ARMY RD&A MAGAZINE

MARCH-APRIL 1987

ILS AND STREAMLINED ACQUISITION

User Demonstrations

Requirements Freeze

Market Analysis

Design Freeze

Tailoring

Research Development Acquisition ARMY RD&A

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ABOUT THE COVER

The impact of the Army streamlined acquisition process on integrated logistic support is the subject of the front cover feature article. The back cover shows a proposed Battlefield Location and Information System Satellite associated with a unique technology effort at the Army Chemical RDE Center.

FEATURES

DEPARTMENTS

As a result of recent changes in the Army's periodicals program, Army RD&A Magazine will no longer be produced. However, since the requirement still exists to keep the RD&A community knowledgeable of important developments, we have been authorized to publish a new Army RD&A Professional Bulletin. The new bulletin will entail some format, content, and potential distribution changes, which are presently being worked out. We look forward to publishing the new bulletin shortly and solicit your continued support.

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ILS and the Streamlined Acquisition Process

By Ted Schmidt

Background

The release of AR 70-1, System Acquisition Policy and Procedure, November 1986, institutionalized the Army Streamlined Acquisition Process (ASAP) as the preferred acquisition strategy when product improvement or nondevelopment items will not fill a stated need. Coupled with AR 71-9, Materiel Objectives and Requirements, released for use on March 27, 1986, this new acquisition process has sent shockwaves throughout the combat and materiel development communities. Flags have raised over the practicality of prescribed time frames and the potentially insurmountable task of developing and fielding a support structure concurrently. Comparisons have been drawn between recent experiences with "accelerated" acquisition programs and what can be expected to occur with the implementation of ASAP.

To set the stage for the remainder of this article, the point needs to be made that accelerating is not synonymous with streamlining. Webster provides the following definitions: *ACCELERATE* means to hasten the progress or development of. *STREAMLINE* means to make simpler or more efficient. The difference between the two brings to mind an adage familiar to all of us: Work smarter, not harder.

History shows that progressing from Milestone Decision Review I (MDR I), the initiation of advance development efforts (6.3 Funds), to MDR III, production decision, takes seven to 10 years when applying the "traditional" acquisition process. This time frame, encompassing a Demonstration-Validation Phase and a Full-Scale Development Phase, should seemingly provide more than enough time for developing a support structure and having that structure in place to support initial fieldings. However, history also shows us initial fielding of new equipment is typically executed under a conditional release; that is with one or more of the elements of support lacking at the time of fielding.

Interestingly, there is high correlation in the factors contributing to the length of time systems spent in development and those restricting our ability to field a totally supportable system. These are the same pitfalls that ASAP is aimed at improving.

The Goal

A goal of progressing from program go ahead decision to a production decision within four years has been established for ASAP programs. A simplified comparison of the traditional and streamlined acquisition processes is shown in the January-February 1986 issue of *Army RD&A Magazine*. The major premise in meeting the four year goal is development of a common sense approach (acquisition strategy) to meeting a stated need through a low risk development. Some key initiatives follow.

Initiatives

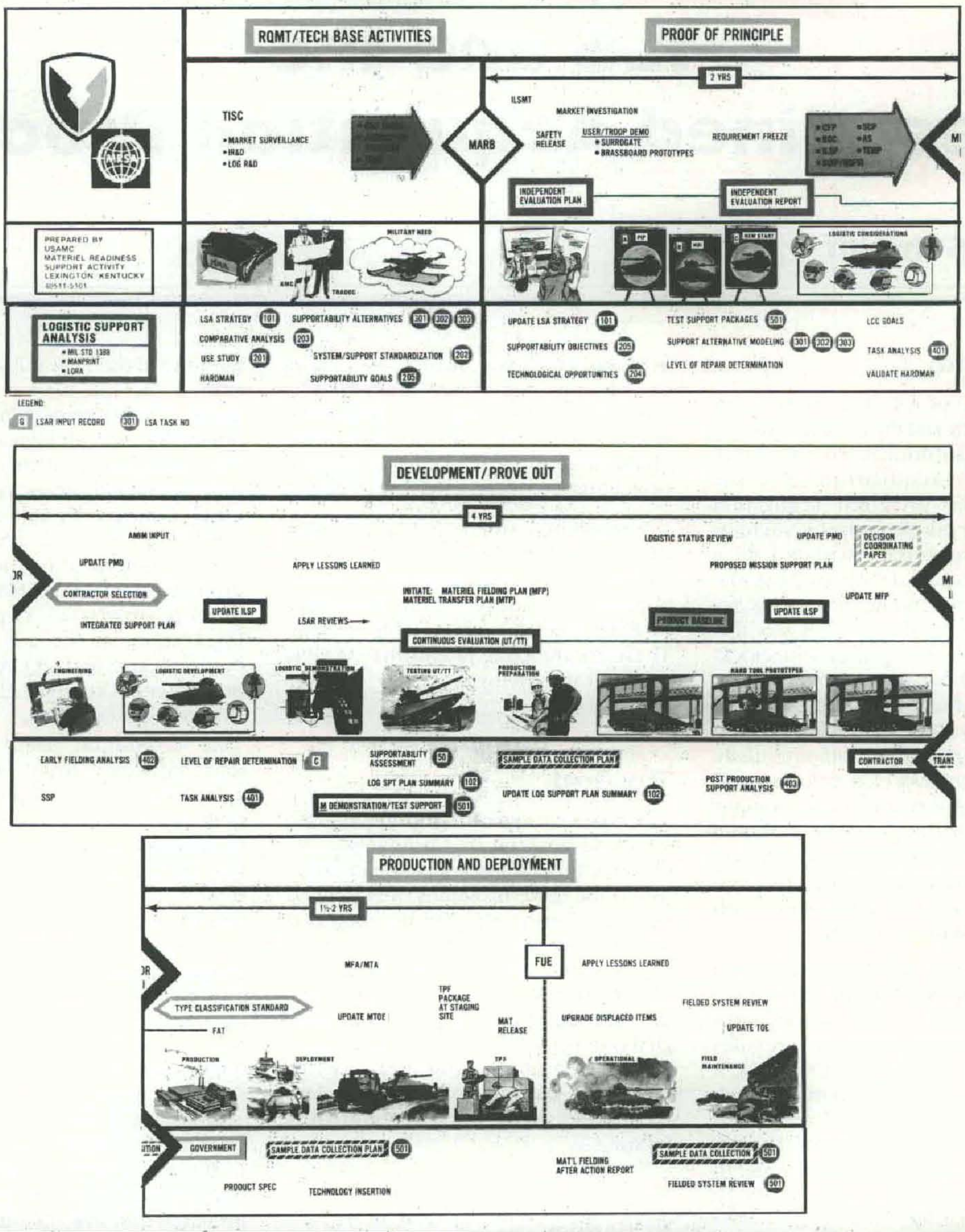
A Technology Integration Steering committee (TISC), consisting of representatives from both the combat and materiel development communities, has been established. The TISC is designed to match technological opportunities with emerging Army needs, surfaced through the Mission Areas Analysis process, and direct and monitor technology maturation accordingly. In effect, research priorities are established based on operational needs. Findings of the TISC will drive the preparation of Operational and Organizational (O&O) Plans which will reflect obtainable technological approaches. The commander of the Army Laboratory Command serves as the Army Materiel Command (AMC) lead for the TISC, and will work advanced system concept offices at the other major subordinate commands (MSCs). The integrated logistic support (ILS) implications of this activity were recognized early, and HQ, AMC has issued policy letters stating LABCOM responsibilities directing ILS.

An acquisition team, consisting of representatives from combat developer, materiel developer, user, tester, evaluator, logistician and other appropriate communities, will be formed before MDR I/II for non-major systems to serve a role similar to the Special Study Group and Special Task Force. This team provides the forum to assure appropriate analyses are conducted in defining materiel requirements and associated constraints. Of particular interest here to the ILS manager, is the opportunity to establish a baseline system and conduct comparative analysis.

O&O Plans are to be submitted for approval six months after formulation of the initial draft. A Required Operational Capability (ROC) is then to be prepared and available for approval to support an MDR I/II decision within 18 months. The approved ROC will be "frozen" at MDR I/II which represents the go/no go decision. This improvement will stabilize the development effort, therefore reducing hardware changes and the resulting impacts on ILS development.

Market Analysis is recognized as a two phased activity. The first phase, Market Surveillance, is a continuous activity directed at maintaining a working knowledge of technical capabilities and

ILS IN THE ARMY STREAMLINED ACQUISITION PROCESS (ASAP)



industrial capacities to meet potential user requirements. The second phase, Market Investigation, is a detailed review of the market aimed at satisfying an approved O&O Plan.

The market investigation is conducted in accordance with an Independent Evaluation Plan, and its results directly influence the acquisition strategy. Both aspects of market analysis afford the ILS community an opportunity to influence the acquisition strategy, assuring supportability is adequately addressed.

User/Troop demonstrations will be conducted during the Proof of Principle (Prior to MDR I/II), employing prototypes or surrogates to confirm operational concepts, and to support the development of an acquisition strategy and test plans. These demonstrations will benefit the ILS community in formulating initial support concepts and identification of potential cost drivers.

Draft (ROC) documents are to be coordinated with industry. The purpose of this coordination is to influence industry's Independent Research and Development activities, and to obtain earlier technological feasibility information to shape realistic requirements, also resulting in risk reduction.These documents are also being coordinated through the System Requirements Review Board at the MSCs, providing an opportunity for participation on the part of the ILS office. The opportunity to participate in the requirements process assures the ILS community the early involvement that has been lacking in the past.

Preplanned Product Improvement

The aforementioned initiatives are all directly aimed at establishing requirements documents that are achievable. The Preplanned Product Improvement (P3I) strategy will be employed for technology insertion as emerging technologies become available and future threats became more eminent. P3I is also designed to avoid excess risk in the development effort. The result is a more reliable and supportable system which will counter the current threat and will grow to meet the future threat with improved technology as it becomes available.

Development-Prove Out

Program approval at Milestone I/II marks the beginning of the Development-Prove Out Phase. It is during this phase that the prescribed time savings are to be realized, but only as a result of the improvements in the technology base and requirements definition described earlier. During this phase, the logistic support structure is developed based on the analyses conducted and concepts developed during the Proof of Principle Phase. Again, ASAP policy includes initiatives that will work in favor of the ILS manager.

Project Manager (PM) designation will typically occur at the beginning of this phase, or immediately preceding it. It is the intention of the AMC commander to ensure the PMs tenure will span the entire development effort through initial fielding. This policy broadens the perspective of the PM and adds continuity to the program. The PM should now (if he wasn't already) be as equally concerned with initial supportability as he is with the developmental aspects of the program.

The goal of the Development/Prove Out Phase is to smooth transition to production through the use of hard tooled prototypes and to freeze design before the type classification decision. The inability to stabilize design in the past has put the ILS manager in the position of the proverbial passenger boarding a moving train when developing support for a given system, but the community's cries have gone somewhat unnoticed.

The introduction of ASAP brings the concerns of the entire acquisition community in parallel with those of the ILS manager. When this goal of design freeze is not obtainable due to risk, limited production options will be exploited to expedite verification testing and transition to full production (only after design freeze) and accomplishment of First Unit Equipped (FUE). (The definition of FUE includes the availability of the support structure as part of the system).

Development programs will maximize the use of proven technology and components. These proven components bring with them defined support requirements and, as a minimum, commercial technical documentation.

The principle of "continuous evaluation" will be used throughout the life cycle, supported by a Common Test Data Collection System. This system is being instituted to eliminate duplicative testing, and facilitate the identification and correction of problem access in a more timely manner. Test data associated with a program will be on-line, providing an audit trail from the program inception through first article test.

Major Challenges

The major challenges facing the ILS manager remain. The requirements for timely provisioning, technical publications, training packages, Modified Table of Organization and Equipment (MTOE) development, parts availability, Test, Measurement and Diagnostic Equipment (TMDE) and Test Program Sets to support total package fielding are monumental. Fortunately, the Logistic Support Analysis/Logistic Support Analysis Record (LSA/LSAR) process, as prescribed by MIL-STD-1388-1A and 1388-2A, respectively, are tailorable.

Effective application of the LSA tasks (government and/or contractor performed) and effective contracting for the delivery of appropriate data items based on the overall program schedule will facilitate delivery of a supportable system. A notional application of ILS principles, to include performance of LSA, is provided in the accompanying chart.

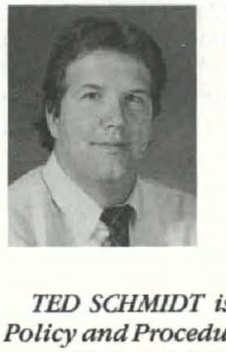
A primary goal of the ILS program has always been to influence hardware design and minimize operating and support requirements. To meet this goal, logistic oriented analysis must be conducted to support the development of requirements documents (O&O Plan and ROC), as well as during the hardware development phases. The overall success of the ILS program is dependent on this foundation.

The definition of the new Requirements/Technical Base Activities and the Proof of Principle Phase provide a more formal structure for the ILS community to work within. Initiatives to freeze requirements and hardware design are intended to reduce development leadtime and improve configuration control, but will also work to the benefit of the ILS manager.

Summary

ASAP is a reality, and a necessary one if the Army is to live within reduced budgets and still continue to modernize. Implementing ASAP presents many challenges to everyone involved in materiel acquisition, and the ILS manager will be no exception. However, the ILS manager stands to gain significantly from the thrusts behind the ASAP.

Granted, there will be less time available to build a logistic support structure, but risk reduction and program stabilization mean fewer false starts—freezing the requirement and design translate to freezing the support structure. The ILS community should stand strongly behind ASAP, but in doing so it should be assured that ASAP is being allowed to work through the initiatives that were brought with it rather than forced to work as before in dealing with accelerated programs.



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Interview With. . .

Dr. Louis M. Cameron

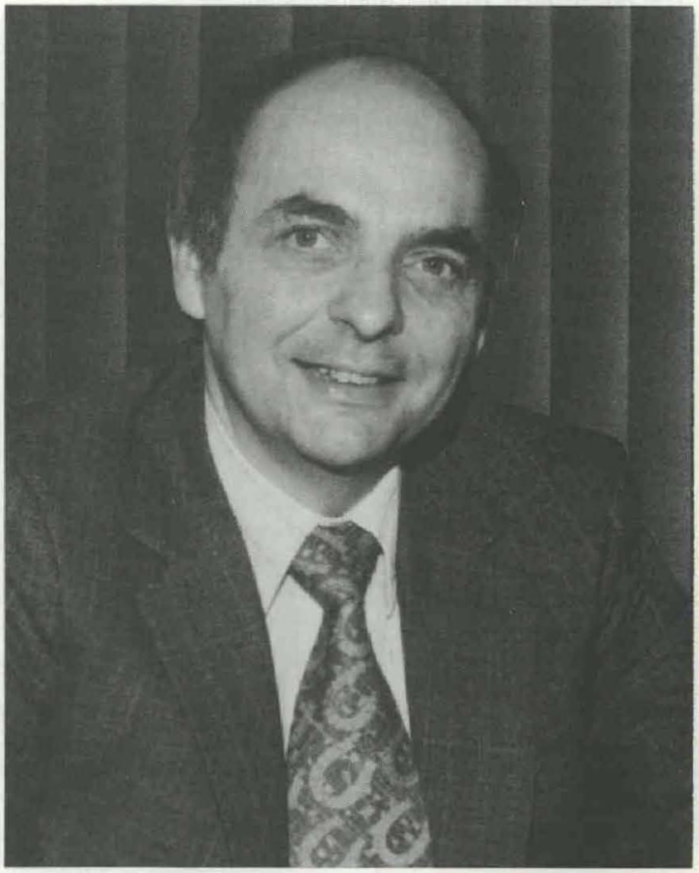
Director of Army Research and Technology

Q. ***What is the primary purpose of the Army's research and technology program?***

A. Our primary purpose is to provide the science and technology necessary for U.S. Army materiel to be affordable and technologically superior to the threat. This requires a strong research and advanced technology program consisting of basic research (6.1), exploratory development (6.2), and and non-system specific advanced development (6.3A). The Army's research and advanced technology (R&AT) program provides fundamental science and technology information in support of materiel systems development and production. We must maintain the proper balance between the need for low risk, evolutionary developments and more visionary leap-ahead technology efforts required to maintain technological superiority in our fielded systems, not just in the laboratory. R&AT is an investment in our future and is vital to the Army's fielding the most effective deterrent to the threat.

Q. ***During the past few years, the Army leadership has emphasized greater use of non-developmental items. How do you rate the success of this effort thus far?***

A. The Army leadership's emphasis on expanding the use of non-developmental items has already had significant positive impact. Of course, the non- developmental approach is only one of three alternatives that must be considered prior to embarking on a traditional life cycle systems management model acquisition approach. The other two alternatives are: (1) change tactical or strategic doctrine, improve training or improve and expand organization, thereby avoiding acquisition of materiel to correct a stated deficiency; and (2) product improvement of existing Army systems. There have been a number of successful applications of NDI to date. One example is the Commercial Utility Cargo Vehicle currently in production and meeting Army requirements for a low cost, lightweight, readily available vehicle. NDI is not a panacea for our desires to reduce the time it takes to field materiel development; however, when appropriate, it can, in fact, shorten that cycle and still satisfy requirements.



Dr. Louis M. Cameron

"We must maintain the proper balance between the need for low risk, evolutionary developments and more visionary leap-ahead technology efforts required to maintain technological superiority in our fielded systems, not just in the laboratory."

Q. *Army critics sometimes claim that the Army tends to expend too much effort on research which offers no real potential for future military applications. How do you respond to this criticism?*

A. I disagree. Perhaps these critics do not recognize that basic research is by nature scientific, theoretical, and more generic than exploratory, advanced and full-scale development. Their perception also fails to acknowledge our recent initiatives to establish Centers of Excellence for technologies that are critical to the military. These technologies include: rotary wing aircraft technology; artificial intelligence; manufacturing science; biotechnology; and electro-optics, to name a few. Eleven of these Centers of Excellence are products of the University Research Initiative (URI) program established in FY86 following comprehensive nationwide competition. URI is part of a DOD-wide program. We see many benefits to this program. Fundamental research and critical Army technologies will be stimulated, and these Centers of Excellence will provide a means of obtaining highly qualified technical advice. A stronger university and Army laboratory interface will result. A major benefit will be that more scientists and engineers will be educated in disciplines crucial to the Army. We must be careful not to require our researchers to show a direct linkage between their basic research endeavors and some future system or specific deficiency. Our laboratory directors must have a significant portion of the basic research program to direct toward those scientific areas for which they foresee the most important benefit to the Army and for which their organization is most qualified to perform. In addition to our Army in-house laboratory research and the research performed by the Centers of Excellence, we also award through the Army Research Office hundreds of contracts to individual investigators in the academic community. These contracts also show relevance to the Army.

"We must be careful not to require our researchers to show a direct linkage between their basic research endeavors and some future system or specific deficiency."

Q. *What areas of technology do you think offer the greatest potential for improving the materiel capabilities of the Army during the next decade?*

A. This year the Army has identified 20 of its highest priority technology demonstration programs. This list of top 20 technology demonstrations reflects those technologies I consider to offer the most potential in the next decade. Some of the technologies prevalent in our "Top 20" include: armor/anti-armor, robotics and machine intelligence; aided target recognition; multiple sensor fusion; propulsion and power sources; simulation; computers/software; microelectronics; signal processing; integrated and automated crew stations; life sciences including biotechnology; distributed C3I; survivability; lightweight/high-strength/high-temperature materials; and MANPRINT technologies. Technology has already changed the modern battlefield by improving firepower; mobility; surveillance and target acquisition; and the potential for concealment and surprise.

Technology has led to increased information flow and continuous operation on an extended integrated battlefield. I see great promise for microelectronics, advanced sensors, expert systems, artificial intelligence, and robotics because of the need for improved battlefield synchronization, lethality, and survivability. These technologies will become increasingly important as our weapon systems become more capable and complex while the Army's size is capped. Our soldiers are being required to cover more and more battlefield area. One challenge, therefore, is to do more with fewer people in less time with fewer mistakes. Total battlefield management is being significantly enhanced by the advances in microelectronics. The spectrum of sensors is making it possible now to scan more of the battlefield under more conditions. We are realizing orders of magnitude enhancement in signal/data processing and greatly increasing our tactical decision aids. We are working closely with the Defense Advanced Research Projects Agency and industry to advance the state-of-the-art of several technologies including: remotely controlled and automated vehicles, and the strategic computing initiative.

Q. *Could you evaluate the potential impact of the Gramm-Rudman legislation on the Army's R&D program?*

A. The reduction in our R&AT funding in the first year of the law, FY 1986, caused us to drop some of our lower priority, though still valuable, programs. In keeping with our management initiative to provide the critical mass of resources for programs and not to stretch everything out, we eliminated some of the lower priority programs so that other, higher priority programs could be properly executed. We felt this approach to absorbing budget reductions provided the Army with a better investment than simply applying across-the-board "salami slicing" reductions. Congress reduced our FY 1987 R&AT budget request by a substantial margin, which I believe was caused, at least in part, by the need to meet Gramm-Rudman budget constraints. In addition to terminating some programs, we have had to reduce the number of competing technologies and advanced concepts we can pursue for a given problem. This is always risky. Mistakes manifest themselves in terms of the right technologies not being matured in time for the start of full-scale development of future systems.

Q. *What is the Army doing to improve its research and technology interface with the academic community?*

A. The Army's new University Research Initiatives (URI) program is such an initiative. The Army committed its URI program from its inception to be focused around research centers to meet Army needs rather than concentrating on increasing existing fellowship and instrumentation funding. The Army's URI program has a strong emphasis on the interchange of Army laboratory and university scientists and engineers to both build a strong interface to the academic community and to concentrate national academic resources on Army problems. Before the URI program was initiated, the Army had already recognized the value of applying the resource critical mass in the academic community to solving Army problems. The Army has had a Center of Excellence in mathematics for some years. Several years ago the Army expanded this concept by establishing three Centers of Excellence in rotary wing aircraft technology. Recently the Army established two Centers of Excellence in artificial intelligence that are already leveraging equipment and resources from industry. In addition to the many centers in academia, the Army sponsors a multitude of research contracts covering the broad scope of Army research interests. The program at our Army Research Office concentrates on direct funding to the university community, and our Army laboratories each have research funding that can be used to support academic research.

Q. ***How does the Army avoid technological surprises that might cause premature weapon system obsolescence?***

A. It is the responsibility of the Army R&AT community to be as cognizant as possible of the current and future state-of-the-technology in their areas of responsibility. The Army R&AT community closely follows the work in the university community; in industry, including tracking IR&D; the work in the other Services; and the work sponsored by DARPA and the DOE national labs. This interaction with these communities provides a very good framework for tracking current and future technologies. In addition, there are formal interchanges of information with our NATO allies, and the intelligence community keeps us informed on technological activities of our potential adversaries. The R&AT community plays a vital role by performing technology assessments in support of advanced systems and concepts, future system concept formulation, and PIP/Block Improvement/P3I program definition. In this manner we reduce the risk of technological surprise to a minimum as we seek to maximize our exploitation of technology for future systems.

Q. ***Last year at an Army/industry conference, a senior Army acquisition manager called on industry to be more vocal regarding the availability of new technology which might benefit the Army. Have you seen some improvements in this area?***

A. I can certainly say that requests by industry representatives to discuss their technology with both myself and my staff have not decreased in the past year. I consider personal visits to our staffs and the Army laboratories just one method for exchanging information and ideas. I think industry is becoming more vocal at the various symposia and government/industry conferences. We have taken steps to increase our interactions with industry by holding more symposia. Just last year the Army held a very well attended successful artificial intelligence/robotics symposium in Austin, TX. The Army laid out a comprehensive set of programs that we were interested in pursuing in this relatively new area and specifically opened the door to feedback from industry. The Army is also making more use of broad agency announcements and requests for information.

"By far our biggest challenge in the short term is to readjust our R&AT programs to meet a vast array of Army requirements for the next decade's systems when our budgets have been cut back."

One recent success story was the Night Vision Electro-optic Center call for white papers on aided target recognition technologies. This resulted in a number of the industry responses being funded. Overall, I think the answer to your question is that industry has always been fairly vocal in informing the Army about their capabilities, but this process has received more visibility in the past year and this perhaps has encouraged more feedback from industry than we previously had.

Q. ***What do you believe are the biggest short-term and long-term challenges facing the Army's Research and Technology Program?***

A. By far our biggest challenge in the short term is to readjust our R&AT programs to meet a vast array of Army requirements for the next decade's systems when our budgets have been cut back. In the 1970s the Army concentrated on the "Big 5" systems: M1, Bradley, Patriot, Apache, and Blackhawk. Today these systems are being fielded in quantity. The challenge in the R&AT community is to provide the most cost effective technology to support the next generation systems, such as LHX and the Armored Family of Vehicles, while providing the technology needed for: the five Key Operational Capabilities; Lighting the Force; solving current Battlefield Development Plan/Mission Area Materiel Plan deficiencies; solving chronic and pervasive problems; and preserving enough resource critical mass to modernize our laboratories so we can do the world class research and technology development the soldier deserves. The five Key Operational Capabilities to which I referred are: Soldier and Unit Performance Enhancement; Battlefield Lethality; Reconnaissance, Surveillance and Target Acquisition; Command, Control and Communication; and Battlefield Sustainment. One of our biggest challenges is to construct a long-term investment strategy commensurate with a realistic budget forecast; modernizing and revitalizing our Army laboratories; and overhauling and modernizing the personnel system for our engineers and scientists. I am currently participating in the DA committee studying this last issue.

Battlefield Location and Information System

By Dr. William S. Seegar, Dr. F. Prescott Ward, Eric J. Hoffman and Joseph G. Wall Jr.

Introduction

In the field of reconnaissance, detection and identification of chemical and biological agents, the U.S. Army's Chemical Research, Development and Engineering Center (CRDEC) at Aberdeen Proving Ground, MD, has asked the following question: Is it feasible to deploy miniature sensors for chemical and biological (C/B) agents on the battlefield, determine their exact position, and relay each sensor's data to a central location?

Tremendous advances in biotechnology and equally stunning achievements in microelectronics hold promise for development of such C/B mini-detectors. In fact, an aggressive acquisition strategy at CRDEC is currently marrying biomaterials, such as antibodies and receptor proteins, to tiny sensing devices including optical waveguides and capacitance chips. Receptor-based detectors actually mimic human responses to chemicals and toxins, and are the best technological hope for all-agent, unknown-agent C/B detectors of the future.

The problem: From arrays of C/B mini-sensors deployed potentially anywhere on the surface of the earth, devise a system to determine exactly where they are, and receive, interpret, collate, and relay this crucial battlefield information to command posts.

Approach

The idea was to develop a small transmitter which could interface with C/B detectors. A satellite-based system seemed the best answer for position-location and data relay, yet proof-of-principle would have to be obtained using an existing system (the fledging project at CRDEC could not afford \$40 million to \$50 million to launch its own "bird").

Transmitter Development

By June of 1984 the first transmitter had been manufactured by APL engineers. It was the size of a pack of cigarettes, weighed only 180 grams, and could be Doppler-located to a nominal accuracy of plus or minus one kilometer. Exposure to sunlight for four hours each day recharged nickel-cadmium batteries for 24 hours of operation.

However, military validation of the system's efficacy was not possible, for the French have asked that ARGOS be reserved for the collection of environmental data.

Considering this caveat, project personnel gained maximum and innovative mileage by meshing their development efforts with an environmental program at CRDEC. They decided to track the movements of migratory birds.

There is a cooperative program at Aberdeen Proving Ground (APG) with state and federal wildlife officials to protect bald eagles on the installation. Since Canada and the United States discontinued the use of DDT and other chlorinated pesticides in 1971, populations of this endangered species have mushroomed in eastern North America, and Aberdeen is once again the premier habitat for bald eagles in the Middle Atlantic states. More than 100 spent the winter on the installation last year. Biologists hope to insure that facets of APG's diverse military mission do not impact adversely this rare resource.

In July of 1984 researchers at APG captured an eagle and affixed one of the transmitting packages to the bird's back. Daily movements were tracked unerringly by satellite for seven months as the bird meandered through eastern states from Maryland to Pennsylvania to Florida.

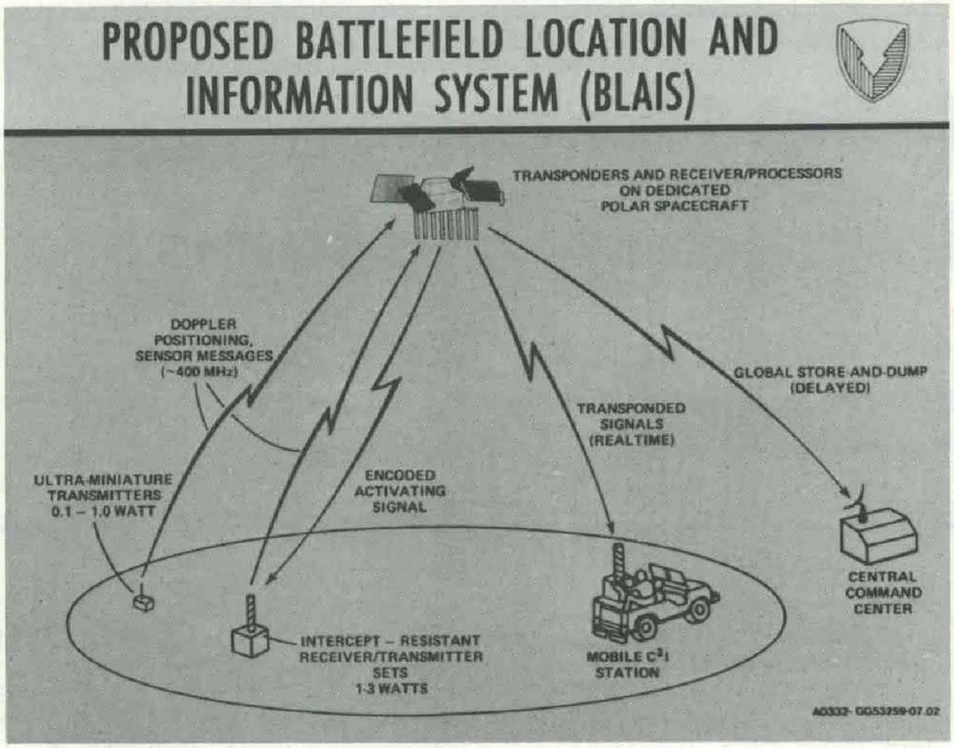
Other telemetry devices placed on swans on Alaska's North Slope and giant petrels in Antarctica have demonstrated the system's ruggedness and global utility. Significantly, transmitters attached to six petrels were also equipped with sensors including one for external temperature and another to monitor motion of the bird.

The temperature sensor, mounted on the front of the transmitter, gave high readings when a bird was stationary because neck features covered the device. The motion sensor was relatively inactive.

On several occasions, petrels took flight during satellite passes and the readings changed dramatically. Temperature plummeted and the motion sensor was saturated. One of the petrels flew more than 2,000 kilometers in 30 days over the South Pacific Ocean west of the Antarctic Peninsula.

It is extraordinary that activity of birds near the South Pole was being remotely monitored in a comfortable office in Maryland by simply dialing an Area 800 telephone number.

Engineers in the Space Department of Johns Hopkins University's Applied Physics Laboratory (APL), Laurel, MD, were contracted to perform a feasibility study. Their calculations indicated that



a transmitter weighing less than 200 grams was possible; that the smallest package would work on solar power (versus non-rechargeable batteries), thus making the theoretical life of the device infinite; and that such transmitters could probably interface with existing ARGOS/TIROS satellites.

The ARGOS/TIROS system comprises two U.S.-owned TIROS weather satellites. Each satellite is instrumented with a small, French-owned ARGOS data-collection system used to position-locate and relay information from instruments aboard such things as current buoys and weather balloons.

Fixing the position of a transmitter is done by Doppler-shift principles. As the two satellites orbit the earth's poles (about once every 90 minutes in orthogonal planes), the ARGOS receiver picks up bursts of transmission (1/3 second every minute). Like the shift in sound frequency of a whistle as a train passes, transmission frequencies shift as a satellite traverses around the earth.

Message data and Doppler counts extracted from the miniature transmitters' transmissions are stored for dumping to a few worldwide sites, where the data are then forwarded to the ARGOS control center in Toulouse, France. Processed data are then distributed in bulk to a few worldwide distribution sites, where users can recover the messages and positions over an automated dial-in network.

Potential Military Utility

There is now little doubt that miniature telemetry devices linked with a space-based system can provide remarkable information from anywhere on the globe. However, assets like ARGOS cannot serve military needs well.

In addition to the environmental restriction, ARGOS is not U.S.-owned. It is an old system which requires inordinate power outputs from transmitters and, with only two satellites in orbit, waiting time can be several hours. The radio frequency links are susceptible to jamming and interception.

These and other limitations, plus the fact that space technology has advanced considerably since ARGOS was built, encouraged us to examine alternatives.

The miniature transmitter development effort led CRDEC, in concert with The Johns Hopkins University Applied Physics Laboratory, to conceive the Battlefield Location and Information System (BLAIS). The Applied Physics Laboratory performed a feasibility study on the Spaceborne BLAIS. The proposed system consists of a constellation of polar orbiting spacecraft that would provide coverage for a population of miniature transmitters dispersed anywhere in the world. The approach would require a translator/receiver system on a small number of polar orbiting spacecraft. The translator would support a near-real-time communication link with the ground transmitters while an on-board receiver and processor would perform a storage and dump mission to designated ground tracking facilities. The accompanying figure is a conceptual block diagram of the BLAIS. Geographic positioning of individual microprocessor controlled transmitters would be accomplished by the Doppler measurement technique. The minimal functional requirements on a BLAIS type system have been considered and are listed below.

- By means of a spaceborne receiver and/or translator return a message of up to 50 (or more) bits net length from small transmitters anywhere in the world to any equipped receiving station.
- From the time the message is input to the transmitter, the message shall arrive at the ground terminal within three seconds when the terminal is within the same satellite coverage circle on the transmitter, and shall arrive within: $(12/n)-T$ hours, 50 percent of the time; 12/n hours, 90 percent of the time; and $(12/n)+T$ hours, 100 percent of the time when the terminal is outside the coverage circle, where n is the number of satellites in the constellation ($n<5$) and T is the satellite period.
- Be able to identify the message as having come from any one of 10,000 or fewer transmitters.
- Maintain probability of correct message reception of >0.98, considering all causes, including bit errors and signal collisions, for the transmitter densities stated below.
- Maintain performance with transmitter densities as high as four in any given 1×1 kilometer square.
- Given knowledge of the transmitter's altitude to plus or minus 20 meters and velocity to plus or minus one kilometer per hour, Doppler track the transmitter to a horizontal error not to exceed plus or minus 200 meters, one-sigma.

The system will maintain a lower limit transmitter weight currently estimated below 100 grams.

There are several existing and proposed civilian space systems that have some of the characteristics of orbit selection sought by the BLAIS constellation. A working knowledge of ARGOS, SARSAT, GOES, GLOMR and GEOSTAR has been useful in developing an approach for BLAIS. Existing civilian data reporting systems consist of small constellations of either near-polar or geostationary satellites. To achieve full earth coverage, including the polar regions, at least one high inclination satellite is needed.

Near-polar, medium altitude (800-1,000 kilometers) satellites have several advantages. As few as one satellite can (eventually) cover the entire earth, although alert (waiting) times may be longer than desired. Average and maximum alert times can be set to any desired value by adding satellites to the constellation. For example, five satellites give an alert time of 40 minutes average with a maximum of 200 minutes. This requirement has been adequate for the Search and Rescue Satellite mission but may not provide rapid enough coverage for a military BLAIS constellation.

Improvement in coverage can be achieved by raising the altitude of the spacecraft. As altitude increases, so does the radius of the coverage circle on the earth. The larger coverage circle increases the probability of the transmitter and a real-time ground receiver being simultaneously within range of the satellite transponder. However, the satellite period also increases with altitude, so the time between repeat visits of any one spacecraft also increases. The net result will be a slight improvement with altitude.

To achieve nearly instantaneous data return with near-polar satellites would require a large number of spacecraft. This would force the satellites to be inexpensive and of limited capability. In order to have a fast near real-time response near-polar system, a constellation of 20-40 satellites would be needed. However, a reasonable compromise between alerting time and number of spacecraft would give near-polar, medium altitude orbiting satellites a number of advantages.

Most important is the fact that the lowest transmitter power requires the lowest altitude. Low orbiting spacecraft could then support the fielding and use of the smallest (less than 100 grams) transmitters. Another advantage of the low altitude satellite is that it provides a strong Doppler shift signal from which ground transmitter position can be determined with as few as one satellite. As altitude increases the Doppler effect weakens, disappearing entirely at geostationary orbit. Low altitude orbits also provide a more benign radiation environment for the satellite electronics and solar cells. Therefore, spacecraft below 1,000-1,200 kilometers can generate more power for a given weight, and can perhaps use the latest very large scale integrated circuits technology that may not survive the radiation dose at higher altitudes. There is also a loft weight advantage for lower altitude satellites.

By means of an advanced fan beam phased array spacecraft antenna, BLAIS will be able to use ground transmitter powers substantially below those required for ARGOS, while simultaneously providing a degree of jam-resistance for military application. This unique technology provides for a more versatile spacecraft system for the Army application.

Conclusion

The U.S. Army BLAIS, as it is conceived, is not in competition with the existing spaceborne assets available to DOD but provides an interim system that addresses the needs for a low cost positioning and data system that will address the Chemical Research, Development and Engineering Center application to reconnaissance, detection, and identification of chemical and biological agents.

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Aberdeen Begins Testing Forklift Prototypes

Prototypes for the Army's new 6,000-pound variable reach rough terrain forklift truck arrived at Aberdeen Proving Ground late last year to begin testing.

The prototypes, which were built from specifications developed by the Troop Support Command's Belvoir RD&E Center, were procured under competitive contracts awarded by the Tank-Automotive Command to the following contractors: Koehring, Inc., of Port Washington, WI; the team of Gradall and BMY of New Philadelphia, OH, and York, PA; and the team of JCB and ConDiesel of England and Waterbury, CT. Each contractor built four prototypes for evaluation and testing. Those manufacturers whose vehicles successfully completed the tests will be permitted to bid on the production contract scheduled for awarding in July 1987.

The Ordnance Missile and Munitions Center and School developed requirements for the forklift. These requirements call for a highly maneuverable 6,000-pound forklift that can be used to reach in and unload MILVANS and 20-foot ISO containers filled with ammunition or Multiple Launch Rocket System pods.

It will replace the 6,000-pound forklift which is approximately 20 years old and no longer supportable, and in some applications, the 4,000-pound rough terrain forklifts currently used by ammunition units. Neither of the current vehicles has the capability of unloading containers without additional equipment. (The 4,000-pound truck can be driven in and out, but a ramp is often required because the ammunition must be unloaded from trailer-mounted containers.

Logistic Costs Versus Reliability

By Jim W. Crabtree

Introduction

Optimize rather than maximize reliability. This is the theme that has been echoed within the Army command staff and is filtering its way into Army policy documents such as AR 702-3, Army Materiel Systems Reliability, Availability, and Maintainability.

The Army command staff has recognized that designing a system for the maximum reliability may not significantly reduce overall life cycle costs or increase the systems operational availability. They have also recognized that an optimum reliability point exists where significant reductions in operation and support costs are offset by significant increases in research, development, test, and evaluation (RDT&E) investments.

This realization led to the establishment of the U.S. Army Materiel Command (AMC) Reliability Versus Cost Task Force which has membership from all AMC major subordinate commands. The primary focus of the task force is to investigate/develop viable techniques and computer models for performing cost versus reliability tradeoffs. The task force will also establish guidelines for performing cost versus reliability studies.

Background

This article focuses on one portion of the task force efforts—the maintenance and support costs—hereafter simply referred to as logistic costs. A literature search of several potentially applicable computer models uncovered two computer models which were predominant: the Optimum Supply and Maintenance Model (OSAMM) and the Logistics Analysis Model (LOGAM). Thus, the task force utilized these two models to study logistic costs versus reliability. The principal investigators were the U.S. Army Missile Command and the AMC Materiel Readiness Support Activity.

Objectives

There were five main objectives of the logistic costs versus reliability study. The first objective was to determine the suitability of OSAMM and LOGAM for trading-off logistic costs versus reliability. The second objective was to determine feasible reliability allocation methods in order to develop a logistic cost versus reliability envelope around a baseline reliability allocation.

The third objective was to determine the impacts that maintenance and supply support optimization have on trading-off logistic costs versus reliability. The fourth objectives was to determine the critical input data required to execute the maintenance and the logistics models early in the life cycle phases of weapon systems. The fifth objective was to utilize actual data from an existing fielded weapon system to accomplish the study.

Scope

The following paragraphs give a brief description of the computer models, weapon system, and reliability allocation methods used in the study. This will set the stage for a discussion of the observations of the study.

OSAMM is designed to optimize both supply and maintenance policies for a weapon system while achieving an operational availability target at the least cost. The maintenance model can also evaluate user furnished policies. The analysis and policy optimization in OSAMM is based on applications (or failure modes) which lends well to the reliability program. The logistics model on the other hand is designed to evaluate user furnished supply and maintenance policies on the basis of cost and operational availability.

LOGAM does not directly have an optimization feature like OSAMM but does have extensive sensitivity analysis capability. It should be noted that the models have diverse analysis methods in achieving the same end logistic costs. The necessity to have consistency of model scenarios for this study made it necessary to adjust certain input and output data of both models.

The fielded weapon system data used for the study came from the M65 Airborne Tube-Launched Optically-Tracked Wire-Guided (TOW) Missile system. Since the TOW is fielded, particular attention was given in the study to model the existing logistic structure presently utilized by the TOW. Therefore, initially the maintenance policy was fixed to that of the fielded TOW in order to compare OSAMM and LOGAM outputted logistic costs. In order to determine the impacts of maintenance and supply support optimization on logistic costs versus reliability, the maintenance policy was optimized from the fixed TOW maintenance policy.

There were four different failure rate allocation methods utilized in the study that had the potential for yielding a logistic costs versus reliability envelope. Such an envelope provides a high and low cost bound (about a baseline cost and failure rate allocation) that could be incurred by reallocation of the line replaceable unit failure rates while still achieving the same system reliability or mean time between failure. The four allocation methods were: Baseline Proration; ARINC Corp. Proration; Unit Price Proration; and the Materiel Readiness Support Activity's Inverse Unit Price Proration. Using each of the above four allocation methods, a sensitivity analysis was performed (varying the system mean time between failure or failure rate) in order to obtain enough data points to plot out a logistic costs versus reliability curve for each allocation method.

Observations

Several key observations/concepts were revealed as a result of the study. The following paragraphs address these.

Both OSAMM and LOGAM are suitable for conducting logistic costs versus reliability trade-offs. The models produce very similar logistic costs versus reliability envelopes and give reasonably close logistic costs (approximately nine percent average difference) for a range of reliability values over the various failure rate allocation methods. The logistic cost versus reliability envelopes are depicted for OSAMM in Figure 1 and for LOGAM in Figure 2.

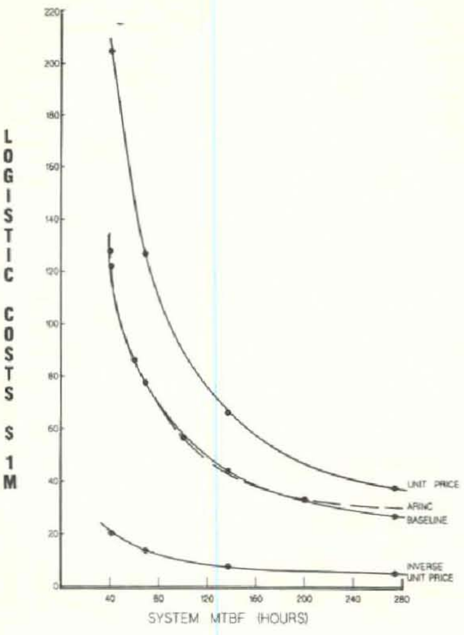


Figure 1. OSAMM Logistic Costs Versus Reliability Curves.

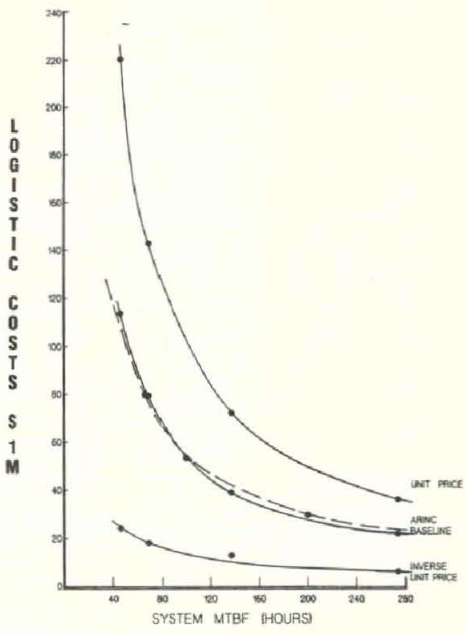


Figure 2. LOGAM Logistic Costs Versus Reliability Curves.

The nine percent difference in costs and differences in modeling philosophies of the two models are evident when the logistic costs versus reliability envelopes of both models are combined as shown in Figure 3. The primary cause for the anomalies were the differences in the models determination of spares. The important thing to note in Figure 3 is that the effects of the anomalies are considered minor when performing logistic costs versus reliability studies, since all the curves reach their point of diminishing returns at about the same mean time between failure. In other words, at a certain point, no matter how much you increase the reliability of the system, it will not significantly reduce logistic costs.

In theory, the ARINC Corp. Proration curves should be exactly the same as the Baseline Proration curves when plotted as a function of mean time between failure. The study results indicate this to be the case as can be seen on Figures 1 and 2. However, due to round-off errors and graphical accuracy, the ARINC Corp. Proration curves were not exactly identical to the Baseline Proration curves (they are extremely close). Thus, the ARINC Corp. Proration method is a viable proration method for determining the Baseline Proration curve.

The Unit Price Proration and Inverse Unit Price Proration methods produce a very good (i.e., wide) logistic costs versus reliability envelope around the Baseline Proration method as can be seen in Figure 3. Although the curves derived using the Unit Price and Inverse Unit Price Proration methods are not the maximum and minimum logistic costs versus reliability curves that can be obtained, they do give a heuristic bound.

Optimization Approach

The maintenance and supply support optimization feature in OSAMM eliminates a long standing complaint with utilization of logistic costs versus reliability curves. This complaint was that no consideration is given, in development of logistic costs versus reliability curves, that a certain design alternative may permit (or demand) a different supply environment.

In order to illustrate potential benefits of optimization, OSAMM was ex-

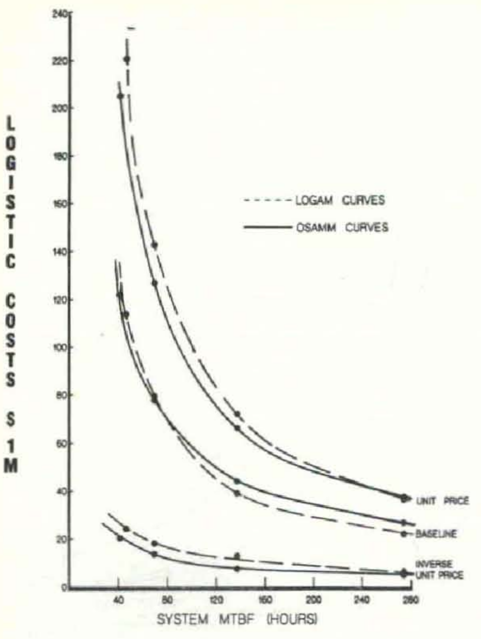


Figure 3. OSAMM and LOGAM Logistic Costs Versus Reliability Curves.

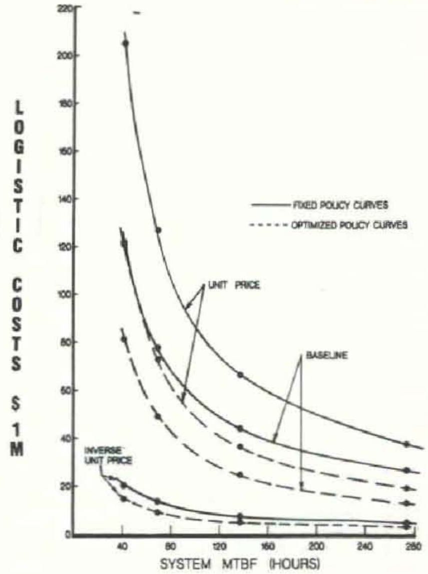


Figure 4. Optimized and Fixed Maintenance Policy Logistic Costs Versus Reliability Curves.

ecuted on the M65 Airborne TOW data with its optimization feature active. Shown in Figure 4 are the logistic costs versus reliability curves derived using the OSAMM optimizer to select a maintenance policy. These optimized curves are overlayed on Figure 4 with the original curves derived in Figure 1 using the fixed maintenance policy.

It is important to note in Figure 4 the large drop in logistic costs for the Baseline Proration curves when using optimized versus fixed maintenance policies. For each data point on each of the curves a different maintenance policy was selected by the OSAMM optimizer. This was expected since the system mean time between failure was changed and proration of the failure rate among the line replaceable units was changed. Thus, variations in the failure rate and proration methods required a variation in the maintenance policy to yield the least logistic costs at the availability required.

Data Needs

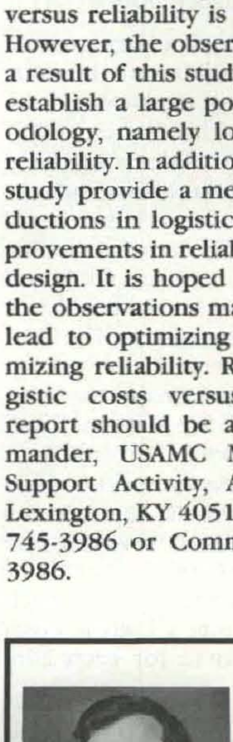
In the concept phase, a more macro approach must be taken in utilizing the models both from a standpoint of data inputs and weapon system hardware breakdown. In other words, it is necessary to utilize estimates or common data values for input and the hardware breakdown will usually be to the line replaceable unit or black box level. The collection and validation of data to be used in execution of models is the single most labor intensive task in conducting an analysis. The data items that are most important in the concept/development phases include: the unit price of items, failure rates or mean time between failure of items, test measurement and diagnostic equipment utilization time and prices, operating life of the system, deployment quantity, operating time per day, availability target, and, to a lesser extent, mean time to repair of items, and the overall maintenance concept.

Summary

In viewing the logistic costs versus reliability envelopes generated in this study, it can be seen that the logistic costs are sensitive to the method used to allocate reliability. Also, maximum improvement in logistic costs is attributed to reducing the failure rate of high unit cost items.

The Inverse Unit Price Proration method shows a large improvement in logistic costs by reducing the failure rate of high unit price items. Using the Unit Price Proration and Inverse Unit Price Proration methods early in the life cycle will bound the logistic costs for a given predicted system reliability. Even if the actual baseline reliability allocation is not known, it can be realistically concluded that the Baseline Proration curve will fall between the other two curves.

The AMC task force efforts to establish a methodology for performing cost versus reliability is far from complete. However, the observations revealed as a result of this study could be used to establish a large portion of that methodology, namely logistic costs versus reliability. In addition, the results of this study provide a means for guiding reductions in logistic costs through improvements in reliability during system design. It is hoped that this study and the observations made as a result of it lead to optimizing rather than maximizing reliability. Requests for the logistic costs versus reliability study report should be addressed to: Commander, USAMC Materiel Readiness Support Activity, ATTN: AMXMD-EL, Lexington, KY 40511-5101, AUTOVON 745-3986 or Commercial (606) 293-3986.



JIM CRABTREE is senior action officer in the Logistics Engineering Branch of the U.S. Army Materiel Command Materiel Readiness Support Activity. He holds a bachelor's degree in engineering from Memphis State University, is a distinguished graduate of the USAMC Maintainability Engineering Program, and is working towards a master's degree in computer science at the University of Kentucky.

ARC Spraying—A Better Means of TEMPEST Proofing

By Ray G. McCormack and Peter F. Williams

Introduction

Electromagnetic shielding of military structures is often necessary to protect sensitive electronics from external interference, prevent compromising emanations from equipment processing classified information, or provide electromagnetic pulse or electromagnetic interference protection. Conventional fixed-facility shielding construction systems are usually either welded sheet metal or modular bolt-together panels. These shielded rooms may be freestanding or part of the basic construction of the host building. Unfortunately, conventional shielding construction technology is relatively expensive and may not be readily applicable to the retrofit of existing structures.

Metal-Arc Spraying

Metal-arc-spraying has been used for many industrial applications, such as building up bearing surfaces, providing coatings for monuments, and inhibiting corrosion. It also has become an accepted technology for shielding the plastic housing of electronic equipment. (A relatively inexpensive way to impart shielding properties to plastic housings is to arc-spray a thin conducting metal coat onto the plastic.) Metal-arc-spraying of room-sized structures is a logical extension of this successful technology.

Metal-arc-spraying is a thermal spray process in which metal is heated to the molten state by an electric arc, converted to tiny liquid metal droplets by compressed air, and propelled onto a surface by a compressed-air blast. The electric system of the arc-sprayer is similar to that of an alternating current arc welder, and uses a transformer to generate high current at relatively low voltage. The voltage and current can be adjusted to control the temperature of the melted metal.

The metal to be sprayed is supplied by two spools of wire. The arc-spray gun has separate feed mechanisms for each spool. The wires are fed from the feed mechanisms through hollow electrodes that are electrically connected to the transformer output. As the wire ends approach contact, an electric arc is generated that continuously melts the metal wires. If all parameters are controlled properly, the molten metal droplets strike the target surface, cool, and solidify, conforming to the microscopic surface irregularities. Solidification creates a mechanical bond between the sprayed surface and the droplets.

If applied at the proper rate, the sprayed surface is not heated extensively, so flammable surfaces such as paper, wood, particle board, or masonite can be sprayed without being damaged by the heat. Although the sprayed-on metal does not have the density or electrical conductivity of the base metals, it does provide a substantial level of electromagnetic shielding.

Parameters other than voltage and current that can be controlled are air pressure, air volume delivered, air velocity, distance from arc-spray gun to target surface, and rate of travel of the gun. These parameters affect the degree of uniformity and homogeneity of the finished surface; this, in turn, affects the density and electrical conductivity. The electrical conductivity and material thickness are the primary factors determining the amount of electromagnetic shielding effectiveness provided.

Some materials, such as plastics, have very smooth, slick surfaces. Two methods may be used to obtain a strong bond between the arc-sprayed metal and the plastic: roughen the surface to improve the macroscopic mechanical bonds or use and agent that will chemically bond with the plastic surface and the arc-sprayed metal.

Recent experimental work has adapted various thermal metal sprays (arc-spray, flame-spray, and plasma-spray) for electromagnetic shielding applications. For example, shielded rooms have used dry-wall (also known as plaster board or gypsum board) panels pre-sprayed with zinc. These panels are then assembled into a room, using special seam designs. However, the results of most of these attempts have been negative, and little information about them is available. In other examples, zinc has been arc-sprayed directly onto the concrete walls of existing rooms.

CERL Efforts

The U.S. Army Construction Engineering Research Laboratory (CERL) has been involved in arc-spray studies for several years. These studies were conducted to:

- measure the basic shielding effectiveness of various sprayed metals, composites, and multiple-layered sprayed shields;
- measure the effect of varying the thickness of sprayed metal;
- measure the bond strength of arc-sprayed metal on concrete;
- measure the shielding effectiveness of a completed 8 by 8 by 8 foot room with plaster-board panels, plaster-finished seams, and arc-sprayed with zinc;

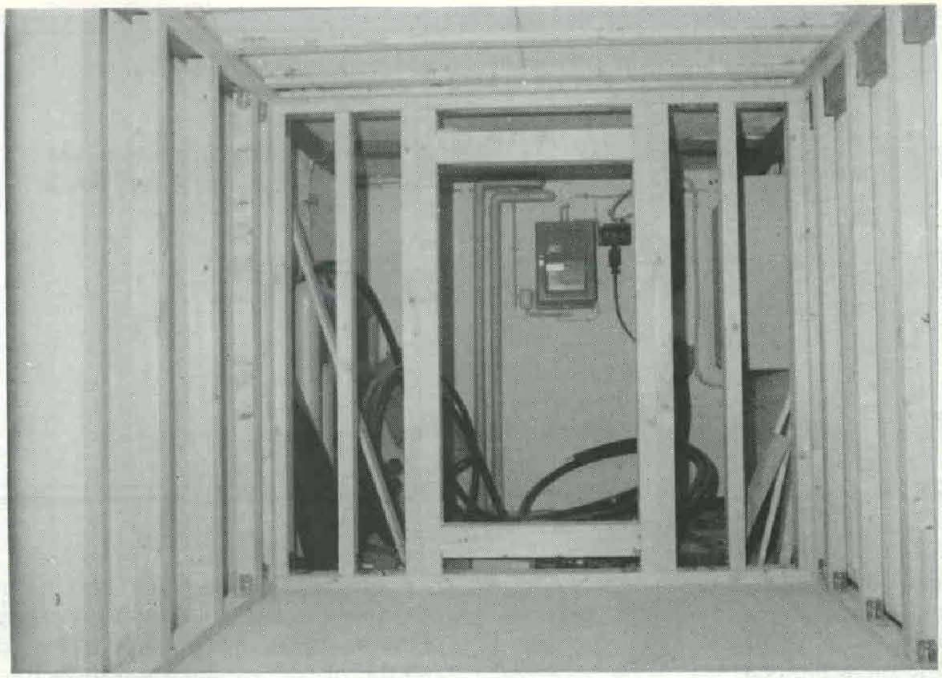


Figure 1. Blind wall framing completed.

- determine sprayed-metal densities and measure the related electrical conductivities of the sprayed materials; and
- determine the effect of arc-spraying on the ferromagnetic properties of steel and nickel.

The work described herein represents a continuation of these arc-spray studies.

The design, construction, and testing of an experimental electromagnetically shielded room to protect communications security for a small computer and related equipment of a North Atlantic Treaty Organization (NATO) school in Europe provided an excellent opportunity to examine the effectiveness of electromagnetic shielding in terms of protective insular properties and its cost effectiveness.

The room in which shielding was required had dimensions of approximately 8 feet wide, 8 feet high, and 18 feet long. The walls, floor, and ceiling were constructed of poured concrete. The room was located at the end of a basement hallway about 8 feet wide. A decorative wood doorway provided entrance to the room which had no other doors or windows. The end of the room opposite the entry door contained several utility entrances and panels, including water entry pipes, power line entry conduits and cables, and telephone entry cables. An electrical breaker panel and a telephone junction box were also in this area. Plastic raceways containing power and telephone cables were routed at each upper room corner junction between the wall and ceiling; the raceways ran from the entry door wall to the opposite room end where the utilities hardware was installed. No provisions had been made to bring heating, ventilating, or air-conditioning ducts into the room. Direct spraying on the walls, floors, and ceiling was considered impractical because of the many penetrations and the raceways.

Design Criteria

Several factors were significant in selecting a shielded room design approach. First, a relatively large secure area surrounded the room to be shielded so lower levels of shielding effectiveness were possible. The minimum distance to an unsecured area was approximately 25 meters.

Furthermore, the equipment to be protected included a small CORVUS computer with associated peripherals, a cathode ray tube display, and a printer. None of these equipment items was expected to radiate high levels of electromagnetic energy. It was thus agreed to use metal-arc-spraying to provide the metal shielding membrane. Information to be gained would include a field evaluation of the arc-spray process that would yield data on practical shielding levels obtainable, installation problems encountered, practical construction costs, and durability information.

Another factor in the design selection process generates metal oxide gases and fine dust particles of both the metal being sprayed and its oxides. Since inhalation of any of these gases and particles would be hazardous, the school commandant refused to allow the spraying to be done on site. It was therefore decided to spray the panels in the factory and, using appropriate seam designs, install them in the room.

Designating the room first required selecting a panel material and the type of metal to be sprayed. Since the room was in a basement, relatively high humidity levels were anticipated. So, it was desirable to select a panel material impervious to water.

A West German firm was located that had developed a patented bond agent to arc-spray metal onto ordinary fiberglass and obtain high bond strength. This firm also claimed that higher electrical conductivity could be obtained with sprayed copper than with any other metal. The panels could also be sprayed on both sides to increase shielding effectiveness. A sample panel with 2½ by 4½ foot dimensions was tested at CERL using techniques of MIL-STD-285. The test panel was found to have approximately 35 decibels of shielding to magnetic fields at 150 kilohertz, rising to 75 decibels or greater at 10 megahertz and beyond. Plane wave and microwave shielding was also greater than 70 decibels.

In the interest of economy, it was determined that none of the existing utilities or wiring within the room should be disturbed. Instead, framing would be provided to install the shield within the existing clear volume of the room. Therefore, a framing wall was required to isolate all utilities at the rear of the room. In addition, the framing for both side walls was moved inward so that the framing cleared the raceways at the upper room corners.

A sandwich seam design for wall seams was developed in which the arc-sprayed panel edges were clamped between a strip of copper foil tape and a flat strip of architectural bronze. Pressure for clamping the seam together was obtained from wood screws at 2-inch spacing. Corner seams were similar to the wall seams, except architectural bronze angles were used instead of the flat strips.

Construction

Standard electromagnetic interference-shielded doors were procured commercially for use in the room. One door was mounted in the existing room entrance doorway. Another door was installed in the shielding wall which was used to separate the shielded volume from the utilities in the rear of the existing room. The doors were made from plywood panels with 26-gauge copper sheet laminated to each side. Both doors used beryllium copper finger stock (two rows) in a groove around the entire door frame periphery. A "knife-edge" around the door periphery mated with the finger stock when the door was closed.

Framing used to support the arc-sprayed panels was made from standard construction lumber. Figure 1 shows the rear wall framing typical of all the framing installed. Figure 2 shows one end of the completed room.

Penetrations required for the room were minimal. Ventilating air was brought in and exhaust air expelled by means of two honeycomb panels in the main door. A small fan was provided with one panel to create air circulation. Electric power was brought into the room through standard power line filters using conventional power line filter mounting and penetration techniques. Inside receptacles, conduit, and lighting fixtures and switches were attached to the shield by the wood screws without compromising the shield.

The floor of the finished room was carpeted to prevent undue wear or abrasion of the arc-sprayed metal on the floor surfaces. Floor panels were placed on particle-board panels which were first placed over the existing concrete floor.

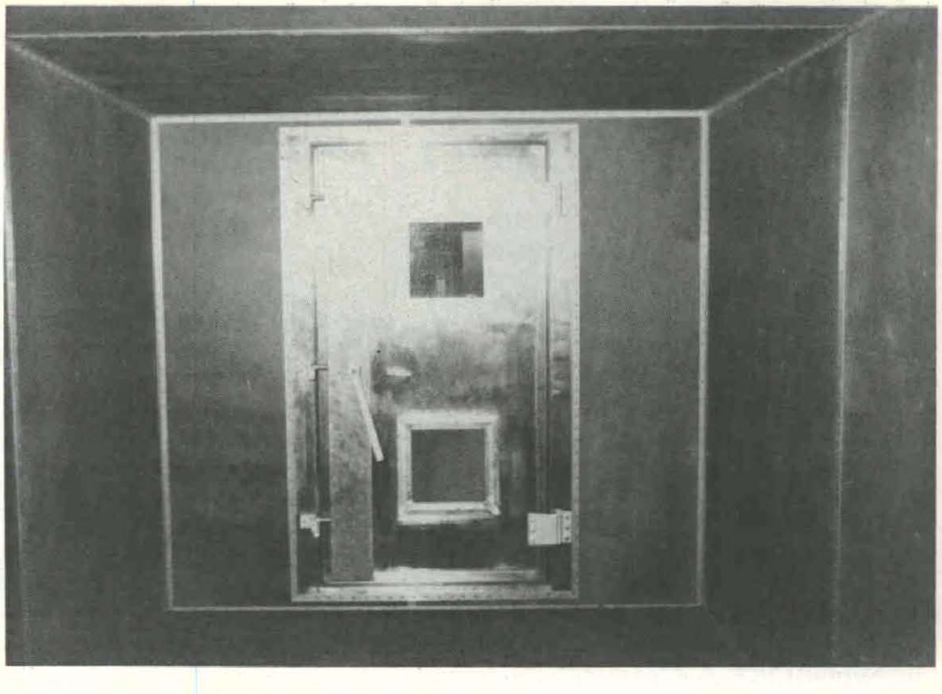


Figure 2. Door in mounted position.

Effectiveness Tests

Upon completion of the shielded room, shielding effectiveness tests were performed on the room using MIL-STD-285 techniques. Study of the data showed lower shielding effectiveness than that obtained for the test panel pre-tested before constructing the room. This difference was due to the different test techniques used. In the NATO room, greater antenna separation was necessary due to the thickness of the concrete wall outside the shield. At the greater antenna spacing it was necessary to use co-axial loop antenna orientations instead of the co-planar orientations used for the test panel in the laboratory.

The shielding levels obtained were lower than those obtained in previous CERL experiments by about 10 decibels at 150 kilohertz for magnetic fields. In the previous work, zinc had been used instead of copper. Furthermore, the spray process in the previous work had been controlled to provide a more homogeneous material than that of the copper-sprayed panels. The copper thickness used in the NATO room was five mils. Previous CERL testing had shown that thickness above five mils did not appreciably improve shielding.

After completing the shielding effectiveness test, the equipment to be protected was installed in the room and placed in operation. A profile of radiated electromagnetic energy versus frequency was then measured for all significant equipment operating modes. This profile was measured inside the room.

Next, the room doors were closed with the equipment operating inside, and measurements were made outside the room to determine whether any signals originating from the protected equipment were detectable. Only at a single frequency was any detectable signal found. Its amplitude was so low it would not be detectable outside the secure zone. Thus, the room was considered acceptable to provide communications security and a temporary certification was granted. (A final test including filter and power line conducted-susceptibility tests is scheduled.)

Since a major objective of the program was to determine costs for arc-sprayed rooms and compare them with those of conventional construction, detailed cost records were kept for the materials, labor, and other construction costs.

Quotations were obtained from three companies that manufacture standard shielded rooms of laminated galvanized steel and plywood. The cost of the basic room, with accessories but without doors, is 53.6 percent of the average cost of the standard commercially available rooms.

Conclusion

Metal-arc-spraying is a viable approach to providing communications security shielding. The room installed is unique. It is anticipated that costs can be reduced with experience and with quantity production. Current research is being conducted in using inert gas to perform the arc-spraying instead of air. This process is expected to increase the electrical conductivity of the sprayed metal, thus improving shielding.

Finally, in the assembly process, the panels were sometimes subjected to inadvertent rough treatment; however, they were not damaged. So, they appear to be rugged enough for general use. At this time, the room has not shown evidence of degradation; however, more time is needed to draw final conclusions.

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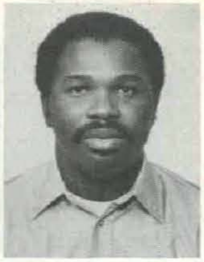


PETER F. WILLIAMS is an electronics technician at CERL. He holds a B.S. degree in electrical engineering technology from Southern Illinois University at Carbondale.

Technology Transfer Aids Private Sector

To restore the Statue of Liberty to its original condition, the National Park Service needed to know the exact composition of the symbolic lady's copper "dress." The service asked an Army research laboratory with a unique capability to characterize materials to analyze a sliver of copper no larger than a fingernail. Thanks to the Materials Technology Laboratory of Watertown, MA, restorers were able to match the copper alloy exactly and prevent the future costly corrosion that would have occurred if incompatible types of metal had been used.

Army labs have often provided technological advances to the civilian economy. For example, in 1946 the Ballistic Research Laboratory at Aberdeen Proving Ground, MD, unveiled the world's first computer—the Electronic Numerator, Integrator, Analyzer, and Computer or ENIAC—thus spawning the multi-billion dollar computer industry. Then, within a decade, another Army lab, the Harry Diamond Laboratories at Adelphi, MD, invented the photographic technique for making integrated circuits that has led to our ability to miniaturize electronics so that a computer with the power of ENIAC's large room full of equipment can be put on a desk or in a briefcase.

Although important technology has come into the civilian economy from Army labs and other federal labs in the past, the process is often slow, according to Clifford E. Lanham, chief of Harry Diamond's Research and Technology Applications Office.

"The American investment in R&D has a slow payback and our competitors are often the ones who reap the reward. To provide easier access to technology for U.S. firms in a competitive world by providing fast, efficient linkages for technology transfer is the purpose of the Federal Laboratory Consortium (FLC). Army labs are active members of the FLC to continue the tradition of contributing innovations to more sectors of the economy in a more timely manner," said Lanham, who is the executive secretary, of the Federal Laboratory Consortium.

According to Lanham, there are numerous examples of Army labs working through the FLC to help productivity of the public sector and competitiveness of the U.S. private sector. Through the efforts of another Army research laboratory, a computerized reading program designed for Navy recruits is now being used by libraries in Baltimore, MD, and Weirton, WV, to combat adult illiteracy. Adapted by the Human Engineering Laboratory at Aberdeen Proving Ground, the program is also being used to improve the functional reading skills of children in the Baltimore County Public School System.

The Atmospheric Sciences Laboratory at White Sands Missile Range, NM, has developed lasers that can remotely sense chemical, biological, and toxic agents on the tactical battlefield. These lasers are now proving to have a peacetime application. Agronomists at New Mexico State University are using them to identify insects, assess their predator-prey relationships, and determine the impact of insecticides upon those relationships.

More recently, contacts by a medical research group through the FLC have identified Army-developed technologies that could help hospitals provide better diagnoses of cancer, heart disorders, and neurological diseases. At the moment, only relatively-well patients can be exposed to magnetic resonance diagnostic machines. Life-support equipment required by very sick patients cannot function in the strong magnetic fields and radio beams used by these machines. Fiber optic and fluidic technologies developed by Harry Diamond Laboratories to make rugged battlefield equipment could conceivably make devices that would help monitor and support critically-ill patients in the strong magnetic fields. This would allow better diagnosis using the magnetic resonance machine.

The laboratories mentioned in these examples report to the U.S. Army Laboratory Command, the newest major subordinate command of the Army Materiel Command. The transfer of their technology to the private side is mandated by Public Law 96-480, the Stevenson-Wydler Technology Innovation Act of 1980. A new amendment to that law, known as the Federal Technology Transfer Act of 1986, greatly strengthens the transfer of technology by authorizing federal laboratories to enter into cooperative programs with state and local governments and the private sector.

These Army laboratories seek to find greater civilian uses for technical knowledge developed originally for military purposes. Like all members of the Federal Laboratory Consortium, they strive to give American taxpayers as much payoff as possible for their research dollars.

Soviet Developments in Organic Materials

By CPT Robert M. Serino

Background

Organic materials are polymer products whose specific attributes are related to starting monomers, processing conditions, and method of utilization. Since the early 1960's their use in military systems has been increasing because organic materials can afford higher specific strength, corrosion resistance, toughness, low or no lubrication requirements, and ease of manufacture over more conventional materials.

Military applications of organic materials include aircraft and missile structures, canopies, clothing, coatings, explosives, hard and soft ballistic protection, machine parts, propellants, shelters, and tires. Forecasts made in 1986 indicate that the overall use of organic materials by U.S. forces will grow at 11 percent per year to 1990. The use of advanced composites, which are largely made from organic materials, will likely grow at 20 percent per year in the same period.

Perhaps the first significant use of organics in a fielded U.S. military system was the employment of plastic furniture on the M-16 rifle. The glass fiber-reinforced phenolic stocks and handgrip on the M-16 were likely used instead of wood because they saved weight, they exhibited good corrosion resistance so necessary for the Southeast Asian climate, and they were relatively easy to manufacture.

Conversely, Soviet small arms tend to be fielded with wood furniture because wood materials generally work well in this application, wood is an abundant raw material, and wood product manufacture is straightforward. However, in order to improve weather resistance, Soviet-made small arms wood parts are usually coated with a water resistant polymer material. Furthermore, while a critical operational component such as the aluminum M-16 rifle magazine has remained relatively unchanged, rifle magazines for the Soviet basic assault rifle have changed from steel in the 1960s, to phenolic composite in the 1970s, to nylon in the 1980s. Their shift to new materials has resulted in a rifle magazine that is impact-resistant, relatively jam-proof, and free of lube requirements.

At this point, we may not yet fully appreciate the Soviet degree of interest in using organic materials for creatively responding to system deficiencies. In order to help us better understand Soviet views, two other historical instances are worthy of note. The first instance occurred in the late 1960s when the Soviets fielded the Ka-26 HOODLUM agricultural utility helicopter. Employing glass fiber-reinforced plastic laminate rotor blades for improved corrosion resistance and reduced maintenance, this was one of the first uses of a composite component on a series production aircraft. The Ka-26 probably served as a test series for later models such as the Ka-32 HELIX.

The second instance occurred in the middle 1970s when the Soviets began fielding new armored vehicles following the fielding of NATO anti-armor, wire-guided missiles. Reported to possibly contain laminates in conjunction with conventional (metal) armor materials, the Soviet armored vehicles were the first to use laminated armor components for improved protection.

Overall, it appears that Soviet designers will not hesitate to employ organic materials when their use will either minimize a system's deficiencies or improve its operating capability.

Recent Developments

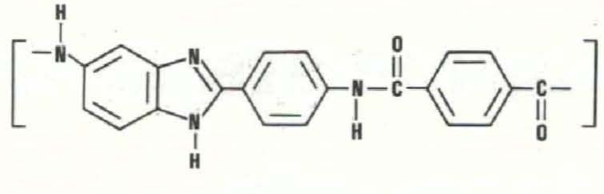
If one were to anticipate future Soviet employment of organic materials in manufactured products, it would be useful to outline recent key Soviet materials developments. In the next few paragraphs we will survey some of the organic material fibers, resins, and processing methods that are reported in scientific literature that seem to be unique to the Soviet Union.

There are two specific types of organic or organic-based fibers that are now having considerable influence on the capability of military systems: aramid fibers and carbon fibers. Aramid fibers such as Dupont Kevlar are finding use in diverse materiel ranging from aircraft structures to body armor. Not surprisingly, the Soviets also produce aramid fibers (under the name Terlon) that are reportedly chemically identical to Kevlar. However, there is another Soviet brand aramid fiber that is similar to Kevlar in terms of mechanical characteristics and systems' utilization, but not in chemical configuration. Described as both Vniivlon and SVM (for super-high modulus), this aramid's chemical configuration is shown elsewhere in this article.

SVM

The chemical structure of SVM fiber appears to be equivalent to a cross between Celanese PBI and Dupont Kevlar aramid fibers. Thus far, two key attributes of the SVM structure are flame retardance and improved compatibility

SVM



with resinous systems such as those used in aerospace composites. In fact, Soviet materials literature consistently claims that SVM/epoxy structural composites exhibit interlaminar shear that is at least 25 percent greater than Kevlar/epoxy when processed under conventional conditions.

Carbon fibers produced by Western firms for structural applications are usually manufactured from either special polyacrylonitrile (PAN) fiber or from coal- or oil-based pitch. Soviet-manufactured carbon fibers are reportedly fabricated from PAN and pitch precursors as well. However, Rayon fibers are apparently also used as a Soviet carbon fiber precursor because of economic considerations. Furthermore, a synthetic phenyloxadiazole fiber known as Oxalon has been used to prepare ultra-high modulus carbon fibers.

In 1981, thermal decomposition of Oxalon under controlled conditions reportedly yielded carbon fibers with high tensile strengths and ultra-high tensile moduli. In accordance with Soviet claims, one can envision the Oxalon polymer permitting useful carbonization through a pyrolytic loss of water and nitrogen to yield carbon fibers. An advantage of using Oxalon as a carbon fiber precursor could be based on the capability to introduce trace quantities of reactive "impurities" into the polymer precursor. These groups could serve to modulate the elasticity of the carbon fiber for specific purposes through the controlled introduction of molecular imperfections.

Many of the Soviet organic material resins available for use in military systems are identical to Western-produced resins in terms of chemical configuration, mechanical characteristics, and systems' utilization: e.g., epoxies, nylons, polyesters, polyimides, and polyolefins. Nevertheless, there are several differences worthy of note. These differences appear to stem from a Soviet tendency to study and to produce resinous materials based on either acrylic or heterocyclic chemistry.

Rolivsan

Rolivsan MV-1 is a unique acrylic-based resin that could find application in systems requiring glass fiber reinforced plastic composites, optical fiber coatings, or environmentally resistant transparencies. It is probably composed of various monomers such as acrylic acid, divinylbenzene, and acrylic anhydride.

Several advantages are envisioned for this particular polymer. These could include ease of processing, flame resistance, good adhesion to glass, and the availability of reactive or "ablating" sites for introducing metal ions or linking oligomers into the polymer matrix.

There has been considerable recent Soviet preparation and study of comb-like polyacrylates. Among many attributes, these materials may be suitable for applications in systems requiring optically sensitive films. Based on the incorporation of "teeth-like" polar ester substituents on an acrylic polymer backbone, Soviet polymer films could afford optical write- read-erase capability through low-energy, laser-induced optical writing on a polymer film, and electric or magnetic field-induced erasure of the laser-written spots at temperatures just below the polymer melting point.

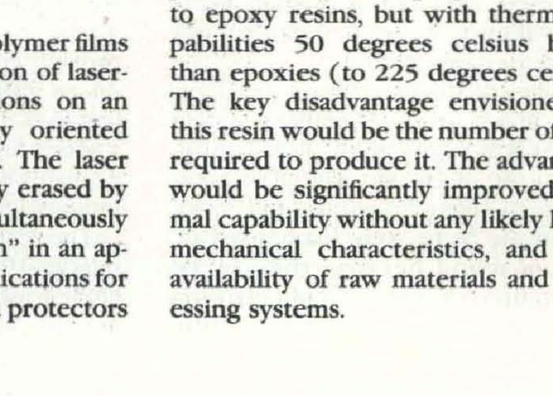
In an actual system, the polymer films could work by the generation of laser-induced optical imperfections on an electrically or magnetically oriented perfect comb-like polymer. The laser spots could be subsequently erased by heating the films and simultaneously reorienting the comb "teeth" in an appropriate field. Possible applications for these films include overload protectors for optical sensors and reusable optical storage media.

Dupont Nomex meta-aramid polymer is used for a variety of applications, including flame retarding fibrous materials and structural honeycomb. The Soviets also produce a chemically identical polymer under the brand name Fenilon, which is used for similar applications. Fenilon is reportedly also employed for molded low-friction components such as polymer bearings and bushings. However, the moldable aramid polymer is composed of a mixture of both meta and para isomers. The Soviet resin employs a precise mixture of isomers because the mixture allows for improved processing conditions by the reduction of pressure and temperature processing conditions through a reduction in polymer crystallinity.

Polybenzoxazole

In view of the pending completion of a 75,000 tonnes per year Bisphenol A production facility at Ufa, USSR, products such as epoxy, polycarbonate, polyester, and polysulfone resins will probably enjoy growing Soviet use in upcoming years. In addition, recent efforts to utilize this raw material with others such as terephthalic acid, may yield greater than pilot quantities of new polybenzoxazole resins for a variety of systems applications such as structural composites, coatings, and electronics. As shown in the accompanying drawing and reported by Soviet researchers, resins consisting of the following chemical structure could provide mechanical properties similar to epoxy resins, but with thermal capabilities 50 degrees celsius higher than epoxies (to 225 degrees celsius). The key disadvantage envisioned for this resin would be the number of steps required to produce it. The advantages would be significantly improved thermal capability without any likely loss of mechanical characteristics, and good availability of raw materials and processing systems.

ROLIVSAN



Polymer processing has long been an area of Soviet study. Emphasis has been placed on improving aspects such as curing time, coefficient of friction and compatibility of biphase systems such as composites.

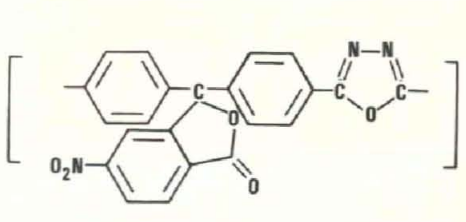
Advances in the early 1980s have led to the Soviet production of improved polyolefin materials with coefficients of friction reportedly better than those of fluoropolymers such as Teflon. By treating the surface of a material like polyethylene with gamma radiation, the Soviets claim that it is possible to replace expensive, labor-intensive, machined Teflon components of farm machinery with molded and surface-treated polyethylene components.

Derived from the aerobic, radiation-induced cross-linking of polymer chains, linear polymers are reportedly converted to an amorphous three-dimensional network that affords operating rates of wear less than one percent of the original starting material. Although this radiation technique probably results in shrinkage of treated polymer components because of the formation of more polymer chemical bonds, treated parts are likely size adjusted to compensate for dimensional reduction. Furthermore, recent Soviet studies indicate that electron-beam treatment of rubber fluid seals results in improved low-friction seals with substantially longer service lives.

As mentioned earlier, Soviet carbon fibers are also produced from Rayon. Novel efforts apparently directed towards improving Rayon-based carbon fiber/epoxy matrix compatibility in structural composites have been keyed to the incorporation of metal and metal-oxide particles on carbon fibers. Coating the fibers with epoxy and heating the coated fibers to 120 degrees celsius reportedly effected metal-initiated epoxy polymerization reactions. Similar chemistry could be useful in improving the shear properties of carbon/epoxy structural composites.

Research is ongoing that seems to indicate that SVM fiber may have been specifically developed to improve critical structural composite mechanical properties such as laminar shear. Using model compounds such as pyridine and bismaleimide, workers have demonstrated that pyridine reactivity, which may be similar to that of SVM under certain conditions, can be useful in initiating the polymerization of bismaleimide.

POLYNITROOXADIAZOLE



In a similar fashion, SVM fibers may be able to improve the structural properties of composite materials to the extent that isotropic improvement exceeds anisotropic degradation. Soviet workers have said that bonding between SVM and epoxy is so strong that pull-out tests on SVM/epoxy composite tend to yield cohesive degradation of the composite rather than the adhesive degradation that is typical of Kevlar/epoxy.

Polynitrooxadiazole

The 1985 synthesis and nitration of a Soviet polymer with a configuration similar to that of Oxalon may find utility in composites when used in a fiber blend. As depicted in the accompanying chemical structure, the nitro-group (-NO2) of the oxadiazole polymer offers the potential to be converted to an amine (-NH2) group. If made into a suitable polymer fiber, this amine group could be used to react with composite matrices such as epoxy or bismaleimide.

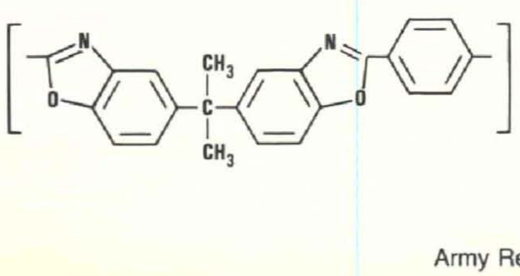
Thus, in view of chemical and mechanical possibilities, a future Soviet hybrid composite could be manufactured that would provide superior properties by allowing for the adhesive, mechanical, and chemical attachment of composite fiber and matrix materials. Improvements to impact strength, weather resistance, and isotropic strength could influence the design and construction of future composite-intensive systems such as aircraft, armored vehicles, bridges, and light guns.

Conclusion

It has been the intent of this article to outline some of the key areas of Soviet efforts in organic material fibers, resins, and processes. It is clear that a number of ongoing Soviet studies are quite different from those of the West even in terms of basic chemistry. However, Soviet work appears to be based on variations of equivalent Western technologies. These variations could be indicative of differences in research or development priorities. Further, it is possible for us to envision how some of the chemical results from Soviet studies could favorably impact on future Soviet military systems. Our continued study of their differing approaches may lead to better solutions to our own questions, as well as warn us of future threats.

CPT ROBERT M. SERINO holds a doctorate in organic chemistry from Brandeis University. He is presently stationed at the U.S. Army Foreign Science and Technology Center, Charlottesville, VA.

POLYBENZOXAZOLE



The Palletized Load System

By Doris L. Hudgins

The U.S. Army Tank-Automotive Command's (TACOM) project manager for medium tactical vehicles and the Training and Doctrine Command (TRADOC) are making great strides toward providing the Army with a revolutionary means of distributing supplies—the Palletized Load System (PLS). The PLS promises increased efficiency with reduced manpower, and an internationally interchangeable, demountable flatrack for loading, transporting and unloading cargo.

This unique system consists of a cargo truck which features a hydraulic pickup unit that is designed to load and unload large flatracks of palletized/containerized cargo directly from and to the ground. Included in the system is a cargo trailer which is able to carry a flatrack payload similar to that carried by the truck.

A recent trilateral agreement between the United States, West Germany and Great Britain brought about a breakthrough in PLS flatrack design. PLS equipment operated by those three countries can utilize each other's flatracks since they will be interchangeable. The British developed a drawing incorporating DIN (a German language designation) standard dimensional characteristics developed by the Germans for their demountable flatrack design.

The Palletized Load System was introduced to the Army in July 1983 by the Army Development and Employment Agency (ADEA), a field-operated DA agency under the command of the 9th Infantry Division, at Fort Lewis, WA. Three 15-ton British-built systems were leased by ADEA for concept evaluation of ammunition distribution within the division. Later, three more 15-ton units and 15 7½-ton units were added.

The 9th ID found numerous new applications for the PLS, and the troops became highly enthusiastic about the system.

Although ADEA's concept testing of the PLS was primarily geared to the hauling of large amounts of heavy ammunition, they found that the PLS excels in many other roles--bulk cargo carrier; evacuation vehicle; transporter for petroleum, water, and all sizes of ammunition; transporter of ISO (International Organization for Standardization) containers, ribbon bridges, and command and communication shelters.

When TRADOC saw the results of an early study on the ADEA effort, thought was given to application throughout the entire Army distribution system. Not only was the PLS proving highly effective as a high-volume ammunition mover, but, when compared to conventional tactical trucks, it was demonstrating the ability to do more hauling of other supplies and equipment with less personnel. In the long run, TRADOC saw the potential for freeing up personnel slots to create new divisions.

TRADOC then took the first step toward developing an Operational and Organizational (O&O) Plan to establish the main requirement. TRADOC's Logistics Center looked at further studies and concurred with the O&O Plan which was approved in December 1983.

Leased PLS, complete with cargo trailer, was used for a concept Force Development Test and Experimentation at Fort Hood, TX.

TRADOC's next step was to prepare a Required Operational Capability document, which defines the user's needs. After extensive coordination by TRADOC it was finalized and forwarded for DA approval in April 1986. Meanwhile, TACOM as materiel developer laid out a program to carry the PLS into production using the Nondevelopment Item approach. A strategy for conducting a market investigation was formed to assure that the performance specification would be technically achievable by industry.

After comments from industry were reviewed, TACOM began preparation of a Request for Proposal, which will be advertised internationally for a competitive runoff. Three prototype contracts will then be awarded to build and test each competitor's hardware in a government test based on Army mission profiles. Based on FY88 funding, awards are projected for the April-May 1988 time frame.

In the interim, TRADOC decided that concept hardware would be needed for user exercises and testing involving doctrinal changes to the way ammunition and supplies are moved. So TACOM initiated a competitive solicitation package for leasing surrogate PLS equipment.

In November 1985 TACOM awarded a lease contract to Kenworth Truck Company, Renton, WA, for 46 all-wheel-drive trucks with trailers, equipped with a combined total of 276 flatracks. This equipment was used for a concept Force Development Test and Experimentation at Fort Hood, TX., from Oct. 25 to Nov. 16. The testing was sponsored by the TRADOC Combined Arms Test Agency, and Kenworth provided maintenance, spare-part support and training for the equipment. The testing consisted of three 5-day scenarios, each of which ran around the clock:

- The first scenario simulated moving ammunition and supplies under battlefield conditions with existing conventional tactical trucks per current doctrine.

- The second involved using PLS in lieu of existing equipment—replacement on a one-to-one basis using the current doctrine which allowed the movement of an increased tonnage of supplies.

- In the third scenario, using a new supply doctrine, the number of PLS trucks and equipment was reduced to the minimum level necessary to get the job done (move the same tonnage of supplies as the first test), which also meant a reduction in manpower (truck drivers and forklift and crane operators).

Cargo truck with hydraulic pickup unit in a downloading mode.

Although the Fort Hood test results are not yet available, it quickly became obvious during the tests that anything that can fit within the 8-foot by 20-foot flatrack size constraint and weight limit can be transported by PLS. This can vary from a fuel bladder to a 2½-ton truck.

Besides having the versatility of playing many roles, the PLS is expected to result in numerous savings in costs and manpower:

- Time-savings—The entire operation of loading or unloading can be done by the driver from inside the cab in less than one minute.

- Vehicle cost savings—Because of the efficiency of the PLS, fewer trucks are needed, therefore, less fuel, repair parts, tires and maintenance are required.

- Materials handling equipment savings—Because of the elimination of transferring supplies from one vehicle to another there should be a reduction in the number of forklift trucks or cranes needed.

- Manpower savings—Fewer trucks will mean less drivers, and the reduction of forklift trucks and cranes and their operators will further reduce manpower requirements.

- Space savings—The flatracks can be compactly stacked in aircraft, in storage and on the PLS truck bed. Also, the loaded flatrack, as well as the PLS truck chassis, would be air transportable.

It is felt at this time, that to meet the Army's requirements, two sizes will be needed—an 8-ton (7¼ metric tons) and a 16½-ton (15 metric tons) size. In both cases, the concept includes a trailer with the same payload as the truck. The 8-ton will be used for lighter supplies, and the 16½-ton will handle heavier items such as artillery ammunition.

The PLS concept is expected to have enormous benefits for the Army from a productivity standpoint. If all proceeds according to present plans, a contract award for PLS production will take place in April or May 1990.

DORIS L. HUDGINS is a technical writer-editor for the RDE Center at the U.S. Army Tank-Automotive Command, Warren, MI.

New Laser Vibration Sensor Aids Depot in Transmission Inspections

By Mary A. O'Keeffe

Doesn't everyone dream of having just what they need to do their job well? How about the chance to contribute ideas for the design of some of those needed tools? Imagine, asking for equipment support and having it materialize right before your eyes.

Well, this is exactly what's happening in the Transmission Section of the Power Train and Special Equipment Branch, Maintenance Directorate at Tooele Army Depot, UT. Right now designs are being drawn up and tests are being run on the Laser Vibration Sensor Inspection Test System (LVS/ITS).

The test system consists of a gas tube laser sensor, which is capable of extremely accurate and sensitive measurement of vibration, and a MASSCOMP computer, which processes and analyzes the vibration data for engineering interpretation.

The laser beam is enclosed for safety reasons. If the tubing were bumped the measurements would be invalid, therefore, a smaller, more compact and rugged diode sensor is now being developed. The computer is housed in a dust-free, cool environment. It is also protected from power fluctuations by a built-in regulator.

The system is the brainchild of Robert Watts, an engineer at the U.S. Army Tank-Automotive Command. TACOM's engineers are involved because it's a research and development project. Watts had talked to people at Tooele Army Depot about specific needs of the Transmission Section. He then talked to contractors about finding state-of-the-art equipment that might fit the description of what the depot was looking for. The contractor, Mechanical Technologies Inc. (MTI), was able to locate off-the-shelf equipment. Watts feels it will do the job of performing diagnostic tests for the 2.5 ton transmission and 5-ton transfer case. The problem Watts and engineers from MTI and Tooele Army Depot are evaluating concerns these transmissions and transfer cases.

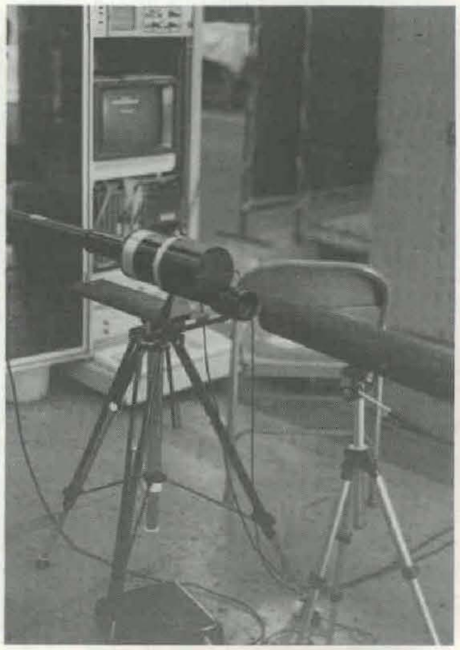
"What they're trying to do is figure out a way to diagnose what's wrong with transmissions and transfers without having to tear them apart. Or, after it's built up and tested and we hear something wrong we can say it's a gear or whatever," said Stan Perkes, manufacturing, methods and technology coordinator.

Inspectors making a quality check on the internal components of used transmissions and transfer cases have not had the benefit of working with diagnostic equipment. Instead, they use their own ears and listen for clues. They know when a transmission or transfer doesn't sound right, but they can't always accurately pinpoint the problem explained Eldred Brunner, chief of the Transmission Section at the depot. This listening procedure means that all incoming items have to be disassembled, cleaned, and then visually inspected. In some cases measurements are taken. If new parts are needed, they are put in, and the listening phase begins again. This cycle is repeated as many times as needed to produce an item making no unusual noise.

The Depot Maintenance Work Requirement says only to reject those items with an unusual noise, but does not describe specific noises. It all comes down to judgement.

Brunner said that besides being somewhat inefficient, the system can also be frustrating. Sometimes meshing new parts with old parts, both made by different manufacturers, will cause an unusual noise. The noise means the transmission or transfer case will not pass the quality check even though it may be good. The drawbacks of this old system show why a new one is needed. The new LVS/ITS is more accurate, efficient and cost effective, Watts said. Use of the laser and computer will produce verifiable measurements. Inspectors will be working with information generated by the new system, they will no longer have to tear apart whole transmissions and transfer cases to examine each part.

The computer data will give inspectors the information they need to determine which components need repair or replacing, which might only require taking out one piece. The data should



The test system consists of a gas tube laser sensor and a MASSCOMP computer.

also prevent reusable components, i.e., bearings, from landing in the scrap bin. Plus, the computer base will be around as long as the system is used; it will not retire or transfer like the inspectors eventually do.

Watts said the entire test cycle takes 15 to 20 minutes. Transmissions and transfer cases are tested in each gear and shifting phase. Overall, a significant amount of time will be saved.

Watts and others at MTI and Tooele Army Depot, including Trang Nguyen, the depot's project engineer, feel the laser will perform better than the existing technology. Being unattached to the item being tested, the laser would not run the risk of changing the vibration measurements. The laser has a wider range than the accelerometer and time is not needed to prepare it or glue it onto the tested item. After the laser beam is put in place, it's turned on and aligned. The system might have to be recalibrated every six months.

The LVS/ITS is used to pick up frequencies of vibrations made by transmissions and transfer cases in operation. Additional readings of vibrations are picked up by sensors strategically placed on the test stand input/output drive. The data collected are fed into the computer.

At this stage of development the new test system is not able to identify a bad component.

"We only know that there is something wrong. We don't really know what it is until we get into it. A determination will have to be made from there based on the pattern about whether it's bad enough to replace," said Brunner.

Think of a doctor knowing when something is wrong. He wouldn't necessarily want to open up a patient before he knew exactly what was wrong. He would need to run more tests and completely identify the problem before the item is torn apart.

In the future, engineers hope that the system will be sophisticated enough to run more tests and completely identify the problem before the item is torn apart.

To develop the diagnostic logic and test the prototype, LVS/ITS dry runs were conducted at Tooele Army Depot. Brunner said they put together seven 2.5-ton transmissions and seven 5-ton transfer cases with faulty components.

Fifteen types of bad components were chosen by looking back at mortality histories of previous transmissions and transfer cases, and using parts with typical defects. A total of 90 different fault or wear levels were tested in the 14 end items. The laser and sensors picked up the vibrations of these components and fed them into the computer. The computer then compared the vibrations to the standards already fed into the computer by Watts and the contractor.

The test cycle is automatically run with an operator standing by who follows instructions from the computer. The operator is responsible for focusing the laser beam and verifying the information fed into the computer.

According to Watts, the testing went very well. A great deal of data were gathered at a much lower cost to the government than if a contractor had been hired to do the tests. Time was also saved. Data were collected in less than 10 working days as opposed to eight months.

The new system will pay for itself in three to four years Watts said. The contract has been divided into four phases with each phase expected to cost about $700,000.

Watts has designed the system to be fairly mobile. It will not fit easily into a suitcase, but it will be suited for a depot environment. As the technology is perfected, the system will get smaller and smaller. Watts' long-range plans are to produce an end item portable for the field.

It will be more than two years before the final LVS/ITS prototype is delivered to Tooele Army Depot. In these early stages the concept is being tested and the results are being evaluated to come up with a workable system. In the meantime, the LVS/ITS will be modified, if necessary, and returned to Tooele for more testing on the same seven transfer cases. After more evaluation and modification, the depot will use the system for one year to see how well it performs.

The depot's engineers and the personnel in the transmission section are pleased with the support they are receiving which will help them do their job more efficiently. They are also pleased to have the chance to be involved in the design process of the support equipment.

MARY A. O'KEEFFE is a public affairs specialist at Tooele Army Depot in Tooele, UT. She received a bachelor's degree in art history from Boston College in 1982.

Army Updating Radio Stations

Radio stations located on Army bases around the globe will soon be updated with new equipment. The U.S. Army Information Systems Selection and Acquisition Activity awarded a $397,960 contract for radio operators consoles to be utilized in the Military Affiliated Radio Stations (MARS/Gateway) Project. These radio stations are the major high frequency radio stations for in-the-clear radio-telephone, and voice communication links with the overseas MARS stations.

Although these radio stations are located on Army bases, their primary mission is not military. A soldier in Korea, for example, who wants to say "hello" to mom at Christmas, can visit his local MARS radio station and call her from a MARS/Gateway station in the United States through a telephone tie line to his parents' home.

Equipment acquired under this contract will replace MARS/Gateway equipment that is antiquated and difficult to operate and maintain. In some cases, the equipment to be replaced is 20 to 30 years old.

The new equipment will update radio stations in the Presidio of San Francisco, CA; Fort Meade, MD; Fort Sam Houston, TX; Camp Coiner, Korea; and Kaiserslautern, West Germany. The contract award was made to ITT Telecom Products Corp., Raleigh, NC.

AMC in "The Land That Broods"

By William J. Haslem

This is the law of the Yukon, and ever she makes it plain; "Send not your foolish and feeble; send me your strong and your sane, Strong for the red rage of battle; sane, for I harry them sore; Send me men girt for the combat, men who are grit to the core; Swift as the panther in triumph, fierce as the bear in defeat, Sired of a bulldog parent, steeled in the furnace heat.

Robert Service didn't have the Army Materiel Command (AMC) in mind when he wrote *The Law of the Yukon*. But he did understand the type of person it takes to successfully cope with the cold, unforgiving vastness of the far north. And he did describe many of the soldiers and civilians who man AMC's activities in Alaska.

What is AMC doing in Alaska? It is doing the same thing it does worldwide—supporting the soldier. With the recent establishment of the Sixth Light Infantry Division in Alaska, that support becomes ever more important. AMC has liaison people and maintenance technicians at the division and several representatives of its laboratories assigned in Alaska. Elements of the Test and Evaluation Command and the Army Laboratory Command are stationed in Alaska. The largest is the Cold Regions Test Center located at Fort Greely, AK. An element of TECOM, the Cold Regions Test Center performs natural environment testing of all types of material for the Army, the other services, other government agencies, and for industry.

Why does AMC need a test agency in Alaska? Can't cold testing be better performed in laboratory cold chambers? These are commonly asked and valid questions. There are many reasons for natural environment testing. First, many items under development cannot be realistically or economically tested in chambers. How do you fly a helicopter in a chamber, or fire a tank on the move, or test air defense missiles or guns? Obviously, trying to simulate such complex actions would be much more expensive than actually doing it in nature. We can't control nature, but we can control when we test.

Secondly, testing in the natural environment is undoubtedly more realistic than chamber tests. The Alaska winter is ever present and in-escapable during testing. That means that the operators and maintainers of the equipment must cope with the environment. Comfort cannot be obtained by stepping from the chamber. Natural environment testing tests the entire system—the test equipment, the logistical support concept, the operators, the maintainers, the communications, the power sources, everything. That's important. That's something that is difficult, if not impossible, to achieve in laboratory chambers which generally look at one or two variables at a time.

One of the more important reasons for testing in Alaska is that past experience of the Army operating in the far north demonstrated the great need for it. Right after World War II, joint task force operations Frigid and Williwaw in Alaska uncovered numerous deficiencies in materiel and doctrine for operating in the arctic. An after-action report recommended that a permanent test activity be established in Alaska. In response to this need, the Arctic Test Board was established in 1949. That organization eventually evolved into what is now called the Cold Regions Test Center (CRTC).

The Cold Regions Test Center and Fort Greely are located about 100 miles Southeast of Fairbanks. Contrary to common belief, the coldest part of Alaska is not the North Pole, but the interior. The Delta and Tanana Rivers that run past Fort Greely form broad

M2 Bradley Infantry Fighting Vehicle firing at CRTC.

valleys which allow the cold, dense arctic air to settle in and provide prolonged periods of cold. Fort Greely's 670,000 acres of land are in effect a giant cold chamber, but one in which all of nature's many variables are presented. Indeed, Robert Service may as well have been writing about Fort Greely when he wrote:

I am the land that listens, I am the land that broods; Steeped in eternal beauty, crystalline waters and woods, Long have I waited lonely, shunned as a thing accurst, Monstrous, moody, pathetic, the last of the lands and the first; Visioning camp-fires at twilight, sad with a longing forlorn, Feeling my womb o'er-pregnant with the seed of cities unborn, Wild and wide are my borders, stern as death is my sway, ...

CRTC Test Soldier firing small arms while testing AH-64 Protective Mask.

The land is stern and lonely. The crisp, cold silence of winter is frequently interrupted by CRTC's testing. But such brief interruptions are quickly swallowed up by the vast land that listens. The environment indelibly affects every person who serves at Fort Greely. You love it or you hate it; you can't forget or ignore it.

In addition to testing equipment, the Alaskan winters test the men and women. Human factors deficiencies quickly show up in the harsh environment of winter. We try to test complete systems, and the human is the most important part of the system. It is important that Army equipment be fully functional when the operator is cold, afraid, tired of isolation and darkness, and just generally under stress. The equipment must be designed so that it is easily used by such soldiers. The best way to determine that is by testing it with such soldiers, in such an environment. Time is an important factor. Equipment that may be operated satisfactorily for a short time, may perform poorly after prolonged use by those cold, short-tempered soldiers. Better to find that out now than during a war.

M2 Bradley Infantry Fighting Vehicle being prepared for cold-start testing at CRTC.

Large scale joint exercises in Alaska every-other winter demonstrate the difficulties of surviving and operating in the cold. But they also demonstrate that with well designed equipment and proper training the Army can fight in the far north. You can be sure that some of our potential enemies can too. The northern regions are taking on an increasing strategic importance. Increasing populations, oil, minerals, and strategic location all combine to give added importance to the far north. However, the far north is not the only place that cold winters occur. European and Asian winters have taken their toll of American soldiers in past wars. Often, cold injuries exceeded war injuries. We must be better prepared to prevent that from happening again. One way is to conduct rigorous testing of materiel in the cold before it is issued.

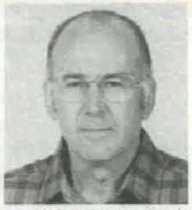
The Cold Regions Test Center conducts many different types of tests on all types of equipment. The center has a cadre of 250 military and 35 civilian personnel. During each winter, soldiers are brought in for up to six months on a temporary duty basis to act as operators, maintainers and testers. This gives flexibility to adjust the workforce to each season's test workload and it provides very valuable human factors information on the tests. Soldier testers also expand their training horizons to include the winter battlefield. The center is bulk-funded. Department of Defense activities do not pay for labor and normal overhead costs. Only project-specific costs are passed on to the test sponsor. This keeps costs low and testing responsive.

Fort Greely is a tiny and beautiful portion of Alaska. Man has had little impact on it. We intend to keep it that way. CRTC's commander COL Wayne A. Hanson, a native Alaskan himself, is as interested as any protectionist in guarding the natural beauty of the test ranges. He has embarked on a vigorous program to clean up past mistakes and to make sure that future use of Fort Greely preserves its pristine beauty.

Cold. Yes, Fort Greely is cold. It is isolated. It is primitive. Yet CRTC has a very high re-enlistment rate. Many soldiers try for years to get to Fort Greely. Tour extensions are the rule. Why? I think there are a number of reasons. One is that CRTC provides meaningful, tangible work. The soldier works in his military occupational specialty, sees the results of his work, and is constantly challenged to his limits. Another reason, I believe, is that there is an unexplainable attraction in living in an environment where nature rules.

Alaska, despite recent development, remains largely untouched. There are no fences, no "keep-out" signs, no pollution. A hardy flora and fauna provides unlimited opportunities for enjoying nature, photographing it, hunting, fishing and just generally seeing the world as God intended it to be. Yes the environment is harsh at times, but hardy people love the challenge. CRTC is comprised of strong people, people who obey the Law of the Yukon.

This is the Law of the Yukon, that only the Strong shall thrive;
That surely the Weak shall perish, and only the Fit survive.
Dissolute, damned and despairful, crippled and palsied and slain,
This is the Will of the Yukon, Lo, how she makes it plain!



WILLIAM J. HASLEM is a physical scientist and serves as technical advisor at the U.S. Army Cold Regions Test Center, Fort Greely, AK. He holds a B.S. degree in chemistry from the University of Utah and an M.A. degree in industrial management from Central Michigan University.

Natick Chemist Improves Sulfite Analysis

A new, vastly improved, speedier and more reliable procedure for determining the amount of sulfites being used as additives and preservatives in food items, developed by Dr. H.-J. Kim, senior chemist at the Natick Research, Development and Engineering Center, Natick, MA, may soon play a key role in ensuring compliance with the new regulations on sulfites issued by the Food and Drug Administration.

The first FDA ruling, effective January 9, 1987, requires that the presence of sulfiting agents in a detectable amount (10 ppm or more) in a food product must be declared on the label of the package or container.

The second decrees the revocation, effective August 8, 1987, of the GRAS (Generally Recognized as Safe) status of sulfiting agents for fruits and vegetables intended to be served or sold raw or presented to consumers as fresh, and that any such use would constitute the use of unapproved food additives and render the food adulterated by FDA standards.

Sulfites have been used as additives and anti-microbial agents as far back as the Roman Empire, seemingly without adverse effects. However, within recent years, sulfites have been added to raw fresh fruits and vegetables in open displays (e.g. restaurant salad bars) to control the unattractive and non-appetizing enzymatic browning that unavoidably takes place.

Along with the popularity of these open displays, numerous reports have arisen concerning the sensitivity of individuals, especially asthmatics, to sulfiting agents. Reports in the medical literature, consumer complaints, comments of state and local health departments, and of medical associations, all have led to supporting the FDA revocation of the GRAS system on these items and the determination that an efficient method capable of reliably analyzing residual levels of sulfites at the 10 ppm level must be developed.

Dr. Kim's new system, utilizing ion exclusion chromatography with electro-chemical detection, overcomes many of the deficiencies that are being noted by users of the present Monier-Williams analytical procedure, considered the standard by the FDA and recently modified by that agency, to detect sulfites.

Many contend the Monier-Williams procedure, the official method of the Association of Official Analytical Chemists (AOAC), does not meet these requirements. In some cases, it is subject to interference, gives false-positive readings, is time consuming (two hours distillation time at high acid concentrations) and is not suitable for quality control in monitoring sulfite contents of food. The FDA also had recognized the need for a quicker and more efficient method of analysis.

With the procedure reported by Dr. Kim in the January 1987 issue of Food Technology, many of these and other problem areas discussed at the 100th annual meeting of AOAC at Scottsdale, AZ can be easily remedied.

Because the procedure involves extracting sulfite, separating it on a chromatographic column, and detecting the separated sulfite with an electro-chemical probe, Dr. Kim reports that the analysis time is reduced to less than 10 minutes, that the method is a much more sensitive way of determining sulfites in food (less than one ppm), and that it is selective in that sulfite can be analyzed despite the presence of other interfering compounds. The Kim system is extremely reliable, producing consistent results more accurately than by the Monier-Williams method, and is especially versatile in that it can be used with most known foods containing sulfites.

A patent application will be filled by the government, which favors transferring this technology to industry in the public interest.

Meeting Of The Minds . . . The MTL/USMA Summer Research Program

By Maureen A. MacFarlane

Giving cadets, as well as faculty members, opportunities is an integral part of the educational experience at the U.S. Military Academy (USMA), West Point, NY. Helping the academy to provide these opportunities, through the recently developed MTL-USMA Summer Research Program, is the U.S. Army Materials Technology Laboratory (MTL) in Watertown, MA.

The Army's lead laboratory in the areas of materials, materials testing technology, solid mechanics and lightweight armor, MTL has provided the nurturing support for this five-year old program which provides both USMA cadets and faculty members with opportunities to explore, to grow, and to learn. Directed by the U.S. Army Laboratory Command in Adelphi, MD, MTL manages and conducts the Army's materials research and development program, as designated by the U.S. Army Materiel Command (AMC) in Alexandria, VA.

This joint educational venture between MTL and USMA received its inspiration from MTL's Associate Director Dr. Richard Chait. While participating in USMA's Visiting Professor Program for the 1983-1984 academic year, Dr. Chait saw the possibilities and benefits a summer research program involving USMA cadets and faculty could provide to both USMA and MTL.

"Through teaching materials engineering and structural integrity courses at USMA it was evident to me that the cadets could gain a great deal of knowledge and appreciation for the role of materials in weapon systems by working in an R&D laboratory environment gaining hands-on experience. I discussed, at great length, the possibilities of developing this relationship with COL Kenneth Grice of the Physics Department at USMA. He saw the benefits and became an active point of contact at West Point.

"A program of this type, which serves both the needs of West Point and MTL, does not start overnight nor is it a one-man show. During the past three years there were many discussions between COL Grice and myself and the guest lecturers that I brought to USMA from MTL as to how we could make the program a viable one. The most valuable ingredient is communication; communicating MTL's needs to West Point, and communicating the interests and qualifications of the West Point cadets to MTL," says Dr. Chait.

"MAJ Steve Medaglia, a former instructor at West Point and now deputy director of MTL's Organic Materials Laboratory, has spent a great deal of time to insure that MTL's role as a communication link was fulfilled. As a result of this communication, the program we have put together is a meaningful one giving the USMA cadets and staff an appreciation for the importance of materials in weapon systems design and reliability.

"A credit to the MTL/USMA Summer Research Program is that throughout the coming academic year, some of these summer research efforts will be be continued at West Point, allowing both the faculty and cadets at West Point to continue during the academic year to expand their knowledge not only of mature materials like metals and metal alloys but also of advanced composites and ceramic materials."

Providing both cadets and officers with the opportunity to work in an Army laboratory for a period of four to eight weeks during the summer, the the summer program offers the opportunity to explore fields of science and technology, to grow in understanding of the materiel acquisition management process and the R&D which supports fielded systems, and to learn by applying textbook learning to actual Army applications.

Since its establishment in 1981, the summer research program has expanded to include not only MTL, but also the Los Alamos National Laboratories in Los Alamos, NM; the U.S. Army Ballistic Research Laboratory at Aberdeen Proving Ground, MD; the U.S. Army Harry Diamond Laboratories in Adelphi, MD; the U.S. Army Missile Command in Huntsville, AL; and the Naval Post Graduate School Laboratory in Monterey, CA.

Also in 1986, for the first time since the program was established, a cadet was assigned to private industry, performing research in the laboratories of Rockwell International in California.

For all parties involved, this research program has proven beneficial. The cadets and the officers have the benefit of working with and learning from the top researchers and scientists who staff the Army's lead laboratories, while the laboratories involved reap the benefits of having additional researchers who are well educated, highly motivated, and eager and willing to learn.

Although the cadets and officers can be assigned to a laboratory for a period ranging from four to eight weeks, the usual period for an assignment is five weeks. This is because the military duties and functions of the cadets and officers leave them with little free time. However the program has been designed to provide the cadets and officers with a maximum amount of experience in a minimal amount of time.

Due to the numerous military obligations of the officers, USMA usually is able to let only two or three officers participate each summer. For the officers who participate in the program, the emphasis is on introducing them to a new field of science and technology and providing them with basic knowledge and understanding so that they can continue to perform research in this field when they return to the academy.

In 1986 three officers were relieved of their other military obligations and participated in the Summer Research Program. Two of the officers, who are involved in the nuclear field, were assigned duty status at the Los Alamos National Laboratories, while COL Grice was assigned to duty status at the Nondestructive Evaluation Branch (NEB) of MTL's Mechanics and Structural Integrity Laboratory.

During his stay at MTL, COL Grice studied ceramic and aluminum samples under controlled conditions. As a result of this research, which was directed by the Chief of NEB Dr. Alfred L. Broz and his assistant, Dr. William Spurgeon, COL Grice built a working knowledge base of ultrasonics, which is one aspect of non-destructive testing and evaluation. Ultrasonic testing and evaluation is used to detect flaws or defects in metal and ceramic materials as well as to determine the material's characteristics.

As a result of his participation, COL Grice will be able to apply this knowledge to the continuation of a research project, which was initiated during his stay at MTL. This project involves preliminary evaluation of specific materials in order to determine their potential for use in goggles. These goggles would protect the wearer's eyes from damage if they were exposed to laser beams.

A member of the Ordnance Corps for the past 20 years, COL Grice comments about his experience in the MTL-USMA Summer Research Program: "MTL is an ideal spot for participation because it supports the active Army research mission. It is the type of assignment an Ordnance Officer might expect to have at some time during his career, and the experience provides me with a better understanding of this type of assignment which will aid me when I am counseling younger officers about seeking assignments."

For the cadets, as future officers, participation in the program is on a voluntary basis. Although the cadets must give up their leave time to participate in the program, well over half of the junior class does participate, and the motivation behind each cadet's participation is different. Some cadets elect to participate in the program because they want to experience a laboratory environment, others because they wish to explore a particular aspect of Army R&D, while others choose to participate because they are able to perform research at a laboratory which is affiliated with a particular branch of the Army.

In 1986, 10 cadets spent the summer at MTL as part of the MTL-USMA Summer Research Program. This group of cadets was the largest in the history of the program. By assisting in MTL's ongoing research the cadets received hands-on research experience and a firsthand look at what the Army is doing as it applies to weapon systems.

Conducting research in laser protection, non-destructive evaluation and testing, armor material development, tank track rubber compound development and evaluation, polymeric materials for chemical protection, robotics applications to materials testing and composite processing research and development, the cadets gained invaluable knowledge about the materiel acquisition management process and the research and development work which supports fielded systems.

Benefiting from exposure to a laboratory environment, the cadets who participate in this program are able to explore new areas of interest as they reinforce their USMA educational experience through exposure to real world situations and problems.

During a series of briefings which were held near the end of the cadets' stay at MTL, each cadet had the opportunity to demonstrate what he was taking away from MTL as a result of his research experience. Through a 10 minute technical presentation which encompassed the scope of their work at MTL, the cadets revealed the depth and scope of their newly-acquired knowledge as well as how this knowledge could possibly be incorporated into future studies at USMA. This presentation was followed by a five minute question-and-answer period in which the audience—the civilian supervisors and co-workers of the cadets as well as MTL military personnel—were able to ask the cadets "thinking" questions about their field of research. Through this questions-and-answer period the cadets, as researchers and as future Army officers, demonstrated their ability to apply their knowledge to field problems.

For the first time in the history of the MTL-USMA Summer Research Program, the cadets who participated in the program were being able to incorporate and continue some of their research when they returned to the Military Academy in the fall as part of the MTL-USMA Cadet/Faculty Research Program. The objective of the MTL-USMA Cadet/Faculty Research Program is to establish an MTL-supported cadet research program at USMA. Supporting up to six cadet projects per semester, this program is an extension of the MTL-USMA Summer Research Program.

The selected cadets who participate in this program conduct their research at USMA, under the guidance of a faculty advisor, as part of their normal academic program. The expectations of and requirements for the research projects in this program are threefold: the project is expected to represent work which MTL has identified as necessary; the project must be one that USMA believes will provide both the cadets and the faculty members who are involved, with a meaningful and challenging experience; and, the project must require a level of background, experience and knowledge which is appropriate for a senior cadet to execute with some assistance and guidance from a faculty member.

At the end of the semester each cadet in the program must submit, to both MTL and USMA, a technical report of the results of the analysis and research. The findings may then be presented at student conferences, such as the Eastern Science Conference or the University of Rochester New York Conference.

The results of research projects also may be published in the appropriate student journals, such as the *Journal of Undergraduate Research*. Additionally, some of the work may lead to joint publication by USMA faculty members and MTL personnel in other journals such as the *American Journal of Physics, and Material Evaluations.*

The MTL-USMA Summer Research Program and its extension, the MTL-USMA Cadet/Faculty Research Program, are full of opportunities intended to guarantee that future Army officers will be aware of the support available to them as field users.

MAUREEN A. MACFARLANE was a staff writer in the Public Affairs Office at the U.S. Army Materials Technology Laboratory, Watertown, MA. She is now a graduate student at Boston University.

From The Field . . .

Army Improving Protective Eyewear

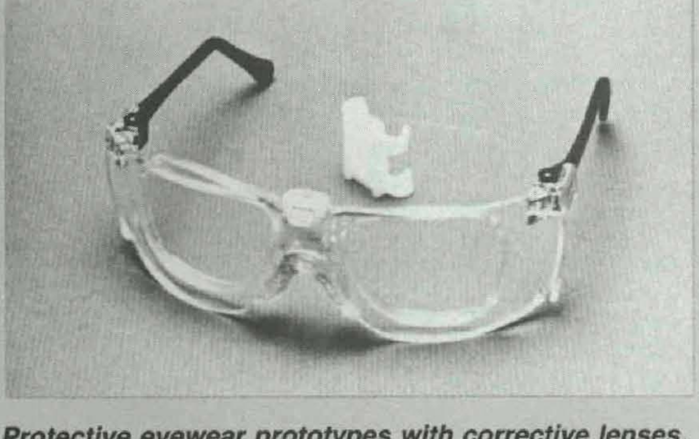
Any field commander offered the opportunity to reduce casualties by up to 10 percent would certainly accept this force enhancement. Ballistic protective eyewear currently in development is expected to provide this capability by 1990.

Nine percent of combat-related injuries in Vietnam involved the eye. Seven percent of Israeli Defense Force casualties in the 1982 Israeli-Lebanon War were ocular injuries. Fifty percent of weapon-related peacetime training injuries are caused by small missiles or flying fragments moving at moderate to slow speeds. This is the most preventable type of eye injury.

In response to these data, and recognizing the over abundance of glasses, frames and lenses used by the Army, in 1984 the U.S. Army Medical Research and Development Command (USAMRDC) tasked its newly formed subordinate unit, the U.S. Army Medical Materiel Development Activity (USAMMDA) to develop a concept to provide a standardized system for protection against all threats—ballistic, laser, wind, and dust.

The concept was briefed to the commanding general, U.S. Army Materiel Command, who jointly tasked USAMMDA and the U.S. Army Natick Research, Development, and Engineering Center to develop protective eyewear. Eyewear development requires input from and coordination with many communities within the Army. Medical input is coordinated by USAMMDA, and Natick is coordinating the operational and developmental testing of protective eyewear prototypes. Several other agencies in the research and development and aviation communities provided input described below.

Polycarbonate wraparound glasses which are able to stop .22 caliber bullets fired from 30 feet have already been developed by the American Optical Corp. under contract to USAMMDA. When these glasses sustain greater impact, they break into large fragments instead of small, sharper pieces, thereby reducing the threat of injury from lens fragments. In addition to ballistic protection, eyewear must have vision correction capability, laser protection, and wind and dust protection.



Protective eyewear prototypes with corrective lenses.

The primary developmental item of the Integrated Eyewear Program is the prescription lens carrier. This medical device is the common element which mounts clear and laser protective spectacle lenses to both the polycarbonate ballistic protective eyewrap and the XM-40 chemical-biological protective mask. Its mounted lenses are cut to the standard aviation shape and size. Use of the carrier with aviation lenses in the eyewrap and the mask makes it logistically economical.

Other developmental items which are attachable to the protective eyewrap are a nylon wind/dust protective edgesert and an optional polyproprionate laser protective frontsert. Laser and other directed energy protection as well as wind and dust protection will be available for field use within 36-48 months.

The protective eyewear system with its optional attachments has several advantages. The eyewear is scratch resistant and can be cleaned in the field. Additionally, it can be worn day and night, is light weight, comfortable, and attractive. All of these factors encourage daily wear.

Research and development have also been focused in the aviation sector. An aviation visor with laser protection for the HGU-56/P Aircrew Integrated Helmet System and polycarbonate lens bubbles with and without laser protection for the XM-43 chemical-biological protective mask are promising developmental items. Already in use is USAMMDA's specially modified aviation frame for the AH-64 aviator. Designed according to specifications supplied by the U.S. Army Aeromedical Research Laboratory (USAARL), the modified aviation frame accommodates the Integrated Helmet and Display Sighting System.

The Letterman Army Institute of Research (LAIR) supports the Integrated Eyewear Program by conducting research to determine ocular susceptibility to laser radiation and ballistic fragments, to specify protection parameters, and to evaluate effects of prototype lens and frame material on vision and performance. The LAIR and the Aviation Systems Command (AVSCOM) closely coordinate their efforts in the development and testing of laser protective visors and lenses. In a coordinated effort with LAIR and AVSCOM, USAARL is assessing other developmental visors.

Two divisions of the U.S. Army Environmental Hygiene Agency (EHA) and the U.S. Army Human Engineering Laboratory (HEL) have also played key roles in the Integrated Eyewear Program. The Occupational and Environmental Medicine Division is currently evaluating visual blur and prismatic imbalance (deviation of light rays caused by the angling of the lenses, which could lead to double vision) associated with induced face-form angle in optical corrections for the protective glasses and protective mask. They will recommend acceptable levels of these effects. The Laser Microwave Division of EHA is evaluating the effectiveness of laser-protective eyewear by measuring its luminous transmittance to ensure the wearer can see at dawn, dusk, and night. They also measure optical density to determine the ability to absorb laser energy and protect against the laser threat. Demographic data depicting the facial characteristics of soldiers was collected by HEL and furnished to the Occupational Vision Protection Division in EHA for input to a computer study to minimize or eliminate the unwanted induced effects.

Engineers from the U.S. Army Chemical Research, Development, and Engineering Center substantially contributed to the development of the mounting nose piece and mounting mask block for the common lens carrier. The innovatively designed T-channel for the nose piece and mask block readily and securely attaches the lens carrier to both the protective spectacles and the protective mask.

From January through March 1987, the U.S. Army Test and Evaluation Command will coordinate the Technical Feasibility Testing of the new protective eyewear devices.

Shepherding a new piece of medical equipment through the complex materiel developmental process is an important function of USAMMDA which requires extensive interagency coordination. The USAMRDC, through USAMMDA serves as the lead agency in this effort. Protection of soldier vision, and subsequent savings in manpower and health care costs, are valuable products of research for the soldier.

Army Conducts Metabolic Rate Study

Remember when one of the first things you learned in the Army was never to volunteer? Members of a rifle platoon of the 7th Infantry Division (Light) from Fort Ord, CA, recently took their chances at Aberdeen Proving Ground, MD, as volunteers in a unique Army study that could have big payoffs for all soldiers.

Twenty-four infantrymen spent six weeks carrying combat loads of various sizes and weights over obstacle, cross-country, and long-walk courses operated by the Human Engineering Laboratory (HEL).

Their loads weighed between 23 and 103 pounds and contained the fighting equipment, clothing, and food that the U.S. Army Infantry School and the Training and Doctrine Command say infantrymen need to carry out their missions.

For the first time, soldiers worked under actual field conditions while investigators continuously monitored their heart rates and body temperatures. Previously, such measurements were only made under laboratory conditions.

Each test participant carried a small transmitter in his back pack. The transmitters received signals from sensors mounted on the soldiers' bodies and relayed them to a monitoring base station. With a 55-foot receiving antenna, the station could pick up signals out to a range of more than four kilometers.

The signals were fed into a computer that displayed them onto a screen for monitoring purposes. The displays were updated every five seconds and stored on discs for later printout and analysis.

"These data will provide the basis, in future tests, of at least three new measures of performance proficiency—work rate, total work performed, and heart rate across the range of loads carried in combat situations by U.S. Army soldiers," said HEL investigator Dr. Art Woodward.

"Up to now, our only measurement of performance has been the time it takes a soldier to traverse the obstacle course," added HEL investigator Doug Jones. "Now we're trying to calibrate the obstacle and cross-country courses—to establish performance baselines for them—that will allow us to measure the soldiers' metabolic rates as they run the courses."

HEL, which reports to the U.S. Army Laboratory Command, conducted the study jointly with the U.S. Army Research Institute for Environmental Medicine (ARIEM), a part of the U.S. Army Medical Research and Development Command at Fort Detrick, MD. ARIEM investigators collected the data needed to measure metabolic rates such as oxygen consumption, the strength of critical muscle groups, and body composition.

While on bivouac, the soldiers negotiated a 500-meter, all-weather course with 13 major obstacles; a four-kilometer cross-country walk course, and a two-kilometer flat or long-walk course.

They ran the obstacle course twice a day, as rapidly as possible. Their times varied between three to 11 minutes, depending on the size of the load carried.

During another portion of the test, they walked the cross-country course twice a day while carrying heavy loads. Traveling at a three-mile-per-hour pace, the troops negotiated the course in 40 to 50 minutes.

Harry Diamond Labs Test Multi-Option Fuze

During a firing test late last year in Blossom Point, MD, a 12-millimeter projectile armed with a M734 multi-option fuze demonstrated its ability by penetrating the roof of an urban building and, after a set delay, exploding inside it.

The test was conducted by Harry Diamond Laboratories to demonstrate the fuze's usefulness in Military Operations against Urban Terrain.

A total of eight rounds were fired. Each round contained an M734 multi-option fuze set to its delay option so as to detonate a 120-millimeter training/practice projectile 50 to 100 milliseconds after impact. The delay mode is one of four detonating modes of the M734 fuze that can be pre-selected by the troops before firing the round. The other three modes or options are proximity, near-surface burst, and impact.

Test Coordinator Jonathan Fine said the rounds were fired against the wall of a building that simulated a roof. The simulated roof consisted of a layer of slate followed by a layer of ¾-inch plywood. The plywood was backed by 2-by-10-foot rafters with 16-inch spacing between centers and contained thermal insulation enclosed by plaster board.

These materials, are similar to the types used in urban dwellings and buildings found in Europe and that could be occupied by snipers, Fine said.

During the tests, a modified version of the M734 fuze—a digital electronic time (ET) fuze—was also fired. The German-made Diehl mechanical time fuze, and the only time fuze now available for American mortars, was fired as a control.

"The electronic time fuze proved both easier to set and much more accurate than the Diehl fuze," said Fine.

Whereas the Diehl fuze is set by two men using a special wrench, the electronic time fuze requires no special tool. Moreover a single person can set the ET fuze by rotating thumb-wheel switches which not only display the set time but also produce "clicks" that can be both felt and heard, added Fine.

"Event times obtained with the electronic time fuzes were within 50 milliseconds (thousandths of a second) of the set times. The Diehl fuzes functioned within 425 milliseconds of their set times," said Fine.

In battle, mortar ammunition is used to destroy, illuminate, or obscure targets. For the ET tests, 29 81-millimeter mortar rounds were armed with fuzes set to burst them in the air at predetermined times. These times ranged from 8.1 to 32.8 seconds.

Under the terms of a contract to be awarded this year, 435 digital electronic time fuzes will be produced over a four-month period, according to HDL contracts specialist Gerard K. McVeigh.

Career Programs . . .

FA52 Personnel Proponency Committee Meets

MG Vincent E. Falter, deputy assistant secretary of defense (atomic energy), was the senior member of an Oct. 22-23, 1986 Functional Area 52 (Nuclear Weapons) Personnel Proponency Committee meeting, hosted by the Nuclear Chemical Directorate, Combined Arms Combat Development Activity (CACDA). The committee met at Fort Leavenworth, KS, to review current FA52 personnel initiatives and assist in determining future personnel management requirements and initiatives for nuclear weapons officers.

As the FA52 proponent manager, CACDA has been proactive in all life-cycle functions for the last 18 months. This proactive approach in fulfilling the functional area responsibilities has been manifested in several forms, including:

- development and publication of the first FA52 Professional Development Guide;
- development of the first FA52 Advanced Civil Schooling Program Handbook;
- development of a specific master's level program for the 52A officer (strategic and tactical science-weapons effects);
- publication and distribution of four FA52 newsletters (updates);
- completion of a 1986 survey of all FA52 officers; and
- publication of articles publicizing FA52 in four professional military publications.

The director, Nuclear Chemical Directorate, CACDA, gave the opening remarks for the committee. These included an overview of the state of the FA52 program, the thrust of the current meeting, and the proponent's specific guidance to the committee for addressing outstanding FA52 issues to meet the challenges of the 1990s.

The FA52 proponent manager then presented the status of the 1985 FA52 action plan and covered the key issues, problems and concerns that face FA52 for the next several years. These issues include: resolution of FA52 field grade shortages; FA52 descriptions, roles, and requirements; FA52 advanced civil schooling program; expansion of Army Education Requirements Board positions for 52A officers; expansion of FA52 development positions in TOE/TDAs; and identification of FA52 05- and 06-level command positions.

After the initial briefings, the committee was divided into two working groups which addressed 11 key issues facing FA52 and made appropriate recommendations to each. The most pressing problem facing FA52, as mentioned above, is the current shortage of field grade officers (04 and 05). Various solicitation programs are being worked to eliminate the problem in the near term. A deliberate over-accession of captains, at the seventh year of service, will eliminate the shortage of field grade officers by FY90/91.

The FY87 FA52 action plan, which contains the issues and recommendations of the FA52 proponency committee will be published no later than the second quarter of FY87. Many of the recommendations contained in the plan are already being addressed. Every agency in the Army which has an FA52 authorized position will receive a copy of the FY87 FA52 action plan. The FA52 proponent manager is available to present the FA52 personnel situation and the status of the FY87 FA52 action plan at key meetings and action groups dealing with nuclear weapons matters.

The following FA52 personnel related items also have been, or will be, published by the proponent and mailed to every officer holding FA52 in the near future:

- FA52 Update 1-87, which will include the results of the 1986 FA52 survey (1st Qtr, FY87);
- FA52 Advanced Civil Schooling Program Handbook (2nd Qtr, FY87);
- FA52 Professional Development Guide (1st revision) (2nd Qtr, FY87);
- FA52 update 2-87, which will include the results of the November 87 MILPERCEN Army Education Requirements Board and the detailed results of the October 86 FA52 Proponency Committee meeting (3rd Qtr, FY87).

Any FA52 officer who does not receive these items and desires them, should call FA52 Proponent Manager MAJ Johnie J. Wright on AUTOVON 552-2724/5183).

The MILPERCEN FA52 assignment officer presented three briefings to the proponency committee dealing with the health of the functional area (demographics), the conduct of promotion and schooling boards, and a professional development overview which included the new single versus dual tracking program.

The health of the FA52 is considered excellent, with one significant problem being a near-term shortage of field grade officers. Promotion and schooling statistics indicated that FA52 officers historically are selected at rates slightly higher than the Army average.

An overview of the Nuclear Weapons Officer Course, which is jointly taught by the Ordnance Missile and Munitions Center and School, the Interservice Nuclear Weapons School, the Command and General Staff College, and CACDA's Nuclear Chemical Directorate, was also presented. The overview explained the genesis of the course, the major objectives and elements of the course, and the dates of the next three classes. The next three classes will be conducted July 6-24, 1987, Feb. 7-26, 1988, and July 7-22, 1988.

Conferences & Symposia . . .

Upcoming Conferences

- The U.S. Army project manager for smoke/obscurants is sponsoring Smoke/Obscurants Symposium XI, April 21-23, 1987, at the Kessiakoff Conference and Education Center, Johns Hopkins University in Laurel, MD. The symposium theme is "Smoke: A Combat Multiplier."

Additional information is available from Walter G. Klimek, commercial phone (301) 278-5411 or AUTOVON 298-5411.

- 1987 Test and Evaluation Symposium, Nevada Automotive Test Center, Reno, NV, April 28–30, 1987. POC: Ronald P. Lenert, AV 298-5194, COL V. McDonald, USA (Ret.), (703) 522-1820, or Henry Handler, (202) 274-8671.

Executive's Corner . . .

AMC Commander GEN Richard H. Thompson Discusses . . .

Acquisition Challenges for the Future

The following remarks were initially presented at the 7th Annual National Contract Management Association's East Coast National Conference. They reflect GEN Thompson's acquisition policies and contain comments which affect companies doing business with the Army Materiel Command (AMC).

Introduction

What do I see on the horizon? Let me put it in terms of an analogy. I see the acquisition community as a veteran tightrope walker—although the city may differ, the audience may differ, the tent and the wire itself may differ--the path of the tightrope walker remains relatively constant, and the tightrope walker's challenge remains the same: to move forward, despite the differing environment, but not in a way that would make him lose his balance.

This is the challenge I see in acquisition—to continue to move forward to change, but not in a revolutionary manner that will make us lose our balance.

So how do we move forward? What are these changes? What do I see down the tightrope?

First let me make it clear that while there is no question that the Army's approach to acquisition is changing, we are not talking about a wave of changes—a revolution of change.

Those of you who have heard me speak in the past have heard me refer to the changes in the Army's approach to acquisition as "TRENDS." This is how I continue to see them—as trends, steps across the tightrope.

And these trends—these changes—won't show up in every acquisition but only when the specifics of the individual acquisition cycle indicate that a new approach is appropriate.

Flexibility

I guess that's really my first trend—we're much more conscious of the need for flexibility during all phases of procurement. And although we're all aware of the increasing regulatory requirements (all 21 feet of them with a possible growth to 28 feet this year alone), our trend is definitely toward making procurement more flexible. To be more specific, let's talk Requests For Proposals (RFPs).

Within AMC, our focus is now toward performance. We have a "Nothing is Sacrosanct" approach to the development of solicitations, to include general provisions. No specification is considered sacred. If industry can propose to do something differently and better, we are encouraging them to do so. Our goal is to tell industry what we want without drowning both them—and us—in the details of how we want it done.

A good example is a recent solicitation for Night Vision Devices. The original document went from two inches thick (not including drawings and specifications) to three-quarters of an inch, and the content changed considerably, too:

- Technical requirements were reduced to a system performance specification with drawings provided "FOR INFORMATION ONLY"—not for precise duplication.
- Offerors were allowed to propose their own logistic support concept and a configuration management approach—provided they were compatible with each other.
- We did not specify data requirements for submission of test plans and management plans. Instead, we asked contractors to submit their plans to meet our needs and to give us best value.

Another example of our effort to reduce restrictions in RFP's, as evidenced by reductions in the total page count of the RFP, is the LHX (Light Helicopter Experimental) engine:

- that page count was reduced by 75 percent (from 571 to 144 pages);
- data items went down 60 percent (from 173 to 49);
- and specifications were reduced 75 percent (from 159 to 40).

Another example is the 120mm mortar. Our original RFP contained over 1,000 pages without development of ammunition. The final count for both the weapon and ammunition was 217 pages. The initial 163 data items with limited tailoring were cut to a maximum of 85 tailored with ammunition development, and we deleted all of the 7,500 references to other documents.

In the case of the Advanced Anti-Tank Weapon System Medium (AAWS-M), we eliminated unrealistic and redundant requirements. As only one example, why have a rain requirement when the system was also expected to be immersible?

These solicitations illustrate two significant changes:

- On the technical level, we are stating simply and completely what we need, not how to do it.
- On the "cultural" level, we are changing our thinking; we're deliberately fostering flexibility and latitude for innovation.

Bottom line: If we are to take advantage of the innovations and cost efficiencies available in the commercial environment, performance-oriented, flexible RFPs are a must.

Turning to negotiation, we are recognizing the differences among individual contractors. To impose the same terms and conditions in all contracts can stifle motivation and flexibility.

I think this makes good business sense—again, flexibility and fairness are our watchwords.

We are using waivers and deviations as tools to get the best value for the Army. If we can enhance value using waivers and deviations, we will do so.

- And we intend to remove the negative connotation from both words and make them positive contributors to our quest for value.

Challenges

So what are the challenges presented by this move to more flexibility? What could cause us to lose our balance on this tightrope? I see the challenges as twofold:

- To us, the government, the challenge is to overcome the protectionist tendency to put everything into the RFP, without overreacting and—going to the opposite extreme—not adequately communicating our needs.
- To industry, the challenge is to be innovative, to live up to our challenge to be creative.

One final note on RFPs. AMC's RFPs really have changed in the past two years, and sometimes we think that our industry counterparts aren't reading them. I caution the industry attendees not to assume you've read it all before—you might miss something that will make or break your offer.

Shortening the Cycle

Another trend is shortening the acquisition cycle. Everyone agrees it takes too long, but what's being done about it? Within AMC, we are attacking this problem on several fronts:

- We are concentrating on making tailored acquisition the norm rather than the exception. This means, in most cases, employing two formal milestone reviews rather than three. Concept exploration and demonstration/validation are being combined—and simplified—into a "Proof of Principle" phase, that allows us to combine milestones I and II.
- "Brassboard" systems, (or components or surrogates), are being demonstrated through troop use to prove out both the technical approach and the operational concept before proceeding to Full-Scale Development (FSD).
- This allows us to concentrate the FSD effort on integration of proven components into a viable system and on prove-out of the production process and logistic support package prior to entry into production.
- There has been an increased focus on production engineering and planning as integral parts of the design effort; and, accordingly, production planning will receive increased emphasis in the source selection process.
- We are committed to improving in the areas of production transition and follow-on production capability and have recently established a production base advocate at AMC to ensure that production considerations are fully explored and addressed in acquisition strategies.

NDI

Hand-in-hand with streamlining, I see a continuing emphasis on non-developmental items (NDI) because they offer real time and money savings. One good example of NDI is found in our Mobile Subscriber Equipment (MSE) program. Here we see a long-term package procurement program with two fixed-price contracts for production and support. We see the development of a system that didn't exist before, but the components were available—the key was to package the existing components to meet our needs. We saved a large amount of research and development money using the NDI approach, versus the "starting from scratch" approach, for MSE.

NDI offers a considerable challenge for us because it requires the development of acquisition strategies that take advantage of existing technology—but still accommodate follow-on competition at the end item and part level and that fulfill our standardization/interchangeability needs.

Balancing Risk

The final trend involves new efforts toward balancing risk and responsibility. I must be honest and say that in the past, risk has been skewed toward the government. There is a continuing need for industry to assume more risks as they do in the commercial environment. Balancing of risk is necessary if we are to accurately forecast and control funds and schedules—two elements critical to program success.

Attempting to balance acceptable risk involves adopting a more commercial philosophy, to include:

- more use of firm fixed-price contracts,
- and a move toward increased investment by industry with less government facility investment.

As a final note on the balance of risk and responsibility, I see a shift toward making our prime contractors participants in the development of competition for future end items and spares.

A good example of this is the LHX engine, where two teams of two contractors each are participating in development—one as a joint venture (AVCO/United Tech) and one as a partnership (Allison/Garrett).

Each team is responsible for establishing their relationship so that two sources—for a single design—will be qualified during development. The relationship must also provide for long-term maintenance of the single design so that end item competition can be sustained downstream.

Development of competitive sources at the component and spares level is is also required—the extent of competition available at all levels will be an evaluation factor in down-selecting for future awards.

Conclusion

I believe all of these trends are good news. Our climate today requires prudence and more guarantees. We are driven by economic necessity and are learning many lessons from business itself.

We are learning to be more flexible—to streamline the acquisition process and use NDI effectively—and we are learning about appropriate levels of risk and responsibility. But we are not jumping off the tightrope; we are carefully attempting to maintain our balance as we move forward across that tightrope.

And if we're smart, and selective, we'll reach our destination successfully. And, we'll get there faster and spend fewer resources doing so.

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