development of drug delivery devices.

The kit markedly increases the survival capability of soldiers on the chemical battlefield over earlier devices. Undoubtedly, the NAAK can be further refined to be more compact and easier to use while still administering appropriate combinations of drugs without undesirable drug interactions. This research effort has been sponsored by the U.S. Army Medical Materiel Development Activity (USAMMDA) in close association with the U.S. Army Medical Research Institute of Chemical Defense (USAMRICD) and other Army activities.

The advent of potent nerve agents led to the fielding of an atropine antidote by the U.S. Army after World War II. Since survival of the soldier exposed to nerve agent depends on the immediate administration of antidote, this was fielded as individual equipment, to be self-administered by the soldier or given by a fellow soldier.

To achieve the simplest and most rapid delivery of drug in the field environment, this antidote is given by intramuscular injection.

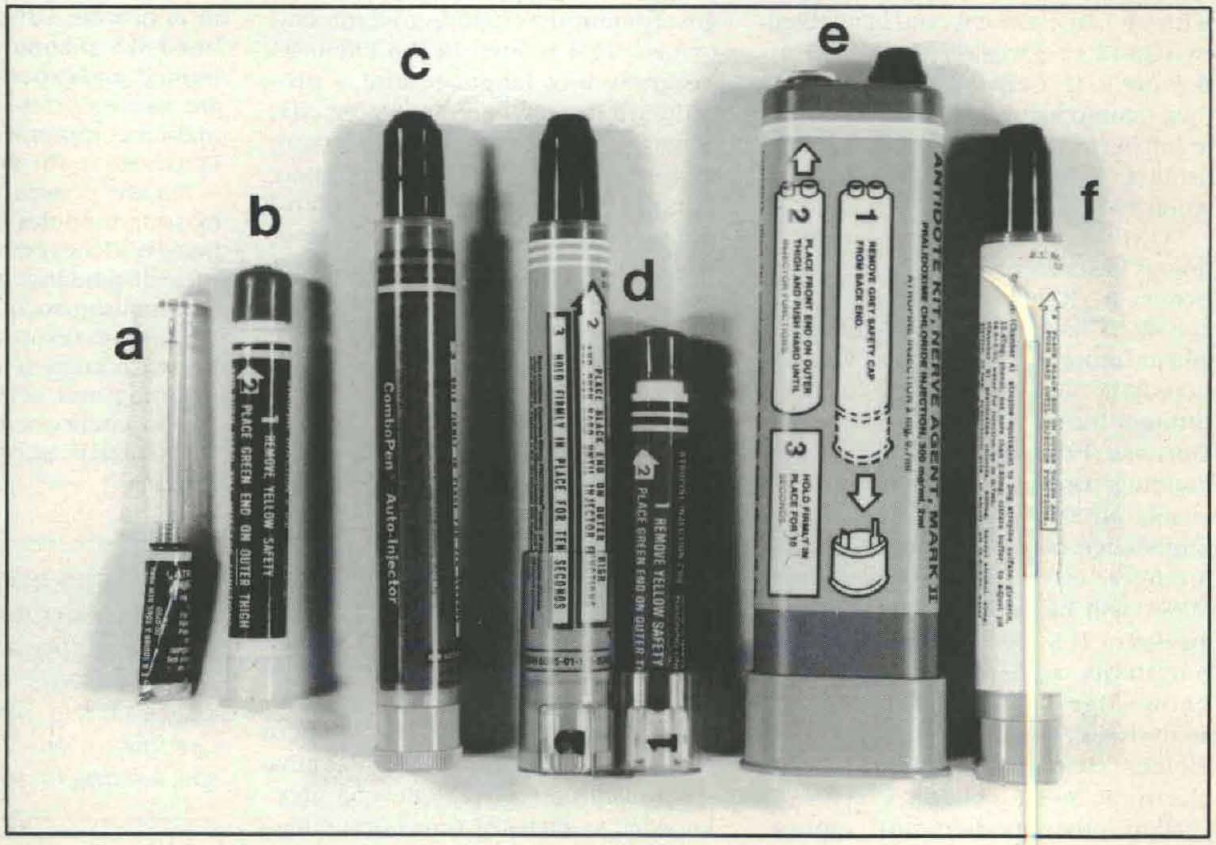


Figure 1. *Nerve agent antidote kits which have been fielded by the U.S. Army include:* **a)** *the syrette, containing atropine tartrate,* **b)** *the AtroPen, containing citrated atropine,* **c)** *the ComboPen, containing TAB, and* **d)** *the currently fielded MARK I, with AtroPen and ComboPen injectors for delivery of atropine and PAMCL. Experimental devices include:* **e)** *the MARK II device, with AtroPen and ComboPen injectors in a single housing, and* **f)** *a multichambered device containing atropine and PAMCL in separate compartments.*

The first device for intramuscular administration appeared in the form of a syrette, a miniature version of the toothpaste tube with a long needle attached (Figure 1a). This required a delicate fingertip maneuver to remove a metal plunger from the needle and then required the soldier to plunge the needle into a muscle and squeeze atropine tartrate through the needle. In the case of actual nerve agent exposure, it may be less difficult to overcome psychological barriers to plunging a needle into oneself than the problem of a diminishing manual dexterity as nerve agent symptoms develop. Either or both factors could be significant and prevent a soldier from receiving the lifesaving antidote. Thus, the appearance of the first automatic injector (autoinjector) was a major improvement in atropine delivery.

The first autoinjectors appeared in the 1950s as either nose-activated or butt-activated devices, requiring a single action to obtain a spring delivery of the needle and antidote. Such a device, with the needle resident in the atropine solution (the AtroPen), was first purchased by the Army in 1959 (Figure 1b) and eventually replaced the syrette. The AtroPen delivers the needle and the antidote into the tissues swiftly with a single convenient action and without the soldier seeing the needle. In addition, it is painless to most soldiers, and in early tests of the units, soldiers were overwhelmingly in favor of the autoinjector. Atropinization (the biological end-effects generally represented by a rise in heart rate, dry mouth, and pupil dilation) was more rapidly achieved by use of a citrated form of atropine, instead of atropine sulfate, the more familiar clinical preparation of the drug.

The AtroPen is a device which comes as close to intravenous injection as we have yet seen with intramuscular injection. The injector design produces a forcible ejection of atropine through the needle from the moment it emerges at the tip of the autoinjector, and the drug is sprayed through the tissue along the full length of the needle path. While this means that some atropine will be deposited into subcutaneous as well as intramuscular sites, this mechanism of delivery almost certainly enhances the rate of absorption by achieving the widest possible dispersion of drug. In most test subjects, the highest blood levels of atropine are achieved within the first few minutes following injection by the AtroPen. This compares favorably with intravenous administration and, on the chemical battlefield, injection directly through the chemical protective suit is the optimal approach to administering drug rapidly without further exposing the soldier to chemical agent.

The injector design produces a forcible ejection of atropine through the needle from the moment it emerges at the tip of the autoinjector, and the drug is sprayed through the tissue along the full length of the needle path.

In 1974, a larger version of autoinjector was fielded by DOD. The TAB ComboPen (Figure 1c) was filled with a mixture of TMB-4 (an oxime), atropine, and benactyzine, based on a formulation which emerged during the 1973 Arab-Israeli conflict. When the ComboPen injector is fired, the needle first fully extends into the muscle and then the drug is forcefully delivered into a deep muscle site; therefore, it does not achieve the same tissue dispersion produced by the AtroPen. This alternate design was necessitated by larger antidote volumes since the mechanism of the AtroPen does not permit delivery of greater than one milliliter volumes.

In November 1980, an Army chief of staff memorandum directed an expedited replacement of TAB with a preferred antidote composed of atropine and the only FDA approved oxime, 2-pralidoxime chloride (PAMCL). Because of the larger volume and its reactivity with metal, the PAMCL was packaged in the same injector used for the TAB mixture, the ComboPen. The atropine and PAMCL were to be injected sequentially by separate AtroPen and ComboPen injectors. For convenience, the two injectors were kept together by fixing the safety caps to a single holder. This NAAK assemblage is referred to as the MARK I device (Figure 1d).

The rationale for maintaining two separate injectors was based on studies by Dr. Frederick Sidell at USAMRICD which demonstrated that when atropine and PAMCL were combined in a single syringe, the high concentration of PAMCL slowed the atropine absorption, as gauged by a doubling of the time to maximum heart rate effect. The dual injector arrangement has the coincidental advantage that varying combinations of atropine and PAMCL can be administered, allowing some degree of variation in medical doctrine.

Shortly after the MARK I was fielded in 1983, a project was begun to produce an injector which would be easier for the soldier to use. This led to the development of a device with fewer external components and which required only a single action by the soldier to deliver antidote, the MARK II Dual Barreled Autoinjector (Figure 1e). It was anticipated that this device could be fielded in time to replace the more than 2.1 million MARK I units due to expire over several years. It also maintained a separation of the two drugs (atropine and PAMCL) with two needles emerging simultaneously but approximately 1-inch apart.

Clinical tests of the prototype device in 1985 revealed that this separation led to identical absorption rates and heart rate effects when compared to the AtroPen alone and to the MARK I. Operational tests conducted by the U.S. Army Armor and Engineer Board at Fort Knox, KY, indicated that the MARK II device was much preferred by soldiers over the MARK I, and it was easier to use correctly, especially in poor light conditions.

Test players indicated that they would be more reluctant to give themselves two separate injections as with the MARK I. However, field developmental tests conducted using 9th Infantry Division soldiers in a field exercise at Yakima Firing Center, WA, revealed a potential for the atropine barrel to escape its safety mechanism when the device was exposed to intense pounding (during driving over rough terrain). Some soldiers even refused to carry the devices for the test after

seeing the needles emerge inappropriately. It was suggested that relatively minor modifications of the injector could eliminate this problem. Ultimately, the additional complexity and higher cost of the device compared to the MARK I led to a recommendation that the MARK II not be fielded but be retained as a "backup system" for future fielding consideration or other drug antidote combinations. This conclusion was also based on newly emerging technologies, including a multichambered injector.

The advantage of one needle and one action as well as a smaller, lighter device may outweigh relative differences in atropine absorption capability.

The MARK II development was followed by an alternate approach to the problem. Although the mixing problem with atropine and PAMCL had been clearly demonstrated, the studies had been performed with manual injections using ordinary syringes. The possibility remained that with the greater force of injection of an autoinjector, the solutions might be sufficiently distributed through the tissue that the osmolarity of the solution would no longer present a problem to atropine absorption. Perhaps more importantly, differences in tissue distribution of drugs delivered by the AtroPen compared to the ComboPen suggested a means to alter atropine absorption rates with autoinjector design.

A modification of the ComboPen with an additional plunger and additional drug compartments produced a multichambered device which would inject its separated contents through one needle sequentially (Figure 1f). Clinical trials conducted at Madigan Army Medical Center using soldier subjects revealed that the multichambered device gave a slower atropine absorption rate compared to the MARK I. However, the results also highlighted the surprising rapidity of atropine absorption which followed injection by either device. Since an initial blood level of atropine which would afford a nerve agent exposed soldier some minimal therapeutic benefit has not been established, the implications of this statistical difference in absorption between the two injectors remain unknown.

The advantage of one needle and one action as well as a smaller, lighter device may outweigh relative differences in atropine absorption time, particularly if the devi es result in the same survival capability. Other points in favor of the new device may be an improved likelihood that soldiers will carry the more portable, single needle, single action injector because one needle is psychologically more palatable and its reduced size may permit storage in more accessible locations.

Other nerve agent antidote kit designs have been proposed but these present other problems. NATO allies have explored the use of other oximes but these drugs may not possess the stability of PAMCL and they lack FDA approval. Recently, the inclusion of an anticonvulsant to the atropine-PAMCL antidote has been suggested. This could be devised as another compartment of a single injector or as a separate autoinjector. Ideally, injector development will culminate with a small injector which can be used with the simplest possible action.

Autoinjector development has resulted in a significant improvement in soldier protection against nerve agent poisoning. Spinoff research has already led to several civilian medical applications and further development of drug delivery products may play an important role in sustaining warfighting capabilities on a chemical battlefield.

LTC WILLIS H. JACOB was project officer for the MARK II Dual Barrel Autoinjector and the multichambered autoinjector at the U.S. Army Medical Materiel Development Activity, Fort Detrick, MD. He is now the chief of the Anatomy and Physiology Branch, Medicine and Surgery Division at the Academy of Health Sciences, Fort Sam Houston, TX. He has a doctorate in physiology from the University of Kansas.

CPT KARL E. FRIEDL performed autoinjector studies in the Department of Clinical Investigation, Madigan Army Medical Center, Tacoma, WA. He is now assigned to the Exercise Physiology Division, U.S. Army Research Institute of Environmental Medicine, Natick, MA. He has a doctorate in physiology from the University of California at Santa Barbara.

THE NONCOMMISSIONED OFFICER AND HEAVY FORCE MODERNIZATION

By MAJ David Ifflander

Traditionally, noncommissioned officers (NCOs) have been assigned within project management offices, with the majority of these assignments to programs in the deployment phase after a new system design was well established. These NCOs found themselves working primarily in the logistics area in the fielding and training aspects of a given system.

While NCOs provided invaluable expertise stemming from their experience with soldiers, their impact was felt primarily after the system was in the field. However, it became apparent that NCOs could have a more significant impact on new systems if they became involved earlier in the materiel acquisition process.

During 1989, which was officially the year of the NCO, a timely decision was made answering the Army's need to have senior NCOs involved at critical points throughout the materiel acquisition process. Chief of Staff of the Army (CSA) GEN Carl E. Vuono made this much-needed decision to integrate senior NCOs into the Program Executive Office (PEO) for Heavy Force Modernization (HFM) six major programs.

The PEO for HFM was selected to implement the CSA's decision for more NCO involvement. This is an optimal situation because of the different systems development efforts which are just getting underway. These six programs are assigned to three activities:

- **Tank Automotive Command (TACOM):** Block III Tank, Combat Mobility Vehicle, and Future Infantry Fighting Vehicle;
- **Armament Research, Development and Engineering Center (ARDEC) of AMCCOM:** Advanced Field Artillery System and Future Armored Resupply Vehicle-Ammunition; and
- **Missile Command (MICOM):** Line of Sight — Anti-tank.

The heart of the HFM philosophy is affordable, increased warfighting capabilities. The six vehicles will be developed using two common chassis: heavy and medium protection levels. The advantages of these systems are numerous. Foremost, they are not only among the most advanced weapon systems in the Army, but also the most cost effective in terms of commonality of components, production, logistics support and MANPRINT.

The purpose of the common chassis is to maintain commonality of repair parts, tools/test equipment, and technology, to name a few. This translates into lower costs in maintaining and operating vehicles in the field. With technology growing by leaps and bounds, there was no one to translate the "boots on the ground" requirements early in the life cycle of systems development. This is where the NCO is needed. Who better to provide the input required than those responsible for the operation, maintenance and support of these systems? The answer is the senior noncommissioned officers who live in the vehicles.

Therefore, when the CSA made the decision to involve more senior NCOs within the PEO for HFM, several major commands were immediately tasked to make it happen. The commander of the Training and Doctrine Command (TRADOC) asked each school (as appropriate) to nominate an outstanding NCO to be part of the new emerging system. These names were forwarded to Sergeant Major of the Army William Gates for approval. In addition, action was taken to ensure the respective branches recognized the new requirement for NCO assignment within the materiel acquisition program.

The PEO for HFM, in concert with each of the project managers (PM), developed the initial justifications and job descriptions for each NCO, based upon the CSA's guidance. Essential elements of that guidance are:

- Each NCO will have successfully completed the Advanced Noncommissioned Officers Course and, if possible, completed the First Sergeants Course with a recent assignment in their MOS at the battalion level.
- The job description within the PM office would be individually tailored based on where that system is in the developmental effort upon the NCOs arrival.
- The NCOs would be involved in all aspects of initial development focusing particularly on MANPRINT, design influence, test planning, fielding, technical publications, and special tool/test equipment.
- Ability to coordinate with the TRADOC community and the field is a must and the NCO must be knowledgeable of the various TRADOC documents which are involved in new systems development.
- Ability to act as the PM's advisor in areas related to training, maintenance, resource management, and mission employment of the new system.

The above criteria cover a broad spectrum of what is required of the NCOs assigned to PEO/PMs. While each of these elements is important, the most critical attribute is that selected NCOs are among the most outstanding in their field.

Depending upon the acquisition strategy, new systems development is a long range effort which can take several years from program initiation through full-scale development. Therefore, the results of our NCOs' efforts may not be highly visible until the new system reaches the field. These noncommissioned officers have direct access to the PEO (a 3-star general) and his deputy for future systems (a 2-star general).

Having been nominated by the TRADOC center commanders, the NCOs represent the user, the hands on interface, and speak to the design engineers in soldier common sense language. They are heard and this frequently requires project managers to rethink the problem from an NCO user perspective. In the words of one of the NCOs selected, "This assignment is the opportunity of a lifetime; it offers us the challenge to use our experience to impact how the Army will fight in the future. We have moved into officer country, and they are listening to what we say and acting upon our recommendations."

MAJ DAVID IFFLANDER, a field artillery officer, is the assistant project officer-logistics in The Block III Tank Program at the U.S. Army Tank-Automotive Command, Warren, MI. He is a 1977 graduate of the University of Arizona (Tucson) and holds a B.S. degree in public administration.

NBC Contamination Survivability...

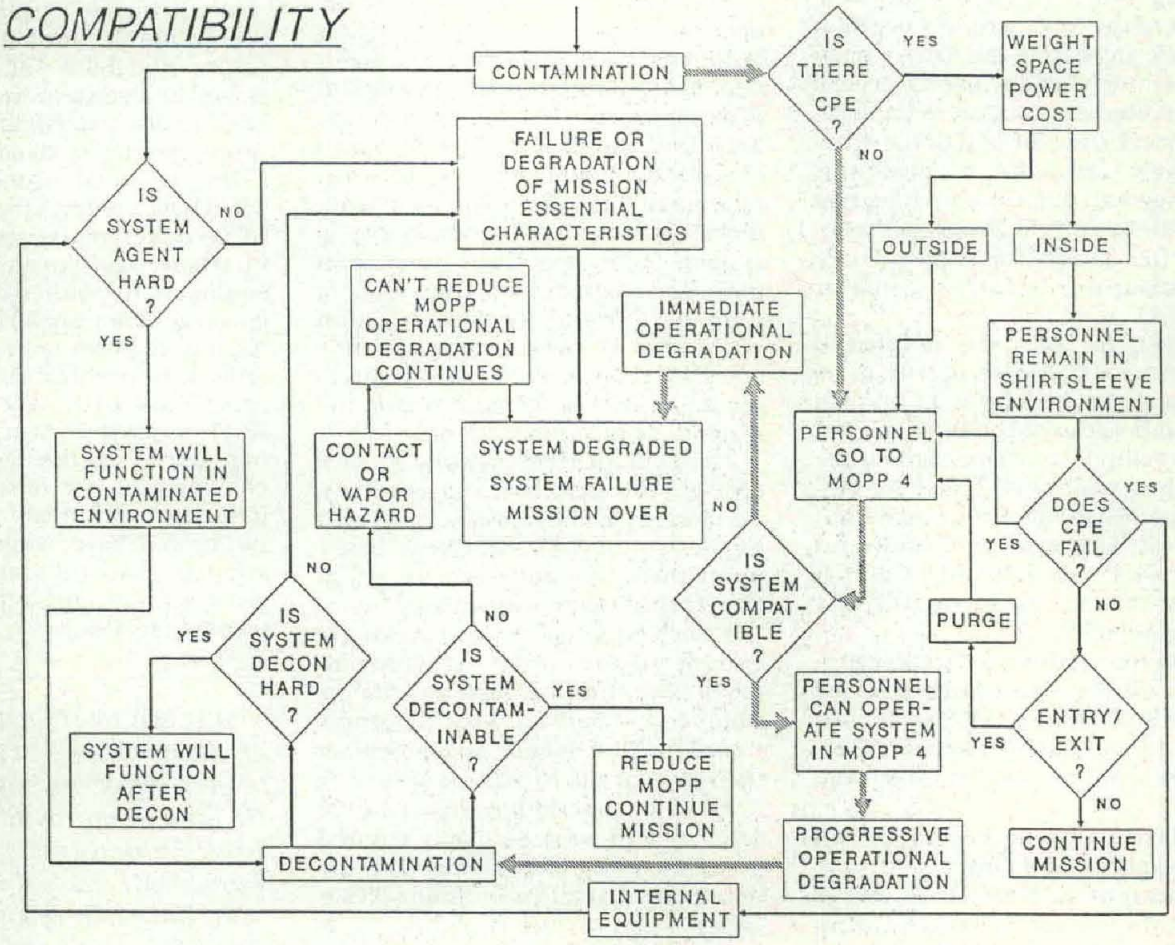
A FLOW DIAGRAM APPROACH

By Frank J. Belcastro
and
Dr. Joseph J. Feeney

Introduction

The Department of the Army published Army Regulation (AR) 70-71, entitled *Nuclear, Biological and Chemical (NBC) Contamination Survivability of Army Materiel,* in 1984. NBC contamination survivability is defined by AR 70-71 as the capability of a system and its crew to withstand an NBC-contaminated environment, including decontamination, without losing the ability to accomplish its mission. Characteristics of NBC contamination survivability are decontaminability, hardness (against agents and decontaminants), and compatibility of the NBC-protected man with his equipment. These characteristics are based on engineering design criteria which are intended for use only in a developmental setting.

Figure 1.



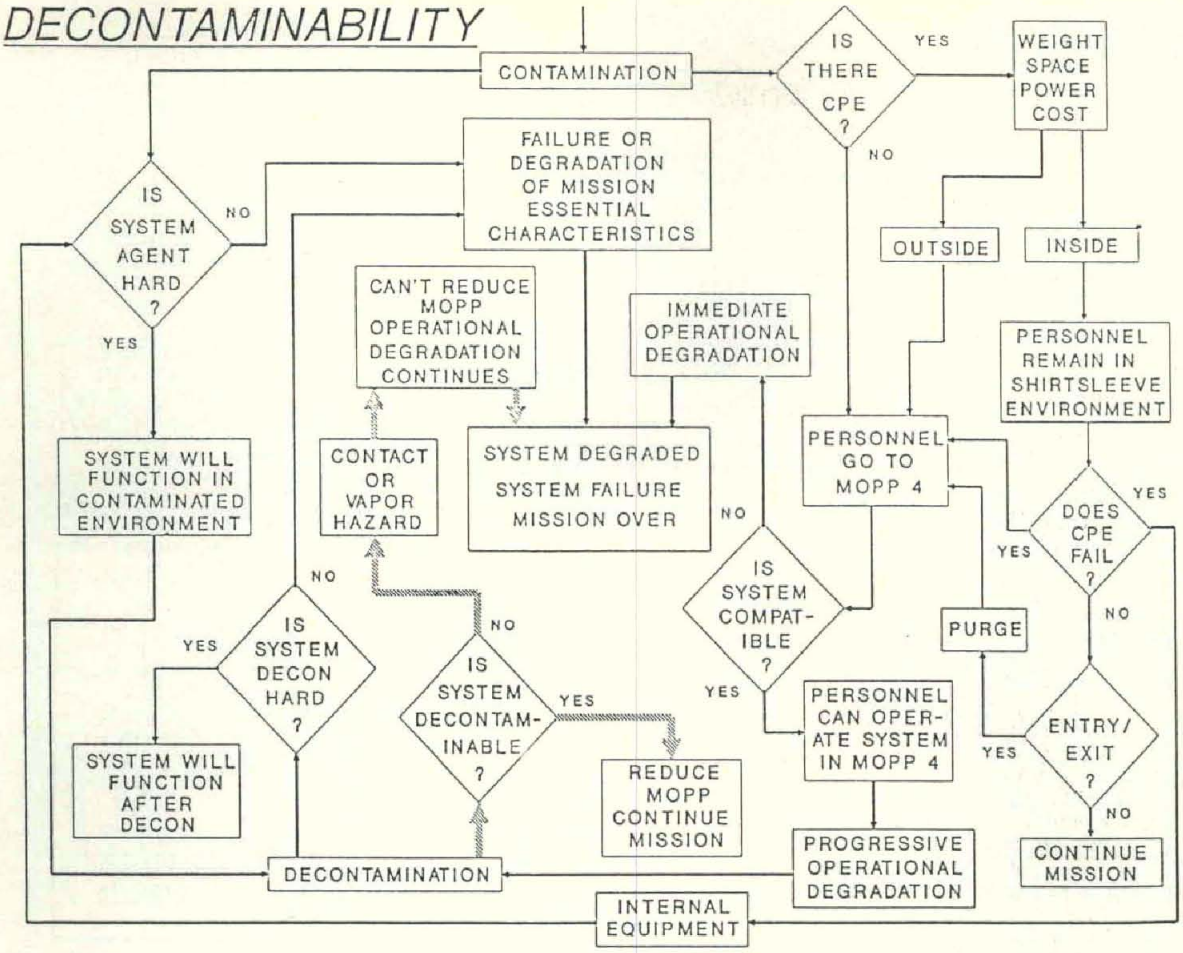


Figure 2.

AR 70-71 establishes Army-wide policies and procedures to insure that survivability measures are considered early in the acquisition cycle of mission-essential equipment and that these measures are maintained throughout the development and procurement of the system. Three specific problems, encountered when conducting operations in an NBC-contaminated environment, are addressed by AR 70-71:

- Performance degradation caused by interfacing of personnel dressed in the NBC protective ensemble and the equipment they must operate;
- Hazards to personnel from residual NBC contamination; and
- Performance degradation of equipment caused by exposure to NBC contaminants and decontaminants.

To further define AR 70-71, the Army has published approved quantitative NBC contamination survivability criteria for mission-essential materiel to address each of these problems.

This article provides a basic understanding of the NBC contamination survivability criteria. These criteria are presented in a flow diagram format stressing the importance of each individual criterion, as well as their interrelationships.

Flow Diagrams

Figures 1, 2 and 3 show schematic representations of the three characteristics of NBC contamination survivability — compatibility, decontaminability, and hardness — and their potential impact on a system. Additionally, because of its possible use in addressing compatibility, the integration of collective protection into a system has been incorporated into the flow diagram. Each characteristic is highlighted by a dashed line to stress the applicable portion of the diagram.

Beginning with the system being contaminated, the flow diagram follows several routes with intermediate decision points along the way. Depending upon the "yes" or "no" responses given, the end point will either be that the system will continue to function and be operable on the NBC-contaminated battlefield, or the system, and possibly the mission, will be seriously degraded or fail completely.

Compatibility

Compatibility is the capability of the equipment to be operated, maintained, and resupplied by personnel wearing the full NBC protective ensemble.

With the increasing number of countries reportedly possessing an NBC weapons capability, the potential for use of these weapons has also expanded. These weapons can be used in wartime for two purposes:

- To cause immediate mission degradation by killing or incapacitating military personnel; and
- To cause mission degradation, with immediate and long-term consequences, by forcing military personnel to perform their mission functions while wearing the full NBC protective ensemble.

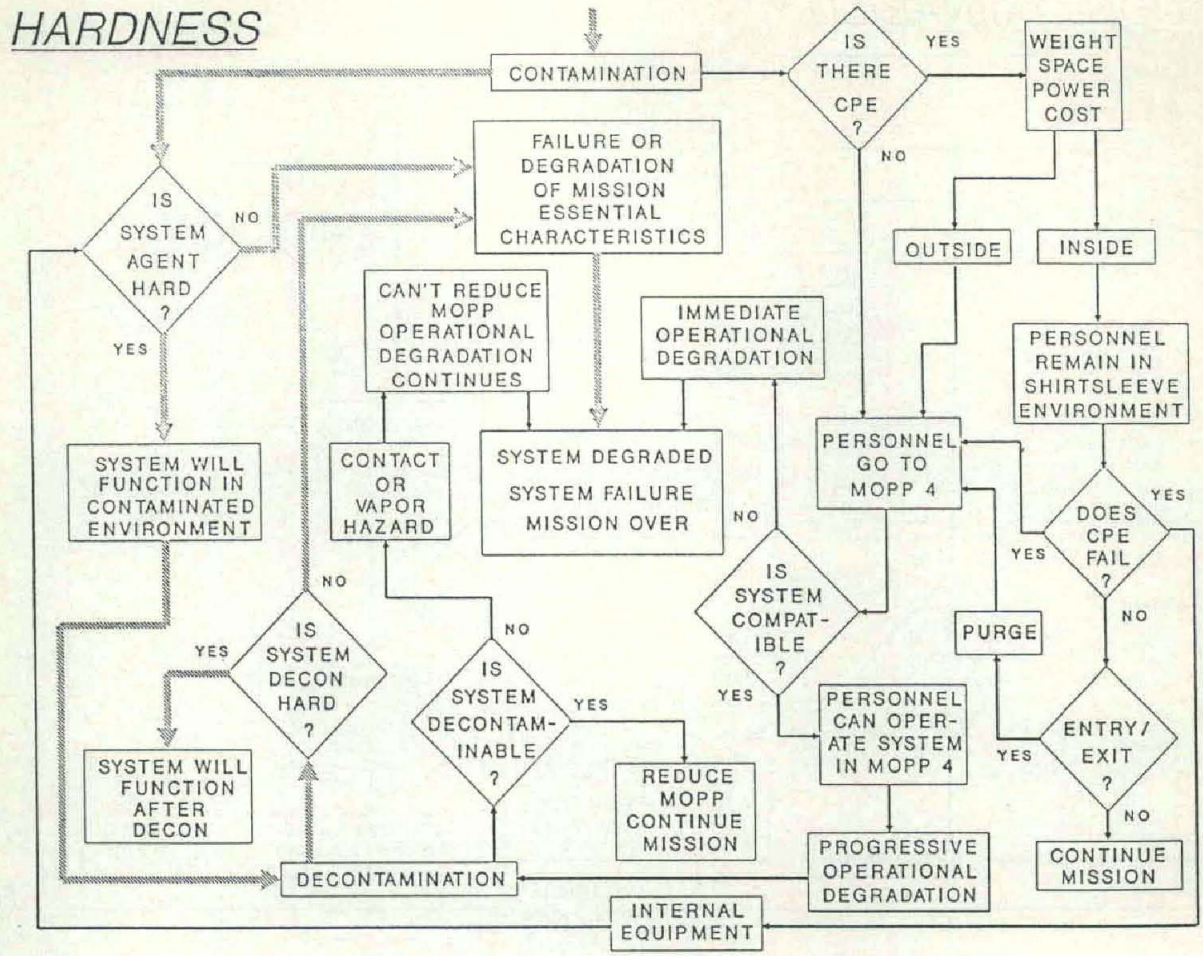


Figure 3.

Use of the NBC protective ensemble minimizes the killing or incapacitation of military personnel, enabling them to continue their wartime mission; however, its encumbering aspects are the principal factors responsible for degrading mission readiness and effectiveness. The NBC protective ensemble is very burdensome and can restrict the soldier's vision, hearing, dexterity, coordination, etc.

Although efforts continue to improve the NBC protective ensemble, certain technological limitations will always remain. Therefore, unless the NBC-protected man-equipment interface is recognized and equipment is designed to be operated by soldiers wearing the NBC protective ensemble, there will certainly be an immediate and/or progressive operational degradation when the soldier's mission requires him to operate his unit's equipment while dressed in the full NBC protective ensemble. This interface is the problem that the compatibility criterion aims to rectify.

Figure 1 represents the compatibility portion of the flow diagram. Assuming that the soldiers are not in a collectively protected enclosure when the battlefield becomes contaminated — the collective protection issue will be addressed separately — they will either don their NBC protective ensemble, or upgrade their protection level to Mission Oriented Protective Posture 4 (MOPP 4), the maximum level to which soldiers can be protected.

If a soldier in MOPP 4 cannot effectively interface with his equipment in order to perform his mission-essential tasks, then an immediate degradation of operational capability results. The soldier in MOPP 4 will either be unable to perform his mission-essential tasks or he will become physically exhausted more quickly because he has to expend a greater amount of energy in trying to perform these tasks. This performance degradation can result in system and/or mission failure.

The solution to this NBC-protected man-equipment interface is to incorporate into the human engineering development of equipment those designs that will enable the soldier dressed in MOPP 4 to successfully perform his assigned mission-essential tasks. In an NBC-contaminated environment, activities requiring manual dexterity or visual acuity, such as operation of equipment control knobs, equipment maintenance, etc., must be capable of being accomplished by a soldier wearing mask and gloves. Equipment designs to eliminate sharp corners and edges that may damage the individual soldier's protective overgarment and/or gloves must also be incorporated into equipment development.

If equipment is developed to be compatible with the NBC-protected soldier, then the soldier should be capable of operating and maintaining his equipment, thus enabling the soldier to perform his mission-essential

Collective protection is an integral part of the protection efforts used against NBC contaminants.

tasks effectively in an NBC-contaminated environment. However, if the soldier is required to remain in his full NBC protective ensemble for prolonged periods of time, a progressive degradation of the soldier's operational performance results, produced by the physical, psychological and heat stress burdens associated with extended wearing of the ensemble. Therefore, it is essential that the amount of NBC contamination be reduced to a degree that permits removal of the NBC protective ensemble altogether or, at least, a lowering of the MOPP level required for adequate protection.

Decontaminability

Decontaminability is the capability of a system to be decontaminated to reduce the hazard to personnel operating, maintaining, and resupplying it. Decontamination may be desirable for several reasons:

- To prevent unprotected personnel from being exposed to NBC contamination and becomming a casualty;
- To reduce the spread of NBC contamination; and
- To lower the MOPP level required for protection of personnel, thus reducing the soldier's performance degradation caused by extended periods in the NBC protective ensemble.

Figure 2 highlights the decontaminability portion of the flow diagram. If a system is decontaminable, the soldier will be able to lower his MOPP level and should be able to continue his mission with minimum performance degradation. However, if the system cannot be decontaminated down to a level that poses a negligible risk to unprotected personnel, residual vapor and/or contact hazards will remain. These hazards, which can be caused by contaminants either becoming entrapped in cracks, crevices, and other collection points on the equipment or becoming sorbed into paints, coatings, and other materials on the equipment, will not permit a reduction in the level of MOPP. If the system is not decontaminable, then these hazards will result in soldiers having to conduct mission operations for extended periods of time while in MOPP 4, thus degrading operational performance.

Having equipment that is decontaminable is essential for minimizing degradation of performance and enhancing equipment sustainability in an NBC-contaminated environment. Decontaminability can be addressed by incorporating into a system the appropriate materials, paints, and coatings that are minimally affected by contaminants and decontaminants, and by engineering into a system the necessary design configurations that minimize collection points for contaminants and decontaminants.

Hardness

Hardness is the capability of a system to withstand the damaging effects of NBC contaminants, decontaminants, and procedures required to carry out the decontamination process.

Considerable test data exist that demonstrate degradation of material properties resulting from exposure to NBC contaminants and/or decontaminants. Material properties, mechanical (tensile strength, elasticity, etc.), electrical (resistivity, conductivity, etc.), optical (transmissivity, resolution, etc.), and chemical (permeability, diffusion rate, etc.), can be affected by NBC contaminants and/or decontaminants. The impact resulting from degradation of any of these properties could result in the malfunctioning of a critical equipment component, causing system and/or mission failure.

Figure 3 highlights the hardness portion of the flow diagram. If a system's critical characteristics are not affected by exposure to NBC contaminants and/or decontaminants, then the system will function properly on the NBC-contaminated battlefield. However, if the system's critical characteristics are affected, degradation of the system's operational performance will occur, with system and/or mission failure possible.

The hardness criterion is very crucial in the development of equipment since it is concerned with the condition of mission-essential equipment after it has been subjected to a harsh environment — NBC contaminants and their decontaminants. Having equipment that is hardened against NBC contaminants and decontaminants is required for minimizing degradation of the operational performance and enhancing equipment survivability on the NBC-contaminated battlefield.

Collective Protection Enclosures (CPE)

Collective protection (CP) is an integral part of the protection efforts used against NBC contaminants. It is an enclosure, e.g., a shelter, vehicle, or van, with filtered air, that provides a contamination-free working environment for selected personnel. Collective protection essentially allows the soldier, when enclosed in a CP shelter or vehicle, to perform his mission-essential tasks without having to wear the full NBC protective ensemble. Collective protection is utilized in such facilities as command posts and communications centers, rest and relief stations, etc.

The supporting criteria for AR 70-71 indicate that CP enhances compatibility but it does not provide compatibility. However, the combat developer may elect to substitute CP to address the compatibility requirements of AR 70-71. In doing so, the combat developer accepts the risk of possible crew performance degradation should NBC contamination enter the CP facility, thereby forcing the crew to wear the full NBC protective ensemble.

The misperception that arises when CP is substituted into a system is that the system fully meets all of the NBC contamination survivability requirements of AR 70-71; not only for compatibility, but for decontaminability and hardness as well. This is not the

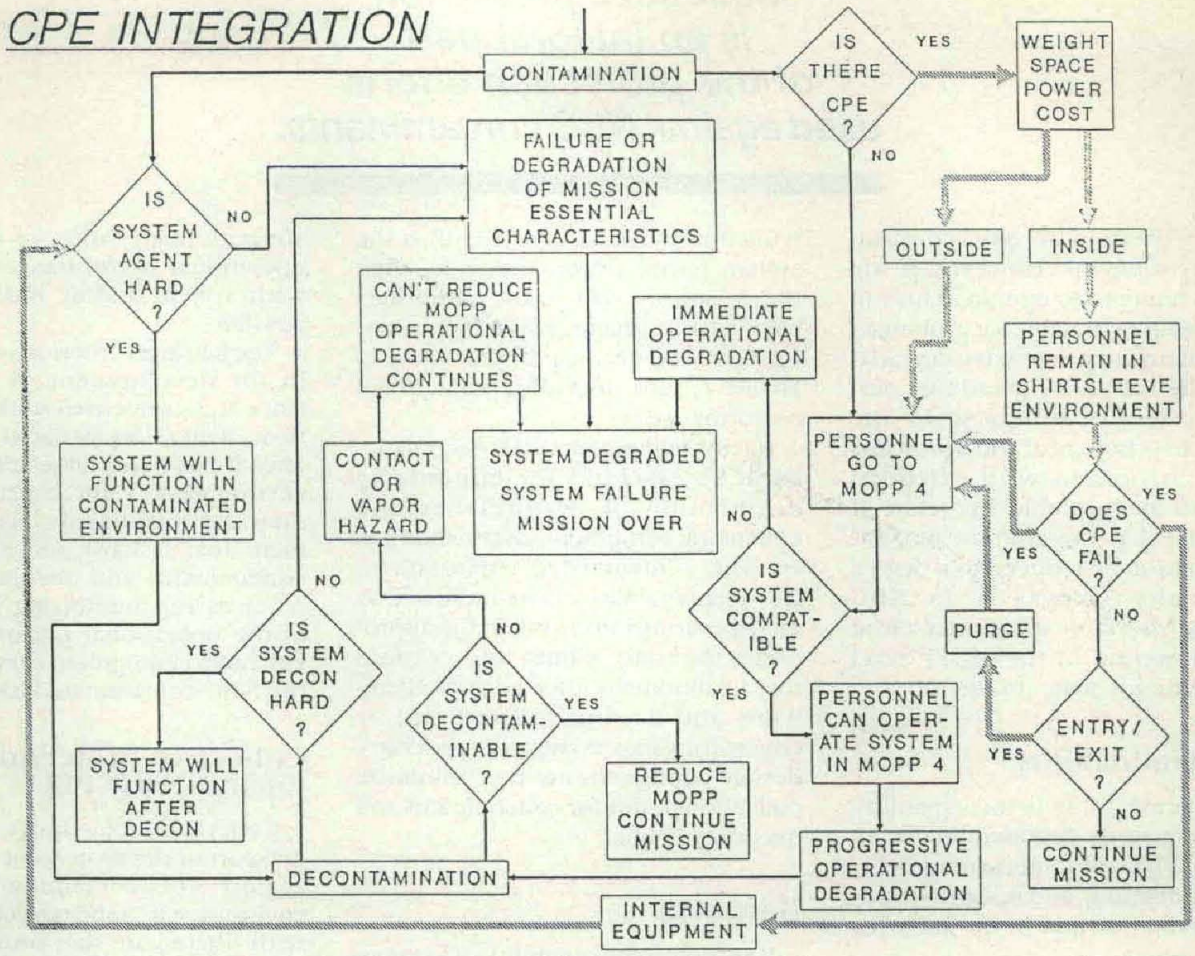


Figure 4.

P to a system only addresses the compatibility criterion. Both the decontaminability and hardness criteria are addressed through incorporation of appropriate designs and materials, not solely by adding CP to the system.

Figure 4 highlights the CPE portion of the flow diagram. If CP is integrated into a system, weight, space, power and cost factors must be considered and traded-off in the overall development of the system. Those mission-essential functions of the system that must be performed outside of CP must meet the compatibility criterion.

If CP is incorporated into a system and the system operated without any problems, the AR 70-71 decontaminability and hardness criteria for the system still must be addressed. Nevertheless, for normal operation of CP within a system, contamination of interior spaces of CP facilities can still result from entry into and/or exit from the NBC-contaminated battlefield. This would require soldiers to wear the full NBC protective ensemble inside the CP facility until it has been purged and contamination levels in the interior spaces are reduced to acceptable limits.

Failure of CP within the system would result in soldiers having to perform their mission-essential tasks in the full NBC protective ensemble. However, if that portion of the system that was within CP cannot be interfaced with NBC-protected personnel (compatibility criterion), an immediate degradation of operational performance would result. Additionally, if the CP within the system fails and the equipment within the interior spaces becomes contaminated, degradation of operational performance will result. This situation then reverts back to the decontaminability and hardness criteria.

Summary

The flow diagrams address the three NBC contamination survivability criteria as defined by AR 70-71. Incorporation of materials and designs are needed to address these criteria. Additionally, the integration of CP into a system has also been incorporated into the flow diagram in order to remove an existing misperception that adding CP to a system satisfies AR 70-71.

FRANK J. BELCASTRO served in the NBC Survivability Office, U.S. Army Chemical RD&E Center (CRDEC) from May 1985 to January 1989. Currently, he is AntiTerrorism Programs team leader, Technical Integration Division, Munitions Directorate, CRDEC. He has a B.S. in mechanical engineering from the University of Maryland.

DR. JOSEPH J. FEENEY served in the NBC Survivability Office, CRDEC from September 1985 to June 1989. Currently, he is a chemist in the Vulnerability/Lethality Assessment Management Office, U.S. Army Laboratory Command. He has a Ph.D. in chemistry from the University of Pittsburgh.

APPLYING THE STANDARDS FOR INTERNAL MANAGEMENT CONTROLS

By Thomas J. Nicholas

Background

The Federal Managers' Financial Integrity Act of 1982 mandated requirements for strengthening internal management controls throughout the agencies of the federal government. The Integrity Act tasked the president's Office of Management and Budget (OMB) with the responsibility of developing implementing guidelines and regulations to assist agencies in evaluating and improving their systems of internal management controls. Accordingly, OMB Circular A-123 prescribes the policies and methodology for evaluating the adequacy of controls. This methodology is most frequently referred to as the "OMB guidelines." The circular also establishes the format and input for the Annual Statement of Assurance (annual report) to the president and Congress, which the law requires of every agency head.

When last revised in 1986, A-123 incorporated the recommendations of the President's Council on Management Improvement and introduced the 5-Year Management Control Plan (MCP). This is the primary vehicle for agencies to identify their assessable unit (subtasks) inventory and schedule evaluations at appropriate levels of management over a 5-year period. In the Army, these assessable unit evaluations are accomplished using DA standard internal control review checklists which are based upon OMB guidelines. The checklists provide day-to-day guidance on essential management controls and are applied "formally" one or more times in a 5-year period as scheduled by the MCP.

Both the checklists and the MCP normally are published in DA 11-series circulars. The complete Army Internal Control Program (AICP), including total implementation of A-123, is found in AR-11-2, Internal Control Systems, dated Dec. 4, 1987.

Congress Sets Standards

When the Congress passed the Integrity Act, they intended to achieve the needed strengthening of management controls by reasserting the responsibility of civilian and military managers at all levels for overall integrity of programs under their supervision. To accomplish that goal, the act directed the comptroller general to prescribe standards to be applied in defining and evaluating the minimum level of quality acceptable for an organization's internal control structure. A short time later, the General Accounting Office (GAO) published "Standards for Internal Controls in the Federal Government." The document presents 12 internal control standards to be applied in the daily performance of all government operations for maximizing management confidence that: actions are in compliance with applicable laws and regulations; funds, property and other assets are safeguarded; financial and statistical information is reliable and item accountability is maintained; and operations are efficient and effective. In effect, the "GAO standards" are each manager's professional standards for ensuring adequate performance as a manager — every day.

There are three objectives in "applying" the GAO standards: devising, implementing and sustaining sound management controls for every Army operation. As stipulated in AR-11-2, every Army manager is responsible for applying the standards in day-to-day operations. In addition, for each Army subtask (identified in Army's MCP) the standards are applied by the HQDA Functional Proponents who identify the subtask's minimum essential requirements, and "devise" management control techniques for ensuring the requirements are accomplished. These details on requirements and management controls are components of the internal management control review documentation process and are published in the DA checklists mentioned above.

Upon receipt by Army-wide operating managers responsible for accomplishing the subtasks, the checklists are used to "implement" the defined control techniques. Equally important, the checklists facilitate the operating manager's responsibility for "sustaining" the defined control techniques commensurate with GAO standards — through day-to-day consideration and, to comply with the Integrity Act, formally not more often than once every two years as scheduled by the MCP.

It's this "formal" periodic use that causes some consternation because compliance also requires documentation demonstrating that the responsible manager actually "verified" the minimum essential management controls are in place and working. This is not an arbitrary burden laid on Army managers, but is vital to Army's ability to certify compliance with the explicit requirements of the OMB guidelines and GAO standards implementing the Integrity Act.

Concerted application of the GAO standards is absolutely essential for sound management control. Because of their importance, all 12 standards have been fully adopted for implementation throughout the Army. They are published in their entirety in AR 11-2, Chapter 2. The AR also states: "Commanders and managers at all levels... will ensure adherence to the Army (GAO) standards."

The 12 standards comprise five general, six specific, and an audit resolution standard. These standards are very broad, and professional managers must exercise judgement in determining whether they are meeting the standards in their operating environments. A working knowledge of the standards coupled with the understanding of how Congress intended for federal managers to apply them is essential to the continued maintenance of good management control systems.

Statement of the Standards

The five general internal control standards apply to all aspects of management controls.

- Internal controls are to provide reasonable assurance that management's objectives will be accomplished.
- Managers and employees are to maintain and demonstrate positive and supportive attitudes toward internal controls at all times.
- Managers and employees are to have personal and professional integrity and maintain a level of competence that allows them to accomplish their assigned duties, as well as understand the importance of developing and implementing good internal management controls.
- Internal control objectives are to be developed for each agency activity and are to be logical, applicable, and reasonably complete.
- Internal control techniques are to be effective and efficient in accomplishing internal control objectives.

A number of specific internal control techniques can be used to provide assurance that the general internal control standards are achieved. These six specific internal control standards classify the wide variety of different techniques that may be used to achieve control objectives. In abbreviated form, the six standards require that:

- Transactions and other significant events must be documented.
- Transactions and other significant events must be recorded promptly.
- Transactions and other significant events must be authorized and executed by persons acting within their authority.
- Key duties must be separated among individuals.
- Qualified and continuous supervision must be provided to ensure that internal control objectives are achieved.
- Access to resources and records must be limited and accountability for custody must be assigned with periodic comparisons of the resources with the recorded accountability.

The Audit Resolution Standard requires that managers promptly evaluate and take action on findings and recommendations reported by auditors.

The practical benefit of the standards to every manager is evident in analyzing the first Comptroller General/GAO Standard. For example, "Reasonable Assurance" acknowledges that 100 percent reliability of management controls generally is not a practical target — and that the cost of specific controls generally should be commensurate with benefits derived from the controls. Commanders and managers at all levels should apply this standard in formally identifying the circumstances constituting "acceptable performance" in matters such as the accuracy of stock locator records, recorded inventory balances, days for processing transactions, the percentage of managers who must have internal control responsibilities in performance agreements at any point in time, and all other measurable events which likely will always involve less than perfect accomplishment.

Defining the acceptable percentage or range will not only facilitate better monitoring and response by top managers, but also will ensure that auditors and inspectors measure success against the reality of performance capabilities. These will change as resources are withdrawn, reduced or stretched out — and the acceptable performance factors should be revised accordingly.

As pertains to the cost benefit considerations called for by the standard, application should include periodic review of every regulation (at every organization issuing regulations) to identify "requirements" that can be terminated.

Every "regulatory requirement" imposes accountable compliance on each manager, costs resources for compliance, and necessitates audit-type coverage. Similar considerations should be involved before adding any new regulatory requirements, and those proposing the incremental requirements should be tasked to demonstrate their determinations about related costs and benefits. Auditors and inspectors share this responsibility in presenting recommendations, and recipient managers should not be reluctant to call for the cost-benefit details justifying applicable recommendations.

The bottom line is that application of the standard can help everyone do a better job and benefit Army operations. For more details on the reasonable assurance and the other 11 standards, contact your internal control administrator or, through the administrator network, the Army Internal Control Office.

Conclusion

Managers who understand the standards of internal management control, and who ensure that their control systems meet these standards, are proving their accountability to the chain of command and the public they serve. Remember the ultimate responsibility for good internal management controls rests with management.

Internal management controls should not be viewed as separate, specialized systems. Rather, they are an integral part of each system or structure that Army management uses to regulate and guide its operations — and get the day-to-day jobs done effectively and economically. Ensuring that controls within each command or organization are in accordance with the standards is the basic Integrity Act responsibility of every Army manager.

THOMAS J. NICHOLAS is deputy for training and assistance to the director of the Army Internal Control Program. He holds a B.B.A. in accounting from Loyola University (Chicago) and an M.S.B.A. from Boston University.

ELEMENTS OF TOTAL QUALITY MANAGEMENT

Editor's Note: The following is an excerpt from a paper written by Thomas R. Stuelpnagel, entitled "World Class Management for Defense." Stuelpnagel is an advisor to industry, government and academia, and former president and CEO of Hughes Helicopters, (now McDonnell Douglas Helicopters). He was stimulated to write this article following his participation in the first Government/Industry TQM Workshop held in Alexandria, VA, on June 29, 1989, hosted by Darold L. Griffin, deputy chief of staff for production, Army Materiel Command. This article discusses the elements and implementation of total quality management as the generally recognized world class management process that is triggering a second industrial revolution. Its principles are universal.

Macro Approach to TQM

A practical way to get committed to TQM and to expedite its adoption in a company is to lay it out end-to-end and then focus first on the 'macro' elements which need to be in place to make it work as a system.

It's true that TQM can be started at any level, but it's more likely to succeed if each higher level understands the process, is committed to it and has put its own house in TQM order.

Attention to the principles of TQM and its 'macro' elements can produce important gains in a short time. The 'macro' elements listed below are an example of this approach and are offered as a road map to top management in both government and industry:

- **Knowledge.** Dr. Deming is the acknowledged expert. An excellent starting point is to read his book *Out of the Crisis*, and debate his 14 points against the existing company culture and procedure.
- **Commitment.** Attendance at a four-day Deming Seminar can be a religious-like experience, helpful in acquiring the commitment and zeal needed to lead an organization in TQM. It can be the most important four days in the company's future!
- **Leadership.** TQM leadership is essential at the top. The CEO must be a believer. Additionally, a statistically oriented TQM promoter, reporting to the CEO, is needed to help implement the process at all levels of the organization — preferably on a full-time basis.
- **Policy.** A company policy related to TQM is helpful and should be distributed to all employees. Ford Motor Co., a leader in TQM, has a policy and a system description that contains about 300 words and is published on two 3 x 5 cards.
- **Statistical Thinking.** Top management control charts and reports are the starting point to set the example in statistical thinking for the company.
- **Program Offices.** Program offices should function as model parallel organizations with profit and loss delegation from the CEO and resources on board to statistically control the program.
- **Program Meetings.** Program meetings are key places to set the TQM example. The challenge is to operate them and the program with four sigma efficiency before expecting the rest of the organization to act accordingly.
- **Procurement.** Conversion of the company to the 'single supplier' approach used in TQM will usually require a change in the procurement policy and special training of procurement managers and suppliers. The objective is to award contracts on the basis of "best value" with long term intention, commitment to continuous improvement and continuous cost reduction, visibility to avoid surprise and full responsibility for the product quality including the elimination of receiving inspections.
- **Delegation.** Deeper delegation of responsibility is the goal for all interfaces and levels in the company. Statistical visibility is used to control the delegated work and avoid surprises. Regulations, inspection, checking and

multiple sign-offs are progressively reduced.

• **Pilot Programs.** Statistical control of management, production, and procurement processes are best started with pilot programs. These programs are expanded in complexity and number as success is achieved.

• **Humanistic Principles.** The humanistic principles involved in the TQM culture are challenging to implement. A starting point is to compare the principles proposed by Deming with the existing culture of the organization, including its procedures, union agreements, accommodation of U.S. laws, etc. Innovative ways are needed to implement the TQM culture.

• **Organization.** In orienting the company to TQM, it is helpful to chart the complete company on one sheet of paper. The purpose is to relate the present organization structure with the more horizontal TQM structure having spans of control of 20, 40 and more at each manager interface.

• **Critical Mass.** Believers are needed at all levels within the organization to propagate the TQM process. Deming suggests that the "critical mass" required for self propagation may be the square root of all the people in the organization.

• **TQM Index.** Use of an index is helpful for measurement of TQM progress. At the start, the index should be based on the activity underway rather than on the results. The objective is to educate and train people in TQM first, and then improve the company's processes later. The temptation to select the toughest company problems for pilot projects should be avoided to minimize the risk of failure and discouragement in the TQM process.

• **Listen Harder.** The technique of listening harder is a TQM cultural step that can be started immediately. Ford, for example, attributes its popular aerodynamic automobile styling to listening harder to its designers — from the highest level.

• **World Class Solutions.** Products can be analyzed by their elements in a search for world class solutions. The use of the more sophisticated TQM techniques, such as Quality Function Deployment, is not required to make major improvements.

• **Model TQM Organizations.** The study of other companies who are already well along with TQM, including Japanese, will provide insight.

• **TQM Technology.** Eventually, in-depth training and pilot projects will be needed in the TQM technologies such as: Taguchi's robust design concepts, design of experiments and the quality loss function for integrating the dollar aspects of quality improvement into budgets and programs; and quality function deployment for integrating the customer into the product cycle. These technologies will take years of practice to apply wisely.

• **Defense Science Board/ Willoughby.** Application of the Defense Science Board/Willoughby principles are important as the road map for TQM through the existing defense acquisition procedures. These procedures cannot be expected to change quickly or radically — nor do they have to change to make TQM effective.

• **University Participation.** Encouragement and assistance to universities is needed to obtain their participation and commitment to TQM. Every university class in engineering and business that graduates with TQM training will advance our country's competitive position and will not have to be retrained later.

• **Total Employee Participation.** Last but certainly not least, is the need to communicate with and educate all employees in the principles and technology of TQM. In this regard, what is done is more important than what is said. Since the change is forever, continuity and persistence are more important than early results. The need is to demonstrate — not just say — that TQM will be a benefit and not a burden to each individual.

It must also be communicated that the employee-company relationship under TQM will be a two way street. All employees must be willing to take the time and make the effort to learn new skills and to be adaptable. TQM will not be free. Sustained job related training and educational support in company time and money will be an ongoing need in equipping all employees for TQM.

Work team organization, participation in decisions and team rewards for success will further expand the TQM team relationship. The opportunity to work for ownership in the company or a share in the gains will be proof of the company's sincerity in TQM. However, the most important benefits will be the employee's greater pride and feeling of accomplishment when working in the TQM environment.

TQM is the competitive edge.

Work team organization, participation in decisions and team rewards for success will further expand the TQM team relationship.

HUMAN USE COMMITTEES IN ARMY RESEARCH AND TESTING

By LTC Gregory P. Berezuk
and Chuck Dasey

All research and development of products designed to improve the survivability of a soldier on the battlefield starts pretty much the same way. The need for enhanced offensive or defensive protection against a known threat is perceived and the appropriate Army research and development activity is tasked to develop the necessary item. The item may be a vaccine to protect the soldier from a bacterial enemy which cannot be seen, or a rifle to provide improved protection from a more visible enemy. In either case, there comes some point in time when the new product must be proved safe for use by soldiers. At this point, the many sensitive issues involved in the use of human beings as test or research subjects must be addressed.

Normally associated with clinical medical research such as experimental use of new drugs, ethical human use policies also apply to human subjects in all Army and Army-sponsored research, development, testing and evaluation (RDTE). A new Army regulation, AR 70-25, *Use of Volunteers as Subjects of Research,* incorporates into Army policy the existing military human use guidelines. The Army surgeon general is the proponent for the regulation and the Surgeon General's Human Use Review and Regulatory Affairs Office (HURRAO) is the primary action office and point of contact for information.

Much of what we recognize and accept today as the basic precepts of ethical treatment of human research subjects had its origin in a military tribunal. The war crimes trials held at Nuremberg West Germany after World War II revealed the horrors perpetrated by Nazi doctors on concentration camp internees. As a result of these revelations, a document now known as the Nuremberg Code was written to detail ". . .certain basic principles that must be observed in order to satisfy moral, ethical and legal concepts [in the use of human subjects]."

Subsequent to the publication of the Nuremberg Code, worldwide attention was focused on the issue of ethical treatment of research volunteers. This attention resulted in the Declaration of Helsinki which is now considered, by most nations, to be the minimum standard for assuring the protection of the rights and welfare of research volunteers. Among the principles set forth in Helsinki in 1964, and amended by the World Medical Assembly in Tokyo in 1975 were:

- Concern for the interests of the subject must always prevail over the interests of science and society.
- Each subject must be adequately informed of the aims, methods, anticipated benefits and potential hazards and discomforts the study may entail.
- Each subject is free to withdraw his or her consent to participation at any time.
- Hazards must be predictable, and the potential benefits must outweigh the hazards.

The next significant event for the Department of Defense in the evolution of human use concerns occurred on Jan. 7, 1983 with the publication of DOD Directive 3216.2. The stated purpose of this directive was to ". . .establish policies, assign responsibility and specify authority for protecting the rights and welfare of humans as subjects of study in DOD supported RDTE and clinical investigation activities." The language of this directive was later incorporated into the code of federal regulations at Title 32 part 219. This regulation applies to the Office of the Secretary of Defense, the heads of all military departments, the Joint Chiefs of Staff and Unified and Specified Commands.

In addition to addressing clinical investigations of drugs, vaccines and medical devices, the provisions of the DOD directive and the subsequent federal regulation encompass the "inclusion of human subjects whether as the direct object of research or the indirect object of research involving more than minimal risk in the development and testing of military weapon systems, vehicles, aircraft and other materiel. The determination of whether the protocol involves more than minimal risk shall be made by review committees. . ."

The recently published revision of AR 70-25 incorporates the elements of the DOD directive, the federal regulation and various other laws, regulations and directives into a single document. This revised regulation provides both general and procedural guidance. It retains the functions of the surgeon general, which include maintaining the Human Subjects Research Review Board (HSRRB) and the HURRAO. The HSRRB, chaired by the assistant surgeon general for R&D, meets regularly to review and approve or disapprove research protocols which employ human subjects.

The new element of AR 70-25 is that commanders of major Army commands that conduct RDTE are encouraged to establish their own human use committees. Commanders may, however, use the HSRRB in lieu of establishing their own human use

committees. The only advantage to using the HSRRB is that it would save the time and effort needed to establish a human use committee. Referring test plans or protocols to the HSRRB may, therefore, be a feasible alternative for organizations which conduct research or testing infrequently.

One disadvantage of using the HSRRB is the time delay which would accompany the coordination of a review with any organization outside the organization conducting the research or testing. A more important disadvantage is that the HSRRB is primarily made up of people with backgrounds in the medical and health sciences. Such a group is poorly equipped to accurately assess the level of risk presented by the operation of a new weapon system, vehicle or aircraft. For such an assessment one would want a review done by a board primarily made up of people who have experience with the type of equipment being tested and the conditions under which the test will be conducted.

The establishment of a human use committee starts with the preparation of written procedures and directives governing the conduct of the committee. The HURRAO can provide copies of such directives from other activities and any other assistance which might be needed in developing these written procedures. The written procedures along with the curricula vitae of the committee members is then forwarded to the HURRAO.

The human use committee must consist of at least five members who are full time federal employees and of diverse backgrounds reflective of the professional competencies needed to conduct adequate reviews. One member of the committee must be a non-scientist (e.g., lawyer, clergyman). The committee must have one member who is not affiliated with the institution and a physician must also be available to the committee as an ad hoc member. The approving official, to who the committee makes its recommendations, may not be a member of the committee.

The primary determination that a human use committee must make is whether the proposed research presents greater than minimal risk to the subjects involved. Minimal risk exists when, "The proposed risks are not considered greater than those encountered in the subject's daily life or during routine physical or psychological examination." In applying this definition one must consider the normal occupation of the subject in order to assess if the proposed risks are greater than those the subject might encounter in the course of their daily life. It would be minimal risk for a test participant to operate equipment which is commonly used by people in his or her occupation. However, if the equipment to be operated is considered an experimental prototype and little information is available regarding the hazards of operating the equipment then the activity may present greater than minimal risk.

In determining the level of risk, the human use committee must also consider conditions under which the test will be conducted. If the test is conducted as part of a previously scheduled training exercise (i.e., the test is "piggybacked" onto the exercise) then the only risks to be considered are those presented by the test equipment. The concept here is that the risks inherent in a training exercise would be faced by the soldier even if the new item were not being tested. The human use committee must then determine if the imposition of the test article into the training exercise elevates the soldier's risk to greater than minimal.

If, however, the activities in which the soldier is to engage are solely for the purpose of testing the new item, then the human use committee needs to consider the risks presented by the conditions specified for the test as well as the risks of operating the test article. In this case the soldier is being exposed to risks which are not part of normal training as well as the risks presented by the test article. The conditions to be considered would include physical exertion, environmental extremes, clothing to be worn, duration of the test, etc.

If a review committee determines that the proposed test presents greater than minimal risk then the informed consent of test participants is required. Also, a medical monitor will have to be appointed to provide care for any research related injuries and to advise the people conducting the test if the conditions under which the testing is being conducted become so hazardous that the testing should be discontinued.

In applying the principles of human use review to the area of equipment testing one must be careful not to unnecessarily delay the testing process by conducting reviews of test plans for equipment which has, through the course of user testing, been proven to present minimal risk to the operator. Therefore, early user tests which employ experimental prototypes about which there is little information to assess the risks of operation would, in most cases, need to receive human use review for each proposed test.

As a piece of equipment progresses through early test stages, the reviewing human use committee may decide that there is enough information available about the new equipment to confidently state that the use of the equipment can correctly be characterized as presenting minimal risk to the soldier. At this point the committee may exempt future test of this equipment from further human use review. The decision as to when in the developmental cycle a piece of equipment no longer needs human use review must be made by the human use committee.

It is important to note that the requirement for human use review does not in any way replace currently required health hazard or safety assessments. Indeed the human use review is the logical follow on to these two activities. Once the health and safety risks of using a given piece of equipment have been identified then the human use committee considers whether the risks are greater than those which the soldier would encounter in performing the duties required of someone with that soldier's duty assignment.

It is important to remember that there is no such thing as a research protocol or test plan which presents no risk. Furthermore, no human use review, or any other kind of review, will totally prevent an accident from occurring in the course of even the most carefully conceived and well controlled test plan or protocol. The human use review does serve to assure that unnecessary risks are eliminated and that residual, unavoidable risks are minimized.

A conscientious human use review is not just a paper drill. It is a duty owed to the soldiers who participate in Army research and testing.

LTC GREGORY P. BEREZUK is chief, Human Use Review and Regulatory Affairs Office, U.S. Army Medical R&D Command.

CHUCK DASEY is public affairs officer for the U.S. Army Medical R&D Command.

By Chuck Paone

COMPOSITE INFANTRY FIGHTING VEHICLE UNVEILED

Plastic tanks may dominate future battlefields.

That may sound strange, but consider that a fiberglass-reinforced plastic (composite) armored vehicle will perform as well as a metal vehicle at reduced weight. Consider also the additional benefits, such as enhanced crew survivability, reduced interior and exterior noise, and reduced manufacturing and life-cycle costs. Suddenly, it doesn't sound so strange, does it?

Armored vehicles composed primarily of composite materials will not be fielded for several years, but the Army recently took a major step in that direction. The U.S. Army Materials Technology Laboratory (MTL), Watertown, MA, and its prime contractor, FMC Defense Systems Group, San Jose, CA, have developed a prototype composite infantry fighting vehicle demonstrating the benefits listed above.

"I've been a tanker all my career and, having seen and ridden in this vehicle, I'm convinced that it's the way to go," said GEN Louis C. Wagner, recently retired commanding general of the Army Materiel Command.

Recently unveiled to the public at FMC's San Jose test facility, the vehicle is now commencing 6,000 miles of field testing at Camp Roberts near Paso Robles, CA. The vehicle will be tested extensively to generate data on its characteristics, including strength, durability and maneuverability. That data is expected to validate computer design modeling techniques established early in the program for thick composite laminates.

Reducing the weight of armored combat vehicles was the main impetus behind this effort, according to William E. Haskell III, MTL's project manager. The idea, however, also carried the potential of advancing the Army's other major thrusts — survivability, lethality and readiness.

"The whole philosophy is that a good laminate, properly tuned, will outperform other materials," said D. Erich Weerth, FMC's program manager.

MTL first worked to develop a thick composite "E-Glass" armor system that could bear sizable loads. Although composite armor systems were

Front View of the Prototype Composite Infantry Fighting Vehicle

Rear View of the Prototype Composite Infantry Fighting Vehicle

commercially available, none had the adequate stiffness to serve as a hull structure.

After advancing the materials research by evaluating a variety of resin systems and fiber finishes, MTL demonstrated the E-Glass technology by designing and fabricating composite hatch doors for a Marine amphibious landing craft.

Although the E-Glass system seemed to work well, according to Haskell, MTL searched for an even better composite structural armor. Working closely with Owens Corning Fiberglass Inc., they developed an "S-2 Glass" structural armor system that exhibited an even greater weight savings, compared to metallic armor, based on equal ballistic performance.

"Before jumping right into the composite hull program, we chose a smaller, less complex armored vehicle component to demonstrate this technology," said Haskell. With FMC as the prime contractor, engineers fabricated turret structures using a wet lay-up, vacuum bag molding process. The resulting structures weighed 15.5 percent less than their aluminum counterparts.

The next logical step was to design and build a hull, said Haskell. The messy and cumbersome wet lay-up process presented a major technological obstacle, however. To overcome this, MTL and FMC sought an S-2-Glass pre-impregnated with a compatible resin. This would also allow them to dramatically reduce the cure cycle, which is the time it takes for the fiber and resin to consolidate and harden. A "pre-preg" from American Cyanimid, Inc. was chosen after evaluating four candidate systems for ballistic, mechanical and processing qualities.

The pre-preg having solved the problem, sights were set on design, fabrication and field testing. The design was constrained by the need to fit the vehicle with an M2 engine, transmission and suspension system, but was otherwise materials driven.

"The true potential of composites will be realized only when the entire vehicle is designed from the composites perspective," said Dr. Edward S. Wright, MTL's director. Nevertheless, this technology demonstrator reduced the weight of the hull and its attached armor by 25 percent.

The reinforcing fiber and polyester resin system that the hull is comprised of are also highly flame resistant, according to Haskell. "You can have a raging fire on one side of the composite wall and very little temperature rise on the other side."

It is not one asset or even the actual vehicle, though, that represents the ultimate importance of this program, according to Haskell; it's that the Army now has a technology base that could serve as the foundation for a future fleet of composite armored vehicles.

The goal in the final phase of this program will be to further develop and extend this technology now being demonstrated for the 30-ton vehicle weight class to the heavy armored vehicle weight class, said Haskell. A composite hull incorporated into a heavier vehicle will have to meet much higher structural loading requirements and be molded in greater thickness and different shapes. The Army will be looking for comparable weight savings.

Before it ever becomes feasible to field composite vehicles, regardless of weight, the Army will have to find a way to mass produce them. So MTL, through contract, will be trying to get industry to help do just that.

Mass production and fielding may be a long way off, but a lot has already been accomplished. "This marks the culmination of years of effort and points the way for the future development of ground vehicles," said Wright. "I'm an old metallurgist, and at first I was a little skeptical, but now I'm definitely convinced."

CHUCK PAONE is a public affairs specialist at the U.S. Army Materials Technology Laboratory. He holds a B.S. degree in journalism from Suffolk University, Boston, MA.

MANPOWER CONSTRAINTS AND R&M SPECIFICATIONS

Finding New and Better Ways to Produce Weapons

By CPT Mark Pliakos

Everyone involved in weapons procurement is always eager to find new and better ways to produce weapons. This discussion focuses on one small aspect of weapons procurement: the initial development of reliability and maintainability (R&M) specifications for developmental systems.

Currently, R&M specifications are derived from proposed mission profiles for the equipment. Those specifications are then challenged by various agencies who must insure the same system conforms to a number of other constraints that were not part of the initial development. One such constraint is maintenance manpower.

This article proposes a process to integrate manpower constraints into the initial R&M development effort. Instead of deriving R&M specifications and using models to discover the amount of maintenance manpower required, combat developers can use a manpower constraint to develop R&M specifications.

The proposal works the Manpower Allocation Requirement Criteria (MARC) in reverse, fixing the number of maintainers and solving for the required maintenance ratio.

The advantages of this process are numerous. First it is truly a manpower and personnel integration (MANPRINT) tool, because the process drives the design with the need to fit the force as it exists. Second, the process produces an audit trail which the combat developer can use to perform trade-offs between R&M specifications and manpower requirements. Finally, the process helps Army data collection agencies pinpoint precise data required by Army planners to produce effective and efficient weapon systems.

The MARC System is the heart of the proposed process. MARC is used by force developers to decide how many maintainers a unit receives for a given density of equipment. Using the maintenance ratio (man hours per operating hour (MH/OH)), number of operating hours, number of pieces of equipment and the number of man-hours that equate to one maintainer position on the MTOE, the force developer derives the number of maintainers the unit requires.

The proposed process fixes the number of maintainers and solves for the maintenance ratio. That maintenance ratio is then translated into a reliability figure and a mean time between failure (MTBF) figure. The R&M data is based on manpower constraints. Any changes in the number of maintainers or the reliability specification can then be

The proposal works the Manpower Allocation Requirement Criteria in reverse, fixing the number of maintainers and solving for the required maintenance ratio.

The impact of any R&M changes can be easily converted into a manpower cost, insuring the equipment can be maintained by the people assigned.

evaluated according to the impact on maintenance manpower and mission performance.

While the full process can be somewhat tedious, it is not complicated, and can be accomplished with a hand-held calculator. A simplified example serves to highlight the benefits of the process. Assume an additional widget is being added to the AH-1. The widget must not require any additional manpower to perform maintenance. The widget will be repaired by the fire control repairman. There are currently six repairers assigned to the unit. What must the widgets reliability be in order to insure no additional maintainers will be required?

The process starts with the MARC equation which is: (Widgets) (MH/OH) (Operating Hours)/1 Position (MH) = Number of Positions.

We fix the number of positions, and solve for the maintenance ratio, MH/OH. One subtelty of the MARC equation is that the number of positions is rounded up or down. If the number of positions is six, the answer produced by the MARC equation can be anywhere between 5.5 and 6.4. This becomes important.

When actually performing a complete analysis, you must set the MARC equation equal to the greatest value that yields the actual answer. In this case, the analyst uses 6.4. Using 6.4, the analyst derives a maintenance ratio that is the maximum total workload the six repairmen can handle before needing another repairman.

Recognize that this widget is an additional workload. The process accounts for this fact by subtracting the current maintenance ratio (the one that produced six repairmen in the first place) from the maximum maintenance ratio derived by using 6.4 positions. The result, the difference in maintenance ratios, represents the maintenance ratio that the total widget population can have without requiring more repairmen.

Using sample data collection (SDC) information, the maintenance ratio can be translated into an MTBF and reliability figure. Some of the fine points of the process have been glossed over, but the previous example serves to highlight the main benefits. First, the R&M data are based on manpower constraints. Some will argue that R&M data should be solely mission oriented. However, R&M data derived by this process can be applied to the proposed mission profiles.

If the R&M specifications are insufficient for mission accomplishment, it is obvious that the only choices are to use the widget less, make the widget more reliable, or add maintainers. Analysts have always known this, but this audit trail forces program managers to make the hard decisions.

The proposed process derives R&M data using an interval of usage rates, not one specific rate. In aviation, this is normally called a wartime flying hour program. The combat developer must normally pick a wartime flying hour program. The chances of the actual wartime program being exactly this figure are very slim.

The proposed process derives data based on an interval which comes from the rounding in the MARC equation. Analytical proof is beyond the scope of this article, but this process has developed R&M data that are valid over a wide range of wartime flying hour programs. The chance of an actual wartime flying hour program falling into an interval is much greater than the chance the wartime flying hour program is exactly any one value.

This process is clearly a MANPRINT tool. It forces the R&M specification to conform to the number of maintainers currently in the force. The impact of any R&M changes can be easily converted into a manpower cost, insuring the equipment can be maintained by the people assigned.

In conclusion, this proposed process can be a great benefit to the procurement community. Any agency interested in a much more rigorous example of this process is welcome to write me at the 78th Aviation Battalion (prov), APO San Francisco 96343-0064. By using manpower constraints to derive R&M data and then analyzing mission capability, the combat developer can clearly show the impact of R&M tradeoffs on unit manning levels and mission accomplishment.

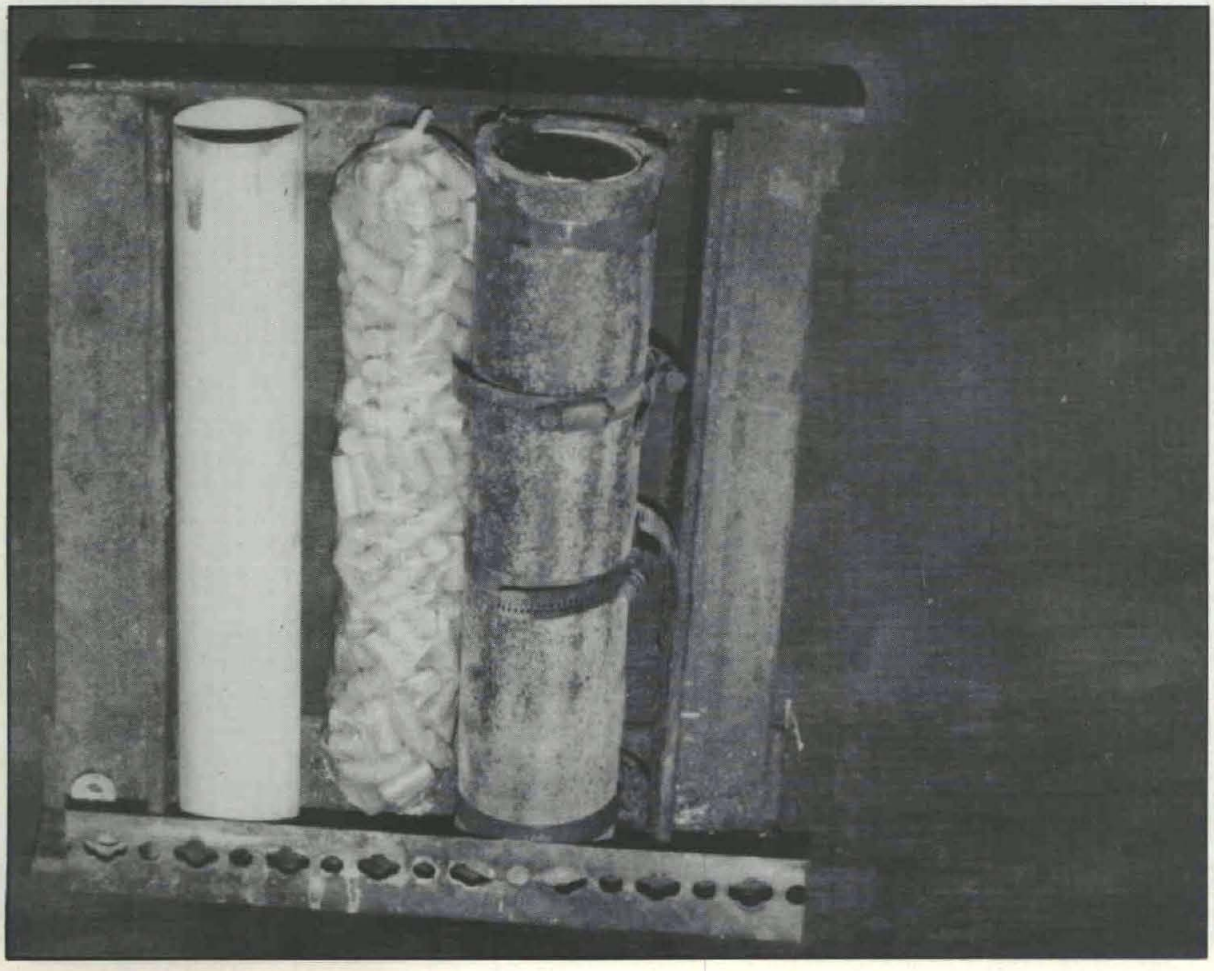
CPT MARK PLIAKOS is director of security, plans and operations, Camp Zama, Japan. He holds a B.S. degree from the U.S. Military Academy and an M.S. from the University of Southern California.

PREVENTING COOK-OFF WITH INTUMESCENT MATERIALS

If struck by a high velocity projectile or shaped charge jet, bags of propellant in a howitzer will ignite and spread heat and flames to surrounding propellant bags, causing them to ignite also. This phenomenon, known as cook-off, could prove fatal to both crew and vehicle in less than a minute.

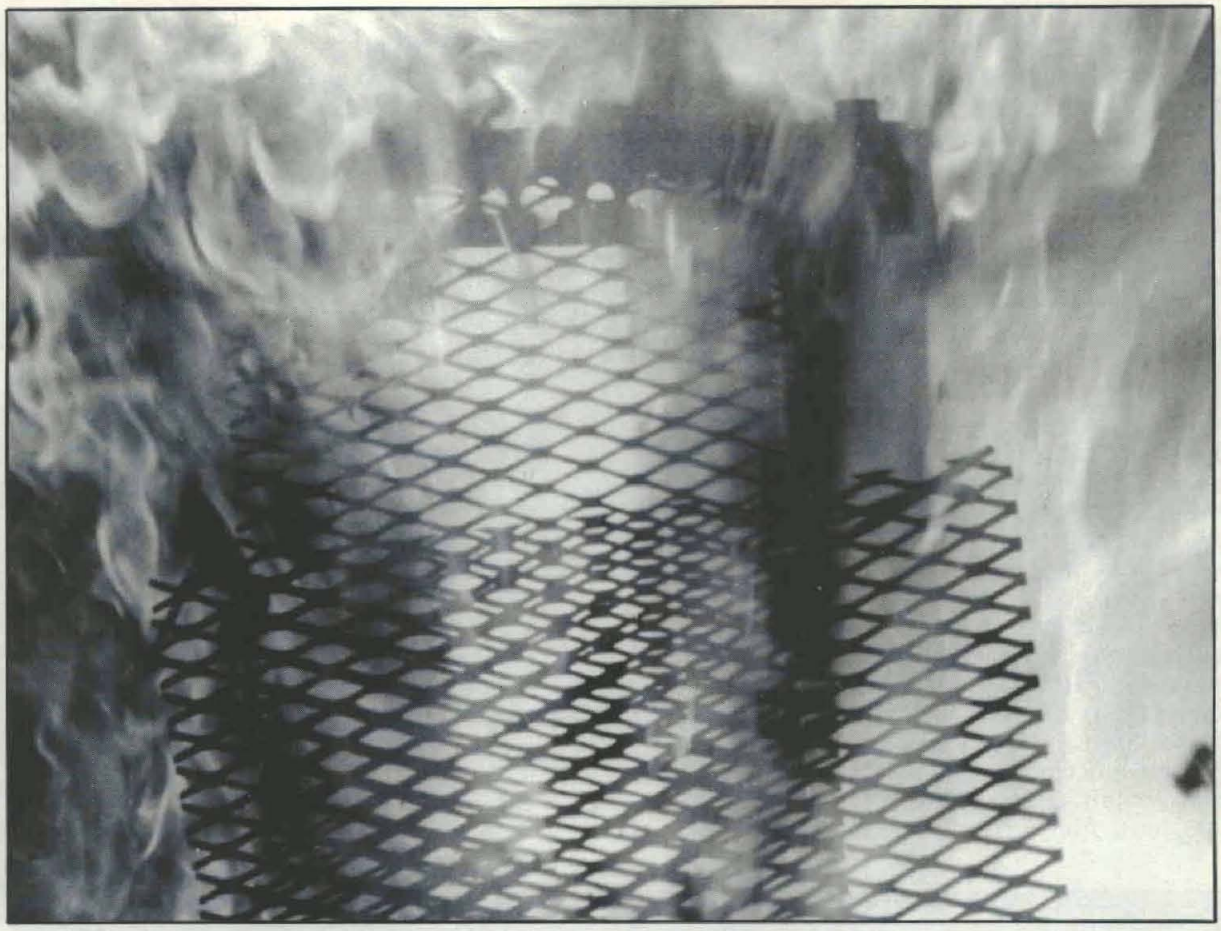
Efforts made by researchers at the U.S. Army Materials Technology Laboratory (MTL), Watertown, MA, to surround these propellants with intumescent (flame retardant) material have succeeded in preventing cook-off. This research is part of MTL's support for the Cannon Artillery Weapons System (CAWS) program at the Army Research, Development and Engineering Center (ARDEC), Dover, NJ, where work is being done to revitalize the M109 Howitzer.

Significant changes in the howitzer's turret, gun, instrumentation and communication system have been designed to improve system performance. PM-CAWS is also examining several concepts designed to enhance survivability. One such concept, which has been found feasible, is to store



Before detonation

The "donor" propellant, which is to be ignited, is surrounded by the unprotected "witness" sleeve (left) and the protected sleeve.



During Detonation

Ignition of the "donor" propellant and subsequent ignition (cook-off) of the propellant in the unprotected sleeve during the test.

on-board propellant in a compartment separated from the crew but accessible by them. Even with such a compartment, though, cook-off could well destroy the crew and vehicle.

The MTL team, headed by researcher John Mescall and comprised of polymer specialist Dominic Macaione and technicians Charles Polley, John Bonitati and Francis Kelley, explored the possibility of protecting propellant bags by storing them in individual cylindrical sleeves. Initially, they looked for weight savings by comparing the performance of composite materials to sleeves made of steel or aluminum. Then they began wrapping all of these sleeves in intumescent materials to see if cook-off could be prevented.

They conducted two different experiments on these materials, concentrating primarily on one-third-scale propellant detonation testing. In early versions of this test, Mescall filled three sleeves with propellant, ignited one, which he called the donor, left one "witness" sleeve unprotected and insulated the third with intumescent material.

The results were clear and direct. The propellant in the unprotected sleeve always burned, igniting each time in approximately 11 seconds, and the sleeves, except for those made of steel, either ruptured or burned through. The propellant in the protected sleeve, on the other hand, never ignited, and the sleeves themselves were in most instances virtually unscathed. Thus, where intumescent agents were used, cook-off was prevented.

Mescall tested for all possible parameters by alternating the variables, which included different types of propellant and sleeve material. In all instances, the results were quite similar.

The MTL team also looked at different types of intumescent material. Two major brands, Interam, manufactured by the 3M Co., and Eypel, put out by Ethyl Inc., were used. Although both did well, Interam, a sturdy rubber matrix, performed best, providing complete protection in every test. Eypel, a lightweight foam material, displayed structural problems during initial tests, but those problems were partially solved with some modification.

Mescall intensified this experiment by removing the sleeve from the donor propellant and increasing the amount of it from one to 2.5 pounds. Still, the protected sleeve and propellant were unaffected by the flames or the heat they generated.

In fact, the heat inside the protected sleeves, as measured by "tempilables" placed inside of the sleeves, never rose above 200 degrees F., the lowest value measurable with this technique. This is very important because, even if the propellant does not come in contact with the flames, heat in excess of this range could cause ignition.

Mescall and his team conducted the second major experiment specifically to measure heat resistance over time. It involved exposing 6-inch by 6-inch sheets of aluminum or steel, of various thicknesses, directly above the 1600 degree C. flame of a meeker burner. Not surprisingly, the temperatures measured on the unexposed side of the sheet — the side that would

After Detonation

The unprotected sleeve, after the test, is shown ruptured. Next to it lies the unscathed protected sleeve and the intact intumescent material. Beneath, the unburned propellant from the protected sleeve is displayed.

touch the propellant — were quite high, reaching a range of 250 to 350 degrees C. in just a few minutes.

When these tests were repeated with intumescent materials placed between the flame and the metal, the temperatures on the unexposed side never rose above 50 degrees C., regardless of time. Again, Interam performed best, mainly because its heat-protecting capacity never diminished with time.

As part of its redefined mission, these MTL engineers are harnessing technology pioneered in private industry. Polymer scientists at MTL have been working with similar materials for several years, but never before in this context.

When or even if this technology will be incorporated into the M109 is uncertain, but the overwhelming evidence of its effectiveness should bring it into the field eventually. The cost for protecting 36 propellant sleeves in an M109 would be quite modest, according to Mescall. Weighing the tremendous benefits of this technology against the possible cost in lives and equipment, Mescall said, "We can't afford not to do it."

MTL, in another portion of the effort to support CAWS, tested a new propellant, which would have made it possible to dramatically extend the howitzer's firing range. Unfortunately, testing revealed that if struck by a shaped charge jet, a bag of this new 6260 propellant would detonate. The previous propellants would burn but not detonate. The 6260, therefore, was deemed too dangerous and had to be dropped from consideration. Some chemical adjustments will be made to existing propellants, however, allowing more moderate range increases.

The final phase of MTL's support for CAWS was conducted by the lab's armor specialists. Through ballistic testing, they determined, on a threat-specific basis, how much Kevlar needed to be added to the M109's armor to prevent damage from fragmentation and spall.

Virtually no armor, however, can keep a high-speed projectile or shaped charge jet from getting through to the propellant; thus using intumescent materials is virtually the only way to avert disaster in those instances. Intumescent materials prevent cook-off. And on the battlefield, that will save the M109 and similar vehicles from destruction — and save the lives of American soldiers as well.

MTL is the Army's lead laboratory for research and development of advanced materials and is part of the U.S. Army Laboratory Command in Adelphi, MD, and the U.S. Army Materiel Command in Alexandria, VA.

The preceding article was written by Chuck Paone, a public affairs specialist at the U.S. Army Materials Technology Laboratory, Watertown, MA. He holds a B.S. degree in journalism from Suffolk University, Boston, MA.

The MAM Course...

'TEACHING THE LANGUAGE OF MATERIEL ACQUISITION'

By CPT (P) Tim Mischkofski

Bringing a new system from concept through fielding is among the evolutionary changes occurring in the Army's Materiel Acquisition Management (MAM) Course. Challenges come as quick as you can say "LCSMM" — the Life Cycle System Management Model.

The MAM Course is taught by the Army Logistics Management College (ALMC), at Fort Lee, VA. Its primary focus is to train mid-level managers for the Army's MAM program, as prescribed by DA Pam 600-3. *Commissioned Officer Professional Development and Utilization.*

Students arriving in FY 90 will see a new, more integrated curriculum. Working in small groups (not unlike CAS3), U.S. and allied students, both civilian and military, are facing new and more challenging course work directed by changes in public law, surveys from field units, and input from major commands.

"The nine-week MAM Course is constantly changing. As a recent example, the Operational Test and Evaluation Agency (OTEA) and TRADOC Headquarters felt that we needed more instruction on materiel and user testing in the course. Also, TRADOC felt that we needed more hands-on instruction in requirements generation. We needed to teach students how to write an Organizational and Operational (O&O) Plan. So, we're implementing these

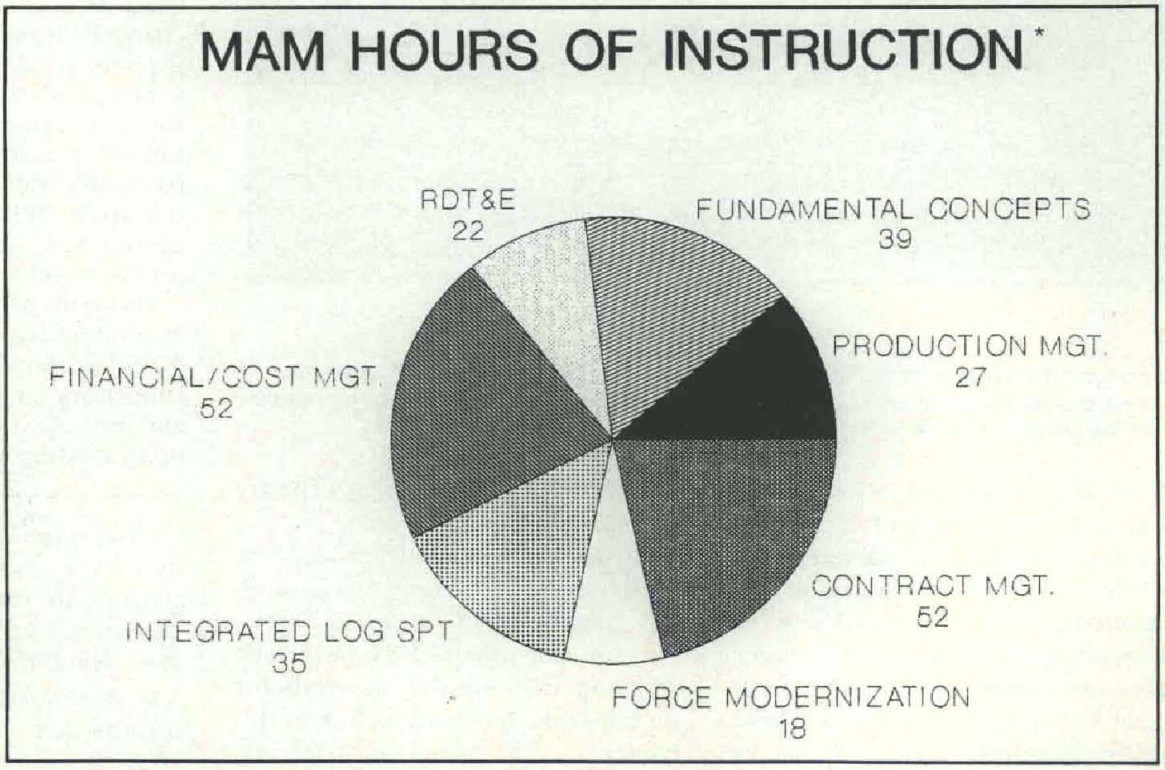


Figure 1.
**Note: Total hours of instruction = 245. Does not count administrative time (i.e., examination/exam critique, research and study, inprocessing/ critique and graduation, physical training, and course director's time, which amounts to about 106 hours out of a total course time of about 351 hours.)*

recommendations," says Joe R. East Jr., ALMC's MAM course director.

The basic MAM Course, which lasts nine weeks, encompasses 245 hours of instruction. The primary units of instruction are grouped into: Fundamental Concepts, Structures, and Policies of MAM (39); Research, Development, Test and Evaluation (22); Financial/Cost Management Techniques (52); Integrated Logistic Support (35); Force Modernization (18); Production Management (27); and Contract Management (52) (See Figure 1).

"The MAM Course is designed to teach the language of materiel acquisition. It breaks the process into eight functional areas around which we build instruction and student projects (See Figure 2). The key is to help the students assemble knowledge of the functional areas through integrating exercises that tie in all phases of the acquisition life cycle," East added.

The current course has been in place since 1984 when the six-week Project Manager Development Course (PMDC) was expanded to nine weeks. It is offered four times a year. Because of the level of student interaction, there is no correspondence version. The majority of students are Army captains and majors. The remainder of the students are Army civilians working in materiel acquisition jobs, officers from other services, and allied officers. With the increasing interest in developing civilian materiel acquisition management specialists, more Army civilian employees are expected in future MAM course.

The ALMC MAM curriculum is designed to stand alone as a basic acquisition course, but is also designed to be eventually followed by the 20-week Program Manager's Course offered by the Defense Systems Management College (DSMC) at Fort Belvoir, VA, a DOD Activity.

As DOD policy recommending a professional track for MAM is implemented, the FY 90 MAM Course load has been modified. Group projects on requirements generation and financial management are already on line, with more changes to come.

"Recently we received a copy of the MAM Occupational Survey Analysis Report prepared by the Soldier Support Center, National Capitol Region (SSC-NCR) in July 1989. Based on responses from over 1,000 MAM officers, the course fared pretty well, with some weakness noted in testing and requirements generation. We've already moved to shore up those weaknesses and have inserted a budgeting exercise developed by one of our Army Reserve mobilization designees," said East.

Early in 1989, President Bush challenged the services to develop "a plan to improve the defense procurement process and management of the Pentagon." The resulting Defense Management Review examined efforts to implement "improvements envisioned by both the Packard Commission in its reports and by Congress in the Goldwater-Nichols Defense Reorganization Act of 1986." The MAM Course serves as an Army basic building block in meeting the president's challenge.

"The Army has been criticized about buying bad bolts, mismanagement of contracts and not doing logistics training very well. But somebody in the Army had an awful lot of foresight to set in place a training program for research and development and contracting specialists that has come a long way over the years.

"The plan of bringing an officer through the MAM Course for their 'basic training,' then giving him or her a three to four year tour of duty in the MAM field, followed by the Program Manager's Course, and then back to a MAM job, makes a tremendous amount of sense," says East.

East added that the law says that the services need to give their officers more acquisition experience before placing them in project manager-type jobs. This includes incorporation of MAM and training with industry tours.

"The MAM course put into perspective all of the things I learned in the Training With Industry (TWI) program at BMY Combat Systems in York, PA," said CPT Thomas P. D'Alio, a recent MAM graduate. "Had I the opportunity to

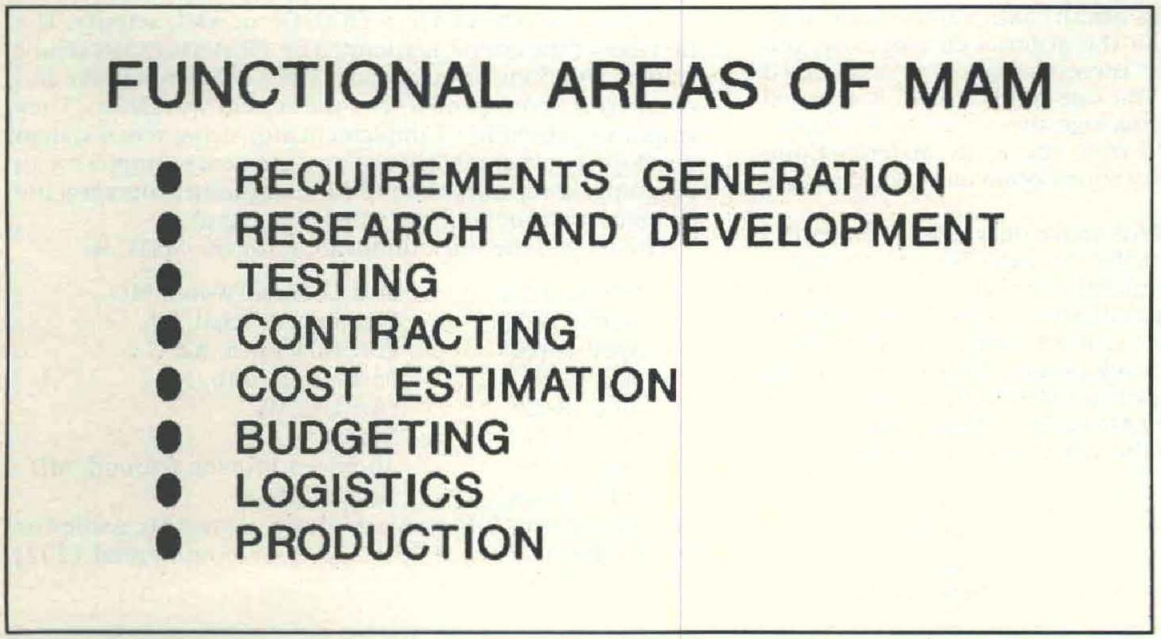


Figure 2.

attend the MAM course prior to TWI, my understanding of the military-industrial acquisition process would have been greatly expanded," he added.

Another factor in the increasing importance of formal MAM instruction is increased interest among allied nations. Korean, Jordanian, and Australian officers are graduates, and Japanese, Saudi Arabian, Phillipine and Turkish officers are tentatively scheduled for future classes.

About 75 percent of ALMC's MAM course is taught by MAM-dedicated instructors. Policy, Cost Estimating, Testing, Requirements Generation, Computer Support, and Contracting are presented primarily by MAM faculty. Expert guest speakers and other ALMC faculty round out the instruction load.

The evolutionary MAM course, challenging for students, is also challenging for the MAM faculty as it attempts to weave a single thread throughout the nine week program.

"The acquisition of a single weapon system as a course instructional concept is not unique. Having gone through a course that uses that idea, I recognize it as a great learning vehicle. At the PM Course, they had a 'System X,' at the Ordnance Center and School, they have the 'Shoe Box' exercise in which the students design and develop a simple shoe box."

"What I want to do for this course is to develop a set of comprehensive practical exercises built on the research, development, testing and fielding of a single weapon system. We've been working on this for about three years. When we were tasked to put together exercises for a test design plan and the 'O and O' plan, we saw an opportunity to bring our integrated exercise scenario on line," said East.

During 1990, ALMC plans to fully integrate all phases of the MAM course around a single scenario, beginning with the O and O plan, budgeting, and possibly a project scheduling exercise using Logistics Planning and Requirements Simplification Systems (LOGPARS).

For ALMC's MAM students, it's all in a day's work.

For information on the MAM Course contact: Commandant, U.S. Army Logistics Management College, ATTN: AMXMC-ACM-MA, Fort Lee, VA 23801-6048, autovon 687-3364, commercial (804)734-3364.

CPT (P) TIM MISHKOFSKI is assigned to the U.S. Army Logistics Center. He holds a 51 functional area, is a recent graduate of MAM, and is a member of the MAM program. He holds an M.S. in management from Hampton University.

MANPRINT TRAINING ANNOUNCED

Student openings for the Manpower Personnel Integration (MANPRINT) Staff Officer Course (MSOC) and MANPRINT Senior Training Course have been announced. The purpose of the MANPRINT course is to train military and civilian personnel to integrate manpower, personnel, training, human factors engineering, health hazards and system safety considerations throughout the materiel development and acquisition process. The three-week course is directed toward action officers. The one-week course is directed toward individuals who manage the acquisition process. Participants are recruited from the Army Materiel Command, the Training and Doctrine Command, other services and industry.

The MSOC is designed for active duty Army officers (03 and 04), warrant officers (CW2 through CW4), noncommissioned officers (E7 through E9), civilians (GS-09 through GS-12) and industry representatives. Typical attendees are assigned or on orders to a combat development, training development, materiel development, Department of the Army staff materiel acquisition staff officer position, or industrial assignment in a MANPRINT functional area.

The FY90 schedule for the MSOC, which is taught at Fort Belvoir, VA, is:

Jan. 22-Feb. 9	June 4-22
March 5-23	July 9-27
April 2-20	Aug. 6-24
April 30-May 18	Sept. 10-28

The MSTC is designed for TRADOC and AMC senior leadership (GO/SES) positions, senior managers of industry, active Army officers (04 through 06) and civilians (GS-13 through GM-15) assigned to a combat development, training development, or materiel development position.

The course is hosted by a TRADOC or AMC activity. The first day of the course is attended by TRADOC/AMC senior leaders and their primary staff. The host commander and counterpart commander lead the system workshop. They emphasize MANPRINT implementation using actual system development/materiel change/procurement examples for an on-going (or recently completed) acquisition program at the proponent agency/school (host command).

The FY90 schedule and location for the MSTC is:

Feb. 12-16	Fort Leonard Wood, MO
March 19-23	Picatinny Arsenal, NJ
April 16-20	Fort Huachuca, AZ
May 14-18	Fort Monmouth, NJ
June 18-22	Fort Lee, VA
July 23-27	Natick, MA
Aug. 20-24	Aberdeen Proving Ground, MD
Sept. 24-28	Warren, MI

For additional information, please contact Mr. Ashley or Dr. Engler at AV 221-3707/3709 or commercial (202) 325-3707/3709.

Bomb Squad Robot To Be Fielded Soon

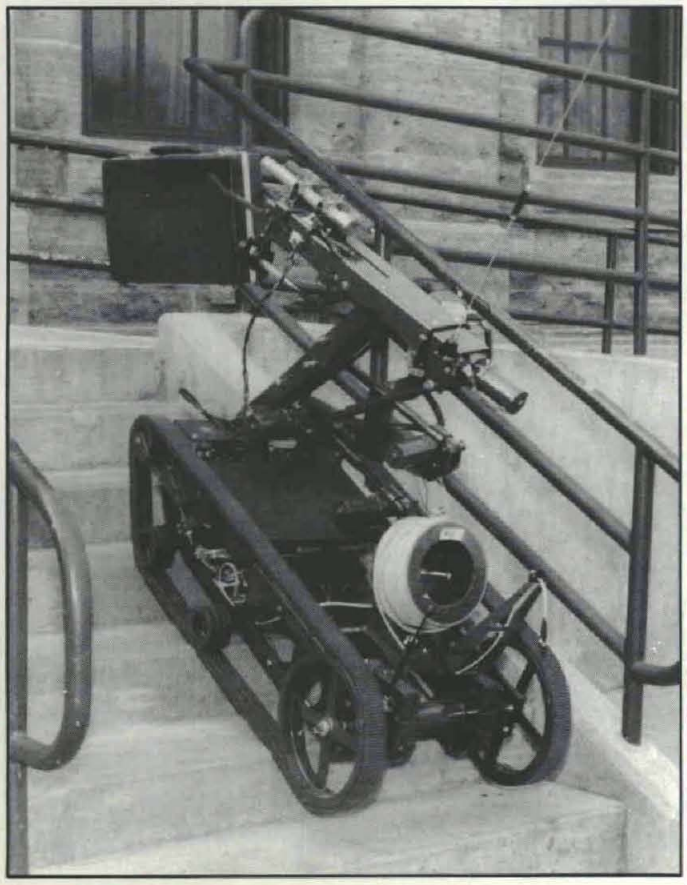
The federal government has taken its share of lumps as the result of big dollar projects and cost overruns. Little is heard about instances of efficiency and ingenuity. Meet the EOD robot.

EOD is the acronym for Explosive Ordnance Disposal and "robot" in this case means a device resembling a miniature tractor. The events leading up to creation of the robot began about two years ago when Army leadership saw an urgent need for a remotely controlled machine which would be able to search for, pick up and move suspected bombs without endangering the operator. The concept was later changed to include the capability to neutralize explosive devices as well as examine and move them.

There were four procurements: the robot system, a tool set, a system of wires and pulleys called a hook and line kit, and an explosive detector known as the "sniffer."

The robot system was procured competitively as an off-the-shelf item with no money allocated for research and development.

Using commercially available parts, a relatively simple device, powered by two wheelchair batteries, was built. Virtually all the components of a 76 item tool set were in government inventory and needed only to be packaged at the Rock Island Arsenal. The hook and line set, used to move a bomb remotely and the explosives detector were also obtained off-the-shelf from private industry.



Bomb Squad Robot System

The first 72 robots were delivered to the Army early last year and are awaiting fielding to Army EOD units around the world. Additionally, the Marine Corps has ordered 15 robots for use by its EOD teams. Delivery of the robots and other items was accomplished in a comparatively short time and at a total cost of $3.7 million — a reduction from the original authorization of $6 million.

For its money, the Army got a mobile robot equipped with both color and black and white video cameras, an arm which can reach its claw in all directions, accessories which accommodate an x-ray machine for observing what's inside a package, a water disrupter to destroy a bomb's electronic detonator and special tools to neutralize a bomb. The robot is also being fitted with a 12-gauge shotgun which can be used to open locked doors or desks.

The robot system weighs under 200 pounds, can climb stairs or a 45 degree slope, stop, maintain its position, and resume the climb.

The separately packaged explosives "sniffer," although not part of the robot, may be used in conjunction with the system or by itself. If all of these abilities fail to keep a bomb from detonating, the remote control systems of the robot will keep the operator well away from the explosion. Used on the radio control mode, the unit has an operating range of up to 900 feet. The fiber optic control system has a range of 325 feet.

Experts Study Camouflage Patterns

Have you ever asked yourself why the Army paints camouflage patterns on vehicles and equipment but supplies tarpaulins, soft tops and cargo covers for the same equipment in a single color green?

The Army's camouflage experts at the Belvoir Research, Development and Engineering Center have been studying this question for several years. By using modern computer-aided-design and computer-aided-manufacturing (CAD/CAM) techniques, it appears that a solution to this problem is now available.

Applying three-color camouflage patterns to fabric components of vehicles is far more difficult than printing a camouflage pattern on cloth that will be used to make Battle Dress Uniforms (BDUs). The three-color patterns cannot repeat like the four-color BDU pattern, and must match the vehicle's painted pattern when the component is installed.

The only way to produce such a fabric component is to use a computer-controlled printing or coating process. The three-color pattern is fed into a computer, which then controls the printing or coating of the basic fabric. The end result is a three-color camouflaged fabric component that will complement the vehicle's painted pattern and provide the maximum camouflage protection for troops and their equipment.

The center's counter surveillance personnel are working with equipment managers across the Army Materiel Command to modernize the fabric components of tactical equipment. Camouflaged soft tops and cargo covers will be introduced to the field in FY90 and beyond.

Using Laboratory Robotics In A Toxic Environment

Routine testing and screening of military materials capable of detoxifying and protecting the soldier against chemical warfare agents require the use of agent simulants. Many such simulants may be hazardous in their own right. Therefore, an automated robotic test method that limits operator exposure to toxic chemicals is desirable.

Former test methods used in the Special Projects Branch, Science and Advanced Technology Directorate at the U.S. Army Natick Research, Development and Engineering Center, Natick, MA, were labor-intensive. For example, they required repetitive operations, such as transferring liquids and samples, injecting reactants into a gas chromatograph, and recording the concentration of detoxification product or remaining simulant.

Individual vials containing the test materials are allowed to react for varying periods of time. Generally, only one sample at a time could previously be run during an eight-hour work day. Test materials are run in plastic vials, sealed to prevent vapors from escaping, in a fume hood.

To limit possible exposure of the analyst to toxic liquid and vapors, to increase precision of the time intervals, and to eliminate the time constraints, a multisample robotic test system was developed by engineering technician Raymond Andreotti and Staff Sergeant Charles Woodbury. It features two laboratory robots, dubbed "Mikey" and "Michelle."

The system, entirely enclosed in a fume hood, uncaps each vial, injects simulant into the vial, records the time, and places each vial into a constant temperature bath for a preset time period. The internal clock of the robotic system continuously monitors the preset time period for each vial. When the individual reaction time is over, Mikey removes the vial from the bath, uncaps it, and Michelle quenches the reaction by adding solvent. The vial is then placed on a rotary shaker for two minutes to extract reactants from the sample.

If the sample requires centrifugation, then the robots will pipet out the sample into a centrifuge tube and spin it for a set time. The sample is then pipetted into a 2 milliliter gas chromatograph (GC). The robotic system sends a signal to the GC to start, waits for the sample to be injected, then removes the vial and places it into a vial rack.

During any idle time, such as when centrifuging or chromatographing, the system checks the reaction time clock of the remaining samples to determine if any are ready to be quenched and, if ready, will proceed to quench and extract samples.

All samples are handled identically until they have all been injected into the GC. Mikey and Michelle are indispensable co-workers to Ray and Charlie in performing repetitive kinetic analyses of materials where each timed reaction must be precise, accurate and offer no exposure to toxic chemicals. No human, no matter how diligent, could ever hope to meet those challenges. Moreover, the robots often work long hours of overtime, keeping accurate records of the time spent on the tests, noting when they start work and shut down for the day (the ultimate in flexitime-keeping).

The robotic system is easily programmable to perform other types of analyses since it can be interfaced with instruments such as liquid chromatographs, electronic balances and spectrophotometers. Programs are stored on floppy disks by the system controller module and can be easily updated to accommodate changing protocols.

The preceding article was written by Raymond E. Andreotti, Special Projects Branch, Science and Advanced Technology Directorate, U.S. Army Natick RDE Center.

Breakthrough Revolutionizes Radar Signal Processing

Using light and sound waves, the U.S. Army Strategic Defense Command has developed a way to make radars that see better and are almost impossible to jam.

As a radar searches for targets, it is constantly bombarded by thousands of electronic signals — communications waves, jammers, civilian broadcasts, and even radiation from space.

The problem for a strategic defense system is to pick out signals from the rest of the "electronic noise" that identify incoming missile warheads. The system must then decode and process the signal into information that a command can use to decide how best to defend against the threatening warheads. The commander must have access to target and tracking information quickly in order to engage the warheads before they can reach their targets — at best, only 15 to 30 minutes.

This task of finding the real target among decoys, penetration aids, chaff and all these other random-noise signals detected by radar, is similar to looking for a needle in a haystack.

Just as a large diameter pipe can carry more water than a small diameter pipe, an ultra-wideband radar signal can return larger amounts of data from a target object, which helps make the identification process more reliable. However, even the fastest of today's digital electronic computer systems can't keep up with the glut that results. A breakthrough in radar signal processing technology made by the U.S. Army Strategic Defense Command promises to make the ultra-wideband radar possible.

The key to this achievement is a high-speed, electro-optic computer that uses laser light to simultaneously process and patternmatch random noise signals as fast as they occur. Rather than digital electronics, this acousto-optic process uses the interaction of laser light and sound waves within a crystal to process the signal.

How it Works

The interaction is accomplished by splitting a single laser beam and using acousto-optic technology to place the pattern of the radar's transmitted signal onto one beam and

the pattern of the target return-signal that is received by the radar onto the other beam. The two beams are merged and a transparent acousto-optic crystal instantly detects the distinctive pattern created by the target.

This ability to match or correlate random sets of signal frequencies that have no set pattern is significant in that it demonstrates that any type of signal pattern can be compared.

Using this technology, an electro-optic computer, built by Dynetics, Inc., Huntsville, AL, under contract with the U.S. Army Strategic Defense Command, can parallel-process hundreds of these signals in one billionth of a second. Thus, this compact computer can perform the billions to trillions of operations per second that would be required for a ballistic missile engagement.

Neural Networks

According to the Strategic Defense Command's electro-optics contract manager, Dr. Michael J. Dorsett, this research into pattern recognition also may contribute to the development of "neural networks" for artificial intelligence. These are large interconnecting networks similar to the human brain.

It is the high-speed parallel processing capability of the electro-optic computer that will allow the implementation of such "neural" computer networks. These concepts may provide the basis for continued research on a sixth-generation computer.

Ada Goes to College

The U.S. Army Communications-Electronics Command (CECOM), Fort Monmouth, NJ, has initiated a new policy designed to aid universities in entering the world of Ada. Ada is the computer software language developed by the Department of Defense for use in all of its future software applications.

Universities have been slow to initiate courses in Ada because of the costs of acquiring the software tools required to support the educational process, most notably, compilers. The cost of Ada compilers can range into thousands of dollars, a figure that universities with already tight budgets have been reluctant to spend.

Recognizing the need to alleviate this burden on the universities, CECOM recently implemented a policy directed at providing universities with Ada compliers at no cost to the schools. Under this policy any nonprofit institution of higher education with a basic or applied research contract from CECOM can legally acquire and retain title to Ada compilers costing less than $5,000 each. The compilers can then be used by the universities to support Ada courses and Ada related training.

For further information concerning the Ada initiative, contact Dr. Martin I. Wolfe, HQ, U.S. Army CECOM, AMSEL-RD-SE-AST, Fort Monmouth, NJ 07703-5000.

High-Temperature Engine Passes NATO Test

Research at the U.S. Army Tank-Automotive Command (TACOM) and the Indiana-based Adiabatics, Inc., has resulted in the continued development of a high-temperature diesel engine which recently passed the North Atlantic Treaty Organization (NATO) 400-hour engine endurance test.

This test is a standard laboratory test developed by the United States and the 15 European nations comprising NATO for use by all member countries. It is an accelerated endurance test which allows engineers to determine the suitability of engines for vehicle application.

Initial engine development work which led to the successful passing of the NATO test was previously conducted in a TACOM-Cummins Engine Co. effort that resulted in the first vehicle test of a high-temperature diesel engine. The Adiabatics engine prototype, which also completed a vehicle test that included 15,000 miles of highway operation in an M813 5-ton truck, is referred to as a low-head-rejection diesel engine. Unlike a conventional diesel, it uses high-temperature materials in the combustion area, enabling it to reject less heat to the cooling system, which does not use water.

Such an engine would offer several advantages over standard water- and air-cooled power plants. For one thing, it would eliminate the need for a radiator, water pump, connecting hoses and cooling fan, which means it would occupy much less space and cut vehicle weight. It would also do away with cooling-system maintenance and repair, thereby reducing overall vehicle life-cycle costs and improving reliability and survivability. Moreover, it would offer better vehicle fuel economy, by reducing parasitic loads that result from the operation of a cooling fan and water pump in a standard engine.

The low-heat-rejection engine consists basically of the Cummins NH in-line six-cylinder, 240-horsepower diesel used in many of the Army's 5-ton trucks. However, the piston domes and cylinder-head faces have a heat-resistant coating consisting of zirconia impregnated with chrome oxide for a seal coat, and the top piston rings and cylinder liners are coated with chrome oxide for increased wear resistance.

For the NATO test, the engine used a special synthetic lubricant that remains stable in hot temperatures. According to TACOM RDE Center engineer Ernest Schwarz, who heads the TACOM-Adiabatics project, development of this oil was the key to the engine's success in passing the test. "Oil has always been the limiting factor in keeping an uncooled engine running," Schwarz said. "It gets extremely hot in the cylinder, and the heat causes conventional mineral oils to decompose and to fail in providing adequate lubrication. Ring sticking is the predominant mode of failure." But the synthetic oil performed very well during the 400 hours, according to Schwarz.

The low-heat-rejection engine demonstrated significantly better fuel economy than that of its standard counterpart in a vehicle. It encountered no problems throughout the

NATO test and was found to be in excellent condition at the end of the test.

Schwarz expressed optimism about the possible future use of low-heat-rejection engines in vehicles. He noted that low-heat-rejection technology is also being pursued by the Department of Energy in research with Cummins Engine Co. and Caterpillar, Inc., for possible application to their commercial engines. Therefore, he said, the likelihood of this technology being used in future Army tactical vehicles is quite high, since these vehicles use commercial engines.

Schwarz also said that this type of technology is most applicable to combat-vehicle engines. "It is being pursued for use in the diesel-engine Advanced Integrated Propulsion System (AIPS) now being developed for the next generation heavy combat vehicles, where high power density propulsion systems are required," he explained.

The preceding article was written by George Taylor, a technical writer-editor for the U.S. Army Tank-Automotive Command.

Scientific and Technical Threat Data on a PC

Introduction

The U.S. Army Intelligence Agency (AIA) produces finished Scientific and Technical Intelligence (S&TI) on foreign military systems that threaten U.S. forces. Typically, customers use current and future weapon system capabilities and recognition information to develop training material, requirements documents, policy, and war plans. All of this enhances the overall readiness of the U.S. military. While AIA continues to support its customers through traditional methods, it is now offering a new means of acquiring and using threat S&TI: the Personal Computer Query Tool (PCQT).

Overview

PCQT is a PC-based product for viewing and querying information on certain weapon systems. The system consists of compiled data management programs and the parametric data files for which AIA is responsible. The data in the initial release have been entered by the U.S. Army Foreign Science and Technology Center (FSTC), Charlottesville, VA. Subsequent releases will include U.S. Army Missile and Space Intelligence Center (MSIC), U.S. Air Force, and U.S. Navy data.

System Description

PCQT allows the S&TI customer to view an individual weapon system, compare weapon systems side by side, produce spreadsheets of parametric data, and view graphics and comments related to a weapon system. The query capability will include searches for terms and parametric values. Spreadsheets can be built and saved for reuse later, merged to produce customized spreadsheets, or saved in American Standard Code for Information Interchange (ASCII) flat-file format to permit loading into word-processing or other software.

PCQT is designed to be easy to use. On-line HELP is available from any point in the program. When HELP is selected, the information on using that particular part of the program will appear on the screen. The system permits scrolling through the entire on-line HELP document. However, with its window menus, highlighted function keys, and choice of mouse or keyboard selection, the system is simple to use with little, if any, assistance. The PCQT software and data base structure provides great flexibility.

The customer will receive an easy-to-install package developed and written by FSTC and designed to run on a standard Zenith-248 with Intel 80286 microprocessor, one high-density floppy disk drive, a 20-megabyte (minimum) hard disk, and a color monitor with EGA or VGA graphics card. Other configurations may also be possible since PCQT runs on any computer that runs DOS.

How to Acquire PCQT

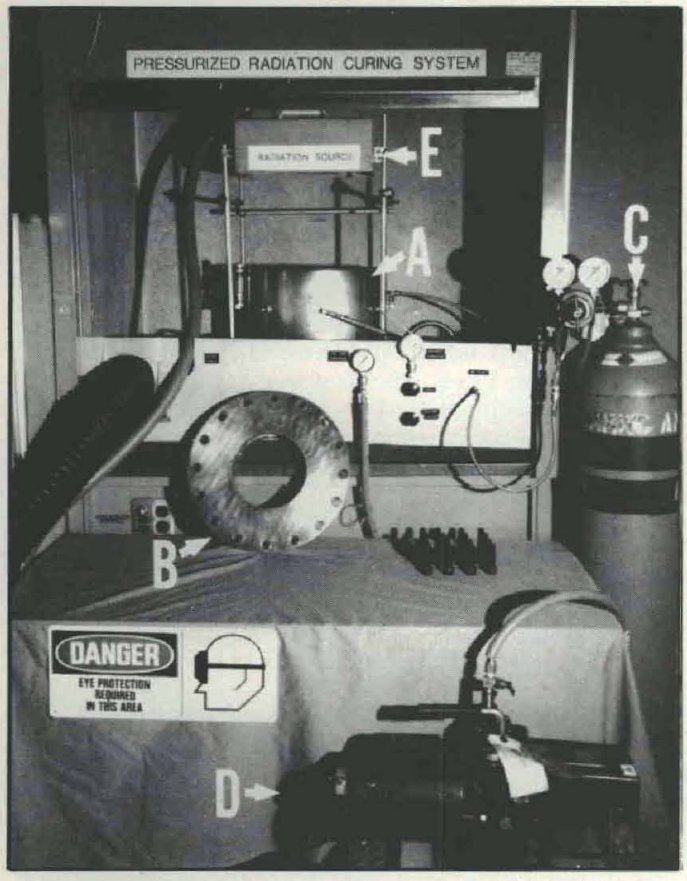
PCQT has been available since September of last year to S&TI customers at approved facilities and with approved document accounts. For further information concerning PCQT, readers are encouraged to contact: U.S. Army Foreign Science and Technology Center, ATTN: Plans and Operations, 220 Seventh Street, NE, Charlottesville, VA 22901-5396.

MTL Develops New Adhesives Curing Process

The U.S. Army Materials Technology Laboratory, Watertown, MA has developed a new polymer adhesive and reinforced polymer composite fabrication process. The process allows polymer-based parts to be cured by radiation while simultaneously being compacted in an autoclave-like pressure environment, using a specially designed windowed pressure vessel. The test vessel at MTL has a pressure range of 0 to 100 psi.

This advance is applicable to two separate technology areas where it shows particular promise: bonding laminated optical devices; and processing polymer composite materials. Currently, the Army and DOD rely heavily on both these technologies, with the number of applications growing each year.

In laminated optical devices, "photo-curable" adhesives (e.g., those that use radiation rather than heat for curing) are often chosen for sensitive optical component applications because the photo cure is essentially a room-temperature cure. Curing at low temperatures is desirable because it minimizes expansions and contractions that occur during conventional thermal processing, which can destroy



Test Vessel and Supporting Components: A) Vessel Body; B) Windowed Coverplate; C) Inert Gas Supply (Nitrogen); D) Vacuum Pump; E) Radiation Source (Xenon Flashlamp)

the performance of sensitive optical devices through distortion. A second reason for selecting radiation curing is its potential for efficient production rates, with cure times ranging from seconds to a few minutes, as opposed to hours in many conventional techniques.

Because the adhesive bond line between optical layers is inherently part of an optical device, the thickness and quality of the bond line affects optical performance. Compaction pressure, combined with the radiation cure, yields two advantages. Thickness and quality of the bond line can be more accurately controlled by adjusting the compacting pressure. In addition, gaseous bubbles, which lead to voids that cause optical distortions, are reduced or eliminated by the compacting pressure on the liquid resin.

In the area of composite materials, thin (approximately 1/8-inch glass/epoxy-acrylate, photo-curable plates and standard 250 degrees Fahrenheit thermal-curable, glass/epoxy plates have been successfully processed in the test vessel. The epoxy-acrylate plates, which used ultraviolet (UV) rays as the curing radiation, were processed in about three minutes. The 250-degree cure epoxy plates used infrared (IR) rays as the curing radiation and were cured in 25 minutes. The preparation for cure was similar to that for conventional processing. A pressure of 90 psi was applied for compaction. The plates turned out as well as conventionally cured high quality autoclaved composites.

The test vessel is able to process small objects up to seven inches in diameter. Currently the system is being modified to allow use of radiations other than UV and IR, including microwaves and ionizing radiations — specifically, accelerated electron beams and gamma rays. These techniques allow deeper penetration through composites and dense solids, increasing the thickness limit of parts that can be cured.

These important, growing areas of technology are already deeply incorporated into military systems. With the development of this process, the Army and DOD have a new tool ready to be applied to adhesive and composite processing problems.

Engineers Enter Joint Research Program

The U.S. Army Corps of Engineers will take part in 17 projects under a landmark research and development program shared with the U.S. construction industry. Robert W. Page, assistant secretary of the Army for civil works, announced that the Corps will participate in the R&D Productivity Advancement Research (CPAR) Program. The Corps solicited proposals for the program early last year. The new program builds on and benefits from the Corps' existing $250 million per year research and development efforts, and the capabilities of its 1,100 engineers and scientists at six laboratories throughout the nation.

In announcing the selected projects, Page said, "I am extremely pleased with the number and quality of the proposals we received. These will provide the initial work that will develop the advanced technology this country needs to increase productivity within its domestic construction industry and to improve our ability to compete world-wide. On the federal level, we expect to reduce costs and realize savings in both civil and military construction, and our work for other agencies."

The Corps received 145 proposals in response to its request. The Corps' R&D laboratories screened the proposals and recommended 45 of them to the CPAR Executive Committee, composed of senior Corps officials. The Committee selected 17 proposals for FY 89 funding.

The selected proposals cover a broad cross-section of construction technology, including advanced materials and construction methods, robotics, innovative information management, and improved design methods. Industry partners include construction and architect/engineer firms, equipment and materials manufacturers, academic institutions, non-profit organizations, trade associations and state agencies.

The Corps will provide $2.732 million for the work, with the industry partners contributing $7.075 million. The average project length is two years.

RD&A NEWS BRIEFS

Cianciolo Becomes AMC DCG for RD&A

LTG August M. Cianciolo has assumed new duties as deputy commanding general for research, development, and acquisition, HQ, U.S. Army Materiel Command, following LTG Jerry M. Bunyard's retirement from the Army.

Cianciolo is a graduate of Xavier University with a B.A. in accounting and has an M.S. in aerospace engineering from the University of Southern California. He has also completed the basic course at The Field Artillery School, the advanced course at The Air Defense Artillery School, the U.S. Army Command and General Staff College, and the U.S. Army War College.

Cianciolo was formerly the commanding general, U.S. Army Missile Command, Redstone Arsenal, AL. Other key assignments have included deputy for systems management, Office of the Assistant Secretary of the Army (RD&A), Washington, DC; deputy director of materiel, plans and programs, later deputy director of weapons systems, Office of the Deputy Chief of Staff for Research, Development, and Acquisition, Washington, DC; and project manager, Standoff Target Acquisition/Attack System, U.S. Army Electronics Research and Development Command, Fort Monmouth, NJ.

Cianciolo is a recipient of the Distiguished Service Medal, the Bronze Star Medal with "V" Device (with two Oak Leaf Clusters), the Meritorious Service Medal (with Oak Leaf Cluster), Air Medals, the Army Commendation Medal (with 2 Oak Leaf Clusters), and the Master Army Aviator Badge.

Awards System for Army Civilians

This past April marked the first anniversary of a major milestone in the Army's incentive awards program. "Before April 1988, we had the equivalent of only the military Army Commendation Medal to cover the large area between the Legion of Merit and the Certificate of Achievement," explained Sandra Cangiano in the Office of the Army's Director of Civilian Personnel. "Creating two new awards, one below and one above the Commander's Award, filled these gaps. The awards criteria and approval authority were aligned to make all of these awards comparable with their military counterparts." she said.

The new Superior Civilian Service Award and the Achievement Medal for Civilian Service gives the Army's civilian population access to five awards, on a par with the military's. Here's how the awards line up in rank order: Decoration for Exceptional Civilian Service, Meritorious Civilian Service Award, Superior Civilian Service Award, Commander's Award for Civilian Service, and Achievement Medal for Civilian Service.

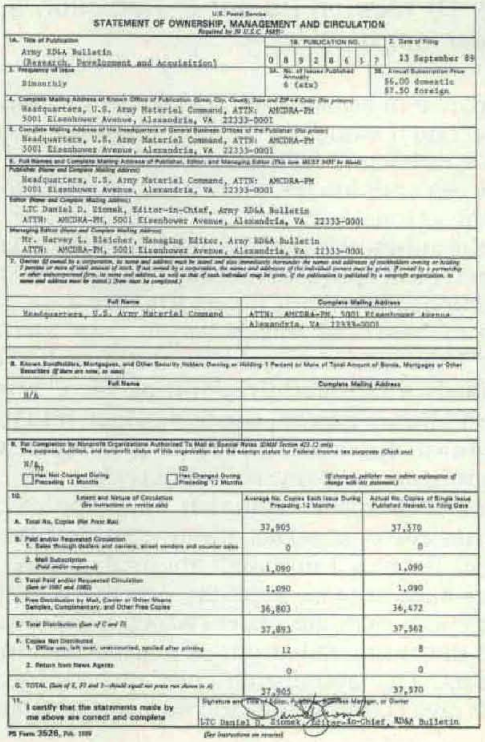
"The Superior Civilian Service Award is presented for outstanding service or achievement, and normally covers a minimum period of one year of service. All appropriated fund and non-appropriated fund employees, both U.S. citizens and foreign nationals, are eligible for consideration," Cangiano said. She added that commanders in the grade of 0-8 and above, and their civilian equivalent, may approve this award. It consists of a medal, lapel pin, and a certificate (DA Form 5655). The comparable military award is the Meritorious Service Medal.

The Achievement Medal for Civilian Service, now the fifth highest on the list, falls directly below the Commander's Award for Civilian Service. "It's presented for noteworthy service or achievement. Again, appropriated fund and non-appropriated fund employees, both U.S. citizens and foreign nationals, are eligible for consideration. Commanders at the 0-5 level and above, and their civilian equivalent, may approve this award. It consists of a medal, lapel pin and certificate (DA Form 5454). The comparable military award is the Army Achievement Medal," Cangiano explained.

She noted that the two new awards came into being from a recommendation of the Army's Civilian Personnel Modernization Project that the system of awards for civilians be aligned with that of the military. The alignment, she added, is intended to maintain the integrity of higher-level awards, increase the commander's opportunity to recognize deserving employees, increase the opportunity for recognition in the absence of monetary awards, and provide awards that may be appropriately used to recognize retiring Army employees.

For the nominating criteria and procedures for processing award candidates, commanders are encouraged to consult AR 672-20 (Incentive Awards), including its interim Change No. 104 (April 28, 1988).

"The certificates and decoration sets for the Superior Civilian Service Award (DA Form 5655) and the Achievement Medal for Civilian Service (DA Form 5654) are available through normal supply channels." Cangiano concluded.



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

1A. Title of Publication: Army RD&A Bulletin (Research, Development and Acquisition)	1B. PUBLICATION NO.: 0 8 9 2 8 6 5 7	2. Date of Filing: 13 September 89
3. Frequency of Issue: Bimonthly	3A. No. of Issues Published Annually: 6 (six)	3B. Annual Subscription Price: $6.00 domestic $7.50 foreign

4. Complete Mailing Address of Known Office of Publication (Street, City, County, State and ZIP+4 Code) (Not printers)
Headquarters, U.S. Army Materiel Command, ATTN: AMCDRA-FM 5001 Eisenhower Avenue, Alexandria, VA 22333-0001

5. Complete Mailing Address of the Headquarters of General Business Offices of the Publisher (Not printer)
Headquarters, U.S. Army Materiel Command, ATTN: AMCDRA-FM 5001 Eisenhower Avenue, Alexandria, VA 22333-0001

6. Full Names and Complete Mailing Address of Publisher, Editor, and Managing Editor (This item MUST NOT be blank)
Publisher (Name and Complete Mailing Address)
Headquarters, U.S. Army Materiel Command, ATTN: AMCDRA-FM 5001 Eisenhower Avenue, Alexandria, VA 22333-0001

Editor (Name and Complete Mailing Address)
LTC Daniel D. Stemek, Editor-in-Chief, Army RD&A Bulletin ATTN: AMCDRA-FM, 5001 Eisenhower Avenue, Alexandria, VA 22333-0001

Managing Editor (Name and Complete Mailing Address)
Mr. Harvey L. Bleicher, Managing Editor, Army RD&A Bulletin ATTN: AMCDRA-FM, 5001 Eisenhower Avenue, Alexandria, VA 22333-0001

7. Owner (If owned by a corporation, its name and address must be stated and also immediately thereunder the names and addresses of stockholders owning or holding 1 percent or more of total amount of stock. If not owned by a corporation, the names and addresses of the individual owners must be given. If owned by a partnership or other unincorporated firm, its name and address, as well as that of each individual must be given. If the publication is published by a nonprofit organization, its name and address must be stated.) (Item must be completed.)

Full Name	Complete Mailing Address
Headquarters, U.S. Army Materiel Command	ATTN: AMCDRA-FM, 5001 Eisenhower Avenue Alexandria, VA 22333-0001

8. Known Bondholders, Mortgagees, and Other Security Holders Owning or Holding 1 Percent or More of Total Amount of Bonds, Mortgages or Other Securities (If there are none, so state)

Full Name	Complete Mailing Address
N/A	

9. For Completion by Nonprofit Organizations Authorized To Mail at Special Rates (DMM Section 423.12 only)
The purpose, function, and nonprofit status of this organization and the exempt status for Federal income tax purposes (Check one)
N/A
(1) ☐ Has Not Changed During Preceding 12 Months (2) ☐ Has Changed During Preceding 12 Months (If changed, publisher must submit explanation of change with this statement.)

10. Extent and Nature of Circulation (See instructions on reverse side)	Average No. Copies Each Issue During Preceding 12 Months	Actual No. Copies of Single Issue Published Nearest to Filing Date
A. Total No. Copies (Net Press Run)	37,905	37,570
B. Paid and/or Requested Circulation 1. Sales through dealers and carriers, street vendors and counter sales	0	0
2. Mail Subscription (Paid and/or requested)	1,090	1,090
C. Total Paid and/or Requested Circulation (Sum of 10B1 and 10B2)	1,090	1,090
D. Free Distribution by Mail, Carrier or Other Means Samples, Complimentary, and Other Free Copies	36,803	36,472
E. Total Distribution (Sum of C and D)	37,893	37,562
F. Copies Not Distributed 1. Office use, left over, unaccounted, spoiled after printing	12	8
2. Return from News Agents	0	0
G. TOTAL (Sum of E, F1 and 2—should equal net press run shown in A)	37,905	37,570

11. I certify that the statements made by me above are correct and complete. Signature and Title of Editor, Publisher, Business Manager, or Owner: LTC Daniel D. Stemek, Editor-in-Chief, RD&A Bulletin

PS Form 3526, Feb. 1989 (See instructions on reverse)

The following correspondence was submitted to Army RD&A Bulletin just prior to GEN Tuttle departing his former assignments as commanding general of the U.S. Army Logistics Center, Fort Lee, VA, and as deputy commanding general for logistics, U.S. Army Training and Doctrine Command. He is now commanding general of the U.S. Army Materiel Command, Alexandria, VA.

DEPARTMENT OF THE ARMY
UNITED STATES ARMY LOGISTICS CENTER
FORT LEE, VIRGINIA 23801-6000

REPLY TO
ATTENTION OF

ATCL-CP

21 September 1989

MEMORANDUM FOR EDITOR, ARMY RD&A BULLETIN, 5001 EISENHOWER AVENUE, ALEXANDRIA, VA 22333-0001

SUBJECT: Army Scientist Program

1. I read the article The Uniformed Scientist - An Uncertain Future, RD&A Bulletin, July - August 1989, by CPT Ralph G. Hay, with great interest. His forthright assessment of the problem and the need for scientists in the Army are well understood by the senior leaders in the Army

2. Let me assure CPT Hay and his fellow "green suit" scientists that their value to the Army is acknowledged and appreciated. There is a solid commitment to create, resource and support a viable career pattern for these valued members of the Army community.

3. First, in late August, the Commanding General of TRADOC gave the Commandant of the Command and General Staff College, in his role as focal point for Leader Development, the charge to develop an Army Scientist program. This effort will begin with the establishment of a working group, including AMC and PERSCOM to develop a management strategy. The group will also develop a life cycle model to include an in-depth analysis and will report to the Chief of Staff, Army on the best approach to recruitment, education, utilization and retention of uniformed scientists.

4. Rest assured that as I prepare to take command of Army Materiel Command, where 80 percent of the Army's scientists work, the Army Scientist Program will be one of my highest priorities.

WILLIAM G. T. TUTTLE, JR.
Lieutenant General, USA
Commanding

ARMY RD&A BULLETIN
ISSN 0892-8657

Headquarters
U.S. Army Materiel Command
5001 Eisenhower Avenue
Alexandria, VA 22333-0001

SECOND CLASS
POSTAGE PAID
AT ALEXANDRIA, VA
(and Additional Offices)

Training in the 21st Century