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ARMY RD&A BULLETIN

Research Development Acquisition

Professional Bulletin of the RD&A Community

FEATURES

DEPARTMENTS

COVER

The Soldier Integrated Protective Ensemble is a U.S. Army Natick RD&E Center Advanced Technology Transition Demonstration (ATTD) Program. One of the Army's 13 funded ATTDs, it is the only one that specifically addresses needs of the individual soldier.

THE SOLDIER INTEGRATED PROTECTIVE ENSEMBLE

By CPT Mike Nugent

The changing nature of the Army towards a highly mobile, lighter force makes the individual combat soldier increasingly significant to the Army's future warfighting potential. Soldiers on future battlefields will face increasingly sophisticated weapons and surveillance systems as well as environmental hazards ranging from climatic extremes to disease carrying vectors. Future conflicts will be intense and devastating.

The diverse nature of Airland Battle-Future combat will make command and control (C2) exceedingly difficult, especially in contaminated environments. The lethal nature of the future battlefield requires that the soldier's protective equipment provide balanced, multiple threat protection. The intensity of future combat operations requires that protective equipment allow soldiers to fight unencumbered by the performance degradation associated with current protective gear.

Flexible, multi-functional soldier systems are required to support the increased emphasis on Low Intensity Conflict. The challenge for materiel developers is to meet the goal of enhancing the operational effectiveness of the force, while providing effective threat protection and improved survivability for the individual soldier.

To accomplish these goals, the U.S. Army Natick Research, Development, and Engineering Center is leading an ambitious project, the Soldier Integrated Protective Ensemble (SIPE) 6.3A Advanced Technology Transition Demonstration (ATTD) Program.

The SIPE ATTD is a technology base program, based on the concepts and capabilities for future systems outlined in the recently drafted Soldier Modernization Plan. Other future concepts include the Maneuver Arms Tactical Protective System, and Combat Vehicle Crewman Protective Ensemble documented in draft Operational and Organizational plans from the Infantry and Armor Schools respectively. Each of these proposed requirements reflect the needs of the user community for multifunctional individual systems which are sufficiently flexible to accommodate their mission requirements.

As one of the Army's 13 funded ATTDs (identified in the March-April 1990 *Army RD&A Bulletin* article "The Army's Technology Base Master Plan"), SIPE is the only ATTD that specifically addresses the needs of the individual soldier. The follow-on full scale development will generate a soldier system to be fielded in the late 1990s.

Program Objective

The objective of the SIPE ATTD is to develop, fabricate and demonstrate a modular, head-to-toe individual fighting system for the ground soldier, which affords improved combat effectiveness, while enhancing survivability by providing balanced protection against multiple battlefield hazards. Equally important, the SIPE ATTD will also generate a baseline of performance for the entire soldier system.

While Natick is the lead agency in this effort, the SIPE ATTD is fully coordinated with the U.S. Army Infantry School (as the Training and Doctrine Command lead) and involves the support of key Army Materiel Command laboratories and centers. The Chemical RD&E Center is contributing to the systems respiratory protection and chemical agent detection capabilities. The Communications and Electronics Command (CECOM) is providing SIPE's soldier-to-soldier communications device and individual soldier computer capabilities. The CECOM Center for Night Vision and Electro-optics is responsible for SIPE's vision enhancement capabilities and, along with the Armament Research Development and Engineering Center, the integration of a weapons interface capability. Additionally, The Human Engineering Laboratory's human factors contributions and the Army Research Institute of Environmental Medicine's physiological testing will be key to the program's success.

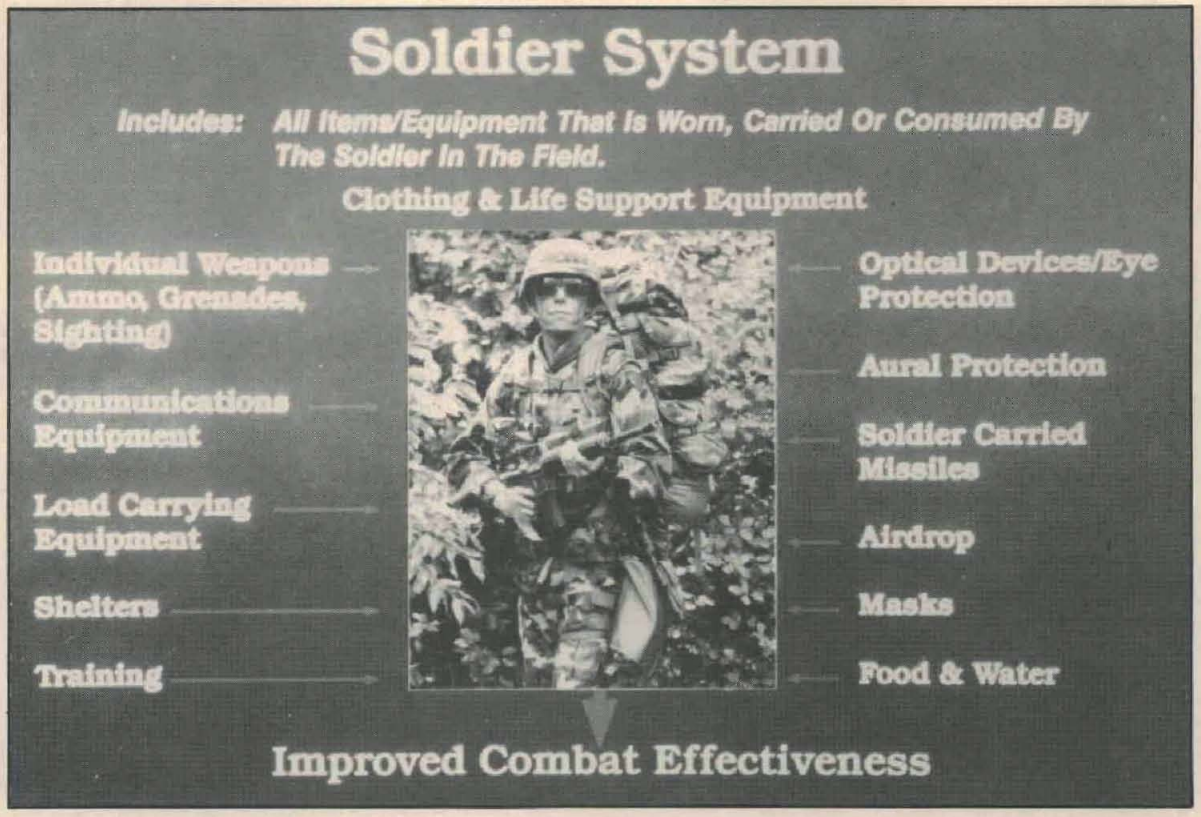


Figure 1.

Battlefield Deficiencies

SIPE will address some of the problems currently faced on the battlefield. The U.S. Army Chemical School's Combined Arms in a Nuclear/Chemical Environment test program indicated severe performance degradation for soldiers operating in protective gear in the areas of communications, effective weapons use, command and control, and overall operational effectiveness.

Communication between soldiers in a nuclear/chemical environment (NCE) was only about half as effective as in a non-threat environment. Sending a clear message required 100 percent more radio transmissions, and the length of the transmissions increased by 47 percent. U.S. force lethality was likewise degraded in the NCE. Successful attacks required twice as many soldiers and firing rates declined by as much as 40 percent. Target identification was especially difficult with 20 percent of shots fired (M16) aimed at friendly personnel. Most significantly, survivability in the NCE was severely degraded; friendly casualties per enemy attack increased by 75 percent.

The traditional approach to the development of soldier equipment on an item-by-item basis has resulted in a plethora of standard items of protective equipment. Although they each provide good protective capabilities, these items are essentially functionally independent, requiring separate items to provide protection from various battlefield hazards. The simultaneous presence of these hazards requires that combinations of separate protective items be worn in an attempt to provide multiple threat protection. The cumulative combinations of protective equipment overburden soldiers with excessive weight, bulk, and increased heat stress, thus limiting mission duration and battlefield efficiency.

Soldier System Approach

SIPE is the first step towards the development of an integrated fighting system using the philosophy and systems approach discussed in the November-December 1989 *Army RD&A Bulletin* article entitled "The Soldier System." To address the problems of performance degradation and achieve the goals of enhanced performance and survivability, the individual soldier must be considered as a combat system.

The soldier system is comprised of the individual and all his equipment, including clothing, protective equipment, communications equipment, weapons and ammunition, food and water, and personal tools. In general, everything worn, carried or consumed by the soldier is considered the "soldier system" (Figure 1). Effective integration of the R&D efforts in these areas will result in the synergy necessary to make the individual soldier a more effective and lethal combat system (Figure 2). This systems approach to developing soldier equipment will result in optimization of the soldier system, whereas a traditional approach optimizes individual items. The approach goes beyond simply developing compatible components. It requires total integration of components and subsystems from the outset.

Using a systems approach, the SIPE program is integrating existing state-of-the-art technologies (Figure 3) into a single system consisting of an Advanced Clothing Subsystem (uniform and body armor, handwear, footwear, and load bearing equipment), Integrated Headgear Subsystem (communications capability, interface with weapons systems, respiratory protection, and laser eye protection), and Microclimate Conditioning/Power

Subsystem (ambient air cooling powered by an engine/generator).

The "soldier system" philosophy will result in a fighting system that can vastly improve a soldier's operational effectiveness and battlefield lethality. The systems approach to SIPE's development will eliminate the functional redundancies of current protective equipment, and result in a significant weight and bulk savings. This weight saving will both improve individual mobility, and allow for longer mission duration. SIPE is expected to achieve a total weight savings of 20 percent to 30 percent (less the Microclimate Conditioning/Power unit) over the current equipment that would be required to afford similar capabilities and levels of protection. Additionally, SIPE will provide new operational capabilities and in some instances enhanced levels of protection over current equipment.

Flexibility Via Modularization

Since all of SIPE's operational and protective capabilities will not be required at all times, SIPE is being engineered to be a modular system to allow for the greatest degree of flexibility in tailoring to meet mission and threat requirements. Leaders will determine the capabilities and types and levels of protection necessary, and configure SIPE's modular components to best support their specific missions. A modular system will provide the flexibility to optimize the balance between performance and protection while not overburdening the soldier with unnecessary equipment. Although SIPE is focused initially on the dismounted infantry soldier, a modular system will also allow other forces to take advantage of some of the operational and protective capabilities that SIPE will provide.

SIPE Subsystems

SIPE's Integrated Headgear Subsystem will include a soldier-to-soldier communications device that will allow encapsulated soldiers to communicate at least as effectively as non-encapsulated soldiers. Improving the capability to communicate will significantly enhance C2. Dismounted soldiers will be able to disperse over wider areas and effectively use movement techniques difficult to control if forced to rely only on hand and arm signals. The wider dispersion of troops will allow units to effectively cover greater areas, and to take advantage of their weapon's maximum effective ranges.

Wider dispersion of soldiers will also contribute to their survivability. Leaders will issue directions and soldiers will make reports quickly and accurately, reducing the time required to implement orders and complete missions. Improved communications will additionally reduce some of the psychological stress of isolation associated with encapsulation. This demonstrates the potential synergy which will be exploited throughout the SIPE ATTD program.

The Integrated Headgear Subsystem will also include the output of SIPE's weapons interface as conceptualized in Figure 4. The weapons interface will consist of a thermal sight mounted on a rifle (M16A2, and possibly other infantry squad weapons), linked electrically or fiber-optically to a display device in the headgear. Soldiers will be able to sight their weapons without the degradation usually experienced when wearing protective masks. The system will provide a "shoot from the hip" capability, and should improve target acquisition and fire control. Additionally, the weapons interface provides an improved all weather, day/night capability over current systems, enhancing the lethality of the individual soldier.

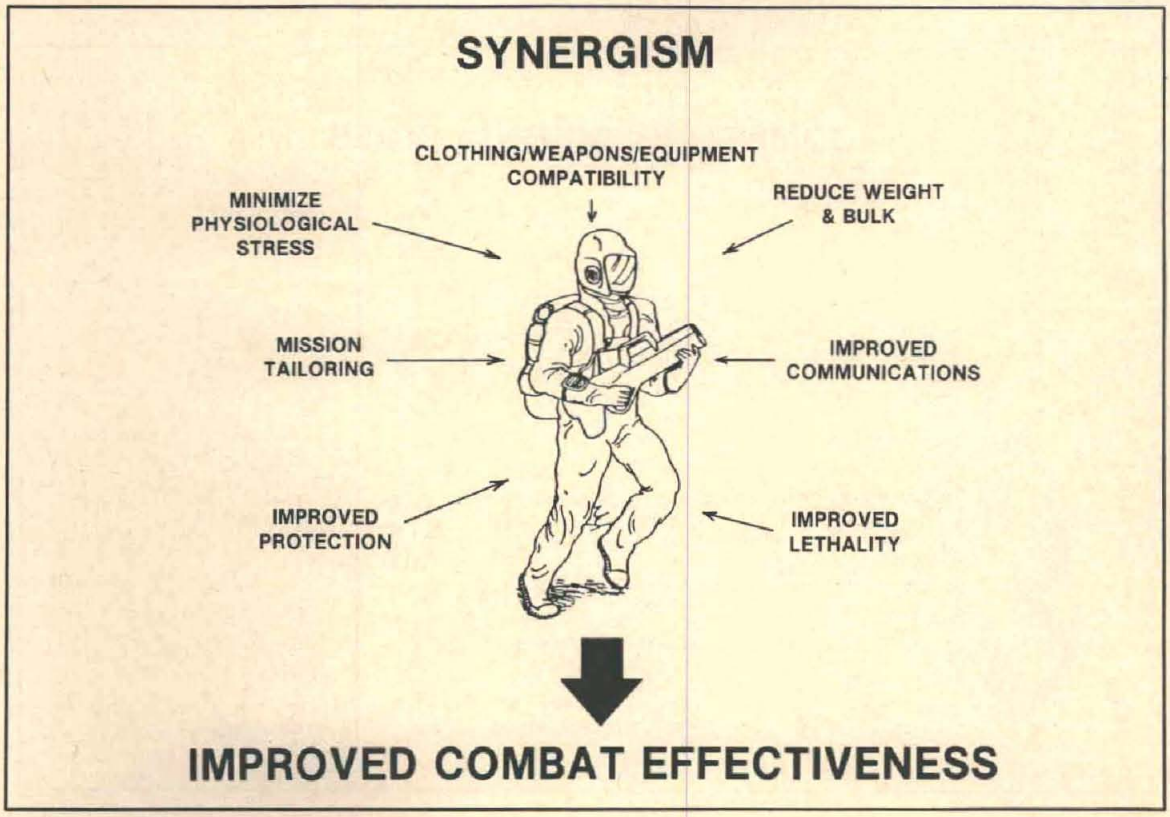


Figure 2.

SIPE's Microclimate Conditioning (MCC)/Power Subsystem will interface with the Advanced Clothing and Integrated Headgear Subsystem. The system will utilize a lightweight power source to filter and circulate ambient air, providing evaporative cooling to maintain the soldier's thermal equilibrium and combat the heat stress induced performance degradation common with current equipment. Microclimate Conditioning will greatly improve soldier comfort, allowing for longer mission duration and further reducing the psychological stress of encapsulation. The MCC will also improve chemical/biological protection by generating an overpressure within the system.

SIPE's Advanced Clothing Subsystem (ACS) will afford soldiers balanced multiple threat protection. In the area of ballistic protection, both fragment and flechette protection modules will be provided. Other modules will protect against liquid, vapor and aerosol chemical and biological hazards, and potentially extend the protection time from the current 24 hours to 36-48 hours or more.

SIPE will protect against both visual and infrared (IR) surveillance and laser eye protection is expected to be improved. SIPE will also provide flame and limited thermal (nuclear) protection. Environmental protection will be provided from precipitation and wind (the first ATTD focuses on a temperate environment; other climatic conditions will be addressed in follow-on efforts), and the system will also allow for both "thru mask" drinking and "thru suit" waste elimination. By providing extended and improved protection over current systems, SIPE will improve survivability, allow for extended operations, and reduce the need for re-supply, lessening the burden on the logistics system.

Modular load bearing equipment (LBE) will be a component of the ACS. The LBE will allow a soldier's load to be configured to maintain the optimum center of gravity, and will adapt to carry the equipment required by riflemen, grenadiers, and Squad Automatic Weapon gunners. For missions that do not require the MCC system, the LBE can be re- configured for ease and efficiency of carrying remaining equipment, or to facilitate carrying additional mission related items.

MANPRINT and Human Factors

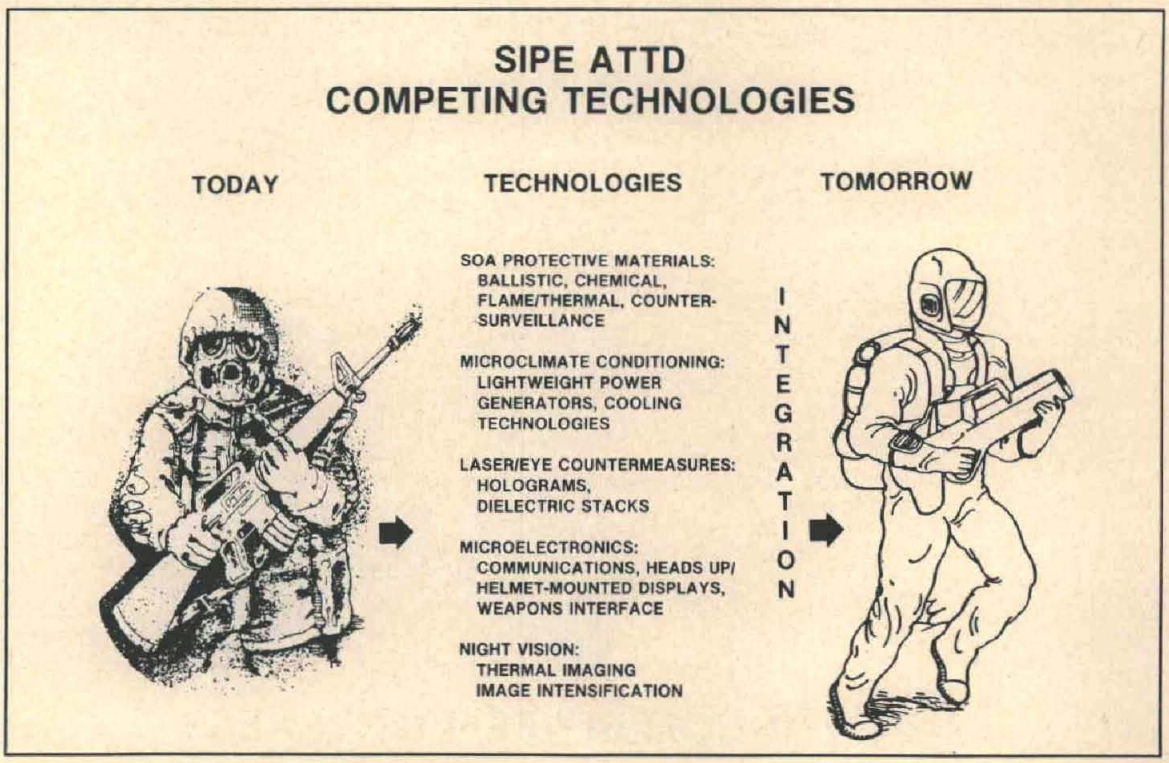
MANPRINT and Human Factors concerns are of utmost importance, and will be at the core of the development of SIPE. Anthropometric concerns, minimization of weight and bulk, and optimization of load distribution are inherent factors in the development of all SIPE's subsystems and components. A major concern will be the systems compatibility and interface with weapons systems, communications gear, combat vehicles and other equipment. Early-on and thorough integration of MANPRINT and human factors considerations are critical to the success of the SIPE ATTD.

User Demonstrations

The SIPE ATTD will culminate in a user demonstration scheduled for the 3rd quarter of FY92. The demonstration will consist of a 3-5 day field scenario with infantry soldiers operating in a realistic environment. To demonstrate the potential for extended NBC operations, the scenario will include a period of total encapsulation of up to 36 hours. The scope of the SIPE ATTD demonstration is currently being developed by the lead materiel developer (Natick) in conjunction with the lead combat developer (Infantry School) and the U.S. Army TEXCOM Infantry Board.

The demonstration will be conducted at training areas at Fort Benning, and will include Army Training and Evaluation Program tasks in both

Figure 3.



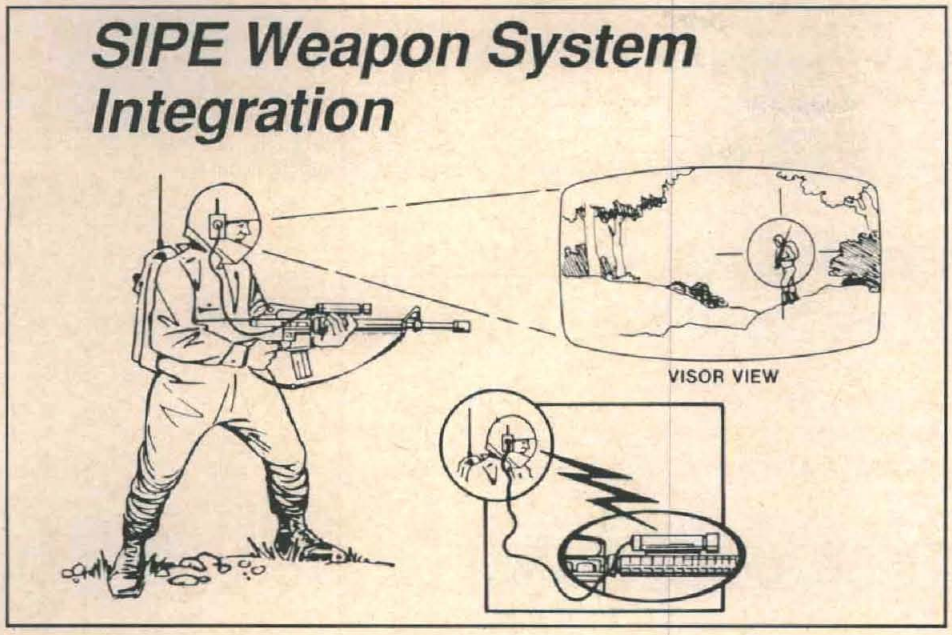


Figure 4.

conventional and chemical environments. In addition, SIPE system evaluations will also be conducted at the Human Engineering Laboratory's obstacle course, and on the instrumented firing ranges at Fort Benning. Performance will be compared to a baseline of operations conducted with both standard equipment (non NBC) as well as current NBC protective gear. To complement the field demonstration, modeling capabilities are being developed to assess improvements in overall survivability of soldiers equipped with SIPE compared to standard baselines.

SIPE Payoffs

SIPE is expected to demonstrate improvements in both performance and survivability based on state-of-the-art technologies. Performance will be enhanced as a result of the improved communications SIPE will provide, the increased lethality SIPE's weapons interface will allow, the improved comfort and extended mission duration afforded by microclimate conditioning, and the weight savings achieved over current equipment. Survivability enhancements will result from the improved mobility of SIPE-equipped soldiers, the multi-threat protection provided, and the maintenance of thermal equilibrium.

The field demonstration will generate the operational data which, along with technical and modeling data, will provide the information necessary to efficiently transition into full scale development (FSD) of next generation soldier systems, improve existing systems, and develop spin-off subsystems and components as required by the user. Upon successful completion of the ATTD, it is expected that SIPE will progress into FSD, scheduled to commence in FY93. Transition time will be minimized due to the development of supporting requirements documents during the SIPE program. A modular soldier system is expected to be fielded in the late 1990s.

Although the emphasis of SIPE is the ground soldier, other Army users, as well as the other services, have been involved so as to implement the greatest degree of standardization and technology sharing as possible as we move towards more sophisticated soldier systems in the future. Future efforts will build upon the lessons learned and technologies and components successfully demonstrated in the first ATTD, coupled with newly mature technology base developments, to focus on integrating soldier systems for other military occupational specialties (MOSs). The needs of combat vehicle crewmen and aircrews will be addressed in the follow on "Crew SIPE" ATTD scheduled to begin in FY93.

Summary

The SIPE ATTD provides the first opportunity for the Army to integrate into the soldier system many of the developments in its technology base, and demonstrate the operational advantages that state-of-the-art technologies can provide the individual soldier. The purpose, however, is not just to demonstrate advanced technologies, but to exploit them to the soldier's advantage.

By providing state-of-the-art equipment to our soldiers, and demonstrating capabilities which do not currently exist on the battlefield, we can increase the clarity of future user requirements, improve the probability of successful FSD, and possibly accelerate FSD.

The ATTD will focus on issues beyond protective equipment to include the entire "soldier system" concept. The efforts and successes of the SIPE program will guide future requirements for integrated protective equipment and all other soldier system research and development efforts.

The SIPE program is the first step towards maximizing the combat effectiveness and lethality of our individual combat soldiers. Regardless of changes in global politics, evolving doctrine, and technological developments, these soldiers will remain the Army's most valuable asset and our most important combat system.

CPT MIKE NUGENT is assigned to the Natick RD&E Center as the R&D coordinator for the SIPE ATTD. He is a graduate of the Armor Officer's Advanced Course, the Combined Arms and Services Staff School, and the Materiel Acquisition Management Course.

INTERVIEW WITH MG PHILIP K. RUSSELL

Commanding General U.S. Army Medical R&D Command

This interview was conducted prior to the announcement of MG Russell's retirement, which is planned for Sept. 30, 1990.

Q. What do you consider to be your most important role as medical R&D commander?

A. The most important issue for an R&D commander is in the balance between the development of research policy and program direction, and the development of leadership. Research policy and program direction evolves from the interaction between the senior scientists and the military commanders. Setting policy for the future is always said to be perhaps THE most important role of the commander. However, you can't separate that from selecting leaders and making sure that the best people are put into positions of authority and responsibility.

Proponency for high levels of professionalism, scientific capability and leadership skills is as important as specific policy decisions. Because of the diversity of the command and the very different areas where we need expertise and leadership, it's more important to have strong leaders and managers in senior positions than for the commander to dictate policy in isolation.

On the other hand, in an era of constricting and declining resources, where both manpower and the dollar budget are predictably going to decrease, policy decisions and prioritization of programs become very important for the short term. However, for the long term, the personnel issues are at least equally important.

Q. In view of the significant political changes and general lessening of tensions throughout the world, is there reason to believe that medical R&D efforts may be substantially reduced?

A. Everyone in the Defense Department is aware that the entire DOD will be substantially reduced in size and that the missions will be significantly changed.

A big part of the medical R&D effort is in the technology base which is very long range and futuristic. There is a general policy that is clearly articulated up through the Chief of Staff of the Army to protect the technology base and protect the future at the expense of short term issues. That support for continuing technology base research in order to be in better position in the long run extends all the way up through the top levels of defense. Now, how strong that support is and how well basic R&D will fare in the DOD and Congressional interfaces are open questions.

I believe that many of our programs are more related to the Army's future missions worldwide, than to a European conflict. For example, infectious disease hazards are more important in tropical areas of the world and the Middle East than in the European theater. So, that part of the program remains equally or more important than before. The dissemination of the chemical and biologic threat to several other countries, especially those in the Middle East, keeps the medical biologic defense and medical chemical defense programs at a significant priority level. The medical threat does not reduce in the same manner as other aspects of the military threat in the current political climate.

I see important changes in the way the services function together in medical R&D. If the current Armed Services Biomedical Research Evaluation and Management Committee's recommendations and Defense Department requirements are met, you will see consolidated laboratories, and a smaller number of laboratories. Several may be joint Army and Navy or three-service joint laboratories.

Yes, we'll be reduced. How much is impossible to tell. However, there's good reason to believe that the technology base will be substantially protected.

Q. How would you assess the current quality of medical R&D personnel?

A. The way to assess the overall quality of medical R&D personnel is by evaluating scientific productivity and scientific status. In many areas, our people — both military and civilian — are in the upper levels of the scientific structure of the world. I believe that in some areas, we have no real competition. In tropical medicine and some

"The biggest difference between medical R&D and equipment/weapons R&D is the relationship between the investment in the technology base, and the investment in the advance development process."

areas of infectious diseases, our folks are among the world's best scientists. The productivity of the Medical R&D Command in developing products among all of our programs has been very high. That is due to the fact that we have had outstanding scientists in the technology base generating the basis for developing the products. We have had very effective professionals managing the development process through the military acquisition process, as well as the FDA regulated licensure process. We have superb scientists doing the definitive efficacy studies in the field. Currently, we have major field trials going on with several vaccines; these are world class progams.

Q. What are some of the key R&D areas that you believe offer the greatest potential for medical advancements during the next decade?

A. The generic area of vaccine development is one that has been moving fastest in the recent two years and one that still has a substantial upward curve. When we learn to exploit the promises that lie in vectored vaccines, when we use carrier organisms such as enteric bacteria and vaccinia virus, and perhaps some other vectors, we will probably produce some really big jumps forward in developing vectored vaccines which we expect will be very effective inexpensive vaccines. We're going to see substantial progress in antiviral drug development. The combination of our basic antiviral drug program, plus the effect that AIDS research has had on antiviral drug therapy will inevitably produce a spin-off outside of the AIDS field. The use of human monoclonal antibodies for a variety of purposes is another field that is just beginning to unfold. Technology for developing and producing human monoclonal antibodies offers immense opportunities for treatment of such things as septic shock in the post-operative individual, and for prophylaxis against toxins and chemical agents.

In the field of combat casualty care, I believe research and development in bone repair and materials for bone replacement will move ahead substantially. Our current programs show some promise and there is a fair amount of research outside the military in the aspect of materiels. In the next decade we'll see some important advances in oxygen-carrying fluids for resuscitation of trauma victims, sometimes called blood substitutes.

I think we will see major changes in the management of burns. We're likely to see another major step in both covering burns and treating them. Laser surgery is an area that hasn't been fully exploited in the burn area.

Environmental issues are going to be big ones downstream. I don't see anybody making dramatic breakthroughs, but there are a lot of technologies that need to be refined and properly exploited to help understand and solve some of the big environmental issues that the Army is facing. Our industrial base has environmental impact, and the medical department's role in environmental and occupational health issues will be extremely important.

In the chemical defense area, I see monoclonal antibodies playing a big role in protection against nerve agents and I think we'll come up with some good ways to protect against the mustard agent, both by skin protective materiels and by the possibility of actually interfering with the action of the agent. I expect that the combination of

"One of the more important contributions we made to understanding the AIDS epidemic and the AIDS infection was the early emphasis on heterosexual transmission."

monoclonal antibodies and other kinds of scavenger materials will give the level of protection we need without using MOPP gear. That is very important.

Q. In what ways does the medical RD&A process differ from the more "glamorous" weapons acquisition process?

A. The biggest difference between medical R&D and equipment/weapons R&D is the relationship between the investment in the technology base, and the investment in the advance development processes. Medical R&D requires a long term and high level investment in the tech base. The end stage product development is not necessarily shorter because we're constrained by the licensure requirements, but it's a lot less expensive. We're heavy on technology base and light on advanced development. The weapons acquisition structure is the other way around.

To some extent, once we solve a problem, it tends to stay solved. The Army's problems with many diseases have been solved, and they stay that way. The Yellow Fever problem was finally finished off from the military point of view with the development and fielding of the Yellow Fever vaccine just prior to World War II. It's not going to come back again, unlike the weapons business where they go generation after generation after generation dealing with the same problem. The Army Medical R&D Command has, in the time that I've been in, eliminated the problems of the epidemics of respiratory infections in the recruit camp through development of vaccines. Similarly, vaccines eliminated a meningoccal epidemic; and solved the problem of Hepatitis B. It takes substantial long-term investment in technology base research but, in the long run, we usually provide definitive solutions. I expect that within the next decade or so we might take some other major military threat diseases out of the threat category. For example, I think we'll remove Hepatitis A from the threat category very soon, again with a new vaccine.

One of the other differences from the equipment/weapons side of the house is that we have very substantial similarities between the services, both in terms of needs and in terms of the ways we solve problems. The Army is the executive agent and the lead agent in several areas. It gives us tri-service responsibility. In medical systems, there is tri-service coordination, and we do not compete among the services for resources to do the work.

Q. In what ways has the Army provided leadership in AIDS research?

A. Very early during the emergence of the epidemic, the military got out front in screening, serologic testing, and early diagnosis. We recognized the medical desirability of early diagnosis and intervention. We recognized the value to the Department of Defense of the early screening of recruit applicants. We also recognized the value of screening the force and understanding the course of the epidemic within the armed forces.

When widespread testing was impossible in the civilian community for a variety of bio-political reasons, the Department of Defense moved ahead and established what is recognized as the highest quality, large-scale serologic testing program ever done. It was a substantial accomplishment in both the basic immunology of the testing and quality assurance. It's amazing that we've screened millions of recruit applicants and armed forces personnel with an incredibly low error rate. We have received appropriate recognition for doing that.

We moved out early in establishing the classification standard — the Walter Reed Staging System. It was controversial at first, but was eventually accepted world-wide. We established it because we needed it to do long-range studies on the course of the disease. It turned out to be an

extremely important contribution to understanding the disease. The military's focus on early stage infection and diagnosis allowed the emergence of the concept that early recognition and intervention is probably the best way to affect the ultimate outcome for the individual. To achieve the biggest impact to be made on the course of the infection, intervention must begin early.

We may have made some big contributions in understanding the geographic distribution and spread of the disease. The combination of Army and Navy overseas programs has given us a good picture of the course of the epidemic in Central and East Africa, North Africa, and parts of Asia. That is an important contribution to the overall understanding of HIV as a world-wide epidemic.

One of the more important contributions we made to understanding the AIDS epidemic and the AIDS infection was the early emphasis on heterosexual transmission. At the time this position was put forward by Army researchers, the focus was on the epidemic in male homosexuals and later on in the drug-abusing community. As the epidemic plays out in the various sub-populations, the importance of heterosexual transmission is being recognized. Certainly, it's extremely important within the military community. Just taking the position that heterosexual transmission was important was a very courageous position as little as three or four years ago. I think Dr. Redfield, Dr. Burke, Dr. Tramont, and their co-workers at Walter Reed Army Institute of Research (WRAIR) got out front and were absolutely correct.

The combination of focusing on the early stage of the disease and a broad perspective of epidemiology has made the Army program quite different from the rest of the national program. It gives us a special perspective and has allowed us to offer some unique advances. Early immunotherapy with the vaccine candidates that are coming along will probably offer one of the more important advances. The ability to detect the infected individual before substantial damage to the immune system occurs, and intervention with vaccines to boost the immune response, will have a tremendous impact on the outcome. This could possibly allow the infected individual to outlive the disease, thus dealing with it for a normal life span. Right now, we're talking about an onset of seven to 10 years. By offering the immune system the opportunity to respond in a manner different than the natural virus stimulates it, we could concievably save the lives of lots of folks. I realize that's a dangerous scientific speculation.

I also think that the military database we've acquired through screening of recruits has provided a very, very important perspective on the distribution and progress of the epidemic in the United States. It's a statistically skewed database. However, it's one that is both understandable and interpretable and provides the only nationwide database on the U.S. epidemic that relates to early stage infections. Virtually all the other data is based on the disease, which is seven to 10 years behind the leading edge of the epidemic.

Q. Can you report on any other new or significant achievements or breakthroughs in medical research where your command has played an instrumental role?

A. I've already mentioned some of the earlier vaccine issues. I think our role in malaria vaccine development has been a very critical and seminal one and it will be in the future.

Our command was responsible for isolating the Hantaan virus — the virus that causes Hemorraghic Fever with Renal Syndrome — and provided the basis for the current vaccine development. I expect we'll be involved with the vaccine trials that will provide the basis for control of this disease. It's a huge problem in parts of Korea, China, and the Soviet Union. Related viruses also cause problems through Northern Europe.

Many large problems will be controlled with vaccines and we've been the central focus and international leaders in that research. Army scientists were the first to develop a Hepatitis A inactivated virus vaccine. The vaccines that we will be field testing in the future will be produced by some of the large international drug companies, but it was our leadership that pushed the industry in that direction. The vaccine made at Walter Reed was the prototype.

We've been providing a national leadership role in several areas of neuroscience and neurophysiology. The impact of that research has not been direct and dramatic, but it has been extremely important in developing countermeasures to nerve agents and nerve toxins and in the general field of neurophysiology, neurotransmitter research.

Combat casualty care programs produced some very, very important advances in micro-encapsulated antibiotic use. Those studies will change the way we deal with potentially infected wounds on the battlefield in the future.

The fielding of Ballistic and Laser Protective Spectacles (BLPS) was an important achievement and was a combined effort with Natick Laboratories. I think we played a major role in getting those into the field. The next generation, which should be coming along hopefully within a year or two, is an important part of our program.

A very contentious issue recently was use of contact lenses by aviators. I think our trials and evaluation of contact lens wear in aviators will go a long way towards solving the problem. We will demonstrate ways to allow contact lenses to be used under certain kinds of restrictive conditions. That's an important piece of information.

Current pre-treatment antidotes plus the expected early fielding of the anti-convulsant agent have been great successes. The combination of pyridostigmine pre-treatment, plus the atropine and 2-PAM antidote, plus the anti-convulsant provides a high level of protection against nerve agents. As a matter of fact, it gives a much higher level than had been predicted earlier. Those products are achievements that the scientists in the medical/chemical defense program can be very proud of.

Fielding of the M291 Skin Decon Kit was also a big step forward. It's a tremendous improvement over the previous materiel and utilizes modern biochemistry. It is one of the programs that had low visibility because it progressed so smoothly — good basic research, good basic ideas and the development process moved along quickly and we beat the projected time table. The materiel is non-toxic, not irritating, and very effective. . . good product!

Overall, I believe the medical chemical defense program has been a highly successful effort that put us into a substantially better position to deal with chemical agents,

"In spite of the expected reductions in the size of the Army and in the overall Defense structure, there are still tremendous opportunities, some very unique and exciting, in the military medical R&D system."

both from a soldier point of view and from a medical point of view.

Q. Do animals play an important role in Army medical research efforts?

A. Army medical research is no different than medical research in the civilian community in that regard. There is an **absolute** dependence on animal research for progress in many of the areas in which we are attempting to solve medical problems. There is no substitute for the whole animal for some aspects of research. There isn't a single medical program in which that statement doesn't pertain.

We cannot test the efficacy of any of our defenses against chemical agents in man. It's impossible. Just think about it. We are not going to expose human volunteers to nerve agents and mustard. Therefore, we're totally dependent on animal systems to determine how efficacious products are. Computer models are just not enough.

Similarly, for the development of drugs and vaccines, the demonstration of safety, and whenever possible, some level of efficacy in animal systems is the only ethical basis for going to man for the initial safety and efficacy trial. It's totally unethical to expose human volunteers to new products in which you don't have the utmost confidence in their basic safety, at the least.

If you consider the broad range of pharmaceutical products, you're talking about drugs, vaccines, bone replacement materiels, replacement materiels for blood vessels and heart valves, a whole spectrum of products requiring evaluation in animals. Similarly, new medical equipment is best tested in animal experiments.

The use of animals in research is an extremely volatile and political issue. We probably have the best oversight and control system of any research organization. We have an extremely high level of professionalism in Army veterinarians. They are outstanding experts in laboratory animal care, and are good "ombudsmen" for the animals, if I can use the term. The recent political furor over the use of dogs in bone replacement research and cats in head trauma research eventually will, as the political issues play out, demonstrate the quality of our research, and the effectiveness of our oversight, review and control systems to insure proper treatment of the animals and high quality science.

Q. What advice would you offer to anyone considering a career in Army medical R&D?

A. In spite of the expected reductions in the size of the Army and in the overall Defense structure, there are still tremendous opportunities, some very unique and exciting, in the military medical R&D system. We have unsolved problems that are very important, both for the Army and for society in general.

We have unique research capabilities that nobody else in the world has. On the one hand, we have overseas laboratories which allow Army scientists to study malaria, leishmaniasis, dengue, and other tropical diseases. We also have a great medical center system where there is tremendous opportunity for many kinds of clinical research. We also have research institutes with very excellent junior scientists and great senior leadership. We have very powerful organizations with an intellectual critical mass, and a good track record for providing opportunities for young researchers to show what they can do. Our smaller organization is going to be much more competitive in the future, so only the best need apply.

By Steven E. Martin

THE FAMILY OF MEDIUM TACTICAL VEHICLES PROGRAM

Overdue Upgrade for the Army's Medium Truck Fleet

Introduction

The Army's truck fleet is, in many ways, unheralded and taken for granted. Just as advertisements for the commercial truck industry a few years ago told us, "if you have it, a truck brought it." The same holds true for today's Army in the field. If anything is out there in the field, a truck had to deliver it and get it there. In short, whatever it is, it was on a truck at some point.

A sure sign of any Army on the move is that long truck convoy. This article focuses on one of the Army's major truck programs, the new Family of Medium Tactical Vehicles (FMTV).

The Army's tactical wheeled vehicle fleet is basically comprised of three distinct segments, the light, medium, and heavy fleets. For the foreseeable future, there is basically only one major production program in each fleet in today's era of budgetary constraints.

The Army's light truck fleet consists of the Commercial Utility Cargo Vehicle (CUCV) and the High Mobility Multipurpose Wheeled Vehicle (HMMWV). The HMMWV has been the major factor in the ability of the Army to conduct light division and rapid response type of operations. The evening news showed us all telling images of these vehicles in action during Operation "Just Cause" in Panama. Field reports indicated that these vehicles operated admirably under a wide variety of conditions, including hostile fire. The agility, versatility and mobility afforded by these vehicles is unparalleled.

The Army's heavy truck fleet is characterized by the 10-ton capacity Heavy Expanded Mobility Tactical Truck, the M915 series line haul trucks and in the future, the Palletized Loading System, for transportation of prepackaged and "palletized" cargo.

The current medium fleet is comprised of both 2 1/2-ton and 5-ton class vehicles. These medium trucks are truly the "workhorses" of the Army's truck fleet. They are multipurpose vehicles which do a wide variety of tasks in the field.

In a sense the medium fleet has, for the past 20 years at least, been sacrificed to provide for the upgrade of the light and heavy fleets. However, with many of the medium fleet's vehicles feeling the effects of both age and overwork, the medium fleet must now be upgraded if we are to maintain a fully capable total truck fleet in support of a mission ready force. For example, most of the 2 1/2-ton trucks were procured in the mid 1960s so these trucks are all more than 20 years of age.

For the Army's medium truck fleet, it is not uncommon for the age of the truck to exceed the age of the driver. In fact that is the norm! With the severe use that any truck experiences, and especially an Army truck, we can all imagine the shape that some of these older vehicles are in. A visit to almost any Army unit will provide one with a graphic portrait of the urgency of the need to upgrade and/or replace these medium truck assets.

The existing fleet of medium trucks is characterized by these overaged and maintenance intensive vehicles, many of which are well beyond their originally planned "service life." In many cases parts and labor costs are extremely high which results in high total Operations and Support (O&S) costs, money which could be spent wiser, to upgrade equipment.

So the time is at hand for the medium fleet. The Army's medium truck fleet is planned to be upgraded by both the Family of Medium Tactical Vehicles and the Service Life Extension Program (SLEP) as outlined by the Army's Tactical Wheeled Vehicle Modernization Plan (Mod Plan). The FMTV program will provide a new truck which incorporates the latest in commercial automotive technology. The goal is that the FMTV will do for the medium fleet what the HMMWV has provided for the light fleet — a major leap forward in technology, capability and mobility. This is doubly important in that many future Army systems are built upon the "platform" that a tactical vehicle provides.

After introduction of the HMMWV, many Army systems were designed to be transported by and operated from the HMMWV. The same will occur for the FMTV fleet.

The Service Life Extension Program is intended to be an interim measure which will upgrade existing medium truck assets which are still required, through selected rebuild and upgrade of the trucks. The goal of SLEP to substantially reduce O&S costs for the vehicles already fielded. SLEP can provide a serviceable and capable vehicle until these trucks can be replaced with new vehicles.

Figure 1 depicts the vehicle configurations of the FMTV program and lists the primary missions for the vehicles. A wide variety of models will be available for both the Light Medium Tactical Vehicle (LMTV), the 2 1/2-ton variant and the Medium Tactical Vehicle (MTV), the 5-ton variant.

DA Management of Trucks

The Support Systems Division of the Army staff is located at AMC Headquarters and provides DA level management of the OPA 1 budget appropriation.

OPA 1 is the acronym for Other Procurement, Army 1. In short, OPA 1 *is* trucks and trailers. Generally, all Army trucks and trailers are procured within the OPA 1 budget appropriation. Exceptions do exist, for example, trucks procured for a specific system, such as the HMMWVs procured by the Mobile Subscriber Equipment program. The appropriation manager for both the budget appropriations OPA 1 and OPA 3 is Deputy for Combat Service Support MG Joe W. Rigby.

The OPA 3 budget appropriation contains the remainder of the equipment generally called combat support or combat service support equipment. Some examples would be bridging, generators, clothing and shelters. MG Rigby's staff includes system engineers as well as program analysts to accomplish the varied tasks assigned to the division.

MG Rigby reports not only to the AMC command chain but also reports to Assistant Secretary of the Army for Research, Development and Acquisition (ASARDA) Stephen K. Conver. The actual day to day "nuts and bolts" of developing the new Family of Medium Tactical Vehicles is the responsibility of Program Executive Officer for Combat Support Melvin E. Burcz. Reporting to Burcz are various project managers. In the case of the FMTV program, the responsible individual is COL Larry Day, project manager for medium tactical vehicles. COL Day has a very capable staff of engineers that wrestle with the daily tribulations of developing a new Army vehicle.

Members of the PEO-CS and the SARDA staff have forged an effective relationship which enables the Army leadership to stay "up to speed" on the FMTV program and provide the information necessary for the Army leadership to support the program in this era of declining budgets.

The M939A2 Series 5-Ton Truck

The only ongoing truck production at this time for the medium truck fleet is the production of the M939A2 Series 5-Ton truck. These are being manufactured by BMY, a Division of Harsco. Inc., at their facility in Marysville, OH. After some initial production startup delays, production is now proceeding very well. The production

FAMILY OF MEDIUM TACTICAL VEHICLES (FMTV)

PRIMARY MISSIONS
- UNIT MOBILITY
- UNIT RESUPPLY
- TRANSPORT OF EQUIPMENT & PERSONNEL

CONFIGURATION - LIGHT VARIANT
- CARGO
- VAN
- CHASSIS

CONFIGURATIONS - MEDIUM VARIANT
- CARGO
- CARGO W/MHE
- LONG WHEELBASE CARGO
- LONG WHEELBASE CARGO W/MHE
- EXPANSIBLE VAN
- TRACTOR
- DUMP
- WRECKER
- TANKER
- CHASSIS
- LWB CHASSIS

Figure 1.

startup "growing pains" experienced in this Army program are indicative of a new producer that is faced with all of the facilitization, vendor qualification, staffing, and management effort required to begin a major manufacturing effort.

Daily production is now averaging about 40 trucks per day and product quality is very high. However, the M939A2 series truck does not represent a major step forward in automotive technology. The M939A2 series trucks are basically the same trucks produced previously for the Army. The exceptions are the incorporation of a new, commercially available diesel engine and the addition of a Central Tire Inflation System for enhanced mobility under adverse terrain conditions. Other than that, the truck is produced to the government owned Technical Data Package. To the casual observer the truck looks identical to earlier production models. The intent of the M939A2 program was to provide trucks to continue to fill existing Army shortages until the Family of Medium Tactical Vehicles is available.

The current production will continue through 1991 under the current contract. These trucks are being fielded to fill existing shortages, that is to provide a truck to a unit with a shortage, and also to support the fielding of other Army systems such as the Deployable Medical System. Other Services as well as the National Guard and Army Reserve will also receive vehicles.

Background on the FMTV

The FMTV program was initiated basically as an outgrowth of the Medium Tactical Truck (MTT) program. The MTT was proposed in early 1983 as a response to an Army requirement for a highly mobile 4X4 vehicle with a 2 1/2 to 3 1/2-ton payload capacity to replace the existing 2 1/2-ton M44 series trucks, as well as the 5-ton payload M39 and M809 series trucks.

A market survey was conducted with industry in late summer 1983 to explore the feasibility of producing a truck with a 2 1/2 to 3 1/2-ton capacity, while also considering the feasibility of growth potential to a 5 to 6-ton payload range vehicle while retaining the maximum emphasis on commonality of components. The majority of the truck industry responses confirmed the potential feasibility of the concept, but only if both vehicles were prototyped at the same time. The

FAMILY OF MEDIUM TACTICAL VEHICLES (FMTV)

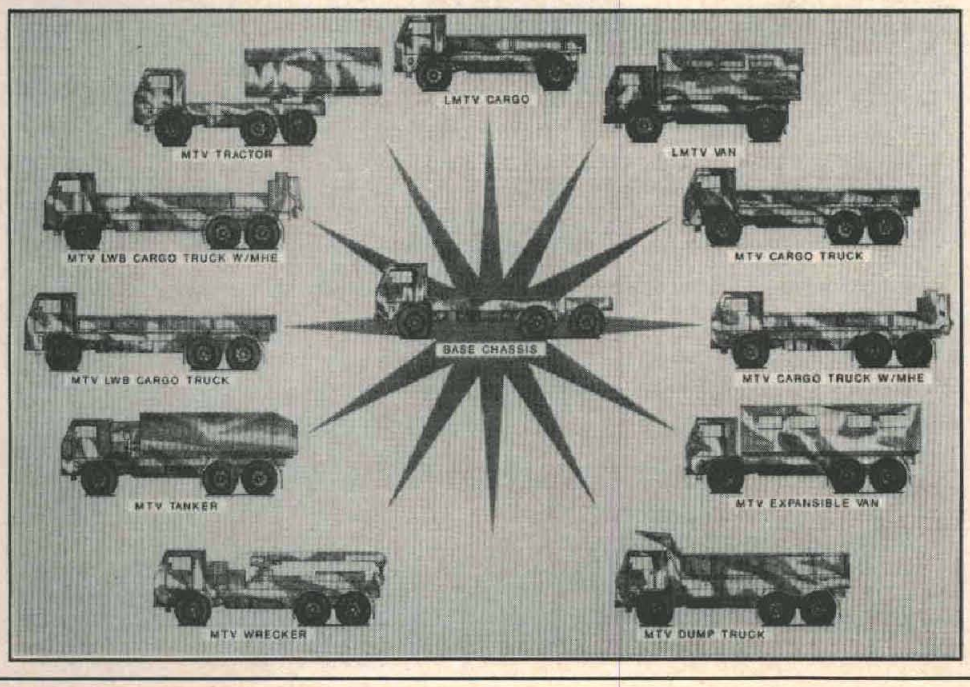


Figure 2.

MTT program was cancelled in 1983 due to the lack of a requirement document from the combat developer.

A Draft Operational and Organizational Plan for a Family of Medium Tactical Vehicles was released by the combat developer in September 1984. The family included a Light Medium Tactical Vehicle series with a minimum 2 1/2-ton capacity and companion trailer and Medium Tactical Vehicle series with a minimum 5-ton capacity and companion trailer.

The Transportation Center and School, as the TRADOC proponent for the FMTV program, drafted an FMTV Required Operational Capability which was expanded for a Joint Service Operational Requirement (JSOR), due to Marine Corps and Air Force interest. The JSOR received interim approval on May 1, 1986. An FMTV market investigation was conducted in the June-July 1986 timeframe with industry through the *Commerce Business Daily* and included a questionnaire, a draft system performance specification and the interim JSOR document.

Although industry confirmed the feasibility of the FMTV concept based on integration of commercially based components to meet the JSOR and system specification requirements, no firm had an existing commercial product or system which met all the requirements. The FMTV acquisition strategy and acquisition plan were then developed based on the acquired data. The FMTV Army System Acquisition Review Council convened in late 1987, whereupon the FMTV acquisition strategy and plan were approved.

The FMTV Milestone I/II Defense Acquisition Board (DAB) review was conducted on May 23, 1988 which provided the OSD level endorsement of the FMTV Test and Evaluation Master Plan, acquisition plan and strategy and concurred with the Army plan to competitively award up to three hardware demonstration/prototype contracts for 15 trucks and five trailers from each vendor for extensive government hardware performance and endurance testing and operational testing.

Contractor proposals as well as hardware test results will be used as input into a "best value" source selection process for production award of a five year multiyear contract in 1991. In March 1990, the DAB secretary published a DOD Major System review list in which the Defense Acquisition Executive delegated the FMTV Milestone III production award decision to the Army acquisition executive.

Technical Description

The FMTV will be the "next generation" vehicle for the medium truck fleet. The vehicle selected and produced now will be in Army service 30 years from now. One of the primary features of these vehicles is incorporation of logistics commonality as a primary design feature right from the start. Figure 2 provides a graphical representation of just how this is accomplished. All of the model variants are basically derived from the same chassis.

The Army's goal is not to develop new components but to capitalize on the very latest in commercially proven components and technology. Commer-

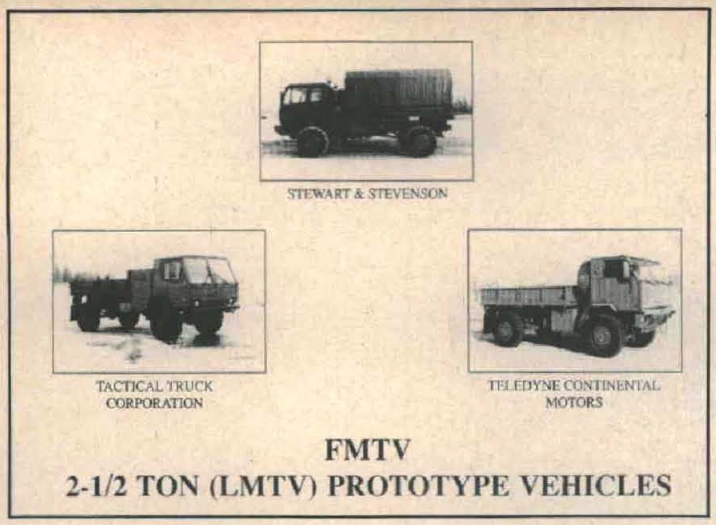


Figure 3.

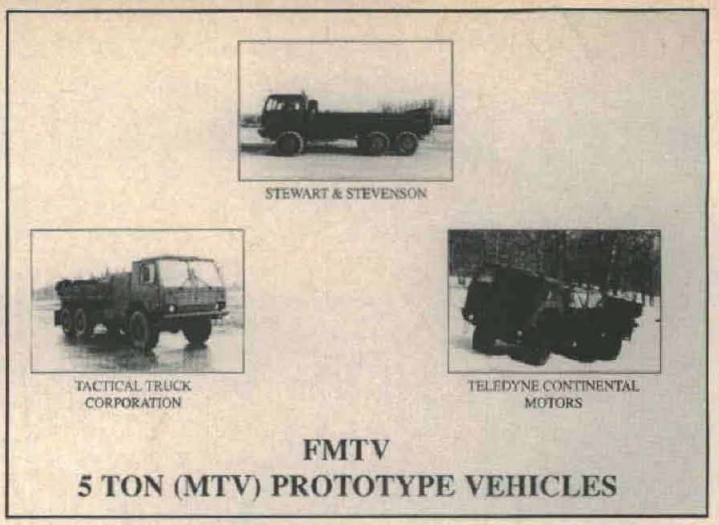


Figure 4.

cially available components such as engines, transmissions, and axles are being utilized. And lastly, a wide variety of kits will be available for the FMTV vehicles to provide for special mission applications. Examples include, arctic, troop seat, winch, and fording kits.

Prototype Contracts

Prototype contracts were awarded to three competitors to provide vehicles for testing. The competitors are): Stewart and Stevenson, Tactical Truck Corp.(a team comprised of General Motors and BMY), and Teledyne. All of these companies are current or past Army suppliers and/or experienced with Army programs. Some examples: General Motors produced the Army's CUCV fleet in the early 1980s. Teledyne was a competitor for the Army's HMMWV program before AM General won the production contract. Stewart and Stevenson has been a long time Army supplier of trailers, generator sets, and aircraft maintenance equipment as well as a competitor for the M939A2 program. BMY, as we mentioned earlier, is the current 5-ton truck producer. Thus, all of these companies have significant experience with government contracts in general and Army contracts specifically.

Figure 3 shows the trucks provided by each contractor for the LMTV and Figure 4 shows the 5-ton variant from each contractor. You will note the distinctive similarity of the trucks from each manufacturer. THE MTV trucks look almost identical to the LMTV models, the critical difference being the additional axle and longer frame.

Prototype Testing

In January of 1990, each contractor provided 15 trucks and five trailers for government testing and evaluation. The testing program will continue until December of 1990 with the primary test locations being Yuma and Aberdeen Proving Grounds. The prototype testing phase also includes early user test and evaluation to be conducted at Fort Stewart GA. The testing at Fort Stewart will challenge the vehicles in very realistic mission profiles. Information is being gathered pretty much on a daily basis as the testing program progresses. The vehicles have been widely heralded and are surpassing all performance criteria originally established.

All three competitors have provided very capable and competitive products for evaluation. The current program schedule calls for the first FMTV production contract to be awarded in April of 1991 with the First Unit Equipped milestone to occur in mid FY 93.

Conclusion

The upgrade of the Army's medium truck fleet is "in the works." Both the Family of Medium Tactical Vehicles Program, and the Service Life Extension Program are planned to be implemented to provide the overdue upgrade for the medium truck fleet.

If force structure cuts are implemented, an opportunity will be available to eliminate additional overaged truck assets from the system. The FMTV program will primarily continue to fill existing shortages. Follow-on production will enable the Army to continue to retire other medium truck assets. The Army truck community has been pleased with the progress of the program to date.

Production of the new FMTV vehicles is widely anticipated at all levels of the Army truck community, from Congress to the mechanics in the motor pools around the world. Regardless of which contractor is selected for production, the soldier is sure to be a winner. Remember, if you have it, a truck brought it!

STEVEN MARTIN is a system staff engineer in the Support Systems Division, Office of the Deputy Chief of Staff for Development, Engineering and Acquisition, HQ, U.S. Army Materiel Command. He is the Army staff officer responsible for medium tactical trucks. Martin is an engineering graduate of the University of Maryland, has an M.S. in systems management from the University of Southern California, and holds post graduate certificates from USC.

The Manufacturing Technology Facility...

CECOM's NEW MANUFACTURING 'SCHOOLHOUSE'

By James J. Barbarello
and Oliver F. Reynolds

Introduction

On March 19, 1990, GEN William G.T. Tuttle presided over the official opening ceremonies for the U.S. Army Communications-Electronics Command's (CECOM) Manufacturing Technology Facility (MTF) at Fort Monmouth, NJ. During the ceremonies, GEN Tuttle stated "...this schoolhouse will serve as a prototype for all of AMC.".

The official opening of the Manufacturing Technology Facility was the culmination of many years of planning and hard work by many people at CECOM. It all began about four years ago when the staff of the newly formed Production & Manufacturing Technology Directorate, like many others at that time, noticed that manufacturing know-how had become a key factor in attaining program performance, schedule and cost targets.

The Japanese and others in the Pacific Rim were stressing the importance of good manufacturing (and capturing countless markets in the process). They had realized that research and development could only be truly successful when coupled with efficient manufacturing systems. But at CECOM, like many other places, manufacturing was not high on the agenda.

When we canvassed academe for courses on basic manufacturing knowledge, processes, and hands-on factory floor experience, we found such courses to be almost non-existent. The traditional method of learning basic manufacturing processes by plant visits with senior engineers was being stifled by waning travel budgets. In fact, we the government were losing our manufacturing corporate knowledge base, which was contributing to contractual and materiel delivery problems.

If we transfer the basic corporate manufacturing knowledge to technical people new to the production mission, we could reverse the erosion we had been seeing for years. We could also save the government money by avoiding contract claims, reducing the amount of non-conforming materiel delivered by contractors, and lowering field maintenance costs by procuring more reliable products. That was the beginning of the MTF concept; a "hands-on" facility encompassing all of the basic electronics manufacturing processes and their interrelations. But at that time, it was still only a vision.

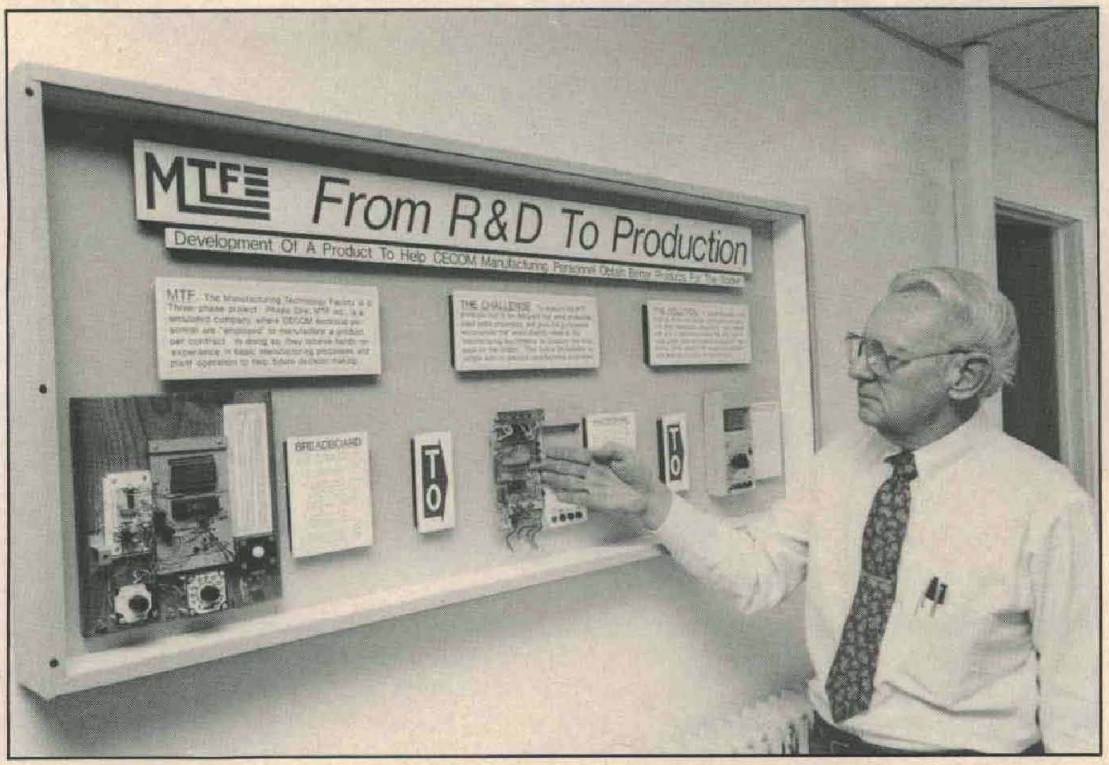
A Partnership Arrangement

In late 1988, Jim Barbarello made a proposal to his director, C.F. MacDonnell, Jr., of the Production and Manufacturing Technology Directorate. With refinements by MacDonnell, and concurrence from the then CECOM Commander MG Billy M. Thomas, the proposal was presented to HQ AMC.

The proposal made to Darold Griffin, then deputy chief of staff for production, was for a partnership arrangement in the establishment of such a facility. Seeing the need and benefits, Griffin fully supported the concept and provided startup funding in the amount of $150K, and a pledge of continued participation. CECOM's part of the partnership would be extensive use of local facilities, resources ("self-help") and a sharing of the funding required for continued operation.

CECOM's Technology and Assessment Office supplied the technical expertise to help create a small, typical manufacturing "company." What was missing was a project manager (sort of a "general contractor"); someone with industry and government experience who could make sure everything came together in the six months we had to complete the project. That's where Oliver Reynolds (whom everyone calls Ollie) came in. With this team, the vision was starting to materialize, and the MTF was coming alive.

Considering retirement, Ollie received an offer he couldn't refuse from MacDonnell. Ollie began by obtaining a 7,200 square foot World War II building in the Evans Area of Fort Monmouth. His unique combination of marketing, administrative and technical skills allowed him to attack and coordinate the effort just like any industry operations manager. Whether it be obtaining technical equipment or construction supplies, complying with Occupational Safety and Health Administration requirements or cajoling the facilities engineers into getting the work he needed done, Ollie was our man. We soon learned that both a good technical team and a knowledge-



Oliver Reynolds provides details of the product display in the main hallway of the MTF. The display subtitle states "Development of a product to help CECOM manufacturing personnel obtain better products for the soldier". From left to right are the original breadboard development model, the engineering development prototype, and the final production unit.

able project manager were invaluable in this type of project.

With only $150K to fully establish a small manufacturing facility, much of the work had to be done on a self-help basis. The building had to be stripped down to the walls and rebuilt inside. This was done in major part by over 100 volunteers from the Production and Manufacturing Technology Directorate on lunch breaks, after work and on weekends. The result is a striking simulation of a small electronics manufacturing company, organized with a full corporate structure (CEO and president, vice presidents, etc.) like any other typical commercial enterprise, and complete with wood and machine shops, training/conference rooms, lunchroom facilities, and a complete manufacturing floor.

The Course

While in actuality, MTF is a training course, it is presented as a total immersion manufacturing "experience." As they enter the front doors of the MTF, the students cease to be CECOM personnel and, for the next two weeks, become employees of MTF, Inc. The immersion process is total; the "employees" receive MTF identification badges, a pre-employment exam and orientation. During their employment, they will participate in each and every portion of the operation of a typical electronics manufacturer and be evaluated on a daily basis.

They begin as engineering employees, reviewing two newly awarded contracts from CECOM (we developed special fixed price, firm delivery schedule contracts, full sets of engineering drawings, and product specifications for the products they will be building).

The employees are separated into two product teams, one for each of the two products to be built and delivered on contract. They participate in a detailed contract review headed by one of MTE Inc.'s contract managers (actually a CECOM contracting officer who participates on a voluntary basis).

After the contract review, the students perform a detailed drawing and specification review headed by the plant manager, Alex Alessi (a support contract employee of Dynatrend, Inc. with over 25 years of industry experience). The plant manager is assisted by a government employee serving as the production line manager. Typical of government documentation, the contract, drawings, and specification all contain errors, which the employees must find and resolve.

The plant manager then provides an overview of the materials management process, including purchasing and inventory control. Using an automated MRP II (Material Resource Planning) system, the employees then develop a Bill of Materials (BOM). From the corporate vendors information database, they must select vendors for the material based on factors such as lowest cost, quality history and lead time. From this exercise they learn that lowest cost is not always the deciding factor. The purchase orders are then released for purchase and delivery.

Over the next day and a half, the employees receive instruction on manufacturing/production engineering, packaging, test criteria and procedures, soldering and general workmanship, and process instructions. The process instructions are the work instructions the manufacturing employees receive and must follow to fabricate the product. The employees review some existing process instructions, and must develop some others. What they don't know at this point is that the instructions developed by one team will be used for manufacture by the other. This later becomes a prominent demonstration of the need for clear and accurate process instructions. This portion of the course ends

with a basic introduction to concurrent engineering, including some practical applications that were employed during the design of the product they will be building.

On the fourth day, the employees shed their engineering roles and become normal production line workers. Where they were required to wear business attire, they must now wear appropriate production line clothing. No longer engineers, they must now follow instructions to the letter. They begin this new role on the receiving dock where they receive the materials ordered by purchasing, generate receiving reports, match them to the purchase orders and forward the material to incoming inspection. There they perform both electrical and mechanical incoming inspection to specific procedures using a mix of manual and automated inspection equipment. They execute discrepant materials disposition (there are always some discrepant materials "planted") and forward the compliant materials to stores.

Using a master kit list obtained from the MRP II system, they then pull materials from stores and build master kits. These kits are then broken down into individual kits at the production line work stations. Prior to beginning fabrication, they are instructed on work station equipment and procedures, including ElectroStatic Discharge (ESD) methods and procedures. Errors have been incorporated into the process instructions which require the employees to stop work and, in some cases, develop engineering changes before proceeding. They must actually stop and wait for a response from the government (a lesson in how time to respond to engineering changes affects the production line).

During the course of manufacture, Defense Contract Administrative Services (DCAS) periodically stops in. It is not uncommon for DCAS to find several problems, argue with the plant manager, and sometimes even issue a corrective action. The employees experience government representatives from the other side of the fence (and what actually happens when the government representative leaves).

Once the products have been fabricated, the employees become test personnel. Each team tests the other team's product, but each employee is required to perform drop tests on his own product (preceded by anticipation and followed by elation when the product still functions). The last task is to package the product, per contract requirements, for shipment. This is followed by a post-employment test to ensure each student has properly grasped the course information. Upon graduation, each employee is released from MTF, Inc. and returns back to the CECOM family a more informed and educated employee in product manufacturing. The students keep the product they have built.

The Products

The employees build one of two products, either a Digital Multimeter with a temperature probe, or a Digital Multimeter with a logic probe. The products were conceived and designed in-house with specific purposes in mind. They had to incorporate basic manufacturing processes like printed wiring assembly fabrication, cable construction, mechanical assembly, subassembly electrical alignment, combining of multiple sub-assemblies into a final product, and end-item test and acceptance.

In designing the products, we had to avoid the "bells and whistles" urge and remember that the product itself was not as important as the processes and manufacturing interrelations we were attempting to teach. After building the product, the students have a better understanding of basic soldering, ElectroStatic Discharge (ESD) implications, the need and benefits of incoming inspection, proper materials handling, the implications of and need for good process instructions, and many other manufacturing aspects generic to all electronic products.

To round out the project, we developed and constructed incoming inspection Automated Test Equipment, mechanical inspection jigs, production fixtures and jigs, a Materials Resource Planning computer system, and a Work Progress reporting computer system. The ATE and other computer systems run on any of the seven standard IBM PC compatible (both desktop and laptop) computers in the facility. The ATE automatically logs component measuremenets and produces statistical process control information which is fed back to the students.

The Future

An expansion of the MTF is underway. At the present time, MTF can accommodate 10 employees per session. Because of the need for this type of manufacturing technology training, MTF is expanding to accommodate 16 employees per session. This will allow MTF to accept other CECOM personnel, as well as personnel from other AMC commands (on an as requested basis).

A hands-on training facility is only phase I of the MTF project. In phase II, MTF will apply concurrent engineering principles. Finally, phase III will be the introduction of a quick reaction manufacturing and problem solving capability.

Benefits

To date, all student feedback has been exceptionally positive. They have indicated the course will help them better understand how to deal with contractors. They better understand the interrelation of their actions on contract performance, how to read contracts, understand technical drawings, evaluate processes, and gage a contractor's efforts. The MTF has become what we hoped it would, a tool for transferring corporate knowledge about basic manufacturing in a concise, easily understood way. For more information on MTF Inc., contact Ollie Reynolds at (201) 544-5353 or DSN 994-5353.

JAMES J. BARBARELLO is the associate director for manufacturing technology in the Production and Manufacturing Technology Directorate, U.S. Army Communications-Electronics Command. He has a B.S.E.E. degree from the City College of New York and an M.S. degree in management science from Fairleigh Dickinson University.

OLIVER F. REYNOLDS is the MTF project manager and holds a degree from Pierce Technology in New York.

THE ROLE OF R&D IN REDUCING O&S COSTS

By LTC Richard H. Harenburg (USAR)

Author's Note: In the March-April 1990 issue of *Army RD&A Bulletin*, the Army's Technology Base Master Plan was presented. This article describes the application of the Army technology base to achieve a reduction in Army operation and support (O&S) costs.

Introduction

The application of advanced technology to reduce Army operation and support costs provides a "military metaphor" to a similar challenge facing American industry in this decade. In an internationally competitive economic environment with Japan and Europe, it is becoming increasingly important to apply the best tools and technology to maintain "market share" and a favorable international balance of trade.

The future defense of America depends on maintaining a strong industrial base in the face of the changing world environment. Our ability to apply and adapt our technology to meet the international challenge is a key factor in assuring our future success and national security. A government-industry team has been suggested as part of a strategy to maintain the nation's industrial base and assure the national defense. The following discussion provides examples of Army R&D which may be directed at reducing O&S costs.

Background

Army operation and support encompasses the personnel, intelligence, tactical operations, and logistics of peace and war time Army operations. Historically, the operation and support costs after fielding a new weapon system are more than twice the acquisition costs. This figure suggests a significant source of opportunity for cost savings and productivity improvement. A similar parallel exists in industrial operations, where low production cost is essential for maintaining a competitive position in the international marketplace.

Cost Savings

Any discussion of cost savings should quickly clarify that the savings in this case is an outcome of using superior tools and techniques, maximizing product quality, and improving the quality of operations. Some investment is required. A technology insertion road map is necessary to apply the technology and achieve the desired objectives.

Cost Drivers

A large portion of O&S costs have been driven by prior decisions to reduce development costs. The historic conflict between near term program objectives to meet cost, schedule, and performance goals on major programs and the longer term goal of reducing

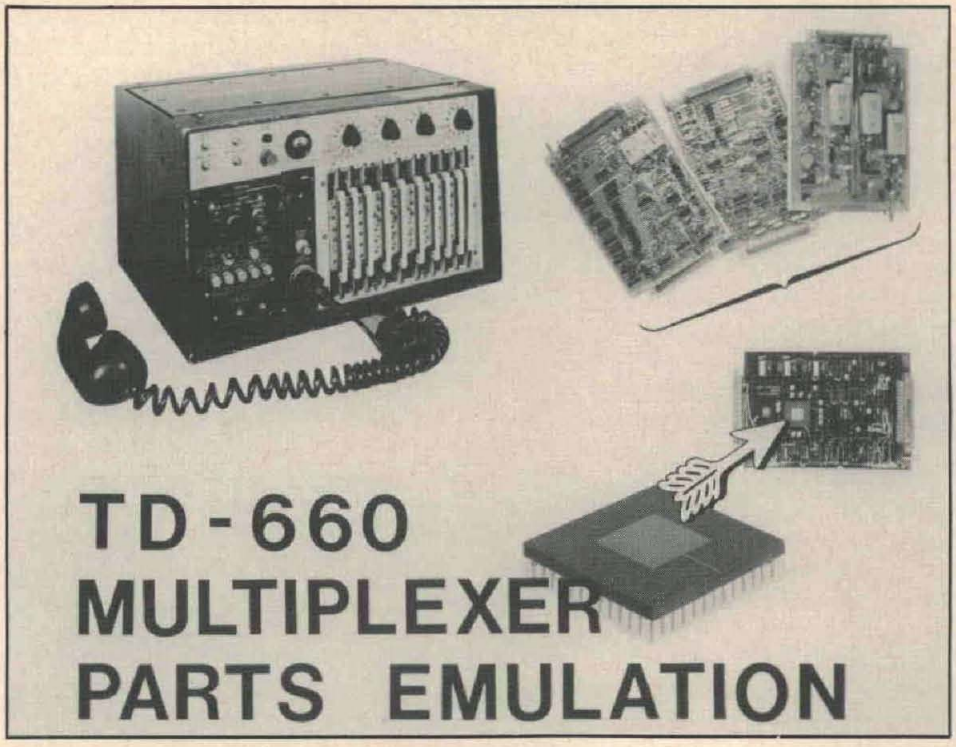


Figure 1.

both the acquisition costs and the ownership costs suggests that an investment strategy is needed which will encourage, fund, measure, and reward development in areas having longer term O&S cost savings.

In general, it is evident from many historic lessons learned that a relatively small investment early in the development stage of a major system can have high leverage in O&S cost savings over the life of the system. It is also evident from history that design changes late in the development cycle to achieve O&S cost savings are much more expensive.

Several tech base efforts are currently underway within the Army which have the potential for reducing O&S costs. The success of these efforts is determined by the management and funding priority provided for technology insertion to achieve the desired results in fielded systems.

Investment Strategy

The application of O&S cost reduction goals early in the development process provides the highest return on investment (ROI). A return on investment as high as 10:1 or greater is possible. To achieve the desired ROI, a technology insertion road map is needed which combines the goals and objectives for cost reduction with an investment strategy for specific projects producing measurable results.

Technology base initiatives currently exist in the areas of standard modular electronics, testability/built in test, reliability, maintainability, producibility, commonality, and standardization. Additional technology effort exists in the development of computer-aided design tools to facilitate consideration of reliability, availability, and maintainability alternatives early in the design process. However, concern for increased acquisition costs often prevents optimal implementation of these O&S cost saving measures in major programs.

The linkage of the Army technology base initiatives for O&S cost savings into a coherent program to achieve the desired savings requires a road map, an investment strategy, and the definition of metrics to measure performance. This strategy should be incorporated into a Total Quality Management (TQM) Program which includes the manufacturing and quality control technologies to achieve optimal O&S cost savings.

Microelectronics Device Technology

Advanced microelectronics component technology, including the DOD VHSIC (Very High Speed Integrated Circuits) and MIMIC (Microwave and Millimeter Wave Integrated Circuits) Programs are examples of R&D investments which have made significant advances and offer an excellent return on investment (ROI). This technology has resulted in powerful and low cost computer based tools to achieve higher degrees of efficiency and design optimization than previously possible.

In the area of computer aided engineering (CAE) tools, new methods and tools are being developed to substantially reduce costs over previous alternatives.

Several product improvement and technology insertion initiatives are currently under way for existing Army systems to achieve reduced O&S costs. Many of these center on eliminating obsolete components associated with rapidly advancing technology. In both the digital and analog areas of electronic component technology, new technology has replaced obsolete components which are no longer available, reduced parts count, and increased reliability. Several initiatives in the technology base are directed at facilitating technology insertion into existing systems.

Design and O&S Cost Reduction Project

This project at the Electronics Technology and Devices Laboratory is geared to O&S cost reduction in the development phase of new systems, and will facilitate the technology insertion and product improvement of new components into existing systems. The project has provided VHSIC Hardware Description Language (VHDL) computer-based design tools and successfully redesigned the electronics portion of existing systems such as the TD-660 multiplexer (Figure 1) for the purpose of replacing obsolete components which are expensive, unreliable, or no longer available.

For systems still in development, the project addresses the O&S cost drivers of testability, reliability, thermal stress, packaging, and documentation and facilitates lower cost future technology insertion. A March 1988 survey identified 23 military microelectronics device families no longer available. For a total of 697 device types needed, the total cost was $26M for one of each

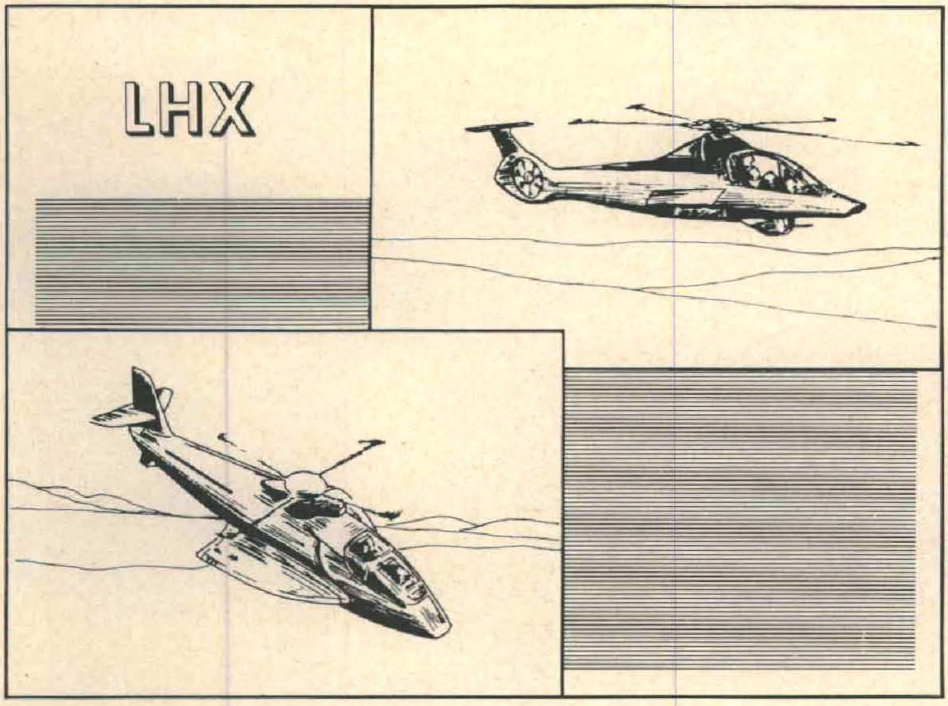


Figure 2.

type. This averages to $37,300 for each part. If we could get these at Radio Shack we might expect to pay three dollars.

The rapidly advancing microelectronics industry often makes our designs obsolete before they are fielded. This project facilitates a rapid update using the newest component technology prior to production.

Logistics Operations

Several initiatives currently exist in the technology base to reduce the volume of parts in the repair pipeline and decrease field maintenance. These include programs to develop and incorporate built- in-test and fail-soft/graceful degradation designs into systems for accurate fault detection/isolation, and greater mission completion capability. Additional efforts apply automation to reduce manpower and equipment costs for O&S operations.

Standardization

Several projects have been initiated to introduce standard modular components which permit a lower cost two level maintenance concept in a broad range of Army and DOD systems. A Joint Integrated Avionics Working Group (JIAWG) has been established to coordinate and promote standard modular design in the avionics for the Army Light Helicopter (Figure 2), Air Force Advanced Tactical Fighter (ATF), and Navy Advanced Technology Aircraft (ATA) and A-12 aircraft.

The Integrated Communications, Navigation, and Identification Avionics (ICNIA) Program is another example of applying the synergistic forces of microelectronic component technology, new design tools, and design integration to achieve reduced size, weight, power, and cost.

Software Support

The cost of software maintenance is an example of Army and DOD O&S costs which have become a significant part of the defense budget. Improved computer aided software engineering (CASE) tools are currently in development to reduce the support cost for fielded software.

Reliability Testing

A key area of O&S cost savings in development programs is in Reliability Development Growth Testing (RDGT) prior to production. Achievement of reliability goals is directly related to achievement of O&S cost saving goals.

SINCGARS Reliability

The initial SINCGARS hardware provided a mean time between failure (MTBF) of 250 hours rather than the target MTBF of 1,250 hours. Replacement of discrete components with integrated circuits reduced parts count, removed thermal and mechanical stress points, and increased reliability to the desired 1,250 hours MTBF.

M1 Tank Testability

The M1 tank (Figure 3) requires several boxes of cables to interface to test equipment due to numerous specialized connectors. Large amounts of documentation are required to perform necessary tests. This project includes improved M1 tank testability to achieve lower support costs.

Complex Microcircuit Parts Qualification

The military qualification process for microcircuits delays their availability for consideration by hardware designers.

Figure 3. M1 shown with large amounts of documentation required to perform necessary tests.

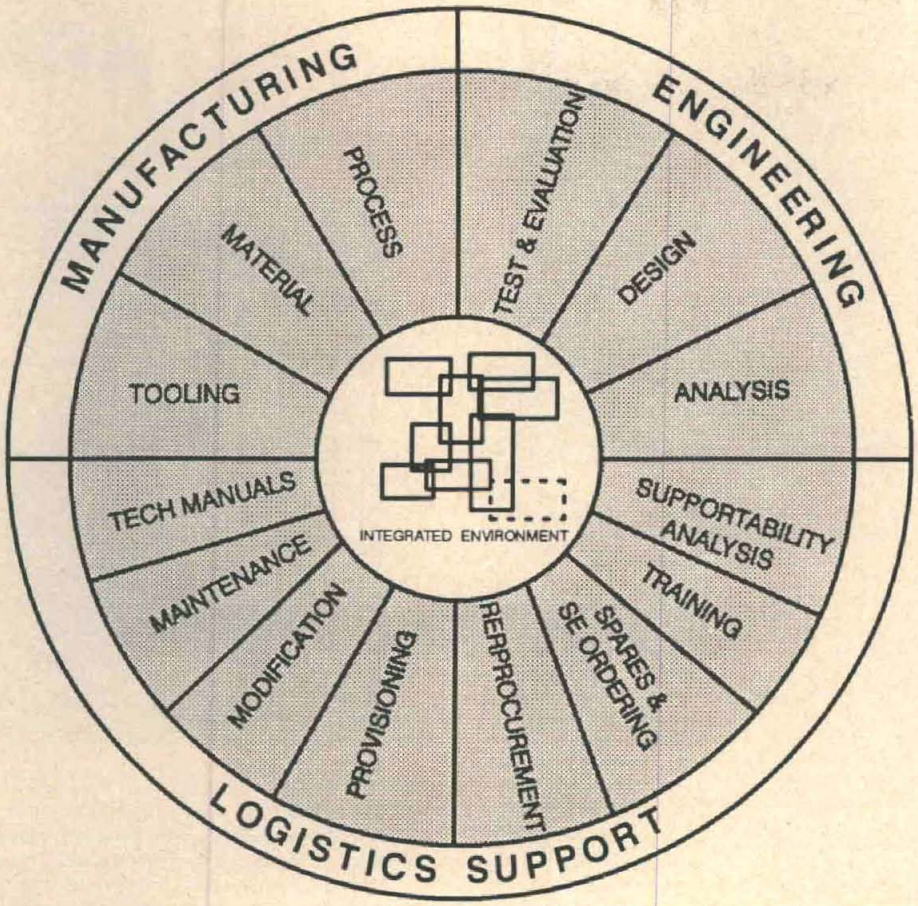


Figure 4.

What is CALS?. . .CALS is a DOD and Industry strategy for the transition from paper-intensive acquisition and logistic processes to a highly automated and integrated mode of operation for the weapon systems of the 1990s. CALS addresses the generation, access, management, maintenance, distribution, and use of technical data in digital form in the design, manufacture, and support of weapon systems, ships, and equipment.

This delay in the availability of the desired qualified parts contributes to the use of non-standard or obsolete parts in the design, which ultimately contributes to increased O&S costs. The Generic Qualification approach, called QML, replaces or supplements QPL and overcomes these shortcomings.

Computer-Aided Acquisition and Logistic Support (CALS)

CALS is a DOD and industry initiative that addresses the integration and use of automated digital technical information for weapon system design, manufacture, and support (Figure 4). In September 1985, the deputy secretary of Defense issued a statement to the secretaries of the military departments approving recommendations of a DOD-industry task force on CALS. These recommendations were designed to achieve major improvements in supportable weapon system design, and to improve the accuracy, timeliness, and use of technical information.

CALS is a DOD and industry strategy for the transition from paper-intensive acquisition and logistic processes to a highly automated and integrated mode of operation for weapon systems of the 1990s. DOD and industry have established an effective management structure for planning, managing, and implementing CALS. The CALS Program provides an example of a military/industry team with high potential for O&S cost savings for the military while strengthening the nation's industrial base.

Conclusions

The application of the Army Technology Base to reduce O&S costs is an idea whose time has come from the standpoint of maintaining and modernizing the industrial base as well as from the standpoint of military operations. Many of the initiatives having particularly high payoff originate from rapid advances in computer technology which have in turn originated from rapid advances in microelectronic device technology.

We are at the final stages of what has actually been a long evolutionary process and are about to reap the rewards of our investment. Many industries have already re- tooled and modernized with dramatic improvements in quality and productivity. It is proposed as a challenge to the Army that we apply these same innovative technologies to improve the quality and productivity of our military support operations.

LTC RICHARD H. HARENBURG, USAR, is a mobilization designee with the U.S. Army Laboratory Command, Electronics Technology and Devices Laboratory, Fort Monmouth, NJ, and a member of the 6386th RTU (logistics), Bell, CA. He holds a B.A. degree from Ripon College, and an M.S. from Fairleigh Dickinson University. He is also a graduate of the Army Command and General Staff College and is enrolled in the Air War College.

PEO-ASM

MG Peter M. McVey

MG Peter M. McVey holds a bachelor's degree in economics from St John's University in New York City, NY, and a master's degree in psychology from Newark State College, NJ. His military education includes the Armor Advance Course, the Army Command and General Staff College, and the National War College. His most notable assignments were cavalry squadron commander and brigade commander in the 3rd Infantry Division, and deputy chief of staff for operations (G-3), V Corps, U.S. Army — Europe.

If only one phrase could be used to exemplify MG McVey's leadership philosophy, it would be "Make Haste Slowly." He often communicates this to subordinates at timely moments when tensions are high and decisions need to be made quickly. Make Haste Slowly involves taking the time to examine a problem and determine the objectives. It means developing a plan, with milestones, that can achieve the set objectives. It embraces the use of timely guidance, and letting those responsible for execution do their jobs. Finally, it means standing back, providing overwatch, and being prepared to modify the plan when necessary. Simply put, Make Haste Slowly means to plan carefully — execute violently. Above all, MG McVey believes strongly in the value of hard work, common sense, and not being timid.

Missions and Organization

The Program Executive Officer for Armored Systems Modernization (PEO-ASM) oversees a matrix organization of more than 400 personnel. PEO-ASM serves as the Army's centralized manager for the Abrams Tank (M1A1 and M1A2), the Bradley Fighting Vehicle, Survivability Systems and six developing systems: the Block III Tank, the Future Infantry Fighting Vehicle (FIFV), the Combat Mobility Vehicle (CMV), the Advanced Field Artillery System (AFAS), the Line of Sight Anti-Tank (LOSAT) and the Future Armored Resupply Vehicle-Ammunition (FARV-A).

The bulk of the PEO-ASM programs are located at Warren, MI, along with the PEO headquarters. AFAS and FARV-A are at Picatinny Arsenal, NJ, and LOSAT is at Huntsville, AL. Fielding team locations include Europe, Korea, and Fort Carson, CO. PEO liaison teams are stationed at the Pentagon, Bonn Federal Republic of Germany, and Fort Knox, KY.

PEO-ASM provides overall direction and guidance for the development, acquisition, testing, product improvement, and fielding of assigned programs. Also, PEO-ASM assists in cost estimating, planning, programming, budgeting, program integration, and provides oversight. PEO-ASM controls an annual budget of over $2.3 billion.

ASM-PEO HEADQUARTERS GROUP

PEO	MG Peter M. McVey DSN 786-6662 Comm. (313)574-6662	Warren, MI
Deputy PEO (Current/Mid-Term Systems)	Jerry L. Chapin DSN 786-5684 Comm. (313)574-5684	Warren, MI
Deputy PEO (Future Systems)	COL Donald W. Derrah (Acting) DSN 786-6660 Comm. (313)574-6660	Warren, MI

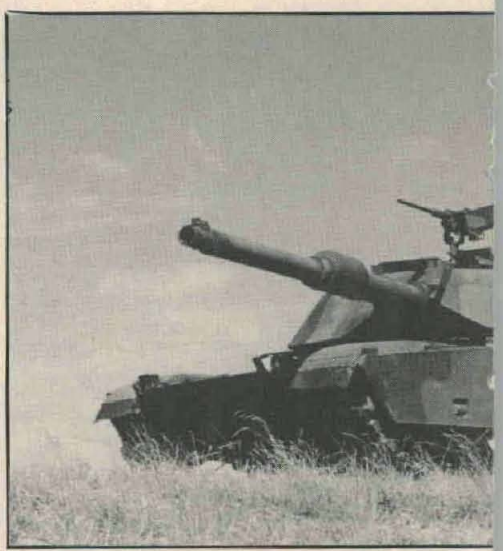
ASM PROGRAM MANAGERS
Current/Mid-Term Systems

PM Abrams	COL John S. Caldwell Jr. DSN 786-6885 Comm. (313)574-6885	Warren, MI
PM BFVS	COL J. B. Holeman Jr. DSN 786-5630 Comm. (313)574-5630	Warren, MI
PM Survivability Systems	COL William J. Miller DSN 786-6720 Comm. (313)574-6720	Warren, MI

Future Systems

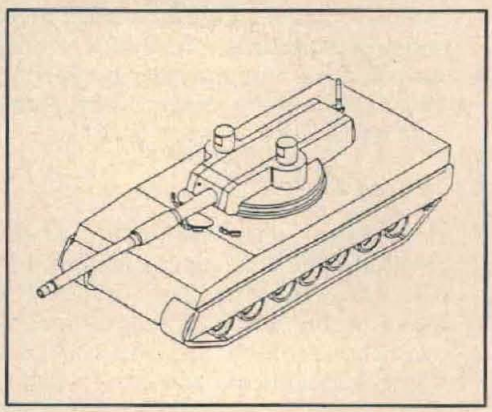
PM Block III	Roland Asoklis (Acting) DSN 786-6954 Comm. (313)574-6954	Warren, MI
PM CMV	COL Thomas D. Manula DSN 786-5440 Comm. (313)574-5440	Warren, MI
PM FIFV	COL Dennis C. Deming DSN 786-5927 Comm. (313)574-5927	Warren, MI
PM AFAS	COL David A. Napoliello DSN 880-5349 Comm. (201)724-5349	Picatinny Arsenal, NJ
PM FARV-A	COL James G. Voss DSN 880-8077 Comm. (201)724-8077	Picatinny Arsenal, NJ
PM LOSAT	COL Marvin S. Smith DSN 788-0851 Comm. (205)842-0851	Huntsville, AL

PR
ARMO



M1 ABRAMS
(M1A2 /

The mission of the Abrams Tank is to close with and
firepower, maneuver, and shock effect. The ongoing M1
Tank with the necessary improvement in lethality, sur
the middle 1990s. Noteworthy improvements for the M
the Commander's Independent Thermal Viewer, Positir
architecture. The M1A2 is currently limited to a produc
duction and being fielded.



BLOCK III TANK

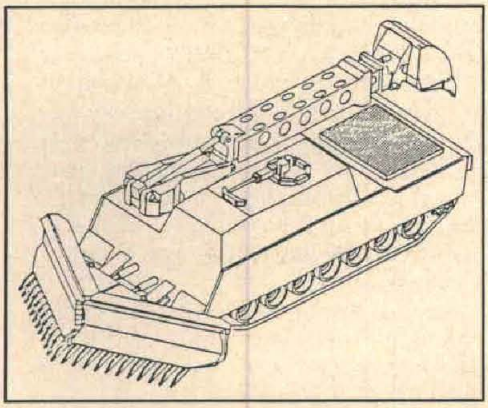
Using the heavy protection level Common Chassis, the Block III Tank incorporates the Multisensor Target Acquisition System (MTAS) along with remote view displays to acquire, engage, and destroy threat targets while moving cross-country. It will also possess a laser adjunct system as part of the MTAS suite. The Advanced Tank Cannon System (ATACS) will incorporate an automatic loading system to achieve an increased firing rate. The ATACS will fire both chemical energy and kinetic energy rounds to defeat the projected armored threat through the turn of the century and beyond. The Block III Tank is scheduled to begin advanced development in FY90 and to begin production at the turn of the century.

OGRAM EXECUTIVE OFFICER
RED SYSTEMS MODERNIZATION

. . . First in a Continuing Series

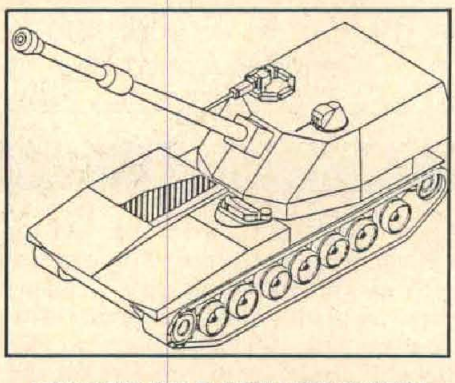
SERIES TANK
ABRAMS)

destroy enemy forces on the integrated battlefield using A2 full scale development program will provide an Abrams ivability, and fightability required to defeat the threat of M1A2 include Improved Commander's Weapon Station, n Navigation Equipment, and distributed data and power tion demonstration of 62 tanks. The M1A1 is now in pro-



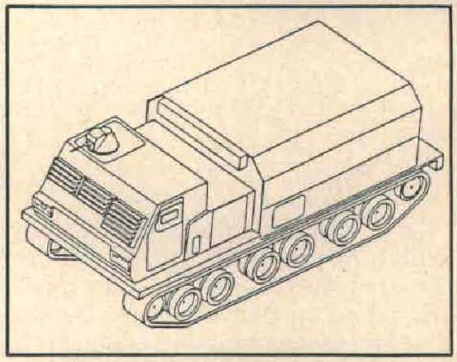
COMBAT MOBILITY VEHICLE (CMV)

The CMV, using the heavy protection Common Chassis, consists of a full width mine clearing blade equipped with automatic depth control; a power driven excavating arm capable of digging, lifting, and grappling; and a commander's control module for a two-man crew integrated onto a tailored heavy Common Chassis. While tailored for the specific requirements of the CMV, displays, controls, protection, and logistic support functions in the commander's control module will be compatible with the other systems using the heavy Common Chassis. The CMV is scheduled to begin advanced development in FY91 and to begin production by the turn of the century.



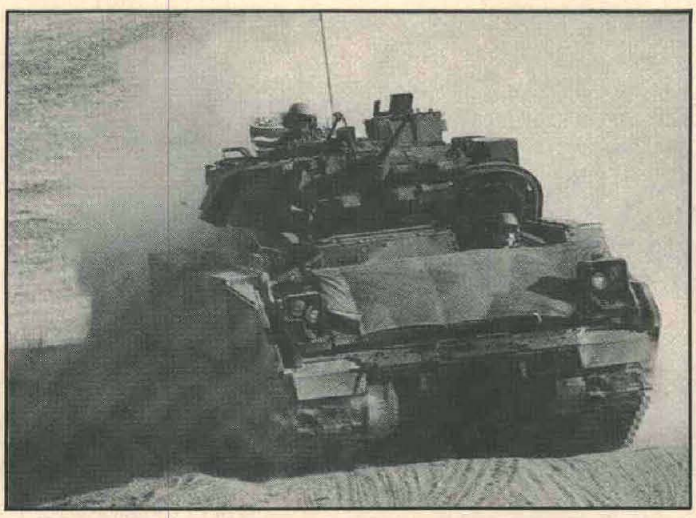
ADVANCED FIELD ARTILLERY SYSTEM (AFAS)

The AFAS will be mated on the heavy protection level Common Chassis. The crew will consist of four to six personnel distributed between the AFAS and its resupply vehicle, the FARV-A. The AFAS will perform operations autonomously and be able to self-locate, self-orient, and fire within 30 seconds. The 155mm weapon, which will have a sustained fire rate of three to six rounds per minute, will also be capable of firing in the direct fire mode. Automated handling and firing of all current and developmental rounds, including conventional, chemical, nuclear, and smart munitions, will be incorporated into the AFAS design. The AFAS is scheduled to begin advanced development in FY91 and to begin production at the turn of the century.



FUTURE ARMORED RESUPPLY VEHICLE — AMMUNITION (FARV-A)

The FARV-A will provide ammunition resupply services to AFAS in the forward area while under armor with hatches closed. It will be based on the MLRS chassis and will employ robotics and microelectronics to facilitate continuous resupply operations by a single crew member. The FARV-A vehicle will be able to identify, locate, and navigate to the AFAS. The capability to quickly and efficiently transfer ammunition from the resupply vehicles to the AFAS is to be accomplished in both clean and NBC environments with no contamination to crew or ammunition. The FARV-A is scheduled to begin advanced development in FY92 and to begin production at the turn of the century.



BRADLEY FIGHTING VEHICLE SYSTEM (BFVS)

The BFVS consists of the M2 Infantry Fighting Vehicle, which carries a 9-man squad, and the M3 Cavalry Fighting Vehicle, which carries a 5-man squad. The speed and mobility characteristics of the MFVS make it compatible with the M1 series Abrams main battle tank. The most advanced version of the BFVS, the "A2", incorporates an improved powerpack and high survivability armor package which enhances ballistic protection on the front and sides from up to 30mm AP rounds. The BFVS has been fielded in CONUS and the Federal Republic of Germany (FRG) in both A0 and A1 configuration. Currently, selected units in the FRG are being upgraded to the A2 version.

SAMPLE DATA COLLECTION ASSISTS LAMP-H PROJECT

By Alan M. Brandt and Kevin G. Aandahl

Even through blueprints for the Army's newest generation of turbine powered Air Cushion Vehicles (ACV) are still on the drawing board, marine development and quality engineers at the Belvoir Research, Development and Engineering Center located at Fort Belvoir, VA are already estimating the Reliability, Availability and Maintainability (RAM) characteristics of the Lighter, Amphibious-Heavy Lift, known as the LAMP-H.

The capability to accurately estimate RAM characteristics of the LAMP-H, long before it ever hovers across the water, is aided by the availability of historical data bases. One principal data base used in this assessment process was compiled under the U.S. Army Troop Support Command's (TROSCOM) Sample Data Collection (SDC) program located in St. Louis, MO. Utilizing the statistical information gathered by this program, marine system engineers have the ability to develop mathematical models for analyzing and comparing the Army's older generation ACVs to the expected values of the LAMP-H. Through this modeling technique, Army transportation officials computed a solid estimate of this hovercraft's operational capabilities.

Using historical data bases to perform computer modeling is primarily an exercise in "number crunching" mathematical calculation. Given enough time, an engineer with plenty of pencils and scratch pads would do the job as well as a computer loaded with historical data. But resorting to that method means the solution would be so slow in developing — years compared with weeks or days — it would be of little value.

One of the trickiest challenges facing marine engineers involved with the LAMP-H program at Fort Belvoir, has been searching for relevant data on systems that share common characteristics and then applying it, in an innovative manner, once its located. The relevant data utilized by Belvoir engineers is from the SDC effort on the Lighter, Air Cushion Vehicle-30 ton (LACV-30). The LACV-30 was the Army's first air cushion vehicle representing technology dating back to the mid-70s. SDC was conducted on the LACV-30 from 1982 through 1987 and offers a mature data base packed with reliable information.

The Army's SDC program obtains information on fielded equipment performance while in the hands of the soldier. Data is collected only on a sample of the equipment population, thus producing small amounts of high quality data at a reasonable cost. SDC collects both operational and maintenance data on all activities occurring in organizational and support units.

Normally, SDC is conducted on selected new equipment just entering the Army's inventory, after major equipment modification, or after overhaul, rebuilding or reconditioning. The resulting data can be used to form a life-cycle data base which supports a system assessment program used for special studies or to fulfill special requirements as in the case of the LAMP-H.

"One of the products developed using SDC data," says Fort Belvoir general engineer Dan Rusyniak, "was a LACV-30 RAM baseline report from TROSCOM's Directorate for Product Assurance and Testing." This directorate, besides overseeing TROSCOM's SDC program, responds to data requests from both Army and industry.

"The information provided in this RAM baseline report was essential in substantiating the levels of reliability and availability the LAMP-H should deliver when it becomes operational," Rusyniak said. "In this particular case, the LACV-30 SDC data base was of particular value. Product Assurance engineers at TROSCOM took this data and 'scored' it by individual data elements creating a Mean Time Between Operational Mission Failure (MTBOMF) and maintenance data base, which we used to measure the reliability and maintainability of the craft."

Submitting a RAM rationale report is one of the first steps taken by engineers on the lengthy procedure to develop and field new equipment from concept to completion. In the case of the LAMP-H, the Army's Transportation School at Fort Eustis, VA, tasked Fort Belvoir's RD&E Center marine development engineers to provide an engineering analysis on the entire system.

A RAM rationale report is required to validate that the craft will meet the user's stated RAM request.

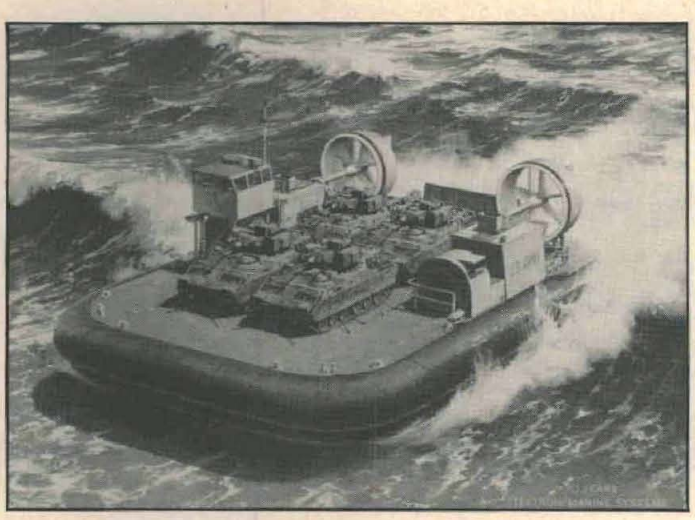
"You have to have a RAM rationale to have the requirements approved. The critical part is obviously (having) accurate data to complete the procedure, otherwise the project doesn't progress," says Rusyniak. "Without historical data like SDC, it can become a show stopper."

Besides using LACV-30 SDC data, Fort Belvoir engineers also used RAM data kept on the U.S. Navy's Landing Craft Air Cushion (LCAC).

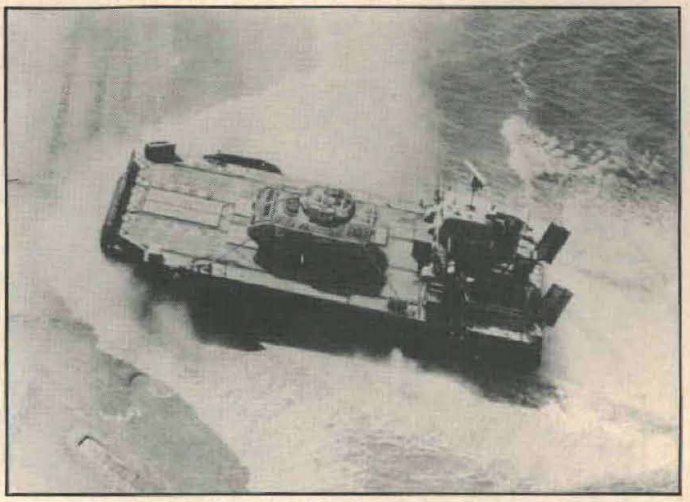
"We were lucky to have two data sources," says Rusyniak. "It gave us the opportunity to compare them, adjust for differences, and come up with a representative figure. We felt good about the answers we were seeing when we discovered that both data sources were in the same ball park."

Using SDC data bases as tools for engineering analyses are only as good as the accuracy of the original data going into them.

"We wanted a total maintenance ratio



Lighter, Amphibious - Heavy Lift (LAMP-H)



Lighter, Air Cushion Vehicle - 30

which will also be used in productivity analyses," says Raef Schmidt, a mechanical engineer on Fort Belvoir's Marine Development Team. "SDC data can also forecast how many missions the LAMP-H will be capable of completing in a certain period of time. This information is of particular value as a statistical backup for Army logisticians to determine how many LAMP-H's will be needed to move required amounts of equipment and supplies to the beach. SDC can also track high failure rate components on current technology which alerts us to design a more problem free solution," he says.

When fielded, the LAMP-H will eventually replace the slower and less capable LARC 60 (Lighter Amphibious Resupply Cargo, 60 ton) which was introduced during the Korean War. The 70 to 100 ton capacity of the LAMP-H, combined with its operating speed of 10 to 15 knots, will make this new system almost twice as productive as the LARC 60.

ACV technology allows the LAMP-H the capacity to haul loads like the M1A1 battle tank or three to four Bradley fighting vehicles onto and beyond unimproved beaches where terrain or lack of port facilities prevent more traditional types of lighterage from transporting and discharging cargo.

Many of SDC's benefits are intangible. But real savings in both time and money can be measured and realized by those using it.

"With SDC data we've saved significant overall time in researching and obtaining component level reliabilities on a total system," said Schmidt. "SDC acts like a microscope to help us focus in on problem area components, as well. At the minimum, it has saved us anywhere from six months to six years in researching and obtaining component level numbers, and that could potentially add up to millions of dollars saved."

In this era of tight fiscal constraints, using SDC data to forecast ways of reducing operating and support costs makes good financial sense. According to BG Kenneth R. Wykle, former director of combat service support at the U.S. Army Training and Doctrine Command (TRADOC), one of the ways to increase efficiency on the LAMP-H is by improving the system's RAM characteristics.

"If it's easier to maintain and does not break as often, then you don't need as many mechanics. If we look at systems that will double equipment reliability, the Army can reduce the number of support mechanics by one-half in the total force," states BG Wykle.

"Maintaining equipment can cost more than the original procurement price," concurs Rusyniak. "A sometimes used rule of thumb among engineers is that it takes 10 times as much money to support a system as it takes to procure it. While arguable, the ratio serves to illustrate that significant costs go towards people to fix a fielded system along with spares. It can cost more to maintain a system than to buy it in the first place. Therefore," concludes Rusyniak, "reliability is important, and if you can spend a little bit more at the outset to make it more reliable, then the savings make the investment worthwhile."

Besides supporting estimates of RAM characteristics, SDC can be utilized to collect data on equipment that is undergoing research, development, test and evaluation as well as items in the procurement cycle. Used properly, SDC is a valuable tool in assessing equipment performance in the hands of the soldier as well as during the development and procurement phases of new Army equipment.

Introducing a new generation of air cushion vehicle watercraft continues to present new challenges that demand engineers and logisticians to employ every available tool at their disposal to meet them. Using what we've documented and learned through SDC in the past can vitally assist the acquisition process by designing and building smarter for tomorrow's Army today. After all, "The only thing new in the world," said former President Harry S. Truman, "is the history you don't know."

ALAN M. BRANDT is the team leader for the Sample Data Collection effort in the Systems Performance Assessment Division, Directorate for Product Assurance, U.S. Army Troop Support Command, St. Louis, MO. He holds a B.S. degree in civil engineering from Southern Illinois University at Edwardsville, IL.

KEVIN G. AANDAHL is a senior video producer for a worldwide defense contractor headquartered in St. Louis, MO. He is a graduate of the Defense Information School's Journalist, Broadcast and Advanced Information Specialist active duty courses and hold's a bachelor's degree in mass communications from Lindenwood College.

DIAGNOSTIC AND REPAIR EXPERT SYSTEM FOR THE ABRAMS TANK

By John Lontos

The Abrams is the most advanced and formidable tank in the world. It is a highly maneuverable and agile land combat assault weapon system possessing sophisticated firepower, surveillance, communications, and survivability systems. The sophisticated and complex nature of these systems also makes the Abrams a formidable machine to troubleshoot quickly and accurately.

Since its inception in the mid-1970s, the Abrams has been the focus of continual efforts to improve its diagnostic capabilities. The lack of an integrated design with respect to diagnostics has resulted in voluminous technical data, bulky test equipment, high no evidence of failure rates, and extensive training requirements.

In 1986, the Training and Doctrine Command (TRADOC), Tank-Automotive Command (TACOM), and Test, Measurement and Diagnostic Equipment (TMDE) Task Forces combined to form what is known as the Abrams Integrated Diagnostic Improvement Joint Working Group (JWG). This group was faced with the task of developing objectives for joint integrated diagnostic improvement and a plan for implementing these objectives.

In response to the efforts of the JWG, the Army product manager for test program sets, using the resources of Giordano Associates, Inc., has embarked on a program to provide organizational level tank maintainers with a diagnostic and repair expert in the form of a portable computer, or portable maintenance aid.

Using a combination of expert system software, instrument-on-a-card technology, and a high performance, ruggedized computer, a tank mechanic will now be able to carry with him all the tools and information required to quickly and accurately troubleshoot the Abrams. The benefits of such a program become immediately apparent.

The amount of technical information currently required to effectively support a tank is unmanageable. Extensive cross referencing between technical manuals (TMs) can result in a maintainer getting halfway through a troubleshooting session before discovering that one of the manuals he needs is miles away. In addition, the maintainer often does not have enough wrenches to hold open the various TMs in the event of wind.

Advances in hard disk, optical media, and non-volatile storage technologies now make it possible for a portable maintenance aid to store and display the vast amounts of textual and graphical information required for troubleshooting these complex systems.

Possibly one of the most important benefits of this project is the reduction of no evidence of failure rates.

Deficiencies in the diagnostic design of the Abrams are the source of another major problem facing tank maintainers. The test equipment presently required to support the Abrams is unrealistically cumbersome in today's tactical environment, or any other environment for that matter. Over 100 unique cable connectors on the tank require the test equipment to possess a multitude of cables, connectors, test program sets and supporting documentation.

Through the use of a currently employed breakout box, which enables easier access to cable connector pins, and a portable maintenance aid-controlled instrument pack containing a digital multi-meter and a counter/timer, the tank maintainer can carry the equivalent of the several hundred pounds of test equipment currently required.

Complex weapons platforms, such as the Abrams, place additional demands on the logistics system by imposing extensive training requirements on maintenance personnel. One of the goals of this project is to enhance current training requirements through the use of computer-based training on the portable maintenance aid itself.

Off-line troubleshooting scenarios and on-line training can act as an on-the-job substitute for current classroom

training. In a similar effort, the Air Force's F-15 Avionics Troubleshooting Tutor project has already demonstrated that the use of expert systems as training tools can result in improved performance and increased conceptual understanding of troubleshooting processes.

Possibly one of the most important benefits of this project is the reduction of no evidence of failure rates. With the price of Line Replaceable Units (LRUs) reaching six figures, tremendous costs are incurred by the logistics system each time an incorrectly diagnosed LRU is replaced and shipped to the rear.

In a recent speech given at the Army Automatic Test Equipment/ Test Program Sets Symposium in Asbury Park, NJ, MG Billy M. Thomas, the then commander, U. S. Army Communications-Electronics Command, stated that beginning in January of 1992, each battalion commander will be required to maintain his own budget, and assume accountability for the cost of replacing and transporting LRUs. This change in the accounting process, and stricter management of available funds, will greatly increase the emphasis on reduced no evidence of failures.

In order for the Abrams Diagnostic and Repair Expert (DARE) program to be successful in meeting its goals, the various components of the DARE must be properly integrated. The DARE is essentially a Computer-Aided Acquisition and Logistic Support-compliant Interactive Electronic Technical Manual (IETM) hosted on a portable maintenance aid. The IETM is composed of three distinct, but interactive software modules: expert system-based diagnostics, supporting electronic technical manual data, and a library of small test programs.

The expert system is the core of the Abrams DARE. Using a commercially available expert system application and input from subject matter experts at the Ordnance Center and School, the Armor School, Tank-Automotive Command, and PM Abrams, expert knowledge is captured and translated into software which will guide and assist the maintainer during troubleshooting.

In addition to facilitating rapid and accurate fault isolation, the expert system will provide the user with the following features:

- Training in the form of tutorial information, theory of operation on a system and subsystem basis, and explanations why certain tests are being performed.
- A notepad-like capability to allow users to feed comments back through the system.
- Extensive graphical support.
- Recovery from errors.
- Automatic initiation of test programs for voltage and resistance measurement.

The instrument pack currently contains a digital multi-meter and a counter/timer, and will enable the maintainer to make all of the measurements necessary to troubleshoot the Abrams.

Complementing the expert system knowledge base is the electronic technical manual data. This consists of all supporting information that the maintainer may need during a troubleshooting session, or following isolation to a faulty LRU. The user will have at his disposal, via several keystrokes, information ranging from remove and replace instructions to preparing equipment for storage, to checking an item's National Stock Number.

The Electronic Technical Manual data is created using authoring software developed by the Air Force Human Resource Labs at Wright Patterson AFB, OH. All of the supporting information in the operator's manual and the unit maintenance manual is entered and stored in the form of a large relational data base. This data base in turn has links to the expert system so that the user is able to temporarily leave a troubleshooting session in order to view additional technical data, and then return to the point where he left off.

The third and final software module is essentially a library of test programs. Unlike typical stand-alone test programs, these are small programs that, when invoked by the expert system, will perform a single measurement using available instrumentation, and then return that value to the expert system for processing. Although the measurement value will be displayed on the screen of the portable maintenance aid, the actual measurement is performed automatically once initiated by the user.

The hardware platform chosen to host this IEITM software is the Contact Test Set II, which consists of a portable maintenance aid and an instrument pack. The portable maintenance aid is a high performance, ruggedized, Risk Instruction Set Computer-based portable computer. It is capable of being used as a stand-alone computer for functions such as system software downloading or tracking historical maintenance data, or in conjunction with the instrument pack for organizational level troubleshooting.

The instrument pack currently contains a digital multi-meter and a counter/timer, and will enable the maintainer to make all of the measurements necessary to troubleshoot the Abrams.

It is worth noting that, in addition to this type of organizational level testing, the instrument pack can be replaced by additional instrumentation, such as a VXI chassis. This will provide a direct support testing capability at the organizational level.

This is not, by any means, the first application of expert system technology to fault diagnosis. It is however, the first program to compliment expert diagnostics with instructive testing along with all of the ancillary information necessary to perform various maintenance tasks for such a large and complex system. Successful merging of these hardware and software technologies will not only result in vast monetary savings throughout the logistics system, but will revolutionize the manner in which weapons systems are currently maintained.

JOHN LONTOS is an engineer with the Fort Monmouth operations of Giordano Associates, Inc. He has a B.S. degree in electrical engineering from Clarkson University, an M.S. in management, and is currently pursuing a master's degree in computer science.

IMPLEMENTING MANPRINT AT THE ARMY CHEMICAL RDE CENTER

'People Are Our Most Important Resource'

By Mary B. Soubie,
MSG James S. Shawver and
Pamela B. Barrett

Background

The Manpower and Personnel Integration Program (MANPRINT) is a Department of the Army program dating back to the early 1980s. The program, as stated in AR 602-2, refers to the comprehensive management and technical effort to assure total system effectiveness by continuous integration into materiel development and acquisition of all relevant information concerning the following: human factors engineering, manpower, personnel, training, system safety, and health hazards.

The philosophy is to have the Army and industry take necessary actions to answer the question: Can this soldier with this training perform these tasks to these standards under these conditions using this equipment? MANPRINT focuses Army development programs on the total system, of which the soldier is an integral part. The thrust becomes "equip the soldier," rather than "man the equipment."

The U.S. Army Chemical RD&E Center (CRDEC) leads the Armament, Munitions and Chemical Command (AMCCOM) in implementing a strong MANPRINT program. The soldier plays a key role in our development efforts because, ultimately, he is the one who will use the equipment. Consequently, our engineering and design must reflect the soldier's needs.

We use many avenues to ensure that MANPRINT is considered in all phases of development. MANPRINT receives command emphasis at the center and AMCCOM. Our commander has assigned the MANPRINT advocacy to his associate technical director for engineering and test (ATD E/T).

Requirements Division MANPRINT Role

The Requirements Division of CRDEC's Advanced Systems Concepts Directorate is the focal point for MANPRINT and is responsible to the ATD E/T for significant actions in the MANPRINT area. The Requirements Division offers several services to the center in the implementation of the MANPRINT program. The division coordinates, staffs, and reviews requirements documents received by the center to ensure all domains of MANPRINT are included.

Prior to submitting a formal response to the user proponent, meetings are held, chaired by a member of the command group, to ensure that our review is thorough and that issues are resolved within the development community.

System Management MANPRINT Plans (SMMPs) receive the same attention as requirements documents.

We work closely with the combat developer to ensure that MANPRINT requirements are written as specifically as possible, eliminating "boiler-plated" paragraphs and untestable criteria. In addition, we strive to build specific MANPRINT requirements into contract documents. Following the review of these documents, division personnel represent the command group at joint working groups, serving as the co-chair with the user proponent. Hence, it is through the Requirements Division that all requirements documents and SMMPs receive command visibility.

The Requirements Division also reports to higher headquarters on MANPRINT activities through the Integrated Logistic Support (ILS) Executive Council as well as at both the CRDEC and AMCCOM Commander's Review and Analysis (R&A). Within the center, MANPRINT is also reported to the technical director at his annual technical reviews. We serve as the center point of contact (POC) for advice, maintenance, updates and general guidance pertaining to MANPRINT information relating to those programs. Finally, a senior NCO chairs the Senior NCO Advisory Committee, a key activity in our MANPRINT strategy.

NCO Advisory Committee

The CRDEC senior NCO Advisory Committee includes the operations sergeants from each of our development directorates, senior NCOs directly involved in the R&D projects, and senior NCOs from the U.S. Army Technical Escort Unit and the Maintenance Operational Procedures Detachment. The mission of the committee is to review proposed projects (tech base), items currently in development, and improvements to existing systems. R&D activities traditionally have few assigned soldiers who can perform this review function.

Senior NCOs serve as a "sanity check" and function as the "voice of the soldier" to supply the valuable user opinion at a time in development when design can be influenced and changes implemented.

User Options

As pointed out in the *MANPRINT Bulletin*, "Troops generally will not function at optimum effectiveness with equipment they dislike or mistrust. Obviously, the most direct way to find out how a user feels about equipment is to ask his opinion. User insight may suggest improvements in hardware design or in operating procedures that compliance checking would not reveal. Problems reported by users may also identify system characteristics that point to health hazards or to system safety problems." The senior NCOs at CRDEC serve as the early user, providing valuable soldier opinions.

The reviews, conducted from a soldier's point of view, involve the soldier early in the design process for all programs. First, does the equipment service the soldier in his environment? The procedure is to tailor reviews to scenario driven, hands-on evaluations, which are conducted in a field environment, during inclement weather, darkness, and in Mission Oriented Protective Posture (MOPP 4) (full chemical protective clothing) conditions. Second, the equipment must be operable in the same environment in which a soldier must train and fight. Third, it must be "soldier-proof." Each system has several NCO committee reviews, starting with the initial concept and continuing through the development of the system. During these reviews, each of the six domains of MANPRINT is considered.

Findings and Recommendations

Following committee reviews, an evaluation is prepared listing the committee's findings and recommendations. This evaluation is sent to the responsible directorates for consideration. The directorate's response, evaluating the committee's recommendations from an engineering point of view, along with the committee's findings, are then forwarded through the Requirements Division to the CRDEC commander. Committee recommendations accepted by management are incorporated into the development program. This documentation is also maintained as part of the historical record and reported at the CRDEC commander's quarterly R&A. Accomplishments in MANPRINT, including the Senior NCO Advisory Committee reviews, are also reported quarterly to the ILS Executive Council as well as at the CRDEC and AMCCOM R&A.

Committee recommendations accepted by management are incorporated into the development program.

Indeed, committee reviews result in positive improvements. For example, the Combined Arms in a Nuclear/Chemical Environment (CANE) study reported a need for improved communications for the masked soldier. The Senior NCO Advisory Committee reviewed an electronic voicemitter for the chemical protective mask which contained a motion sensitive power switch. The committee concluded that the motions of a soldier carrying the mask would continually activate the voicemitter and quickly deplete the battery power. Our Senior NCOs recommended that a positive power switch be installed; a recommendation that was accepted for implementation.

Another example involved a committee review on the Simplified Collective Protection Equipment (SCPE) program. The first recommendation was to keep the present carrying handles on the protective entrance, but also add a handle to each side (top and bottom) in the center of the protective entrance so it can be carried in a vertical position as well as the horizontal position. Second, the configuration of the support kit carrying case was reconfigured so that electrical power cords can have their own protective slot in the case. During demonstrations, power cords were removed from under the motor blower, which, in time, could cause the cords to fray or possibly bend the power connectors on the cord ends. Both of these ideas were accepted and will be incorporated into future designs.

Finally, each member of the Senior NCO Advisory Committee is also a member of a Weapons Systems Management Team (WSMT) which meets on a regular basis to discuss the current program issues and progress to date.

Training Videos

The senior NCOs are also involved in reviewing and assisting in the preparation of training videos. Their recommendations on the script concerning set-up procedures and safety hazards for the M20 Simplified Collective Protection Equipment (SCPE) resulted in a complete rewrite. The committee assisted in the rewrite as well as in the actual taping which took place in St. Louis, MO.

The Senior NCO Advisory Committee also reviewed a series of training videos for the M40 and M42 protective masks and found the tapes to contain some erroneous information. Their review resulted in a recall of the entire series of tapes for revision. In addition, they prepared a script for a new training video entitled "Unit Maintenance of the M40 and M42 Protective Masks." CRDEC personnel will serve as technical advisors and assist in the development of a new video scheduled for production later this year at Fort McClellan, AL.

Production and Proveout

During the Development and Production Proveout Phases, the committee continues to review programs to ensure that soldier issues are resolved. For example, the senior NCOs visited a contractor site on several occasions to review the XM55 Smoke Generator and the XM56 Smoke/Decon System. The committee suggested redesign and repositioning of the system control panel to allow for easier soldier use. A recommendation was made to move the circuit breakers, currently located in the end of the control panel, to the top of the panel. This allows for easy resetting by the operator or the driver/operator. As a result, the contractor is repositioning the circuit breakers to an alternate location on the control panel.

Finally, each member of the Senior NCO Advisory Committee is also a member of a Weapons Systems Management Team (WSMT) which meets on a regular basis to discuss the current program issues and progress to date. This is an excellent forum for members to voice MANPRINT concerns. Many areas of expertise are represented at these meetings including ILS, safety, human factors engineering, and testing. Their input is essential to assure total system effectiveness.

Branch Liaison Team

Although not directly related to the work of the Senior NCO Advisory Committee, senior NCOs at the center are still involved after the production phase. The NCO attached to Requirements Division participates as an invited member of the U.S. Army Chemical School Branch Liaison Team (BLT). The team, organized under the Chemical School located at Fort McClellan, AL, consists of officers and NCOs from the school and a senior NCO member from CRDEC. Their purpose is to learn the field's view on personnel, organization, equipment, and doctrinal matters.

For active components, the BLT will visit each corps headquarters, division, and separate brigade once every two years to collect data. Approximately eight reserve components are scheduled for BLT visits during FY90. Each visit is tailored to those actions ongoing at the U.S. Army Chemical School. Approximately 30-45 days prior to a visit, each school directorate/department is asked for any specific topics on which they need data; these topics are discussed in the BLT interviews.

The team also assists in setting up training classes as well as in supplying useful information on changes to fielded equipment. The team acts as a field trouble shooter by addressing questions on repair parts, safety and maintenance problems, and changes to technical manuals. The CRDEC senior NCO team member helps to close the loop in the materiel acquisition process. Information is treated as lessons learned and folded back into future projects as possible product improvements.

One example occurred during a Branch Liaison Team visit to Fort Knox where issues were raised in reference to Chemical Agent Resistant Coating (CARC). The field required instruction on proper procedures used to paint bumper numbers on vehicles. At the time, Fort Knox vehicles were required to be turned into Direct Support (DS)

maintenance merely to have the bumper numbers applied in CARC paint. This time-consuming procedure caused the loss of the vehicle for several days or weeks depending on the DS workload. After talking with personnel in the Decontamination Systems Division at CRDEC, it was made clear that spot painting of CARC-painted equipment is allowed. Painting of bumper numbers can be done on site, thus eliminating the need to send the vehicle to depot maintenance. The field was supplied TM 43-0139 which contains painting instructions for field use.

Early soldier involvement may eliminate later product improvement actions. For instance, several equipment improvement ideas resulted from a Branch Liaison Team visit to Fort Stewart, GA. The ideas concerned the M12A1 Power-Driven Decontaminating Apparatus. The users suggested that hinges be installed on the control panel so that it would swing out and allow for easy access to the terminal block behind it. However, developers at CRDEC concluded that the control panel could not simply open on hinges without a complete redesign of the wiring, rigid tubing/piping for the gauges and valves, and throttle linkage. Yet, this product improvement was considered an excellent idea.

Given the life cycle status of the M12A1, the change was determined not to be economically feasible. Chances are that if MANPRINT had been implemented in the 1960s, and if soldiers had been involved with early designs and prototypes, the original design of the M12A1 would have included a hinged control panel.

Civilian Workforce

We at the Center strongly believe in teaching the civilian workforce how the soldier and his equipment interface, a position that ultimately enables engineers to design equipment best suited for the soldier. Therefore, CRDEC has taken advantage of the AMC Design Engineers Field Experience With Soldiers (DEFEWS) Program by providing 25 participants since the program's inception. This program offers the opportunity for civilians to understand how the soldier is overburdened in the field. In exercises conducted in all weather conditions they learn, first-hand, the difficulties of performing mission tasks while dressed in chemical protective clothing. They also learn first hand the effects of these conditions on operating equipment. By temporarily placing engineers in the soldiers' environment, they are able to learn from the experience and apply their field knowledge to equipment design. The DEFEWS program helps to focus the engineer on the design of equipment for battlefield use, not laboratory experimentation.

Another example of acquainting the civilian workforce with the soldier's environment is the civilian training at the Chemical Decontamination Training Facility at Fort McClellan. The facility is used to train soldiers and civilians in the operation of chemical defense equipment such as masks, detectors, alarms, and decon procedures, in the presence of live chemical agent. CRDEC participants have said this experience is very beneficial.

Formal MANPRINT training has been an integral part of our program at the center. In addition to the Senior NCO Advisory Committee, over 15 CRDEC people have attended the three-week mid-manager staff officer's course at Fort Belvoir. CRDEC also hosted the one-week MANPRINT Senior Training Course in June 1989 which included command group personnel from the center as well as from the U.S. Army Training and Doctrine Command, U.S. Army Environmental Hygiene Agency, U.S. Army Natick RD&E Center, U.S. Army Logistic Evaluation Agency, and various industrial concerns.

Conclusion

The success of the U.S. Army Chemical RD&E Center's MANPRINT Program, which was implemented in 1987, is the direct result of a lot of good people working toward the common goal of providing capable and dependable equipment for our soldiers. Underlying that goal is the time-tested truism that "People Are Our Most Important Resource."

MARY B. SOUBIE is a requirements specialist in the Requirements Division of the Advanced Systems Concepts Directorate at CRDEC.

MSG JAMES S. SHAWVER is the chairman of the Senior NCO Advisory Committee and works in the Requirements Division of the Advanced Systems Concepts Directorate at CRDEC.

PAMELA B. BARRETT is the chief of the Requirements Division, which is part of the Advanced Systems Concepts Directorate at CERDC.

CONCEPT FOR DESIGNING SECURE BUILDINGS

Providing Successful, Cost-Effective Physical Security for Military Facilities

By Douglas Ellsworth and Dana Finney

Background

Today there is a continual need to protect mission critical DOD facilities against a variety of physical threats ranging from vandalism to terrorism.

Ideally, facilities should be designed with physical security systems that match their function and the projected threat. The rationale is the same as for any building feature: by selecting the components best suited to the building use, life-cycle cost is minimized and the function is served without overdesign.

The U.S. Army Construction Engineering Research Laboratory (USACERL) has developed the concept for a Physical Security Evaluation Procedure (PSEP). The concept was developed in cooperation with the Protective Design Center at the U.S. Army Corps of Engineers' Omaha District. This approach will help facility designers assess the most likely security threats, the required levels of protection, and the most cost-effective protective measures to use for military facilities housing critical assets worldwide.

The Naval Civil Engineering Research Laboratory had previously developed a related system, the Physical Security Requirements Assessment Methodology (PSRAM), which is operable. However, the scope of PSRAM is limited to forced entry attacks; threats such as car or truck bombs, standoff weapons, and other tactics, as well as the likelihood of a threat, are not considered. The user is also required to input the proper threat parameters.

PSRAM uses the "analytical tree" (AT) method to analyze and design physical security for facilities. It considers the relative cost-effectiveness of different combinations of structural hardening, intrusion detection systems (IDS), and security personnel. The approach developed at USACERL would expand the analytical tree concept and integrate PSEP and PSRAM. It would:

- Establish the likelihood of a threat of a given severity occurring with the full spectrum of possible threats considered.
- Identify the minimum acceptable level of protection for the facility and the assets it contains.
- Determine the maximum acceptable life-cycle costs for protection and the level of losses that can be tolerated.
- Project the expected dollar losses over the facility life cycle for various levels of protection.
- Analyze and design the most cost-effective measures against the most likely threats satisfying the above performance and cost constraints.

The first four functions comprise the PSEP Threat Determination Module. This is the portion of PSEP that facility planners would use to identify the most likely attacks and establish the performance and cost goals for the protection system.

Function five above would help facility designers in identifying and designing the most cost-effective protection system to meet these goals. The current version of PSRAM can support this function.

The Analytical Tree Method

The formal name for the AT technique is "reliability event-logic diagrams." It is a sophisticated approach that can be used to describe, isolate, and evaluate complex systems with mathematical rigor. PSRAM and PSEP are built on an adaptation of this method.

To construct an AT for physical security, event-logic diagrams are established to define the interrelationships of threat and physical security events. These diagrams use commonly accepted graphic symbols for events, logic gates, and transfers.

AT techniques have traditionally focused on the occurrence of failures, or a "negative" event. The approach is equally valid for system successes, or a positive outcome. PSEP uses the positive approach. In this case, the AT considers the likelihood of threats occurring and measures the security system performance in terms of the probability that it is successful in stopping the threat cost-effectively.

The mathematics underlying PSEP are complex. In addition to assessing the probability (likelihood) of a threat event, PSEP includes an economic analysis that determines the maximum acceptable cost for security and the projected losses over the facility life cycle. A detailed explanation of these functions is available from the authors.

The Threat Determination Module

The first step in developing the framework for the Threat Determination Module is to identify and define the threat in a way that will be useful for designers. Threats are described as either dedicated or non-dedicated ("casual"). Dedicated threats use an attack mode violent enough to succeed, while casual threats usually do not involve an attack.

Threat objectives can be divided into five categories: personnel injury, destruction (vandalism or sabotage), theft, espionage, and political embarrassment.

Casual threats center around protestors, vandals, and unsophisticated or semi-sophisticated criminals. These threats usually show a willingness to break moral or military codes of conduct and civil, military or criminal law. Many casual threats are crimes of opportunity which are spontaneous and unplanned.

Dedicated threats can be of three types. First is the experienced professional criminal, who is meticulous at planning for minimum risk. This threat is capable of using an overt attack involving explosives or murder as well as a covert attack involving months of planning how to attack a facility without detection. Usually, though, such a threat will use violence against personnel only as a means to limit risk.

Another type of dedicated threat involves subversive agents (saboteurs and spies). A third category includes paramilitary or terrorist threats. Both of these threats are often characterized by intentionally violent acts and disregard for risk. Their goal typically is theft, sabotage, or espionage in attempts to compromise national security, public safety, military readiness, and/or political image. For these threats, causing death or massive destruction to accomplish their goals is often considered desirable, even if success would not require such severity.

For the Threat Determination Module, each type of threat was further defined by four key parameters: personnel; tools, weapons, and equipment; tactics and severity level; and logistics. All of the defined threat elements are placed into a comprehensive matrix for developing the ATs. The above discussion has been a very brief summary of the logic used in identifying and defining the threats by PSEP.

AT for Threat Analysis and Evaluation

This AT is constructed using a general matrix to consider all possible combinations of threat elements, with AND/OR logic gates introduced appropriately between different levels.

The AT structure is intended to be applied cyclically for each asset to be protected, each aggressor type, and each possible tactic and severity level. The "top event" is the individual likelihoods of a given aggressor type being in the geographic area directing an attack of a given type and severity level at the particular assets. The end result is a probability (in percent) of this happening. This is the basis for designing different levels of physical security into a building.

Of course, one or more tactics and severity levels may be directed toward a given asset. PSEP evaluates the probability that a given attack mode and severity level will be stopped, with the individual tactic likelihoods used to establish the most cost-effective protection measures.

Performance Goals and Cost Constraints

The PSEP analytical tree establishes three criteria for determining the performance requirements of physical security measures: the acceptable protection level for a given asset at a given facility; the maximum acceptable cost of the protective measure plus that of any asset losses; and the expected asset losses associated with a given protection level over the life cycle of each facility.

The acceptable protection level is based on such considerations as military value of an asset and its criticality to the mission, the economic value, and the political impact of its loss.

The maximum acceptable cost is expressed as the sum of the available MILCON budget for constructing the facility, the projected operation and maintenance budget that will be available over the life of the facility, and the acceptable level of losses.

Expected life-cycle loss is the sum of replacement costs and investigation costs associated with the theft or destruction of an asset.

Conclusion

The PSEP concept was developed to enhance the professional designer's creative process — not to replace it. As such, it provides a tool which allows designers to look at different options for physical security with some indication of the success to be expected from each option against the identified threat.

To take PSEP and the Threat Determination Module from the concept stage to a working expert system, a data base will need to be developed. In addition, it will be essential to involve the potential users in the development process so that a responsive system can be produced.

The PSEP concept could serve as a framework for building an expert system. Such a system could provide one solution to successful, cost-effective physical security for military facilities, both in new construction and retrofits.

DOUGLAS ELLSWORTH is a principal investigator on the Engineering and Materials Division's Structural Engineering and Physical Security Team at the U.S. Army Construction Engineering Research Laboratory, Champaign, IL. He also serves as USACE executive agent representative for physical security R&D.

DANA FINNEY is a public affairs specialist in the USACERL Public Affairs and Marketing Communications Office.

A NON-FLAMMABLE HYDRAULIC FLUID FOR FUTURE COMBAT VEHICLES

By Connie Van Brocklin

Introduction

The concept of the Armored Systems Modernization Program — accelerated development and procurement of a family of improved armored vehicles utilizing common testing and many common features, has provided a unique opportunity for the adoption of the newest and best technologies.

Use of non-flammable hydraulic fluid (NFH) is an armored combat vehicle improvement which has long been recognized as necessary to improve both vehicle and crew survivability. NFH, and the technology necessary to accompany its use have been under development by both the Air Force and Army since the 1970s. The implementation of NFH has been technically feasible since the mid-1980s, but could not be demonstrated because of the lack of adequate funding and hardware.

Because of the difficulties associated with a hydraulic fluid changeover from petroleum based fluids to the chlorotrifluoroethylene (CTFE) based NFH, an NFH was not adopted earlier for use in the M1 Abrams. NFH could not be easily adopted unless it were designed into the vehicle during the initial stages of development. Since the NFH has been developed and successfully tested and since development for the Armored Systems Modernization Program is now beginning, NFH should be the specified fluid for future armored combat vehicles.

Background

Before 1974, the standard operational hydraulic fluid for all Army ground equipment, including armored vehicles, was MIL-H-6083 (OHT) hydraulic fluid. This fluid is somewhat flammable and was identified as contributing to loss of equipment and life during the Arab/Israeli conflict of 1973. Consequently, MIL-H-46170 (FRH) was developed and introduced as an interim solution to reduce hydraulic fluid fire threat to armored vehicles.

Since fire risks were still present with FRH, which was intended to be an interim fluid, the Belvoir Research Development and Engineering Center (MERADCOM at that time) initiated a program in 1978 to develop a completely non-flammable hydraulic fluid.

The Air Force, with research efforts centered at the Wright Research and Development Center (WRDC), Wright Patterson Air Force Base (WPAFB), also pursued a program to develop a NFH for use in aircraft hydraulic systems. Both research centers concluded that a completely non-flammable hydraulic fluid would have to be chemically different from the currently used fluids so that a simple retrofit, i.e., a one- for-one changeover, with existing hydraulic systems was not feasible. The Air Force then initiated a program for development of an NFH without constraints. A totally new hydraulic system, including all components and compatible elastomeric seals, was to be designed around an NFH.

Based on extensive flammability tests with several candidate fluids from several classes of materials (phosphate esters, silicones, chlorofluorocarbons, fluoroalkylethers), and other factors such as cost and availability, additive solubility, density, and compressibility, the Army and Air Force selected chlorotrifluoroethylene (CTFE) for the non-flammable hydraulic fluid basestock. CTFE is a truly non-flammable fluid with no measurable flash point or fire point.

Because the Air Force NFH requirements are the same as the Army NFH requirements, a joint military specification is being prepared and is currently in coordination.

Fluid Properties

CTFE fluids are saturated low molecular weight polymers of chlorotrifluoroethylene. Their chemical and physical properties are quite different from the hydrocarbon based hydraulic fluids (OHT and FRH) which are used in present military hydraulic systems. The most noticeable differences which must be considered in using a CTFE based hydraulic fluid are its high specific gravity, high volatility, incompatibility with conventional elastomers, lower bulk modulus (greater compressibility), and the extraordinarily low solubility of additives which are needed for corrosion inhibition and wear protection.

The additive solubility problems were overcome in 1985 when the USAF WRDC successfully formulated an NFH which utilized a CTFE oligomer manufactured by the Halocarbon Products Corp., a 3M Corp. proprietary lubricity additive, and a barium sulfonate rust inhibitor. This fluid has an operational temperature range of -54 C to +135 C (65 F to +275 F), with better low temperature viscosities and a higher operating temperature than

FRH. Currently the Air Force is continuing research efforts to obtain a +175 C (+350 F) fluid, which is required for future aircraft systems.

The volatility of CTFE is easily controlled by using a closed hydraulic system. A study of the evaporation loss of CTFE in an M60 hydraulic system reservoir, which is essentially a closed hydraulic system, showed that evaporation loss was almost identical to the loss for OHT, and negligible for both fluids. Elastomers have been developed which are compatible with CTFE and research continues to improve their properties.

Toxicological studies on the CTFE base hydraulic fluid are nearly completed. At temperatures below 500 F (260 C) the fluid has low toxicity by the oral, dermal and inhalation routes. It results in minimal eye irritation, no skin irritation, and mild sensitization. There were no effects in a delayed neurotoxicity study and the fluid is non mutagenic. Some liver effects from prolonged low level exposure may be experienced in primates, but whether this is reversible or significant in humans is not yet known.

Because of its high molecular weight and high density, the CTFE oligomer should not cause ozone layer damage. Recycling is being considered and will be studied to eliminate hazardous waste disposal and to reduce the overall costs of the fluid.

Testing Highlights

Armored vehicle components have been tested with CTFE to determine the system modifications required for its adoption. An investigation conducted by Cadillac Gage in 1985 on the M60A3's gun and turret control hydraulic system concluded that minor hardware modifications (modification of the electronics to increase the electrical loop gain to compensate for the decrease in pilot valve flow gain and increase of the flow area of the third stage valve) were required to counter the adverse effects of the high specific gravity of the new fluid.

In 1988, Cadillac Gage completed follow-on testing of NFH in an M1 gun and turret control system modified according to the recommendations of their earlier study. At medium and high temperatures, the performance of the NFH in the modified system was satisfactory and comparable to the performance of FRH in the unchanged system. At low temperatures NFH demonstrated a much improved performance over FRH. Therefore, with NFH, the heaters used in the M1 to improve FRH low temperature performance could be removed.

CTFE has also been tested in two gun mounts. Firing tests performed at Aberdeen Proving Ground in 1984 in the 105mm recoil mechanism of the M1, the M68 gun mount, resulted in high recoil cylinder oil pressures, causing premature suspension of the testing. This confirmed the necessity of hardware modifications for the recoil mechanism.

In 1988, firing tests were conducted at Watervliet Arsenal with NFH in a M140A1 105E gun mount (used in M60 series tanks) modified according to the findings of the previous testing. The piston grooves of the recoil mechanism were machined deeper radially, thus allowing less restricted flow around the recoil spring during firing. The tests were conducted at

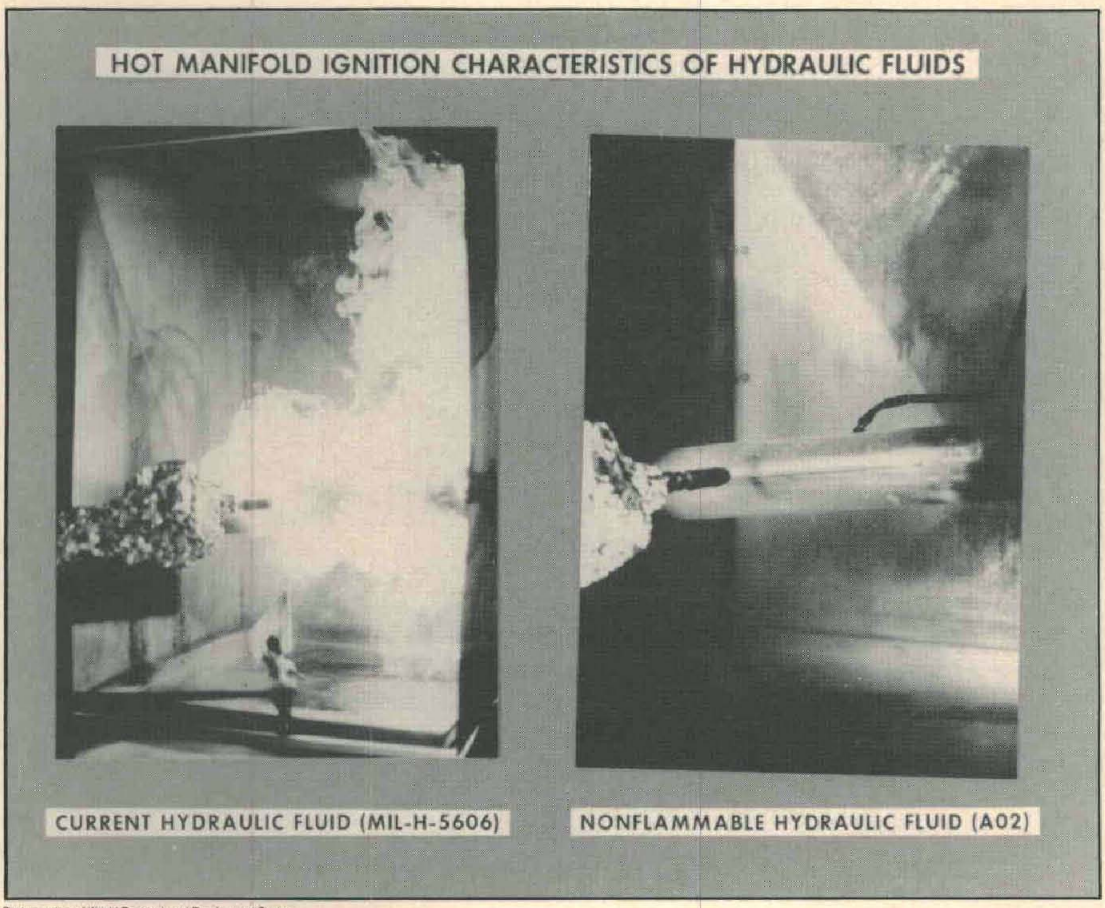


Photo courtesy of Wright Research and Development Center

A test simulating high pressure hydraulic fluid escaping from a ruptured hydraulic line and hitting a hot manifold shows the difference between MIL-H-5606 (equivalent to MIL-H-6083, but contains no corrosion inhibitors) and nonflammable hydraulic fluid, which does not ignite.

the temperature range of 0 to 75 F with regular M467 and upweighted M490 rounds. Firing was successful with all recoil fluid pressures staying within acceptable limits.

NFH has also been proven effective in a current aircraft system. Since most non-combat aircraft hydraulic fluid fires are initiated by hot brakes in the landing gear and wheel well areas, a two fluid hydraulic system uilizing NFH in the brake system has been developed for the C/KC-135 aircraft. NFH performs as well as the original hydraulic fluid, MIL-H-5606.

McDonnell Douglas, under contract to the Air Force, has designed and tested several low energy concepts for advanced aircraft hydraulic systems and the various required components: variable pressure pump, overlapped main control valves, flow augmentation and load recovery valves, and a full up variable pressure system. These four concepts have been adapted for the non-flammable Hydraulic Power Systems for Tactical Aircraft (NHPSTA) program. This program will culminate in testing of a total aircraft hydraulic system utilizing NFH, the Iron Bird, in early 1990.

8000 PSI Systems

A CTFE based hydraulic fluid has a much higher specific gravity (is heavier) and is slightly more compressible than traditional petroleum based hydraulic fluids. One solution to both of these negative features is utilization of higher system pressures. Smaller diameter hydraulic lines and less hydraulic fluid are used in a high pressure hydraulic system which reduces the weight of the hydraulic system.

Because of the Air Force's complementary requirements for a non-flammable hydraulic system utilizing CTFE, a lighter weight hydraulic system, and the increasing horsepower requirements of hydraulic systems, system pressure ratings for advanced aircaft have been raised from 3000 to 8000 psi.

Future armored vehicles could be expected to have 3000 to 5000 psi systems, considerably higher than current vehicles. Considerable research on 8000 psi aircraft hydraulic systems has been sponsored by both the Navy and Air Force.

Design Considerations

Implementation of NFH is feasible, especially for future vehicles which can have necessary modifications designed in at the beginning. The following are some of the design considerations:

- Replacement of seals and other elastomeric components with CTFE-compatible materials such as VITON A-GLT (MIL-R-83485) or non-conventional sealing materials.
- Restriction on some metallurgical materials such as brass and bronze.
- Modification of hydraulic system servomechanisms.
- Modification of gun recoil systems.
- Use of sealed fluid reservoir systems.
- Adoption of a higher pressure system.

Advantages and Disadvantages

The advantages and disadvantages of adopting a totally new hydraulic fluid with its requirements for systems changes must be carefully weighed.

The most important advantage of NFH, which cannot be totally analyzed from a cost standpoint, is its non-flammability and the resulting improvement in vehicle and crew survivability. Currently used hydraulic fluids, even fire resistant FRH, still present a distinct fire hazard to equipment and personnel.

In 1985 the Army Ballistic Research Laboratory tested fire suppression materials and the thin steel overlays which protect hydraulic lines from behind armor debris (BAD). The tests indicated that hot pressurized FRH fluid escaping from perforated lines was readily ignited. Hot pressurized NFH does not ignite.

With the 1989 Senate ratification of the Montreal Protocol and the anticipated banning of production and use of Halon 1301 — the material used in the fire extinguishing systems of armored combat vehicles — alternate fire extinguishing materials will be sought. The elimination of one of the major fire sources in an armored vehicle, the hydraulic fluid, would be an advantage since alternate fire suppression materials may prove to be less effective than Halon 1301.

Another advantage of NFH is its operating temperature range. The low temperature properties of NFH are superior to FRH, which has been criticized for its marginal low temperature properties. Also, the NFH operating temperature limit of 275 F exceeds the FRH operating limit of 250 F.

Disadvantages include the incompatibility with existing hydraulic system elastomers and components and higher fluid cost. Also, opponents of NFH cite the fact that it has not yet been used in a total hydraulic system so there may be some unaddressed problems which will surface.

Acceptable elastomeric materials which are compatible with CTFE have been developed. In addition, non-conventional seals should be considered for some of the more expensive sealing applications. It is true that modification of pumps and components which are compatible with petroleum based hydraulic fluids has not been totally successful. However, pumps and components designed for CTFE and high pressure systems are performing well.

The higher cost of NFH is a consideration which should be outweighed by recyclability, the use of smaller quantities of fluid, and safety considerations. In addition, the cost of the hydraulic fluid is a very small portion of the total cost of a vehicle.

It is possible that unforseen problems will occur, but this is the case with all new technologies. Considerable research has been expended on CTFE since the 1970s so that no major considerations have been overlooked. Since the NFH is being recommended for a totally new system, the problems which can occur with a fluid changeover (residual fluid contamination, elastomer incompatibility) will not be a factor.

CONNIE VAN BROCKLIN is a chemist in the Materials, Fuels and Lubricants Laboratory at the Belvoir RDE Center. She has a bachelor's degree in chemistry from St. Lawrence University.

ARMY ACQUISITION CORPS BOARD SCHEDULE

CALENDAR YEAR 1991

Following is a list of scheduled annual board activities for calendar year 1991. Although most of the boards indicated are familiar to our readers, some boards, such as the Qualification, Validation and Certification Board, and the PERSCOM Acquisition Accession Board, are new as a result of the establishment of the Army Acquisition Corps (AAC). Dates are tentative.

Action	Action Agency	ECD	Status/Remarks
Qualification Validation and Certification Board	PERSCOM and AAESA	Jan 91	MAJ (P), LTC, LTC(P) & COL files reviewed.
PM Board (LTC)	DA Secretariat	Mar 91	PERSCOM gives AAC brf to board mbrs.
COL Promotion Board	DA Secretariat	Apr 91	PERSCOM gives AAC brf to board mbrs. AAC floor established.
CSC Board	DA Secretariat	May 91	PERSCOM gives AAC brf to board mbrs. No AAC floor.
LTC Promotion	DA Secretariat	Jun 91	PERSCOM gives AAC brf to board mbrs. AAC floor established.
4Z Position Validation Panel	AAESA	Aug 91	Revisions to AAC critical position list validated.
SSC Board	DA Secretariat	Sep 91	PERSCOM gives AAC brf to board mbrs. AAC floor established.
MAJ Promotion	DA Secretariat	Sep 91	PERSCOM gives AAC brf to board mbrs. No AAC floor.
PERSCOM Acquisition Accession Board (PAAB)	PERSCOM and AAESA	Oct 91	Review annual accession candidates, civilian and military.
PM Board (COL)	DA Secretariat	Dec 91	PERSCOM gives AAC brf to board mbrs.

AAC Qualification Validation and Certification Board

Conversion of officers holding 6T skill identifier to the newly approved 4M and 4Z skill identifiers began when the Army Acquisition Corps (AAC) Qualification and Validation (QV) Board convened in September 1989. The first QV Board was held at PERSCOM to review the records of all officers participating in the old Materiel Acquisition Management (MAM) Program.

Those officers who met the specified requirements of Public Law 99-145, DOD Directive 5000.52, and it's implementing manual, were retained in the AAC. The board realigned officers retained in the AAC to the new skill identifiers 4M, (AAC Candidate Officer), and 4Z, (Certified Materiel Acquisition Officer).

The initial QV Board was comprised of representatives from AMC, SARDA and PERSCOM. The board found that year groups 1971 through 1982 were understrength as compared to the program's required structure, and year groups from 1965 through 1970 were overstrength in the grades of lieutenant colonel and colonel. The board recommended, with Army chief of staff approval, temporary establishment of a DA selection board to examine the records of the overage year groups and determine "best qualified" officers for retention in the AAC. This "one time" board, known as the Acquisition Officer Selection Board (AOSB) was convened in March 1990, at PERSCOM. Information on the AOSB is contained in an accompanying article in this issue of *Army RD&A Bulletin*.

The next AAC QV Board is scheduled to convene in January 1991. This annual board will review files and validate the credentials of officers in the AAC based on their demonstrated experience and qualifications. Additionally, in preparation for upcoming promotion and selection boards, the AAC QV Board will screen officer files to ensure prescribed levels of training, education and experience are properly documented to support the award of skills 4M and 4Z, in order to meet established selection floors.

The January 91 board will be expanded to include officer certification, and has been renamed the AAC Qualification, Validation and Certification (QVC) Board. During the certification process, the board will identify those officers who have achieved the requisite level of education, training and experience to serve in PM and other designated AAC critical military positions. These officers will be awarded skill 4Z. Certification supports Army implementation of the requirements contained in Public Law and Department of Defense Directive (DoDD) 5000.52.

Officers in the AAC should insure that an accurate and up to date ORB is on file in PERSCOM prior to the annual QVC Board. Questions about the QVC process may be directed to either PERSCOM (DSN 221-3125) or the AAC Proponency Division (DSN 284-9572).

PERSCOM Acquisition Accession Board

The PERSCOM Acquisition Accession Board (PAAB) was established to evaluate and select those military officers best qualified and recommended by their branches to become members of the Army Acquisition Corps. The PAAB selects officers based upon a number of factors including, Basic Year Group, Basic Branch, academic degree, experience, demonstrated performance, and potential. The PAAB will be held on an annual basis beginning in October 1990, at which time

both civilian and military candidates will be accessed into the AAC. The PAAB membership will be adjusted to reflect the composition of the AAC, with specific board make-up and board procedures to be determined under separate guidance. With the advent of the AAC, the 1990 PAAB was preceded by a series of pre PAABs which were designed to align AAC Year Group inventories from 1971 through 1983. Future PAABs will be programmed for October of each year, with the next PAAB scheduled to convene Oct. 16-19, 1990. Officers interested in AAC membership should contact their branch to have their records presented to the PAAB.

Acquisition Officer Selection Board

The Acquisition Officer Selection Board (AOSB) was a "one time" board, which convened in March 1990, to review year group (YG) 65-70 officers in the Materiel Acquisition Management (MAM) Program, and reduce these overage YG to the objective force line for each branch and functional area in the new Army Acquisition Corps (AAC). Under the old MAM program, many officers were being assessed at the lieutenant colonel and colonel level, while a significant shortage existed at the more junior level. The first step at aligning the AAC was the Qualification/Validation Board held in September 1989. This board looked at the assignment history, training, and qualifications of every officer in the old MAM program. Officers were retained in the AAC if they met or could meet, within a set time, the specific requirements of the public law and DOD Directive. YGs 65-70 were still overstrength by approximately 400 officers; however, all of these officers met the requirements of the law. The AOSB was convened as a DA sponsored board to look at the overall manner of performance of officers in the designated YGs, using branch and functional area goals, and retain only the best qualified officers in the AAC. Officers not selected by the AOSB are not precluded from reapplying for AAC membership as new position requirements are identified.

AAC Critical Position Panel

The first annual AAC Critical Position Validation Panel convened August 1-2, 1990, at the Pentagon. The purpose was to review and validate all requests for addition, deletion or change to the military critical acquisition positions (Skill Code 4Z) which are currently documented in TAADS. The panel was composed of seven voting members, officers in the AAC serving at the rank of colonel. Panel members were from the Army Acquisition Executive Support Agency (AAESA), Army Materiel Command (AMC), Strategic Defense Command (SDC), Information Systems Command (ISC), Office of the Director of Information Systems for Command, Control, Communications and Computers (DISC4), Functional Area (FA) 51 proponent and FA 97 proponent. The AAESA panel member also served as board chairman. A PERSCOM representative participated as a non-voting advisor. Proponents for excepted programs (FA52, FA53 and branch 15C35) were also invited to attend as observers. The panel looked at 101 requests for addition, deletion or change of 4Z positions. Currently, there are 358 (LTC/COL) approved AAC critical positions in TAADS. Results of the panel will be published in an upcoming issue of *Army RD&A Bulletin*, following AAE approval.

70 Graduate From MAM Course

On June 1, 1990, 70 students graduated from the Materiel Acquisition Management Course at the U.S. Army Logistics Management College, Fort Lee, VA. Research and development, testing, contracting, requirements generation, logistics and production management are examples of the weapon system acquisition work assignments being offered to these graduates.

BG (now MG) Malcolm R. O'Neill, Director of the Army Acquisition Corps, gave the graduation address and presented diplomas. The Distinguished Graduate Award was presented to CPT Nina Brokaw (TRADOC Test and Experimentation Command, Fort Knox, KY).

The 9-week Materiel Acquisition Management Course provides a broad knowledge of the materiel acquisition process. It covers national policies and objectives that shape the acquisition process and the implementation of these policies and objectives by the U.S. Army. Areas of coverage include acquisition concepts and policies; research, development, test, and evaluation; financial and cost management; integrated logistics support; force modernization; production management; and contract management. Emphasis is placed on developing midlevel managers so that they can effectively participate in the management of the acquisition process.

Adhesive Bonding of Thermoplastic Composites

For several years, the Materials Technology Laboratory (MTL) has led the Army's adhesive bonding improvement initiative (see *Army RD&A Bulletin*, March-April 1989). Among MTL's contributions is a program dealing with the development of bonding procedures for emerging materials expected to find use in next generation and future systems. With appropriate, validated procedures available, adhesive bonding can be considered as a joining method in the initial design of a system, allowing for its most effective application.

Thermoplastic matrix composites are examples of such emerging materials. They offer several advantages over conventional epoxy-based thermoset matrix composites. In addition to overall toughness and moisture resistance, they are noteworthy for their damage tolerance. Thus, they are attractive candidates for the next generation of Army aircraft, such as the Light Helicopter currently under development.

MTL enlisted the services of Professor Anthony J. Kinloch of the Department of Mechanical Engineering of the Imperial College of Science, Technology and Medicine, London, England, to conduct an investigation into the bonding of thermoplastic matrix composites on MTL's behalf. Not only is Professor Kinloch an international authority on the science and technology of adhesive bonding, but his background in the UK Ministry of Defense gives him a special insight into the military requirements of bonded structures. For these reasons, this has been a most effective program.

The Program

This investigation was conducted by Dr. George Kondokian under the direction of Professor Kinloch. It consisted of several phases. The first evaluated the effectiveness of conventional surface treatments of the sort used for the bonding of thermoset composites. These included simple surface roughening, solvent wiping in conjunction with surface roughening, and "acid etching." These treatments were applied to several state-of-the-art thermoplastic matrix composites. In each case, very poor quality bonds were obtained, regardless of the surface treatment.

An investigation into the alternative surface treatments revealed that corona discharge in air provided a surface to which very strong bonds could be formed. Whereas the conventional treatments resulted in bonds having no usable strength (indeed specimens sometimes fell apart before they could be mounted in the test machine), the corona-treated surfaces permitted the formation of bonds so strong that the failure often occurred in the bulk of the composite rather than at the bondline.

Analysis of the corona-treated surfaces by scanning electron microscopy (SEM) and X-ray photoelectron spectroscopy (XPS) showed that the enhanced bond strength resulted from two effects. First, SEM shows that the surface has been roughened on a microscopic scale. This permits the cured adhesive to form mechanical interlocks with the surface. The XPS analysis indicated a significant enrichment of the surface in chemical species that the adhesives could more readily interact with.

With the ability to form strong bonds in hand, Kodokian turned his attention to a theoretical analysis of the joint. As a result, he was able to develop a predicative model useful for indicating the stress levels the bonds could sustain and pointed the way to an improved joint design capable of supporting even greater loads.

MTL has recently initiated a follow-on to this program, also under the direction of Professor Kinloch. It deals with the durability and the impact-resistance of bonded joints to thermoplastic matrix composites, obvious areas of concern with military equipment.

This successful program is an especially fine example of how a research effort can contribute to the producibility and even the repairability of Army materiel.

The preceding article was written by Dr. Stanley Wentworth, a research chemist at the U.S. Army Materiels Technology Laboratory and Chuck Paone a public affairs officer at MTL.

Total Quality Management: A Way of Life

Total Quality Management (TQM) . . . is it a philosophy or is it a program? In Japan it is a philosophy and, like religion, has become a way of life. In the United states, TQM is often misunderstood and thought of as a program.

Since the early 1970s, American business managers have tried to understand why Japanese product quality is better than American product quality. After frequent visits to Japanese factories, they concluded that the Japanese philosophy is reflected in Japanese product quality. To improve American product quality, these managers wanted to communicate the Japanese philosophy to American workers. Searching for words in the Japanese language and expressing them in American-English were difficult tasks. The effort resulted in the phrase "Total Quality Management."

The cultural differences between East and West make it difficult to communicate Japanese philosophy by a simple phrase "Total Quality Management." The word **management** in TQM implies that only the managers must implement TQM. The word **quality** infers that the responsibility belongs to people who manage the quality functions. The word **total** suggests that everything must be done right the first time and it must be perfect.

Dr. Kaoru Ishikawa is a foremost Japanese expert on the subject of Total Quality Management. He explains the cultural differences in his book, *What is Total Quality Control?-The Japanese Way*. Mr. David J. Lu. translated the book from the Japanese language into the English language. Dr. Ishikawa's statement was translated as follows, "Japan is still strongly influenced by the teachings of Confucianism and Buddhism. Confucianism is divided into two strains. One is represented by Mencius, who said that man is by nature good. The basic teachings of Christianity

TQM *(continued)*

appear to say that man is by nature evil. This teaching has cast a shadow over the Western nations' management philosophy. It suggests that people. . .cannot be trusted. In some American factories the number of inspectors amount to roughly 15 percent of all workers engaged in manufacturing. In Japan, the comparable figure is only one percent, in those factories where total quality control is well advanced."

Dr. Ishikawa transliterated the born-sinner concept in Christianity as "Man is by nature evil." He implies that the influence of the born-sinner concept on Western managers hurts American product quality. In contrast, "Man is by nature good" or the born-good concept found in the Eastern religions has positive influence on the Japanese managers. They believe that everyone has something good to share with others in the organization. This belief helps improve Japanese product quality.

Despite the controversy over religious philosophies, many top executives of large U.S. corporations praised Dr. Ishikawa's work. The book made the best-seller list soon after its publication in 1981.

The born-good concept can help us understand the Japanese philosophy. This understanding can help us communicate TQM philosophy. The word **management** in TQM refers to everyone in the organization including the managers. The word **quality** relates to the goodness that everyone can give to both the organization and the work process. The word **total** combines the goodness in each person within the organization to produce better quality products.

Instilling TQM philosophy in the U.S. requires influencing cultural change in the organizations. Equipping managers with a variety of tools for implementation is not enough. U.S. managers need to be trained how to manage their organizations by creating a participative environment.

Total Quality Management combines the goodness in everyone involved in the organization and work process. It is the concerted effort that continuously improves the work process and the product quality. In Japan, TQM or continuous process improvement is a way of life. In the U.S., TQM is a "good" beginning.

The preceding article was written by Subhash S. Paradkar, a general engineer in the Production Assessment Division, Office, Deputy Chief of Staff for Production at Headquarters, U.S. Army Materiel Command.

Snowmobiles Will Play Arctic Military Role

For many winter-sports enthusiasts, cross-country skiing brings hours of fun on snow-covered fields. But for Army troops stationed in arctic regions, it is not a pastime; it is often the only mode of transportation suitable for conducting strike and reconnaissance missions.

This situation is going to change for the better, however. The U.S. Army Tank-Automotive Command's (TACOM) RD&E Center, in response to a request from Special Operations Forces, is involved in efforts to provide a transportation system comprising a snowmobile and sled that will make oversnow travel easier and faster. Referred to as the Mobile Oversnow Transport (MOST) system, it is scheduled for introduction in 1993.

The snowmobile will feature wide-track suspension and dual steering skis for maximum traction and control and weigh approximately 670 pounds. It will have a payload capacity of 350 pounds, a cruising range of 125 miles and a towing capacity of 380 pounds.

The snowmobile will have the capacity to carry two passengers, as well as tools, spare parts, and spare fuel. Under normal circumstances, it will be used to tow one sled, but in an emergency could tow two sleds. Additionally, it will be capable of starting at temperatures down to 40 degrees below zero F. The sled will weigh 80 pounds and have a 300-pound payload capacity. It will also be man-towable in the event of an emergency.

According to RD&E Center project engineer Herbert Schmidt, the MOST system is being procured via the nondevelopmental item (NDI) approach. In NDI, the Army buys equipment that is already in use somewhere in the free world, and modifies it when necessary to meet specific military requirements instead of developing it from scratch. The results of this approach have been to shorten introductory lead time from seven years to about three years and sharply reduce developmental costs.

"An evaluation of different manufacturers' equipment in feasibility tests at Fort Greeley, AK., and the Keweenaw Research Center in Houghton, MI indicates that there are commercially available snowmobiles that can meet our criteria without major modifications," Schmidt said. "The tests also show that a commercial sled will work if it is modified to include a more flexible towing hitch and the addition of runners to minimize sled wear."

Schmidt said purchase descriptions for production snowmobiles and sled prototypes are now being prepared, and are expected to be completed by the end of the year. He said that TACOM will award contracts for 320 each of the snowmobiles and sleds. He added that these will undergo five months of initial production tests, and if the tests are successful, introduction to troops will begin late the following year.

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

Army Honors 16 Outstanding Students

The U.S. Army honored 16 of America's brightest young students in science, mathematics and engineering by selecting their projects as winners at the 41st International Science and Engineering Fair, held May 6-12 in Tulsa, OK.

They were selected from students who attended the fair representing 398 affiliated science fairs throughout the United States and Puerto Rico to compete for awards from industry and government.

STUDENTS *(continued)*

The Army provided 32 judges who reviewed 754 projects and selected winners in each of 13 scientific categories.

The Army winners, each of whom received a personal computer, are James W. Nichols, Oxford, MS; Benjamin C. Preisner, III, Hilton Head, SC; Vivek Kumar, Memphis, TN; Michael Nolt, Lancaster, PA; Jay Allen Coisman, Melbourne, FL; S. Tania Ruiz, Hagerstown, MD; Hugh W. Greene Jr., Somerville, AL; Stacy E. Metzler, Southington, CT; Joshua Fischman, Bethesda, MD; Tahira Boyd, Chicago, IL; Aseem Chawla, Anchorage, AK; Andrew W. Mart, Palm City, FL; and Kristie Morge, Newport News, VA.

The judges also selected Kelly Lindauer, Denver, CO., to represent the Army at the London International Fortnight. Karen Boyle, Braintree, MA., and Raymond Meng, Camp Hill, PA., were named to represent the United States at the Student Science Fair Awards in Tokyo, Japan, in January 1991.

MG Jerry C. Harrison, commander of the U.S. Army Laboratory Command (LABCOM), presented the awards to the Army winners. Harrison urged the students to "Be all that you can be" in the interest of the future of America's technology base.

Each year, the Army provides judges at more than 350 science fairs throughout the United States. These judges come from Army laboratories, ROTC, the Recruiting Command and active and reserve Army units. They select students to receive Army medallions and certificates at the local, regional and state levels to encourage them to pursue their interests in science, mathematics and engineering. More than 100,000 students participate in these fairs annually.

The Army has participated in the International Science and Engineering Fair for more than 33 years. Scientists from the laboratories of LABCOM, the Surgeon General, Corp of Engineers and reserve officers serve as judges in making selections in categories which reflect the Army's broad interest of scientific endeavor.

The other armed services as well as other government agencies and industry also participate in the fair, selecting winners in their own fields of interest.

The *Journal of Defense Research*

Some members of the science and technical community of government laboratories may not be aware of a secret level quarterly technical journal that publishes important research contributions that cannot be published in open technical literature. The *Journal of Defense Research* (JDR) is published by the Defense Advanced Research Projects Agency (DARPA) and is the only refereed journal for classified papers at the secret level.

The JDR was established about 25 years ago in the early days of the Ballistic Missile Defense Program as an outlet for the classified work in this field. In 1969, it expanded its coverage to the areas of strategic and tactical warfare systems and applications. Papers appearing in the journal must conform to the highest professional standards and constitute significant studies that are likely to be of permanent value to defense, research, engineering, and technology.

The journal includes papers involving fundamental technical and conceptual analyses in which present and proposed systems, equipment, hardware, environment and tactics are examined. It includes research results dealing with air, ground, or sea warfare. It does not publish papers that primarily involve the political and economic sciences or policy research. Copies of past issues can be obtained by individuals having the appropriate level of clearance and need to know from the Defense Technical Information Center, Cameron Station, Alexandria, VA 22314.

The journal distributes about 1,300 copies to cleared members of the DOD and to DOD contractors with appropriate need to know. Editorial policy is established by an Executive Steering Board chaired by DARPA and includes senior representatives from OSD and the Services. Editorial quality control is established by an Editorial Board consisting of senior individuals in the defense research community from industry and laboratories.

Requests for placement on the distribution list for the journal should be submitted to the Director, DARPA, 1400 Wilson Boulevard, Arlington, VA 22209-2308, Attention: JDR Program Manager, or telephone (202) 694-5919 or DSN 224-5919.

The journal is also interested in receiving classified papers in defense research. If you are interested in submitting a paper to the journal, please contact the Managing Editor, Journal of Defense Research, Battelle, 1300 North 17th Street, Suite 1520, Arlington, VA 22209-3817 (phone 703-875-3340).

TROSCOM Supports International Cooperative Programs

The U.S. Army Troop Support Command (TROSCOM) and U.S. allies are saving money and increasing survivability by standardizing equipment and combining development efforts.

Through International Cooperative Programs, the United States and its allies share research data and standardize military supplies and equipment; reducing costs for all parties involved. Cooperation is made possible through international agreements and forums which pool technical experts, research data, money and other resources to allow NATO allies to work more efficiently and cost effectively.

One area of international interest includes a single fuel on the battlefield to promote standardization/interoperability. Other areas of interest addressed by TROSCOM include, but are not limited to: bridging, energy conservation, mines, minefield clearing, air delivery, food, clothing and camouflage.

"The United States is reaping the benefit of over $9 billion worth of defense development activity at a cost of only a little over $3 billion," said James Compton, acting deputy undersecretary of Defense for industrial and international programs.

TROSCOM, known as The Soldiers' Command, is a major subordinate command of the Army Materiel Command. TROSCOM represents the United States internationally through cooperative programs at it's Belvoir and Natick Research, Development and Engineering Centers. TROSCOM

TROSCOM *(continued)*

has dozens of agreements with more than 10 different countries including Pakistan, Malaysia, Japan, Israel and Germany.

A Data Exchange Agreement (DEA) is an agreement between the United States and other countries. According to Doris Tribolet, international programs officer at Belvoir RD&E Center, a DEA is an agreement to exchange scientific or technical information in a particular functional area, technical area, or category of weaponry. The Army participates in 25 master agreements under the Defense Data Exchange Program.

When a DEA is in effect, technical exchanges and reciprocating visits are made. The agreements are then evaluated and updated yearly based on changes in mission and technology, Tribolet added.

"DEAs only allow cooperative use of information," Tribolet said, "other cooperative agreements involve personnel and the actual items or equipment."

Standardization Agreements (STANAGS) are the result of cooperative group meetings with our NATO allies. Charles Williams, chief of the Life Support Systems Division of the Individual Protection Directorate at the Natick RD&E Center in Massachusetts is the chairman of the NATO working group for combat clothing and equipment.

Williams' group has passed standardization agreements on ballistic protective gear such as helmets, vests and eyewear, entrenching tools and methods of testing. Labels for the care maintenance and size designation of combat clothing have been another area of emphasis on standardization.

"If U.S. soldiers for some reason need German combat clothing, the information sheet on NATO sizing makes it quite easy to hand out," Williams said. According to Williams, major agreements such as the NATO sizing standard are adhered to by all members because they cover such diversity in sizes. Such agreements also bridge the gap between U.S. and metric measurements. Size labels containing both the NATO size and the member nation's own size can be found in almost all combat clothing.

"The Kevlar vest and helmet are ballistic protective clothing that meet NATO standardization requirements. The U.S. model vest and helmet are not required, however, the same level of protection must be met," said Williams.

Some items, such as the three-piece, folding, entrenching tool become the accepted standard due to their superior designs. Items clearly superior to others save both time and money by eliminating duplicated R&D costs.

Aside from standardization agreements, TROSCOM participates in other international cooperative programs such as a Foreign Equipment Loan Program. Under this program, the United States borrows other countries equipment, such as field kitchens, shelters, good items, etc., for evaluation. The Defense Professional Exchange Program allows the exchange of U.S. scientists and other professionals with other countries such as France, Germany, Korea, Israel and Norway.

A host of solid reasons argue for continued support of these programs, Compton said. Joint development of equipment not only cuts costs, it also creates "two-way (or multiple) street" thinking in international cooperation.

"We are working toward standardization and interoperability," Tribolet said. "We need to be confident that a British part 'X' is interchangeable with U.S. part 'X'. Standardization is what will allow us to work together on the battlefield."

Compton said he couldn't think of many reasons to avoid such agreements with allies.

"Security is certainly not the major reason. After all, if we don't trust allies, that questions the value of maintaining an alliance," he said. "America has had a long history of 'going it alone,' and that appeals to some people, but the world is increasingly interdependent.

"There is no longer any such thing as an independent, stand-alone national defense industrial base," Compton asserted. "Our strategy of coalition defense can and must be backed up by coalition research, development, production and follow-on support."

While DOD's cooperative R&D efforts return handsome dividends, they receive little publicity. He said the reason may be that actual systems, equipment and technology are still a few years away. When they're fielded, though, defense analysts will be able to judge objectively the quality of the products their nations have developed.

Congress, concerned for years that NATO partners and other U.S. allies unnecessarily duplicated U.S. defense efforts, made some changes in the laws.

In the mid-1970s, Public Law restricted cooperative ventures to weapons R&D. There was no provision for coordinated efforts to continue from development into the production phase. The 1986 Quayle Amendment, with the Nunn-Roth-Warner amendments, permitted a cooperative partnership throughout the life cycle of the systems developed.

There are still many restrictions to U.S. cooperation. Developed equipment must be used by the U.S. military. Funding for the Nunn-Roth-Warner projects must also be spent in the United States. This benefits America's industrial base, a prime concern of defense officials.

Before a cooperation proposal becomes reality, a service secretary must sign off on a requirement. Then, officials from each participating nation, usually engineers, scientists or armaments officers, discuss what their defense industries have to offer. Interested parties sign several agreements, including the all-important one on money.

The U.S. share of the bill is funded by the Office of the Secretary of Defense for the first two years. Then the sponsoring service must pay the rest from its own budget, or cancel the program.

With almost daily, positive changes taking place in Eastern Europe, analysts forecast continued cuts in defense spending. TROSCOM and its R&D centers are committed to making cooperative ventures a cost effective way to continue efforts for modernization.

This article was written by Gregory A. Thomas, TROSCOM Public Affairs, with information by Tim Downey, Armed Forces Information Service.

Army Exploring Biotechnology

Imagine camouflage coatings that can change color chameleon-like to fit in with the surrounding environment, biological systems that can produce fuel from air, and lightweight protective body armor based on spider silk fibers.

These are possibilities now in the very early stages of research that could become realities of the 21st century battlefield through application of biotechnology, a key emerging technology that the U.S. Army is exploring.

Biotechnology is a term coined to denote the application of biological processes to produce new, useful products. It is the development or modification of products by a biological process carried out by using organisms, such as yeasts and bacteria, or by using natural substances such as enzymes found in organisms. The Army's research community feels that this method of "mimicking nature" offers the potential to solve some of the military's operational problems.

The Directorate for Technology Planning and Management, U.S. Army Laboratory Command has published a report titled *Biotechnology: Opportunities to Enhance Army Capabilities*. It lists a number of areas in which biotechnology might be applied to meet varied needs of the Army.

Although the report points out that most of the Army's $50 million biotechnology budget for fiscal year 1990 is focused on medical applications, this report concentrates on applications of biotechnology to non-medical areas of Army interest.

According to the report, some of the ways biotechnology could be exploited for Army needs are in the production of the following:

- High performance fibers having both high tensile strength and energy absorption;
- Lighter and lower cost ceramics for use in armor, radomes and electronics;
- Ultrasensitive sensors for detecting chemical and biological agents, controlling manufacturing processes, and protecting the environment;
- Self-assembling biomaterials for use in electronic components such as high current density cathodes;
- Reactive materials for rapid and effective degradation of chemical and biological agents;
- Soldier rations optimized for specific climates and missions; and
- Reactive materials and coatings capable of providing protection against directed energy radiation or capable of mimicking local natural signatures to provide camouflage protection.

The report, which has been distributed to more than 150 Army and Department of Defense scientists and technology developers, is the first step in the Army's effort to develop a long-term strategy for the future development of biotechnology research.

It is intended to inform the Army community about the possible uses for this technology and encourage comment on which uses should be exploited to best meet the Army's needs. The next step will be to prepare a plan which identifies specific goals, resources and the actions to be taken.

Copies of the report may be obtained from the U.S. Army Laboratory Command, Directorate for Technology Planning and Management, ATTN: AMSLC-TP-PB (Joseph Gamson), Adelphi, MD 20783-1145.

KEVLAR Helmet Saves Lives of Two Panama Veterans

Two paratroopers whose Kevlar helmets saved their lives during combat in Panama have recounted their experiences. Sergeant First Class Robert Padin and Staff Sergeant Louis Olivera spoke to employees at the U. S. Army Natick RD&E Center earlier this year. They attributed their survival to the helmets designed at Natick. Padin is a member of the 82nd Airborne Division from Fort Bragg, NC and Olivera is with the 75th Ranger Regiment, Fort Lewis, Wash.

A New York native who spent his youth in Puerto Rico, Padin began by explaining what happened during "Operation Just Cause." Padin was to secure a particular building in Panama and began completing his mission when he was ambushed. He was shot and hit on the helmet. Says Padin, "He shot again, and I don't remember what happened, everything went black, then everything went blue. I thought to myself, well, I'm on my way to heaven. . . my head pounded, it felt like someone hit me with a baseball bat," he recalls.

Padin had been hit twice. The second shot hit his helmet so close to the first that the bullets followed the same path as they tore through the outer layers of the Kevlar, just missing his head. He sustained minor neck injuries from the force of the bullets and had a severe ringing in his ears, but othrewise was unhurt.

Olivera's story began from the moment he had to parachute down into hostile enemy territory. He landed in the middle of an enemy compound.

Olivera, a Wisconsin native, parachuted into a high tension wire which burned his hair. Just about the time he began to wonder what else could go wrong, he realized he was in the middle of an enemy compound as he dropped to the ground. Most of the other men in his unit were a half mile away. Olivera, who was part of a fire support team, put in a radio call for an artillery strike on the compound; almost simultaneously his unit began firing.

As Olivera moved from one position to another, he was ambushed by two Panamanian Defense Force Soldiers. The first two rounds hit him in the chest puncturing his lung, shattered several ribs, and severed a nerve in his right arm. "That, of course, knocked me to the ground and I was lying there really not knowing what happened. I thought at first that the artillery rounds had landed a little short and fragments had hit me, explains Olivera.

KEVLAR *(continued)*

The Panamanian soldiers came to where he was lying. "They came to finish me off," he said. One soldier came up close, about six inches away, pointed a rifle at Olivera's head and pulled the trigger. "At that time the bullet went through the Kevlar helmet," adds Olivera.

The bullet was a tracer round and therefore white hot. Medics later found that the heat was so intense that it cauterized the blood vessels in his head as it cut its path, so he didn't bleed to death.

The Panamanians decided to leave a propaganda bandana attached to the presumed-dead Olivera which said "Macho de monte" and translated means mighty jungle fighter.

Nearly 12 hours later Olivera regained consciousness. He notes with a sense of humor that he thought he had fallen asleep and was in trouble with his commander, but that wasn't the case, he was severely wounded. After several attempts to move he kept losing consciousness, but eventually was able to make radio contact with his unit.

Olivera had a fractured skull and multiple injuries to his head and body. He gives a few reasons for his survival: falling in the mud which helped stem the flow of blood in his shoulder; the Kevlar helmet for stopping the bullet shot at point-blank range; and his youth and conditioning.

Modestly, Olivera points out that while being called a hero by the First Lady, Barbara Bush, who visited him in the hospital, the real heroes are the people who spend their day-to-day activity in research, development and engineering to produce the products which protect soldiers.

'Independent Logistician' Mission Transfers

As a result of the Defense Management Review (DMR), the Integrated Logistics Support (ILS) Division of the U.S. Army Logistics Evaluation Agency (USALEA) will transfer to the U.S. Army Materiel Systems Analysis Activity (AMSAA). AMSAA will assume the mission of the "independent logistician" for the deputy chief of staff for logistics (DCSLOG) in accordance with AR 700-127 and other ILS-related responsibilities that USALEA currently performs. AMSAA will be the voting logistician at in-process reviews (IPRs) for the DCSLOG.

The DMR decision that consolidates test and evaluation elements is intended to improve acquisition management, improve execution of test and evaluation functions, and transfer the USALEA logistics evaluation function to AMSAA.

Technical test and evaluation will be consolidated within the U.S. Army Materiel Command. User test and evaluation will be consolidated within the new Operational Test and Evaluation Command which reports to the Army Chief of Staff. The purpose of the DMR consolidation is to streamline operations, and save spaces and dollars. Reorganization from USALEA to AMSAA, which is subject to Congressional review and approval as required by public law, is proposed for Oct. 1, 1990.

Thomas Succeeds Cianciolo as AMC DCG for RDA

LTG Billy M. Thomas, former commander of the U.S. Army Communications-Electronics Comand and Fort Monmouth, has succeeded LTG August M. Cianciolo as Army Materiel Command deputy commanding general for research, development and acquisition. Cianciolo, who had served as AMC DCG for RD&A since October 1989, has assumed new duties as military deputy to the assistant secretary of the Army for research, development and acquisition.

Thomas is a graduate of Texas Christian University and holds a master's degree in telecommunications operations from George Washington University. He is also a graduate of the Army War College, the Army Command and General Staff College, and the Signal Officer Basic and Advanced Courses.

Prior to assuming command of CECOM and Fort Monmouth, Thomas served on the Army staff as deputy director, combat support systems, Office of the Deputy Chief of Staff for RD&A. Listed among his other key career assignments are deputy commander and assistant commandant, U.S. Army Signal Center and School, Fort Gordon, GA; commander, 93rd Signal Brigade, VII Corps, U.S. Army Europe; and special assistant to the dean, National Defense University, Fort McNair, Washington, DC.

Thomas is a recipient of the Distinguished Service Medal, Legion of Merit with Oak Leaf Cluster (OLC), Bronze Star Medal with two OLC, Meritorious Service Medal with three OLC, Joint Service Commendation Medal, the Army Commendation Medal, and the Parachutist Badge.

CONFERENCES

AAE PEO/PM Conference

Army Acquisition Executive Stephen K. Conver will host a PEO/PM Conference in Orlando, FL, Nov. 28-30, 1990. The Army Acquisition Executive Support Agency will provide personnel and administrative support for the conference. Any questions concerning this event may be directed to Dale Fradley on DSN 284-7676 or commercial telephone (202) 274-7676.

FROM THE ARMY ACQUISITION EXECUTIVE...

Today, the challenge is change. Change in the way we do business is not an option. Our options are the extent and pace of change. As defense expenditures decline, the defense industrial base will inevitably contract. The industry itself will face very tough challenges.

In various speeches, I have called for establishing a partnership with industry. In my opinion, it is imperative that we, in government, do what we can to help our contractors stay in business. I am not advocating that we give away the store. We will continue to negotiate with industry to obtain the best value for the government. I am advocating a more productive working relationship between government and industry.

Contractors have contributed significantly to the military and economic strength of the United States. The tens of thousands of Americans who work in the defense industry are proud of the roles they have in producing world-class weapon systems. We are also proud of our roles. In sharing this pride, our attitude is important. We must view contractors as partners, not as adversaries. We need to do what we can to help our defense industry partners through these uncertain and difficult times.

There are a number of opportunities to ease the burdens of a contracting industry, and we are trying to do all we can. From Secretary Stone on down, we give serious consideration in all our decisions to industrial base implications. For example, if a company is faced with the prospect of closing its doors because we are terminating program production, we can negotiate with company officials to stretch deliveries and keep the industrial base going until new systems come on line. This action is within our power and totally appropriate. If there are additional costs, however, it will be necessary to share them. The government is not in the business of underwriting all the costs of stretched deliveries.

Another area where we can lend a hand is in the area of foreign military sales (FMS). While I believe the FMS program needs greater priority within the Department of Defense, it is timely that FMS are growing, from a low of $2 billion annually from FY86 through FY88, Army sales are expected to reach nearly $7 billion in FY90. This, I conclude, is a testament to the quality products produced by the defense industry. We must be more aggressive in pursuing this avenue in order to help keep the industrial base alive, reduce unit costs, and contribute to a healthy economy.

The future picture for major Army acquisition activities is mixed. We are operating on a tight budget. Let us consider the prospective changes in the way we, in Army RDA, will conduct business. In the coming years, we must structure each new procurement program to give source selection preference to firms that have demonstrated they are proven, quality performers. And, we must make every effort to ensure that we obtain the best overall value for the government, not just the apparent lowest price.

This may result in a flurry of protests. It will not always be easy to determine what constitutes the best value for the government, and best value procurements will often be more difficult to do than simply taking the lowest price. But we can no longer afford "wounded programs." We must get the most capability for our limited dollars — programs delivered on schedule, within budget, with quality assured.

In the years ahead there will likely be less opportunity for competition. As our procurement quantities decline, it is very important that we look at second sources to make certain they are still viable in light of reduced quantities. I have asked my PEOs to look at every single second sourcing arrangement so that we may determine if it is still viable. This is not an indiscriminate action. With limited resources, everything is on the table.

Along the line of industry responsibility, the days of "buying in" are over. With the projected lower production rates, there will be no "getting well" in the production phase. When contractors bid on a development contract, they should bid to make a fair profit. If there is follow-on production, that's a bonus and a separate issue. Production is no longer a guaranteed item.

On both a government and industry matter, we must be careful not to oversell programs. We cannot go to OSD or the Congress and promise things we cannot deliver. When we contemplate the few new programs we will have in the next few years, we should think more about program execution than we do about program marketing. It is one thing to sell a program on the basis of predicted capability, schedule, or cost, but we had better be able to meet our predictions.

We need industry's help in this partnership. We recognize that a shrinking market leads to a more intensely competitive environment, and companies, of course, will look after their own interests. However, if this partnership is to succeed as the budget tightens, we must not lose sight of our long-term defense interests. We must focus on common goals, areas of agreement, and mutual interests to the exclusion of narrow self-interests.

It is my sincere hope that we can go forward in partnership with industry. We will then work together to keep America strong militarily and economically.

Stephen K. Conver

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Headquarters
U.S. Army Materiel Command
5001 Eisenhower Avenue
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