ARMY R,D&A

• RESEARCH
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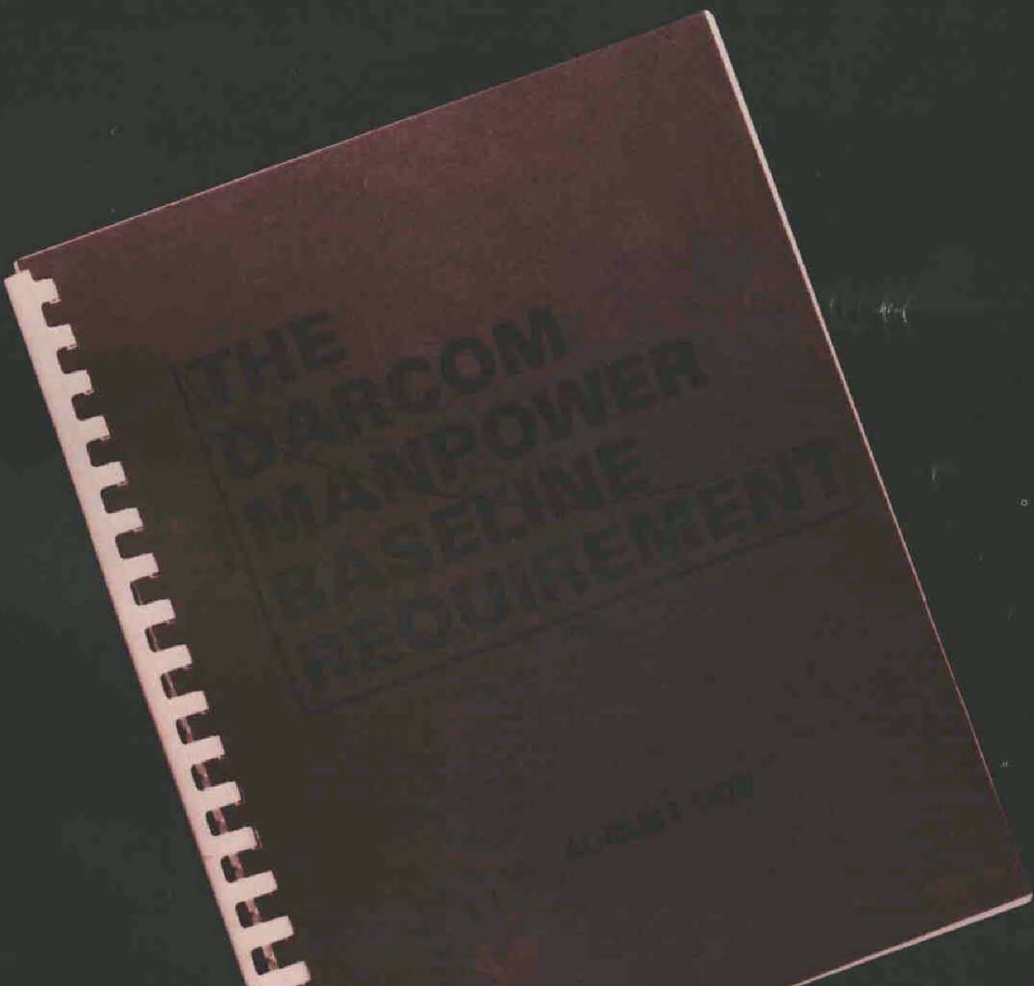
JANUARY-FEBRUARY 1979



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ABOUT THE COVER:

DARCOM has undertaken a quantitative analysis of military and civilian manpower trends over time with the goal of identifying minimum (baseline) requirements to achieve peacetime efficiency and to establish authoritatively a level from which surge/mobilization demands can be accommodated. Entitled the DARCOM Baseline Study, this recently completed analysis is perhaps the most detailed ever undertaken to determine problems and solutions relative to DARCOM's increased RDA and Readiness missions, and is the feature story of this issue of the RDA Magazine.

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FEATURES

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DARCOM Develops Command-Wide Manpower Requirement

By Charles B. Einstein

The DARCOM Baseline Study, approved by DARCOM Commander GEN John R. Guthrie and by Army Chief of Staff GEN Bernard W. Rogers, has been acclaimed as a most revealing and authoritative analysis of DARCOM today. The impact of DARCOM's increased missions and the concurrent personnel reductions are dramatically documented by this study, and should, therefore, be of interest to everyone in the Army RDA community. GEN Guthrie has cited the briefing numerous times in public talks, and has noted that it has been a primary document in his efforts to attain relief from certain manpower actions.

CHARLES B. EINSTEIN has served as management analyst in Headquarters, DARCOM, since 1966. He is recognized as an expert in conducting special, complex mission and resource studies, and one who, over time, has developed and maintained a significant data base essential to such studies. He developed the IOE concept used in this report.

Under the direction of MG Robert L. Bergquist, key members of the DARCOM Manpower Baseline Requirement study were COL Joseph A. Donnan and LTC(P) Donald M. Campbell, cochairmen, Drs. Wayne S. Copes and Erwin M. Atzinger, CPT Daniel J. Speck, Ms. Diane D. McCaa and Messrs. Anthony J. Rymiszewski, Thomas J. Edwards, William M. Ferron, and Mr. Einstein.

The DARCOM Manpower Baseline Requirement report, developed by a small group of specialists under the direct leadership of MG Robert L. Bergquist, DARCOM deputy for Resource Management, examined mission and personnel changes which have taken place within DARCOM, interpreted those changes in relation to personnel requirements, analyzed the accomplishments of its people when compared with performance demands of the research, development and acquisition and materiel readiness missions, and determined that DARCOM, in the period 1968 through 1974:

• Developed, tested and fielded systems adequate to meet the threat as it was known in the early 1970s.

• Provided adequate supply and maintenance service to the Army in the field, both in the Continental United States and its overseas installations.

• Was given a sufficient military and civilian workforce to keep pace with and accomplish changing mission assignments and workloads.

With specific reference to RDA, the threat of the late 1960s and early 1970s resulted in DARCOM assigning an average of 28,840 people exclusively to the RDTE mission. These included some twelve hundred to eighteen hundred military and civilian personnel who staffed approximately forty project manager offices. Personnel resources were considered adequate to counter the threat, develop required systems, support advanced technology, and to maintain an adequate technological base.

Partly because of Vietnam, weapon and equipment systems were retrograded to units and depots in the Continental United States, and partly because large amounts of supplies, ordered for Vietnam, were being delivered to depots, DARCOM enjoyed very high materiel readiness rates. DARCOM had adequate materiel, personnel skills, storage locations, and maintenance facilities. Although DARCOM had no surplus of resources, the command did enjoy a period of sufficiency.

With regard to other DARCOM major functional assignments, the command had adequate people to develop management systems and programs such as quantitative budget analysis, project master planning, life cycle management, configuration management, Army logistics program hardcore automated, and other programs facilitating management of RDA and logistics.

In the early 1970s, DARCOM senior planners recognized that the command must undergo changes. First, the Vietnam war had drawn to a close. Second, the Congress of the United States, reflecting a change in constituent thinking, would soon direct that both defense programs and personnel working for defense would be significantly reduced. Third, DARCOM planners realized that installations scattered across the United States would no longer be required as had been needed to support the large Vietnam Army strength and operations.

The planners, however, knew that this command must retain its RDTE capability because the threat was increasing, and it must retain the core materiel readiness organization from which the command would have a surge and mobilization capability should this unfortunate requirement again exist.

In 1972 the director of Plans and Analysis, DARCOM, developed and published a plan entitled The Optimum Army Materiel Command (TOAMAC). TOAMAC consolidated, closed, reduced and realigned DARCOM's subordinate commands, depots, test facilities, arsenals, and installations, and otherwise moved toward an optimum command geared toward having balanced real property, personnel, and workloads. At that time the director accurately predicted that the active Army, which had had a strength of one and a half million men in uniform in 1968, would decline to a strength of approximately 785,000 by 1975, and then stabilize. He realized that the command must remain viable, and be reduced to a number adequate to support this reduced active Army force—but no more.

TOAMAC was implemented, and the Army force leveled at approximately 785,000. The Army, however, began to undergo many changes, each of which had its impact upon the missions and worklaods in DARCOM. What were some of these changes?

• The Army increased its total active Army divisions by three—from thirteen to sixteen, and equipped those divisions essentially from materiel stored in depots. Personnel to man the new divisions were, in part, taken from DARCOM's total strength. Thus, instead of assisting DARCOM in its RDTE and readiness workloads, these soldiers began to increase demands upon the command because of their new field assignments.

• The Army moved from traditionally light to heavier divisions as it changed from infantry to mechanized infantry divisions, from towed to self propelled artillery battalions, and from wheels to tracked vehicles.

• Soldiers in the field were provided more and specialized equipment with which to fight. Not only was the soldier equipped with a rifle, as an example, but he was provided access to an antitank missile to augment his firepower. He had a choice of weapons to be used as the battlefield situation would dictate.

• After 1975, systems and equipment being issued to the deployed fighting force continued to increase in sophistication. As examples, electronics tube technology became solid state. Artillery elevations and ranges began to be calculated by computers. Guidance and control systems provided better informa-

(Continued on page 2)

DARCOM Develops Manpower Requirement

(Continued from page 1)

tion, were more precise and were much faster. Night vision became a reality. All these improvements resulted in greater offensive capabilities, but they came with a price—that of a much more complex RDA and readiness capability requirement on DARCOM.

• Our allies were sold billions of dollars worth of materiel. Friendly nations bought new, advanced weaponry, and depended upon the U.S. Army for readiness support. The net effect was that, although the U.S. Army was declining in strength, Free World forces began to rely heavily on the United States for not only materiel, but also for supply and maintenance of that materiel. The result was the same as if the Army had never reduced in strength at all.

• Because of economic oversea depot reductions and closures, it became necessary for DARCOM to assume this responsibility and provide support from depots in the United States direct to oversea organizations. DARCOM was called upon to ship boxes of supplies—with fewer numbers of repair parts in each box—to more and more individual units. Requisitions for parts sharply increased, and response time requirements decreased. These changes placed additional workloads upon the entire wholesale supply system.

• To respond to quicker demands for repair parts, DARCOM pre-positioned much of its inventory in Area Oriented Depots (AOD). New Cumberland Army Depot in the East serves the Army in Europe as well as units in the Eastern part of the United States. Red River Army Depot serves the Army in the Southern United States and those in Central and South America. Sharpe Army Depot serves the Western United States, Alaska and the Pacific area. AODs have been called upon to serve as the principal source of peculiar supply for the entire United States Army.

• In addition to changes in the Army force and supply systems, the Army simultaneously changed its method of managing RDA and logistics support. The Army conducted a very comprehensive and introspective study of its way of doing business. The Army Materiel Acquisition Review Committee (AMARC) decided that RDA needed more emphasis—but not to the detriment of the materiel readiness mission. DARCOM subordinate commands, which prior to 1974 were responsible for total life cycle management of weapon systems, began to be separated into two distinct commands for each commodity; one for research, development and initial acquisition, the other for follow on procurement, supply and maintenance of that class of weapon system. RDA received its proper emphasis in the one command and readiness continued to be stressed in the other command. Benefits as envisioned by AMARC were gained; however, additional

I. FORCE STRUCTURE TRENDS -- OTHER MAJOR EVENTS DURING DARCOM DRAWDOWN.

II. MANPOWER CUTS -- WORKLOAD TRENDS - MISSION IMPACTS --- LOG READINESS.

III. MANPOWER CUTS -- WORKLOAD TRENDS - MISSION IMPACTS --- DEVELOPMENT.

IV. BASELINE MANPOWER REQUIREMENT.

Fig. 1. DARCOM Baseline Study

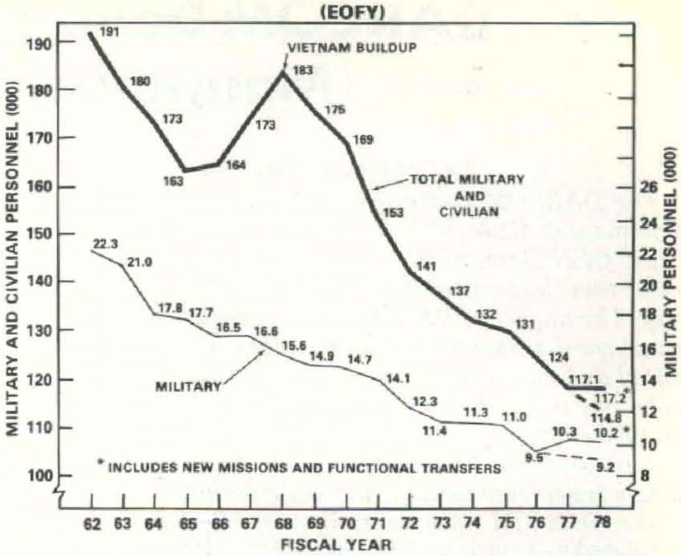

Fig. 2. DARCOM Total Strength Authorized

resources were needed because DARCOM required more people to staff these new commands, and to assure that systems would properly transition from RDA commands to readiness commands.

• New missions were given DARCOM. As an example, DARCOM was appointed Executive Manager for Conventional Ammunition for all United States military departments. This command now performs all procurement, production, wholesale inventory, transportation, and traffic management functions related to conventional ammunition for the Army, Navy, and Air Force. When this new mission was given DARCOM, hundreds of people were required, but never provided.

• Recent years have shown that the requirement to staff mandated program offices has increased. The Baseline study did not take issue with mandated programs—the study points out that additional staffing comes from within, and acts as a drain on limited resources.

• Not only did the Single Manager for Conventional Ammunition come to DARCOM, but additional new missions were directed. DARCOM became the Executive Agent for all Army Security Assistance—that program which is providing billions of dollars to foreign nations. Similarly, the command has received

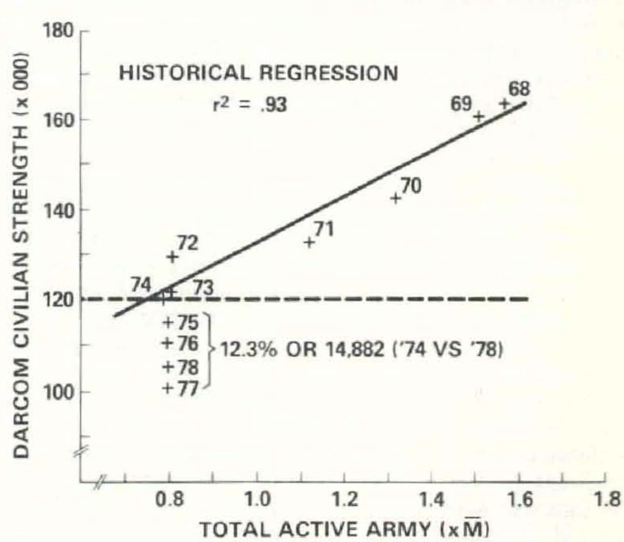

Fig. 3. DARCOM Strength vs Army Strength

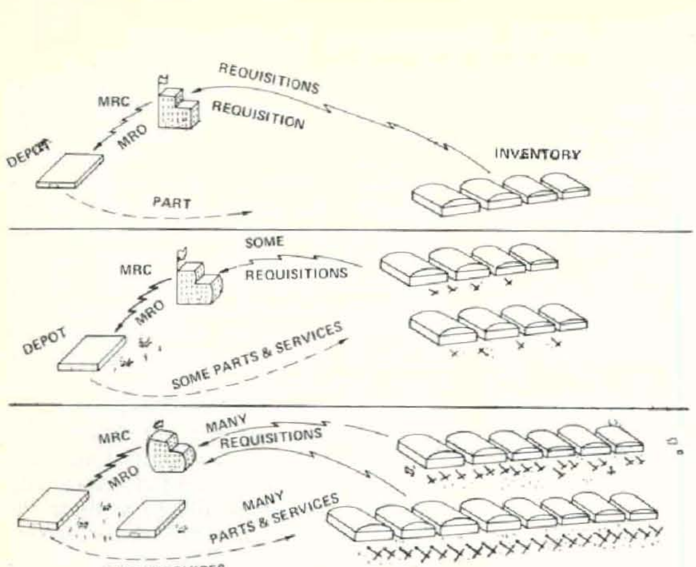

Fig. 4. Intensity of Operational Employment

other responsibilities such as the electronics warfare and signals intelligence RDA and support mission, responsibility for two major maintenance depots in Europe, stocked many common logistics items in its AODs, and aggressively pursued new missions in international research and development. In these instances DARCOM was not given adequate personnel, and has had to augment from in-house resources.

• Finally, as a result of research and development performed in the early 1970's, the Army will be receiving some fifty new weapon systems within the next several years. Current weapon systems are not being replaced; the new inventory is being added to that which is already fielded. The increase will cause more and more procurement, supply, maintenance, product improvement, re-testing, provisioning, and other logistics workloads to be placed on DARCOM.

The DARCOM Manpower Baseline Requirement study, then, examined these changes, not only in regard to the Army, but also, as specifically related to DARCOM, as shown in Figure 1. The first item of this figure relates to Army changes just discussed. The second major thrust of the Baseline study was to analyze manpower reductions, workload trends, and impacts

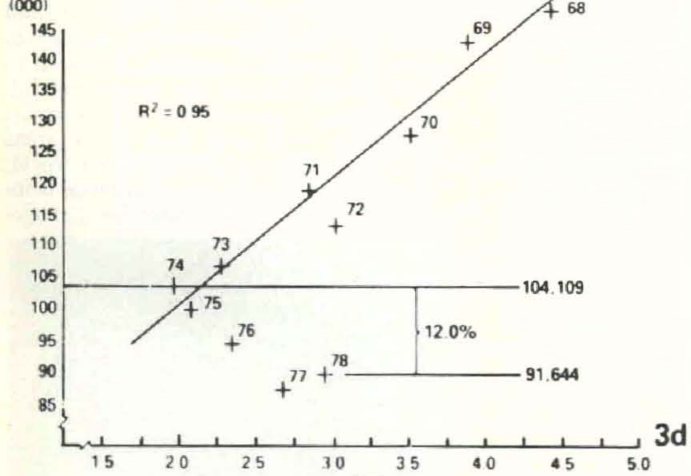

Fig. 5. Total MRC Personnel vs IOE

upon the DARCOM materiel readiness mission; a companion third section applied to materiel development. Based upon trends established in these three parts, the study concluded with a concise statement of manpower requirements to meet peacetime and mobilization conditions.

DARCOM's total military and civilian strength peaked 183,000 personnel in 1968, as indicated at Figure 2. The decline in total strength between 1968 and 1974 was, as it should have been, steady and drew down at the same rate as did the strength of the active Army. The decline in DARCOM strength, however, did not stop when Army strength stabilized in 1974—it continued downward to its present total strength of 117,200. Military strength within DARCOM also showed a steady decline from 22,300 in 1962, to its current strength of 10,200. These reductions appear to be innocuous—until one examines them in relation to either a change in active Army strength, or the change in DARCOM workloads—or both.

A method of relating the change in DARCOM strength to changes in active Army strength or DARCOM workloads, called linear regression, was used to quantify this relationship. Figure 3 shows that the reduction in DARCOM civilian strength (as expressed in thousands along the vertical axis) correlated very strongly with the reduction of the total active Army strength (expressed in millions along the horizontal axis) between the years 1968 until 1974. When the strength of the Army stabilized at 785,000 in 1974, DARCOM contined its decline, and thus, the high correlation ($R^2 = .93$) was destroyed. Based on a strength of 785,000 active military, DARCOM should have approximately 122,000 civilian personnel instead of its current 107,000 (or restated, DARCOM is 12.3 percent below required strength)—if history tells us anything about the number of civilians needed in DARCOM to support the Army.

General Bergquist recognized that DARCOM's current strength requirements should not be based on Army strength alone, especially in view of the many force, logistic, and mission changes which had occurred in recent years. He desired that a second method of relating DARCOM strength requirements be utilized to validate this quantification.

A second method was developed, tested, and did indeed, not only verify the DARCOM shortfall, but provided a basis upon which DARCOM could predict which functional workloads would be adversely impacted if DARCOM continued to receive unwarranted personnel reductions.

The technique is entitled INTENSITY OF OPERATIONAL EMPLOYMENT (IOE). The logic behind the technique is relatively simple. It considers the size of the Army's materiel inventory and relates that inventory to its use in the field. In doing so, a relationship between the inventory, its use, and DARCOM's workload can be established.

Figure 4 illustrates the size of fielded inventory and the use of that inventory in the field. The top portion depicts the fielded inventory with little activity. Consequently, very few requisitions result. The impact on DARCOM's wholesale support system is minimal.

The center scene describes more use of the systems/equipment. Consequently, supply and maintenance activities pick up, and increasing workloads are placed on DARCOM. Note also that the inventory quantity is changing. (The IOE concept applies to either situation—inventory increasing or decreasing.)

The lower third shows a dramatic increase in fielded inventory density and use. Requisition activity increases considerably, as does the requirement to manage Army-peculiar line items, to include requirements determination, procurement, receipt, storage, issue, maintenance, product improvement, etc., of those items.

IOE uses two independent variables which "drive" (cause internal work to be performed) the DARCOM materiel readiness workload, i.e., line items managed and requisitions processed. It is true that the more systems and equipment the Army has in the

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Interview With Black Hawk PM COL Richard Kenyon

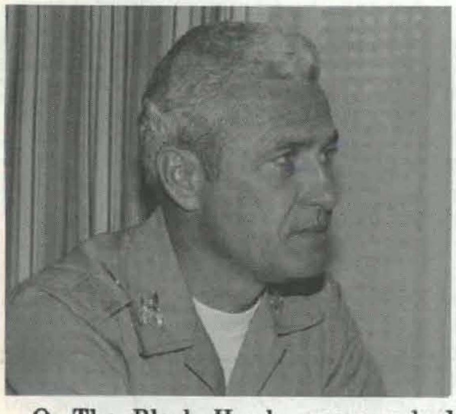
The following interview with COL Richard D. Kenyon, Project Manager, Black Hawk, was arranged before and in total unawareness of the fact that COL Kenyon would be one of two recipients of the Secretary of the Army's 1978 Award for Project/Program Management. He is also a recent nominee for BG rank.

The selection of a project manager for this issue's interview was made as a sequence whereby views of key RDA managers at various levels have been presented. Having presented in the November-December 1978 issue an interview with a DASC, an outstanding project manager was believed a logical follow-on.

COL Kenyon is a 1957 graduate of West Point. He also holds a master of science degree in aeronautical engineering from Princeton University. He completed the Army Command and General Staff College in 1970 and the Industrial College of the Armed Forces in 1974.

His military experience includes two tours in Vietnam where in 1965 he served as a platoon commander in the 197th Combat Aviation Battalion. From 1971-1973, COL Kenyon served as a staff officer with the Airmobility Division, OCRD, DA, and in 1974 was executive officer, Office, Assistant Secretary of the Army (Installations and Logistics).

He served as Project Manager, Heavy Lift Helicopter and as a director, Weapon Systems Management in the U.S. Army Aviation Systems Command before being appointed as Project Manager, Black Hawk in November 1976.



Q. The Black Hawk program had been singled out by some as being a program that was on schedule and within cost estimates—almost a perfect model development effort. Then came the unfortunate crash of a prototype aircraft. What impact did that have on the program?

A. The first impact of such an incident is something that occurs when you have a catastrophic crash and that is a psychological impact. So before you start addressing typical project manager's parameters of cost, performance and schedule, you must deal with the attitudes of all involved. You first have to digest what has happened and learn from it. The second thing is to take the proper actions so that it doesn't happen again, especially in an aircraft program. Once you have done this, then you have to define and implement program actions. Now, to answer your question, the crash of the Black Hawk prototype definitely had an impact on cost, schedule and performance. We made minor design changes to the Black Hawk's electrical system to improve redundancy and reconfigured the position indicating gages of the system related to the accident. That, in itself, required additional cost for an engineering and modification effort. Also, these changes required validation through a test process which incurred a schedule impact. Testing validation had to insure that there was no degradation of the system's performance. Therefore, the accident did cause us, initially, to carefully analyze causes and determine remedial actions. It carried with it the collateral impacts of about $4 million program cost growth, several months schedule slippage due to major test rescheduling and actually better overall performance through redesign to prevent reoccurrence. We are still living with these impacts today.

Q. How much schedule increase did it actually amount to?

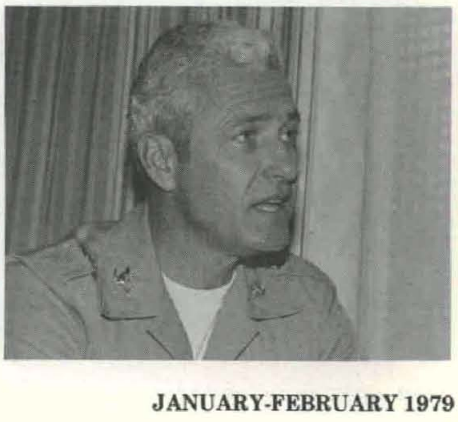
A. The actual schedule increase was due not only to the loss of one of our three prototype test vehicles with a given amount of testing remaining in the program but also the additional validation testing to be done. Redistributing the testing load to production aircraft caused a seven month schedule slip in our "maturity" or development completion effort.

Q. As a project manager of one of the Army's major development programs, what do you see as your key role?

A. I think you would get a different answer to that question from every project manager as a function of his personality, his contractors, the relationship he has with his contractors, and the phase of the program that he is in—be it development, transitional or readiness. I see myself as an individual who must assure the proper interfaces and coordination are being defined and accomplished and I will lump those two into the word communication. A project manager, whether he manages a fairly small system or a large complex system, cannot insure that *everything* is going properly. He can't be involved in every action and that is why he has a staff. He must insure that he examines, on almost a daily basis, what's going on in the program to ascertain which "burning fuzes" are getting the shortest and then make sure that he or his staff is interfacing with the proper elements of the Army and industry. By doing this, those "fuzes" are addressed or put out, problems are defined, actions are taken to resolve those problems, and the follow-on procedues are executed. The action items change depending upon what stage of the materiel development cycle a program has attained. In the early stages, one is looking primarily at developmental or engineering issues and talking with engineers. As the cycle midpoint, the end of development, is reached, one has to insure that new interfaces are established with the DARCOM readiness community and with the troops in the field. A project manager also has to have a constant interface with the TRADOC community to monitor the system requirement and insure accomplishment of TRADOC actions. Of course, I can't forget the constant interaction with the contractors because they play a vital role in all phases. Industry has to understand the program requirements and all of these are not in a contractual document. The contract is a baseline from which to proceed because flexibility is a necessity. My perception of the PM's key role is therefore to insure that the interfaces and communications are being conducted properly and in a timely manner.

Q. What is the biggest obstacle encountered by you relative to carrying out your mission as a project manager?

A. I equate biggest obstacles to major problem areas or items that require management emphasis. Also, I think that when addressing obstacles, I would first define the project manager's world as consisting of three basic elements—cost, performance, and schedule. The obstacles or challenges will again vary depending upon what is going on in the program. In the area of cost, you have the budget cycle and congressional hearings and the implementation of the budget. This cycles as you go through the year. In the area of performance, there is an interface that must be constant between industry and the Project Manager's Office. Related to schedule, we are all trying, as voiced in the A-109 document and by our individual desires, to shorten our development process. In looking at those three areas that define the project manager's world, the continuous obstacle or challenge is insuring that one is applying the manage-



ment effort to those items that are the most critical at any point in time.

Q. Included among your earlier career assignments was a tour as the Project Manager for the Heavy Lift Helicopter. How do you compare the Army's management program during that period with today's management approach?

A. It has not been very long since my HLH assignment because I started working on the Heavy Lift Helicopter in 1974 and worked with that program for about a year. In that short period of time there have not been noteworthy changes in management approaches; however, I believe that the Army has given more cognizance to the requirement for and the validity of project management. This is evidenced by the more stringent selection and training processes for project managers. Furthermore, I see acknowledgement of the requirement for a high caliber of staff to work with the project manager.

Q. Would you agree or disagree that the formal training now being given at the various schools is not adequately preparing Army personnel for future PM assignments?

A. I disagree. While at the recent Project Manager's Conference, I noticed the very large turnover of PMs since last year. There are now many new faces—new officers who are succeeding as project managers. I think we have through an expanded schooling process and repetitive assignments provided a base of capable officers. When addressing schooling though, I will comment about a personal belief. My thoughts and philosophy are that this is a business where you cannot go to a school and somehow emerge perfectly prepared. It is the same as saying that when one graduates from college with an engineering degree he is not yet an engineer. He has to go out in the engineering community and apply the textbook learning to real world situations. I feel the same way about being a project manager. One has to learn from experience. I do not believe that today, after a little better than three years of experience, I am a fully qualified project manager. I am still learning and when I feel that I'm not learning I guess I'm not doing my job. We have come a long way in the formal training of our project management officers. The Defense Systems Management College, courses at Fort Lee, VA, and training with industry prepare officers to become good project managers. I see officers coming onto my staff today with much higher levels of qualification and knowledge attained through formal training.

Q. Suggestions have been made that civilians should be assigned as PMs. Do you have any feelings on this?

A. I will state my answer in terms of aviation system development. I feel that while we would gain the advantage of more continuity, the assignment of civilian PMs would usually lead to the lack of a key ingredient—that of having employed

systems in troop units or even in combat. I therefore believe that project managers, by and large, and certainly for those systems that will have a combat role in the Army, should be military officers.

Q. PMs have been described as the vital interface between the Army and industry to produce the best possible materiel for military requirements at the lowest cost. Based on your experience, is the *lowest cost* the best criteria or the worst criteria in awarding a contract for development of a new item?

A. To answer that I'd have to say that one must look closely at what industry is proposing to you and take it all into consideration. You could select the contractor with the lowest development cost and get a product that could not pass testing, or get into the field. Likewise, you could do that with the highest cost. So you have to consider all parameters, meld them together, and make a judgment. Moreover, we have to consider that in a given system somewhere in the neighborhood of 70 to 75 percent of the cost of that system comes after ownership—after we have procured it—the operating and support costs. Therefore, we want to make sure in development that we are getting a reliable, durable, satisfactory item, and not burden ourselves with an initially low cost item that will eventually drive up the operating and support costs. I'd say that overall cost is one of the most important evaluation elements but the lowest cost does not insure the best system or the lowest life cycle cost.

Q. What suggestions do you have for improving the operation of the PM system of management in the Army?

A. We have a good system of project management in the Army. I have had interfaces with the project or program management procedures in the other services and I think we can hold our heads up to all of them. I would though, mention one suggestion which might improve our operations. Sometimes we do not have enough transfer of knowledge among project managers. I feel we do not take the opportunity, like we have at the Project Manager's Conference, to communicate among ourselves; to discuss what could be common problems, the courses of action available, and the solutions we have reached. We should have more frequent forums, perhaps within commodity areas, to learn from other project managers' experiences.

Q. In the November-December issue we published an interview with one of the Army DASCs. Have you found the DASC system a help, a hinderance, or neither in the day-to-day conduct of your job as a PM?

A. In my mind the DASC is a vital element of project management. The DASC affords a direct link by which the project manager can keep informed of the Pentagon and congressional sensitivities to his program. It is also a two-way street where the project manager has to keep the DSC informed so that he can react to short-term, critical requirements. I have found that a personal relationship with the DASC is very helpful.

Q. How about your relationship as a PM with the TRADOC System Manager (TSM)? Have you seen any difficulties here, or has the creation of the TSM been beneficial to the development community?

A. I give the TSM a unanimous indorsement. The TSM concept has been beneficial to the development community. When the TSM was created, Black Hawk was going into production and we faced the challenges of fielding the system such as providing system manuals, training devices and starting TRADOC schools. The TSM helped a great deal by conducting all of the detailed coordination within his community. This relieved the Project Manager's Office of a series of difficult coordinations. The TSM did a good job and I think it has put us in a good posture to field the Black Hawk. Looking at it on a broader perspective, I feel that the TSM concept will provide an interface throughout development. It is a function of personalities, but I think it is a very useful tool to the project manager and he should create a close personal relationship.

Q. We talked briefly a moment ago about A-109. Have you seen any impact in your program of A-109, either lengthening or shortening the cycle?

A. A-109 was published when the Black Hawk was already at Milestone 3. I have not seen any major changes or modifications to the program related to A-109. We have felt indirectly the basic thrust of A-109 which is to reduce the length of the development cycle and get the system in the field. This has permeated throughout the community. It has caused us to take actions not to go "heel to toe" in testing but to have some overlap of our final qualification with the production effort. I believe that the major impacts of A-109 are being and will be felt by those systems that are coming into the development process with the validation of the requirement at Milestone O. Hopefully, it will be beneficial in eliminating some of the false starts that we have previously had in the development of new systems. It should thereby help us to conserve and apply our scarce resources.

Tentative Agenda Set for Smoke Symposium III at Harry Diamond Labs

The success of Smoke Symposiums I and II has led to the scheduling by COL Henry R. Shelton, PM-Smoke/Obscurants, of the third such symposium, 24-25 April 1979, at the Harry Diamond Laboratories, Adelphi, MD.

The primary goal of Smoke III is the dissemination of accrued information relating to technology and development achievements, effects of smoke/obscurants on weapon systems of all the Services, modeling, instrumentation and methodology, and smoke/obscurant operational concepts.

Emphasis will be upon the information obtained during field testing conducted since Smoke II with various smoke/obscurants and electro-optical systems.

Presentations on related theoretical analysis, laboratory experiments, testing, evaluation and modeling have been invited from industry, and the academic and government research communities.

The tentative agenda for Smoke III is as follows:

Modeling:

• The Electro-Optical Sensors Atmospheric Effects Library (E-O SAEL). L. D. Duncan, U.S.A. Atmospheric Sciences Laboratory (ASL); Smoke Deployment Prediction Model. W. D. Ohmstede, ASL; Battlefield Obscuration Model Act I. R. B. Gomez, ASL; Obscuration Models Based on Smoke Week I and II. C. H. Hayes, Lockheed, Missile and Space Co., Inc.; Gun Flash, Smoke, and Dust Models for Battlefield Environment Weapons System Simulation. Dr. F. P. Gibson, Lockheed; Obscuration Model Predictions Compared to Recent Field Test Results. L. P. Obert, Night Vision and Electro-Optics Laboratory (NV&EOL); A Master Model of Combat Obscuration in a Realistic Scenario. W. R. Verry, The Mitre Corp.; Models for Munition Dust Clouds. Dr. J. Thompson, General Electric-TEMPO; Adaptation of WES High Explosive Cratering Models to the Generation of Battlefield Obscurants. J. B. Mason, Waterways Experiment Station (WES).

Testing, Instrumentation and Methodology:

• Smoke Week II. COL H. R. Shelton, Project Manager, Smoke/Obscurants; Evaluation of Imaging and Non-imaging Sensor Performance in Smoke Week II. H. Anderson, U.S.A. Missile Research and Development Command (MIRADCOM); Multi-Spectral Digital Analysis of Smoke Dust Aerosols. G. R. Blackman, ASL; Performance of Tank Thermal Sight Through Obscurants. C. H. Mikeman, NV&EOL; Preliminary Analysis of DIRT I and GRAF II Battlefield Dust Obscuration Tests. J. F. Ebersole, Aerodyne Research, Inc.; DIRT I Crater Characteristics. B. W. Kennedy, ASL; Recent Developments in Field Testing of Obscurants. Dr. J. N. Cannon, Brigham Young University.

Smoke/Obscurant Technology and Hardware Development:

• Military Smokes—Some United Kingdom Considerations. A. Jarvis, Chemical Defence Establishment, Porton, UK; Examination of the Correlation Between Laboratory and Field Smoke Extinction Data. Dr. G. C. Holst, U.S.A. Chemical Systems Laboratory (CSL); Relative Humidity Dependence of the Infrared Extinction by Aerosol Clouds of Phosphoric Acid. Dr. E. W. Stuebing, CSL; Recent Developments in Smoke Munitions. W. C. Dee, CSL.

Doctrine and Training, Concepts and Systems Evaluation and Systems Evaluation and Analysis:

• An Army Smoke Concept. LTC. D. Bacon, TRADOC Systems Manager, Smoke; Three Years of Testing Night Vision Equipment in an Obscured Visibility Environment. Dr. C. R. Leake, U.S.A. Armor and Engineer Board; A Dynamic Analysis of the Medium Tank Battalion Conducting Hasty Offensive Operations. MAJ J. Steele, HQ Department of the Army; The Impact of Tactical Smoke and HE Obscuration. S. Gerard, U.S.A. Material Systems Analysis Activity (AMSAA); Utility of Copperhead with Ground Laser Designation in a European Battlefield Environment. J. Chernick, AMSAA; Conceptual Development of Aerosol Gases Passive Countermeasures. E. C. Gilbert, U.S.A. Aviation Research and Development Command.

Helicopter R&D Contracts Exceed $800 Thousand

Helicopter research, development, and testing contracts announced recently by the U.S. Army Research and Technology Laboratories, Moffett Field, CA, an element of the U.S. Army Aviation R&D Command, total $800,769.

The largest award, a 2-year $281,765 contract with United Technologies, is for development of a low cost, lightweight, crash and fire survivable flight and crash impact data recorder to improve Army aircraft operational and crash safety.

Termed an Accident Information Retrieval System, the unit is expected to accurately identify accident causes, thus reducing accidents due to similar causes. Crash safety would reportedly be improved by better life support equipment and crash survivable helicopters.

Vought Corp., Dallas, TX, will receive $215,346 to investigate multiple cascaded seals, develop new improved seals and seal configurations for helicopter hydraulic systems and reliability, maintainability, safety, and cut costs by reducing leakage.

George W. Fosdick, project engineer, reports that new innovative seal designs and concepts and seals using new materials will be devised and tests will be conducted to determine the potential operational endurance of the new seals.

Bell Helicopter Textron is getting $99,716 to design a truss tail boom for the AH-1G helicopter. The primary objective is to develop a conceptual design for a composite tail boom that will decrease ballistic vulnerability.

Kaman Aerospace Corp., under a $76,537 contract, will conduct a design assessment of advanced technology, lightweight, low cost, mission-configured gondola modules. The gondola system is expected to be compatible with Army cargo and utility type helicopters.

Sikorsky Aircraft Division, U.T.C., was awarded $66,659 to determine the technical feasibility and application of a central on-board information processing and crew advisory system. This contract, according to project engineer Joseph D. Dickinson, is expected to result in a reduction of flight crew workload and reduced costs and weight compared to current cockpit instrumentation.

Tritec, Inc., Columbia, MD, is gaining $60,746 to develop a low-cost duel input servovalve with the capability of accepting electrical signals from on-board computers, fly-by-wire flight control systems, and fluidic signals from fluidic stability augmentation systems.

When mounted on airplanes, helicopters or other motion producing actuators, the servovalves are designed to provide the capability of transferring computer information, fly-by-wire control inputs, and augmentation system signals to aircraft flight control as well as power plant and environmental control for crew members and equipment.

AMMRC Provides Data for Materials Selection

As a result of recent problems encountered in the production of munitions, the Project Manager for Munitions Production Base Modernization and Expansion, Picatinny Arsenal, Dover, NJ, requested the U.S. Army Materials and Mechanics Reseach Center's assistance in materials selection for equipment used in processing sulfuric acid and nitric acid for the production of nitroguanidine and TNT.

AMMRC is providing a data base for the selection of construction materials by carrying out short-term electrochemical tests and long-term surveillance tests of materials under conditions which simulate service environments.

Short-term electrochemical polarization tests and long-term surveillance tests of 304L, 316L, 321, 347, and Carpenter 20 Cb-3 stainless steels have been carried out in environments which simulate the sulfuric acid concentration system.

This system concentrates, by vacuum evaporation on a continuous basis, a weak, spent sulfuric acid mixture produced in the nitroguanidine manufacturing operation, making it suitable for reuse in nitrating quanidine nitrate to nitroquanidine. Corrosion data demonstrated that 304L, 316L, 321, and 347 stainless steels should not be utilized in the weak acid, first-stage acid, and second-stage acid systems. Passivity was unstable and corrosion rates markedly exceeded 20 mils per year in these environments (20 to 80 percent sulfuric acid).

These stainless steels, however, should be suitable for applications involving the third-stage acid, product acid, first-, second-, and third-stage distillate systems (93 percent sulfuric acid and mixtures of sulfuric and nitric acids in concentrations of less than 10 percent).

Carptenter 20 Cb-3 stainless steel, which is more corrosion resistant than 304L and 316L stainless, should be suitable for use in all of the aforementioned environments.

Data obtained have been applied to the preparation of Design Criteria Packages for sulfuric acid concentrator and sulfuric acid regenerator facilities to insure that the optimum corrosion-resistant material for the application (15-year life requirement) will be considered and used. Significant improvement in performance, reliability, and maintainability will be realized.

MIRADCOM Uses Optical Simulation System for Daily Equipment Tests

At Redstone (AL) Arsenal two men may be seen peering from an airborne vantage point at a valley below. They can see ant-size vehicles on country roads wending through green fields and scattered trees. They can see a sprinkling of small houses leading to a small community, a lake and a dam in the distance, and low hills rising in the background topped by fluffy clouds against the blue sky.

Mr. Don Holder, Army mathematician at the controls of a joystick tilts it forward for a closer look at the airfield just off to the right. Suddenly, he spots a cluster of tanks parked in the grass just off the airfield apron.

He begins a dive squarely at the tanks, they loom uncomfortably close. A crash into the tanks appears imminent.

Just as suddenly, the frightening downward plunge termiates—all simulated.

Holder and coworker, Mr. William Phillips, an electronic engineer, are running practice missions in the Army Missile Research and Development Command's (MIRADCOM's) Advance Simulation Center (ASC), a one-of-a-kind facility housing three test chambers and computers that simulate environments affecting a missile in flight.

They're wringing out equipment nearly every day now in the Electro Optical Simulation System (EOSS). The clouds, the bucolic setting, roads, houses, dams, bridges, vehicles, and airfields are fakes, merely models, but look so real that missiles and weapons tested in the chamber can't distinguish from the real world.

The EOSS features a 32-foot-square moving terrain table containing life-like, 3-dimensional targets, including one which actually moves. Mr. Phil Andrews, a MIRCOM illustrator in RASA's Graphic Arts Branch, just recently painted the sky background behind the table. MIRADCOM's Technology Laboratory obtained a probe from NASA's Marshall Space Flight Center that moves across the table for nap-of-the-earth, or extremely close-in simulations.

MIRADCOM has built a control system to computer operate the probe which can descend within an inch of the table, corresponding to 50 feet in the real world.

"With the terrain model, probe and realistic background, the Army can simulate what any optical system would see in the real world," said Phillips, EOSS cell manager. "Since the cell has a lighting sysem that can simulate everything from starlight to daylight, we can test missiles on their ability to spot, acquire, designate, track and destroy enemy targets under day and night conditions.

"We can perform man-in-the-loop simulations with seekers, remotely piloted vehicles (RPVs), systems like Hellfire, or helicopter flight scenarios," Phillips said. "The probe, the table and control systems provide pitch, roll and yaw motions that simulate realistic flight."

Phillips said MIRADCOM is wringing out the equipment, flying practice missions over the terrain model in preparation for a new command program known as Fiber Optics Guidance Demonstration (FOGD).

Mr. Rex Powell, an aeronautical engineer in the Technology Laboratory's Systems Simulation Directorate, is project engineer for the FOGD program.

"This will be a technology program," Powell said, "to demonstrate and evaluate the use of fiber optics for missile guidance." The fiber optics link, which would be payed out like TOW wire, is a promising new guidance scheme, he explained, much better than wire because it has an extremely wide band width, can handle more information, and is more secure because it's countermeasures free.

"The concept puts the operator's eye in the missile. He sees what the missile sees. Using this technique, we can do more processing, utilize more techniques, yet keep equipment needed to do the job on the ground, not on the missile."

The FOGD program will determine if RPVs, or other similar systems using the fiber optics link, could be used as attack vehicles.

"By using the probe, terrain model and simulator equipment, we can design an optimum system to the FOGD concept," Powell said. "Right now we're attempting to put equipment together and actual flight tests are planned during 1980.

"We will have equipment already tested, trained operators, and know what it looks like before actually flying."

In addition to Powell, Phillips and Holder, others working closely in the program are Mr. Lee Kilbourn, a research physicist in the Systems Simulation Directorate who does technical planning for the EOSS and Infrared Simulation Systems; Mr. Chuck Martin and Mr. Pete Dufour, EOSS technicians; and Mr. Jim Windham, an electronic engineer in MIRCOM's Management Information Systems Directorate who develops and programs simulations.

MIRADCOM Electro Optical Simulation System terrain model.

Army Science Board Gets New Civilian Consultant

Prof. Victor K. T. Tang, Department of Mathematics, Humboldt State University, Arcata, CA, has been sworn in as a civilian consultant member of the U.S. Army Science Board while attending a recent meeting at the U.S. Army Natick R&D Command, Natick, MA.

Composed entirely of civilian consultants from industry, universities and private organizations, the Army Science Board was chartered in November 1977 and assumes the mission of five previous advisory committee to the Department of the Army.

Prof. Tang, a professor-statistician, earned a BA degree in economics from the National Taiwan University, Taipei, Taiwan in 1956, a master's degree in mathematics from the University of Washington, Seattle, WA in 1963, and a PhD in statistics from Iowa State Univ. (1971).

He has authored numerous publications, and is a charter member of the International Association of Survey Statisticians Mu Sigma Rho, the National Statistical Honorary Society, a Fellow of the Royal Statistical Society, England, a member of the Chinese Statistical Society of the U.S., the American Statistical Association and the Institute of Mathematical Statistics.

Listed in *American Men and Women of Science*, Dr. Tang has served as honorary research associate, Department of Statistics, University of California, Berkeley, CA and as a reviewer of Mathematical Reviews with the University of Michigan.

DOD Demonstrates Capabilities of Precision Guided Munitions

Six dead center hits of six shots highlighted the Department of Defense's display to members of the news media and senior officials of the Armed Services of the deadliness of precision guided munitions.

With this awesome demonstration of precision destructiveness, the Department of Defense showed off much of its arsenal of currently operational and developmental precision guided munitions—the so-called "smart" bombs, missiles, and artillery projectiles.

This high degree of hit success, particularly with developmental munitions drew the remark from one experienced observer that "the usual Brass failure factor" was conspicuously absent."

The demonstration was held at White Sands Missile Range, NM, on 12 December 1978. The impact area was in the Small Missile Range's Tularosa Basin where flat sparsely vegetated terrain gave excellent visibility for the audience located in bleachers on Cedar Site part way up the mountains west of the impact area.

The tri-Service demonstration was held, principally for the information of U.S. and foreign news media, in order "to inform the United States public, its allies, and threat nations, that the Department of Defense has such weapons systems and technology available for its defense."

In the interest of economy, the demonstrations were, by direction of Under Secretary of Defense William J. Perry, limited to the extent possible, to planned developmental tests and ordnance already scheduled for training expenditure.

The Army was designated as the Executive Service for the demonstration, with MG O. L. Tobiason, commander, White Sands Missile Range, assigned as demonstration director. MG Tobiason's staff was ably supported in the planning, preparation, and actual conduct of the demonstrations by teams from the Navy, Marine Corps, and Air Force.

The audience, which comprised members of the local and national news media and a limited number of VIPs led by Secretary of Defense Harold Brown, was transported to Cedar Site, where the group was given the opportunity to look at static displays of the types of munitions being demonstrated plus additional weapon systems of the several services for which live firings were not scheduled.

Army systems statically displayed were: the Copperhead projectile, the TOW, and the Stinger missiles. Navy systems displayed were their 5- and 8-inch guided projectiles, the joint USN/USAF HARM antiradiation missile, the Harpoon antiship missile, and the IIR Walleye high value land/sea target missile. The Air Force displayed TV Maverick and IIR

SECRETARY OF DEFENSE Harold Brown examines Copperhead as COL Ronald E. Phillipp, PM, Cannon Artillery Weapons Systems, answers questions at White Sands Missile Range, NM.

Maverick antiarmor missiles, the GBU-15 (CWW) and (PWW) high value target bombs, the Laser Guided GBU-10, 12, antistructure bombs and the Pave Spike Laser Pod.

In clear cold weather, the temperature at 6 a.m. being 29°F., and visibility stretching out in excess of 15 miles, MG Tobiason welcomed the audience. The General stressed that the rounds being fired were already scheduled for expenditure; however, he cautioned that some of what they were to see was developmental and therefore subject to failure. As it turned out all shots were successful.

Dr. W. J. Perry defined precision guided munitions for the audience, and noted that some of the systems being demonstrated would include live warheads for the first time. He noted the need for such munitions to offset some of the numerical advantages of the threat nations. In Dr. Perry's opinion, the technological significance on the battlefield of precision guided munitions would be greater than that of radar in WW II.

The actual firings of this day, he continued, were but five of a family of such munitions, and one could see in these and the displays an advancing level of operational technology.

Perry pointed out that the first demonstration would be the Army's Copperhead, a developmental system that had recently undergone a reconfiguration derived from earlier test data. In its new format, Copperhead had experienced 14 successes in 16 firings. (The two firings that followed raised the score to 16 of 18.)

The significance of precision guided munitions, said Perry, was their role as force multipliers. They allow economy of rounds, of personnel and other critical resources, with an increased probability of hit. It was important, he felt, that not only the American public know what their tax dollars have been doing for them, but for leaders in other nations to recognize U.S. defensive capabilities.

Dr. Perry's remarks followed the actual briefings of the various systems and the live demonstrations.

The Army began with a rundown on Copperhead and then followed with a firing at a static M-47 tank, then a second firing at an M-47 tank moving in a path virtually perpendicular to the howitzer target line.

The static tank was struck dead center on the turret and the moving tank was hit on the hull just under the gun mantlet.

Following a description of the TOW/Cobra technology and tactics, a TOW missile was fired at a third tank, and again a direct hit resulted.

Other Army systems that were described with the aid of static displays were the Hellfire and Stinger.

The Air Force's portion included briefings of the TV Maverick, GBU-15, and Laser Guided Bomb, with live drops of a GBU-15 bomb on a camouflaged revetment containing a simulated command and combat vehicle, and four Laser Guided Bombs in a salvo against a simulated fuel storage area. All were once again dead center.

The Marine Corps then discussed its need for and role in the development of the Laser Maverick Bomb.

The Navy's part began with a description of the HARM- antiradiation missile, the Harpoon antiship missile—suitable for firing from aircraft, ships, or submarines, and finally the Walleye II glide weapon. The final demonstration was target center impact of Walleye on its target after launch from a streaking A-7 aircraft.

Dr. Brown then accepted a few questions from the audience, noting among his answers that the area of precision guided munitions was one area of technology where he believed the U.S. had a lead over potential enemies. He noted that future budgets would include considerable funds for such advanced munitions.

Senior Army attendees included Dr. Percy A. Pierre, Assistant Secretary of the Army (RDA); GEN John A Guthrie, DARCOM commander; and GEN Donn Starry, TRADOC commander.

Copperhead: New Weight for Stopping Enemy Armor!

By LTC Robert A. Nulk

Project Manager, Copperhead

In the past, Army artillery has been used as an effective weapon for saturation fire upon area targets. However, artillery has been lacking in capability to destroy a point target. Because the armored moving target was deemed difficult to kill and because it usually required a direct hit to demobilize it, studies concluded that a new weapon had to be developed to meet this threat if artillery was to play a needed role in stopping Warsaw Pact armor masses.

It was suggested that the ultimate mission of the new weapon system would be to enhance the indirect fire capability by disrupting, delaying, disorganizing, and destroying enemy mechanized forces before and during the time they were engaged by direct fire weapons. Thus, the 155mm howitzer with laser semiactive homing guided munitions was conceived. The munition itself is now commonly called Copperhead.

Follow-on studies conducted by the Army Armament R&D Command, the Army Missile R&D Command, and the Ballistic Research Laboratory culminated in a Request for Proposals to industry in 1971 for a terminal homing laser guidance system on a projectile fired by the 155mm howitzer. Thus, the Copperhead was initiated into development.

The advanced development program was monitored by elements of each government organization previously mentioned. However, the management responsibility was assigned to the Project Management Office of the Cannon Artillery Weapons System. In particular, the Missile R&D Command was assigned the task of insuring that the guidance and control systems would be developed to withstand the 9,000-g launch environment and guide the projectile to the target with unerring accuracy.

The purpose of the advanced development program was to prove that the projectile could be used to increase the effectiveness of standard artillery against point targets. The problems in providing this proof were many and severe. The system with its precise and sensitive electrooptical components had to be designed to withstand the same high-g firing environment as a standard artillery round. The system, with no information provided to the round other than that sensed by the seeker, had to acquire and guide itself to a designated target with extreme accuracy. Moreover, the system had to be compatible with the practical world of artillery. It could not be a delicate laboratory device. Ultimately, the system must be producible in large quantities at reasonable prices.

The advanced development effort was a 2-phase program in which a period of 18 months was allotted to component/subsystem development and 19 months to prototype projectile demonstration. Phase I was concerned primarily with development and implementation of the design, inspection, and test methods needed to harden previously proven guidance, control, and telemetry components and subsystems to 9,000-g and all-up projectiles to 7,200-g. Phase II was dedicated to proving the concept through flight test evaluations. The emphasis on performance and hardening, combined with the extensive test program, had to produce a practical projectile that would meet or exceed all performance requirements.

The successful conclusion of the advanced development program in March 1975 allowed Copperhead to progress into the engineering development program when Martin-Marietta Aerospace was awarded the prime systems development responsibility.

The Copperhead projectile (Figure 1) is 155mm in diameter, 4.5 feet long and weighs 138 pounds. The projectile nose is a blunted conical dome. Aft of the dome is a primary optical lens bonded to a detector assembly. The detector assembly contains other optics, a laser detector and video preamps.

The projectile electronics package is located behind the seeker gyro section and consists of eight printed circuit cards plugged into a motherboard assembly.

The steel warhead structure contains a shaped charge warhead, warhead fuze with safe and arm provisions and interconnecting electrical cables for interfacing the guidance subsystem with the control subsystem. During early testing, a telemetry unit having representative mass and envelope characteristics of the warhead is substituted for the warhead.

The control housing contains slots that permit the fins and fixed wings to be folded inside the structure during storage and cannon launch. Actuator electronics, thermal battery and a cold gas storage bottle for the controls are mounted on the control actuator unit. The control section also contains locks which hold the fins and wings inside the structure and a cam/piston mechanism which deploys the wing upon command. Secondary environment sensors are mounted in the control section to sense muzzle exit from the gun that enables arming of the warhead.

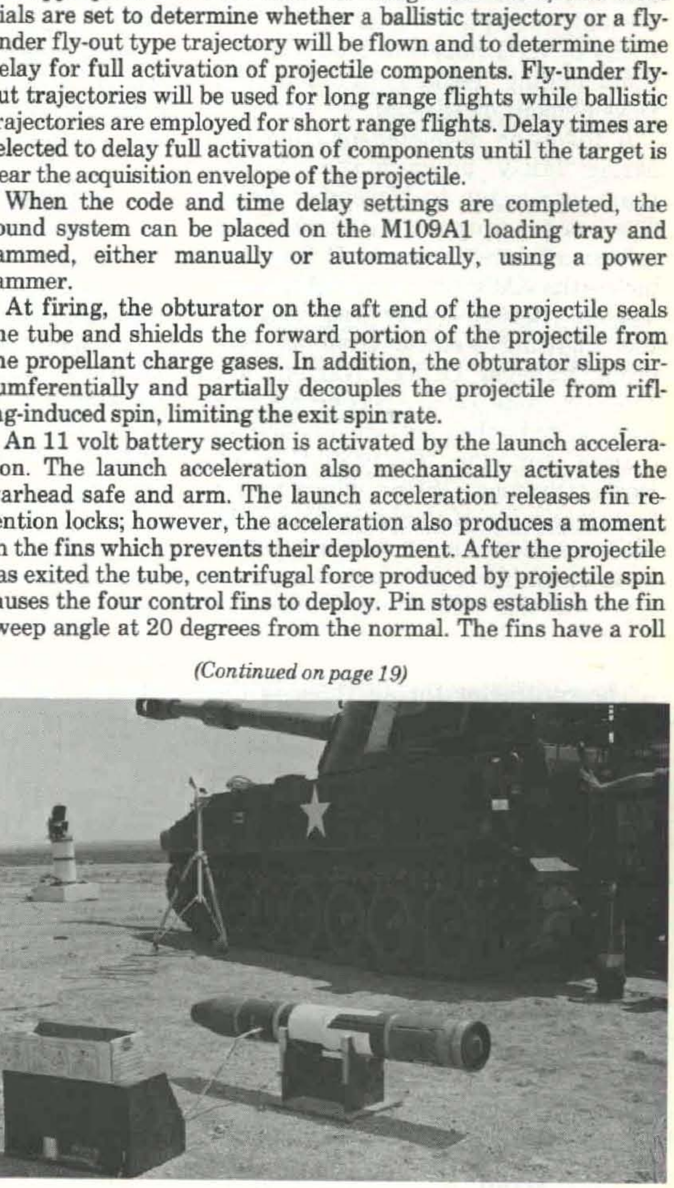
Prior to firing the projectile, three dials are set on the guidance section bourrelet which establish laser code correspondence with the appropriate forward observer designator. Next, two more dials are set to determine whether a ballistic trajectory or a fly-under fly-out type trajectory will be flown and to determine time delay for full activation of projectile components. Fly-under fly-out trajectories will be used for long range flights while ballistic trajectories are employed for short range flights. Delay times are selected to delay full activation of components until the target is near the acquisition envelope of the projectile.

When the code and time delay settings are completed, the round system can be placed on the M109A1 loading tray and rammed, either manually or automatically, using a power rammer.

At firing, the obturator on the aft end of the projectile seals the tube and shields the forward portion of the projectile from the propellant charge gases. In addition, the obturator slips circumferentially and partially decouples the projectile from rifling-induced spin, limiting the exit spin rate.

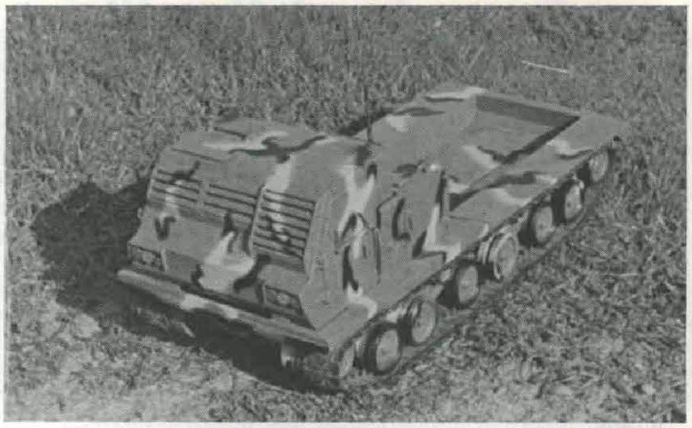
An 11 volt battery section is activated by the launch acceleration. The launch acceleration also mechanically activates the warhead safe and arm. The launch acceleration releases fin retention locks; however, the acceleration also produces a moment on the fins which prevents their deployment. After the projectile has exited the tube, centrifugal force produced by projectile spin causes the four control fins to deploy. Pin stops establish the fin sweep angle at 20 degrees from the normal. The fins have a roll

(Continued on page 19)



COPPERHEAD missile ready for firing at WSMR.

XM2 Infantry Fighting Vehicle (IFV)



General Support Rocket System (GSRS)

Army Formally Accepts First XM2 IFV Prototypes

The first two prototypes of the XM2 Infantry Fighting Vehicle (IFV) were formally accepted recently for the Army by LTG Robert J. Baer, Deputy Commanding General for Materiel Development, DARCOM.

A follow-on development from the earlier "MICV" program, the IFV program was begun in November 1976. The new program included the mission of developing a companion vehicle—the XM3, the Cavalry Fighting Vehicle. Responsibility was assigned the Fighting Vehicle Systems Program Manager Office, Warren, MI. Then, in June 1977 a second mission was added—that of developing a carrier for the General Support Rocket System (GSRS), which would be a derivative of the basic XM2/XM3 with common suspension and power train assemblies. The first two prototypes of this vehicle were also delivered to the Army in November 1978.

The contractor for all three is the FMC Corp. of San Jose, CA.

XM2 represents major technological advances as well as doctrinal changes over the current M113 personnel carrier. The key technological advances include a high mobility capability—essential for the vehicle to work in close support with the new XM1 tank, an integrated day and night thermal imaging sight, vastly improved ballistic protection.

From a doctrinal point of view XM2 will be the first infantry squad carrying vehicle that will allow that squad the option of fighting within rather than having to dismount as with the current M113. Firepower provided the XM2 includes a 25mm automatic cannon, a TOW antitank missile launcher, a 7.62 coaxially mounted machinegun, and finally, six ballistically protected firing ports from which squad members can fire 5.56mm weapons to the sides and rear of the vehicle.

Full-scale engineering development of the XM2/XM3 is now underway, and will require a total of eight test vehicles and engineering services leading to a production. Delivery of the balance of the XM2/XM3 prototypes is to be completed by February 1979, and a production delivery is expected to begin in May 1981.

New Material May Ease Helicopter Gear Failures

Because of increasingly higher operating loads, helicopter transmission gear failures are reportedly on the increase due to scuffing or scoring which is related to increased lubricant temperature and breakdown of lubricant films in gear-to-gear contact. This applies to gears of all types including helical, spur, ring, and spiral bevel.

A promising new, high hot-hardness gear material, planned for use in the CH-47D and other systems, under development by the U.S. Army Materials and Mechanics Reserach Center, Watertown, MA, is a modified Vasco X-2 tool steel which has the potential of minimizing failures attributable to scuffing and scoring.

This is achieved by reducing the carbon level from the usual value of 0.24 to a level of approximately 0.15 and thereby obtaining a tougher core and a case-core hardness differential necessary to produce a sufficiently high residual compressive stress in the case.

However, one serious problem encountered with X-2 is the difficulty in achieving a uniform carburized case. This non-uniform case depth is reportedly due to the presence of chromium oxide scale on the steel surface, which if effectively removed or modified, will permit good carburizing results. This is presently being accomplished by means of a high-cost proprietary process.

The objective of this effort, which has cost reduction as a primary motivation, is to develop an alternate surface treatment for uniform case depth hardening of X-2 alloy steel gears to mitigate the deleterious effect of the chromic oxide scale.

Chemical and electrochemical pretreatments of the X-2 alloy were investigated as a means of eliminating the deleterious blocking effect of passive oxide films. Electrolytic pretreatments, utilizing anodic, cathodic, and reverse polarity cleaning techniques prior to carburizing reportedly result in excellent surface hardnesses (HRC 58 to 61.9) and an optimum case depth of HRC 50.

The most promising chemical pretreatments of X-2 alloy include a one-minute immersion in 10 percent H_2SO_4, a 3-minute electrolytic immersion in HCL utilizing polarity reversal, or electrolytic immersion in ferric sulfate solution for three minutes with polarity reversing.

Chemical and electrochemical pretreatments were found to be comparable or slightly better than the proprietary thermal treatment in obtaining effective case depths of HRC 50 upon subsequent carburizing.

A significant cost driver in the hardening of Vasco X-2 steel is the current use of a high-cost proprietary process surface treatment (thermal oxidation) prior to carburizing. Alternate cost-effective (+50 percent) surface treatments (chemical and electrochemical) permitting uniform case depth hardening may enhance the applicability of Vasco X-2 gear steels.

XM1 Undergoes Multiple Test Studies at WSMR

White Sands Missile Range scientists are performing a series of tests on the XM1 tank.

The tests, which began in November 1978 and are scheduled to run through August 1979, are being conducted by personnel of the Army Materiel Test and Evaluation (ARMTE) Directorate, and are supervised by Mr. Daniel J. Small, the ARMTE project engineer for the test series.

Four kinds of tests will be run, the first of which is electromagnetic radiation (EMR) susceptibility. In this series, the tank and its components will be subjected to high intensity EMR fields, such as those created by radars, navigation beacons, and radio transmissions, to determine the effects of such emissions on the XM1's electronics equipment.

The second type of testing will be nuclear susceptibility. This portion of the project will be used to determine the shielding capabilities of the tank's shell, and the susceptibility of its electrical, electronic, and electro-optical subsystems to high levels of gamma and neutron radiation, as may be encountered in a tactical nuclear detonation.

The gamma and neutron radiation tests will employ the missile range's fast burst nuclear reactor.

Some of the XM1's components also will be tested at the range's solar furnace, which can simulate the extreme heat generated by a nuclear blast.

The third type of study to be done on the tank during its stay at White Sands is infrared signature testing. This will consist of measuring the heat radiation given off by the vehicle. These tests will help to determine the XM1's susceptibility to detection by various infrared sensors.

Radar signature testing is the fourth area of study to be conducted at the range. These tests will be run by Holloman Air Force Base, using their Radar Target Scatter Site (RATSCAT) facility. The RATSCAT will help determine how radar equipment sees the XM1, and thus determine its susceptibility to detection.

Many of the studies to be run in this program will be conducted concurrently. In one case, EMR tests will be run on the tank during the daytime, while infrared signature tests will go on at night.

The entire series of tests at White Sands is a part of the XM1's development as a future Army combat system.

ARRCOM Picked as MILES Commodity Manager

The U.S. Army Armament Materiel Readiness Command (ARRCOM), Rock Island, IL, will become commodity manager for the life cycle of the Multiple Integrated Laser Engagement Systems (MILES) in 1980, following transition from the Project Manager for Training Devices.

MILES is the core system for a family of direct fire simulators which use laser transmitters and detectors that allow realistic war games. It was developed at a cost of $9 million by the DARCOM Project Manager for Training Devices, Orlando, FL, and Xerox Electro Optical Systems, Pasadena, CA. Testing was conducted by the Training Developments Test Directorate, TRADOC Combined Arms Test Activity, Fort Hood, TX.

The Large Caliber Fire Control Section of the Maintenance Directorate at HQ, ARRCOM will handle commodity manager responsibilities. Under the present schedule, the initial $150 million MILES contract will be awarded in early 1979.

MILES devices are being developed for the M16 rifle, the Army's full family of machineguns, Viper, Dragon and TOW missiles, and the M551, M60A1 and A3 main battle tanks. Follow-on effort will expand the MILES system into air defense weapons, mines, helicopters, artillery, Air Force aircraft and enemy weapons systems.

The MILES system will reportedly fill a need that has existed as long as armies have trained—the need to simulate the tremendous lethality of modern weapons and provide a realistic means of casualty assessment.

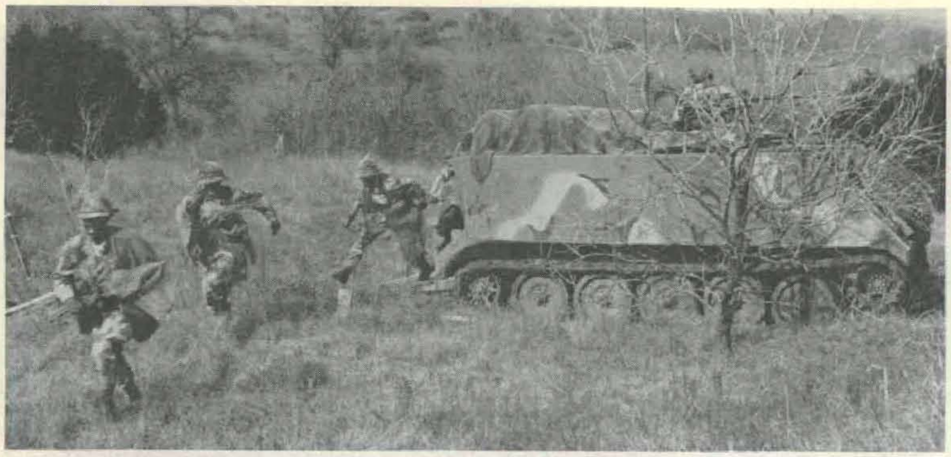
Firing the weapons simulators is much like firing the actual weapons. However, instead of firing live ammunition, these simulators transmit harmless laser beams. To allow the simulation to be as real as possible, the rifle and machineguns use blank ammunition, and the missiles and main guns use weapons effect simulators to simulate the noise, blast and smoke of the actual weapons. Receiving detectors for laser beams are installed on a load carrying harness, and on a strap which fits over a standard issue steel helmet. When a laser beam from a transmitter strikes a detector, an alarm located near the soldier's left ear informs him he has sufferd a "near miss" or that he has been "killed."

Hits, kills and near misses are received by detectors mounted on belts which attach to the front, rear and sides of the vehicle. If the laser detector belts are struck by a laser beam, a horn will sound to indicate the near miss or hit. A horn will sound and a pyrotechnic device will emit smoke in the case of a "kill." To silence the horn, a weapon gun key is used on the control console in the vehicle.

All lasers are low power, meet eye safety requirements and operate from self-contained, long-lasting batteries. The versatility of the microelectronics allow a wide range of weapons simulation. The family of simulators may be expanded to include additional weapons, vehicles and even aircraft.

MILES system for M16 rifle. A buzzer indicated kills or near misses when the laser beam strikes detectors on the soldier's helmet or torso harness. To silence the buzzer, the soldier removes a key from the transmitter of his rifle and inserts it into his harness, which, in turn, disables his transmitter.

M551 Sheridan equipped with MILES training system. The main gun has the capability of firing one of three lasers to simulate the Shillelagh missile, 152 main gun and coaxial machinegun. Additionally, the cupola-mounted 50-caliber machinegun has its own laser transmitter capability.



CAMOUFLAGE PATTERNS designed by the U.S. Army Mobility Equipment R&D Command have replaced the olive drab and white star on all major tactical items. The designs disrupt the signature characteristics of vehicles; reduce contrasts with soil and vegetation, and distort internal shadow areas.

Paints and Coatings Technology: A MERADCOM Forte

By Fred L. Lafferman

To soldiers whose service in or close familiarity with the Army ended with the Vietnam era or earlier, today's standard camouflage patterned vehicles are an interesting change. There were certainly numbers of ex-GIs who wondered why such patterns had not been used before, but shrugged the momentary question to the side as they accepted the Army's traditional one shade olive drab paint scheme.

The reason for the nonstandard camouflage painting system in use by the Army rests in the R&D work done by the Material Technology Laboratory, Mobility Equipment Research and Development Command, Fort Belvoir, VA.

Evolving from its 100 year heritage that began as the Corps of Engineers' principal military R&D agency, the command is now, by virtue of recent Army reorganizations, responsible for a variety of areas— barrier and counter-barrier, countersurveillance, energy and environmental, and supply distribution and construction systems.

To carry out these tasks the command has eight laboratories, seven of which are commodity oriented, i.e., their work is directed toward specific products like mines or mine detection devices. The eighth laboratory—the Material Technology Laboratory, is just that—a technology lab that supports all other Army labs. A subsidiary unit of the Material Technology Laboratory is the Army Coatings Lab, and it is from the work done by this group that the Army's improved camouflage paintings were derived.

The Coating Lab has the job of developing the technology base for new and for improved coatings, for metal pretreatments prior to painting, for organic and semi-organic primers, and for finish coats for ferrous and nonferrous metals.

Additionally, coatings are to be developed that will impart to various substrates, special optical characteristics throughout the ultraviolet, visual and infrared regions to defeat various methods of enemy surveillance. These methods include ultraviolet and infrared photography, lasers, contrast and heat seeking missiles, and night observation techniques.

By the lab's research investigations designed to develop new methods for the analysis of coating materials, better quality control of paints and coatings is expected to result.

Due to new restrictions imposed by recent ecological and toxicological legislation, the lab is also searching for entirely new materials, coatings and test methods. Investigations in the development of new and improved cleaners, derusting compositions and paint removers are continually performed, and the lab maintains a Qualified Products List on a significant number of the specifications. All of these are necessary to provide coating systems offering maximum protection under any operating or environmental condition.

The majority of the work done by this laboratory is performed in-house. It does assist, however, in a large number of procurement contracts and acts as consultant for all of the DARCOM commands on their contracts when paint problems arise.

The Coatings group is very diversified in the type of coatings work that is performed. Extensive research and development programs have been performed in the areas of anti-corrosion and fire retardation. Because of new environmental regulations, field tests are presently being performed evaluating the various lead and zinc chromate anti-corrosive pigment replacements, as well as on lead chromate and moly-orange replacements.

In the analytical area, for the past several years, emphasis has been focused on the use of instrumental techniques in the development of new methods and as replacements for time-consuming wet methods of analysis. At the same time, classical approaches have not been ignored and often produce the best procedures in specific cases.

The laboratory responsibility for coatings research and development is Army-wide. Several programs have recently been completed for the Army Aviation Command and the Project Manager for Aircraft Survivability Equipment in the areas of non-reflective—or as the lab terms it, non-specular coatings for the interior and exterior of helicopters and the exterior of fixed wing aircraft. For the interior of helicopters, a black lacquer was developed using glass beads and quartz silica to achieve this characteristic. It produces comparable properties as the 3M "Nextel" product.

The exterior lacquer for helicopters was developed in an aircraft green color with specific pigmentation to produce the non-specular and low infrared characteristics to resist detection by contrast seeking missiles.

PAINT PATTERNS for mobile "Patriot" power plant blend into desert environment.

For the exterior of fixed wing aircraft, a low infrared reflective, 30 percent visual gray lacquer was developed. By using tungsten oxide, the coatings possess less than 10 percent infrared reflectance in the range of 1.5 to 4.3 nonometers while maintaining a 30 percent visual reflective gray color.

For the Chemical Systems Laboratory, U.S. Army Armament R&D Command, a program has been completed for the development of a chemical agent resistant camouflage coating. The primary chemical agents that this coating is to resist are Mustard Gas and GF. The plymer system is a ½ polyurethane, and a DA policy may be established requiring this coating to replace many of the other camouflage coatings. Extensive programs have also been performed for other commands in solar reflecting coatings.

Perhaps the most significant and certainly one of the most noticeable was a program that was performed during the past several years in the development of a range of camouflage coatings for miliary equipment. In March 1974, the Department of the Army approved and announced a camouflage painting policy for Army tactical equipment which eliminated the traditional olive drab color and established a pallet of eleven new camouflage colors. Field tests have proven that camouflage pattern painting works well in confusing the enemy observer and enhancing battlefield survivability.

The patterns come in a 4-color system. By changing only one of these four colors, or at the most two, the same basic pattern can be made to work equally well in different seasons of the year or in different types of terrain. By using the appropriate color standard camouflage pallet, as specified in MIL-E-52798A, in conjunction with the pattern painting design, a good color combination for almost every terrain can be obtained.

But these camouflage coatings were not developed to protect against visual means of observation only. Besides these eleven colors possessing specific visual requirements, they also have specific infrared characteristics. These different requirements were established to produce a pattern effect to both the visual eye and photography; as color film, black and white, infrared film, and camouflage detection film (color infrared). Actual terrain produces the same pattern effect.

The primary camouflage paint specification is MIL-E-52798A, Enamel, Alkyd, Camouflage. Eleven colors are specified of which four of them are high infrared reflective greens. Besides each of these greens possessing visual and infrared requirements, they also possess minimum-maximum reflectance requirements from 0.6 to 0.9 microns. These specific requirements were established so that the green colors would spectrally match foliage and react the same as foliage when photographed by camouflage detection photography.

Such photography capitalizes on the high infrared reflectance of deciduous foliage to create high contrast between foliage and other materials. A specific combination of these infrared and red region reflectances excite the specific layers of the film to react the same as they would toward foliage. To avoid high contrast between foliage and artificial camouflage, a maximum red region reflectance was established so that only the correct amount of the magenta layer would be exposed and, similarly, a minimum infrared reflectance was required so that the cyan layer will be fully exposed.

Besides these requirements, there is also a minimum-maximum range from 0.6 to 0.9 microns within which the curve must fall. Where foliage appears green on normal color photography, it will appear as a reddish or magenta color on C.D. film. The acceptable color rendered on camouflage detection film produces a Munsell Plot which encompasses the hue range of 6RP to 1.25 R, a chroma range of 7 to 12, and a value range of 3.70 to 4.75.

This paint comes in the eleven camouflage colors and is used primarily as the field applied pattern paint. This enamel is used either on new equipment as the finish coat or as a top coat on previously painted equipment to produce the patterns. In the past two years, over one million gallons of this paint have been procured at a cost to the Army of approximately $8 million, and this figure relates only to the paint procured by the General Services Administration. A significant quantity of camouflage paint has also been purchased by private contractors within this time period. The paint procured by GSA has been strictly for field application.

There are several other camouflage specifications. Since a contractor or depot cannot always use a slow air drying enamel, it was necessary to develop other camouflage specifications.

At present, the most significant programs being conducted in this area are those relating to environmental regulations. For example, due to the Lead Poisoning Act, studies are being performed to replace lead chromate, molybdate orange, and lead anti-corrosive pigments in paints that will be used in residential areas. Also, due to the possible band on hexavalent chromium, especially water soluble types, a program is being conducted to replace zinc chromate in anti-corrosive primers. Zinc chromate has already been eliminated in England.

The most extensive program presently being performed is the development of coatings that will conform to the Clean Air Act, which regulates the solvent emissions in paints. Since there are very few Army paints that presently conform to this act, it will be necessary to have replacements for these within three years. To comply with this, studies are taking place in water base paints, high-solids paints, and 100 percent solids coatings. One other way to comply is for industry to install after burners, but because of cost and the possible restrictions in natural gas, this is impractical in many instances.

One other program being presently performed, which has a significant application to camouflage coatings, is the evaluation of zinc phosphate as an additive to enamel coatings to improve the color stability, gloss retention, and chalk resistance. Extensive accelerated and outdoor weathering tests have been performed which confirmed that the addition of zinc phosphate does extend the service life of camouflage enamels. With the quantity of camouflage enamels that are procured, a significant savings can be observed due to longer repainting cycles.

Examples of other ongoing work at the lab include development of: an elastomeric camouflage coating for the Lance nuclear warhead, low infrared reflective coatings for aviation use, a camouflage hydrophobic coating for the Patriot radar antenna, and a moisture indicating coating for weapon use.

Besides being responsible to the Department of the Army, the laboratory has coordinated in programs with the other military agencies, as well as the FAA, GSA, and CIA in the civil community.

Should further information on the lab's activities be desired, one should contact: Commander, USA MERADCOM, ATTN: DRDME-VO, Fort Belvoir, VA 22060.

FRED L. LAFFERMAN, chief of the Organic/Chemical Coatings Research Team, has been employed since 1957 in the Material Technology Laboratory of the U.S. Army Mobility Equipment Research and Development Command, Fort Belvoir, VA. A research chemist, he joined the Command following graduation from the University of Cincinnati where he received a BS degree in chemistry. He is a member of the Washington Paint Technical Group, National Paint and Coating Association; ASTM; and Society of Paint Technology. In 1974 he was a nominee for the MERADCOM Commander's Award for Technology.

TRACTOR MOBILITY has come a long way since this 1935 CLETRAC 3-ton tractor with towed roll-over type scraper.

Tractor Mobility—The Search Goes On

By James H. Yeardley

During the era of the thirties, the Engineer Board (predecessor of MERADCOM) made a serious study of tractors to determine their worth as labor-saving machinery. Mobility was a prime factor in determining the optimum size and weight of tractors for the Army.

In the early thirties, the crawler or tracked tractor was just beginning to be used for construction, the bulldozer blade was experimental, and Mr. R. C. LeTorneau had not yet revolutionized the rubber-tired wheel for construction machinery. In the Army, the "mule-skinner" had not yet given way to the "cat- skinners."

There was considerable debate among members of the Engineer Board as to the acceptable trade-off between productivity and mobility. Excerpts from a draft 1937 letter to Regimental Commanders give us a glimpse of this debate. "There is one school of thought which holds that the Division Engineers should not be burdened with heavy labor-saving machinery. This group holds that labor-saving machinery should be available in corps depots for requisition when needed.

"Special provisions can be made for moving them to the front when they are required. Another group holds that the Divisional Engineers should be equipped with light tractors as organizational equipment. The tractor should be capable of replacing the animals which were used for Engineer work in the past.

"It is quite probable that these machines actually have the ability to substitute for the mule. Their chief drawback is their inability to keep up with the motorized column on their tracks. They must be carried in trucks. There is considerable doubt as to whether it is worthwhile to provide an expensive motor truck for transportation of a mechanical mule.

"Light bulldozers attached to light tractors have been considered as a tool which might increase their usefulness. This tractor is definitely superior in every way to two mules. It is possible that four excellent mules well trained could outpull it on a dead strain, but by working it 24 hours a day, with a little time out for servicing, it will accomplish as much as six first class mules worked to the limit."

The draft letter to Regimental Commanders went on to mention a third point of debate, the possible consideration of "round wheel-tired tractors."

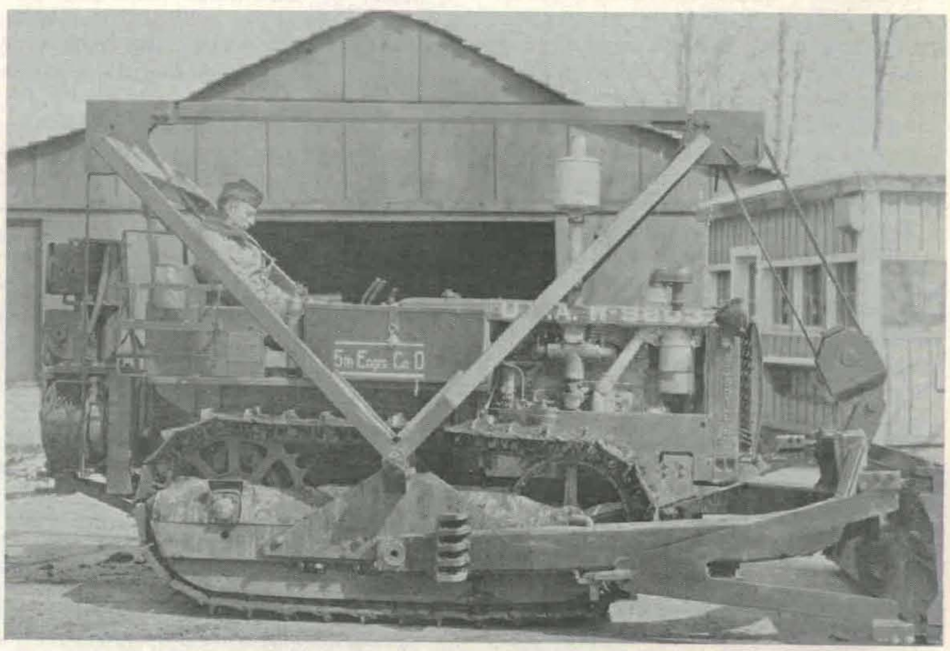
While tractors have long since proven their worth as labor-saving machines in three wars, mobility vs productivity is still being hotly debated. In the past forty years, crawler tractors in the Army have increased from 4 tons to over 40 tons, but operating speed is still only 6 mph.

In those early days of transition in the Army from mules to tractors, land mobility was the only consideration. The mobility equation is now much more complex. Military mobility encompasses land, air, sea, parachute delivery and helicopter transport.

The engineer mission has changed from heavy construction to combat support reinforcement by heavy construction equipment. Trade-off decisions involving such factors as performance, convoy speed, productivity, versatility, logistics and mobility are especially difficult to make in light of the high costs involved when extensive modification of commercial equipment or military design is required.

In the late fifties, the Engineer Research and Development Laboratories (now MERADCOM) developed and prototyped two revolutionary tractors designed to provide optimum productivity, without a sacrifice in mobility. These unique machines were capable of 30 mph convoy speeds yet when filled with earth ballast were able to operate as 25-ton earthmovers. During the ensuing years the machines and their mission profiles have undergone considerable change. Their descendents are currently the M9, formerly the Universal Engineer Tractor (UET), which is armored and has a swimming capability; and the Family of Military Engineer Construction Equipment (FAMECE), which is helicopter transportable.

The UET has completed development, has been type classified and is scheduled to go into production with fielding expected in Fiscal Year 1980. The FAMECE is nearing completion of the operational test phase of development.

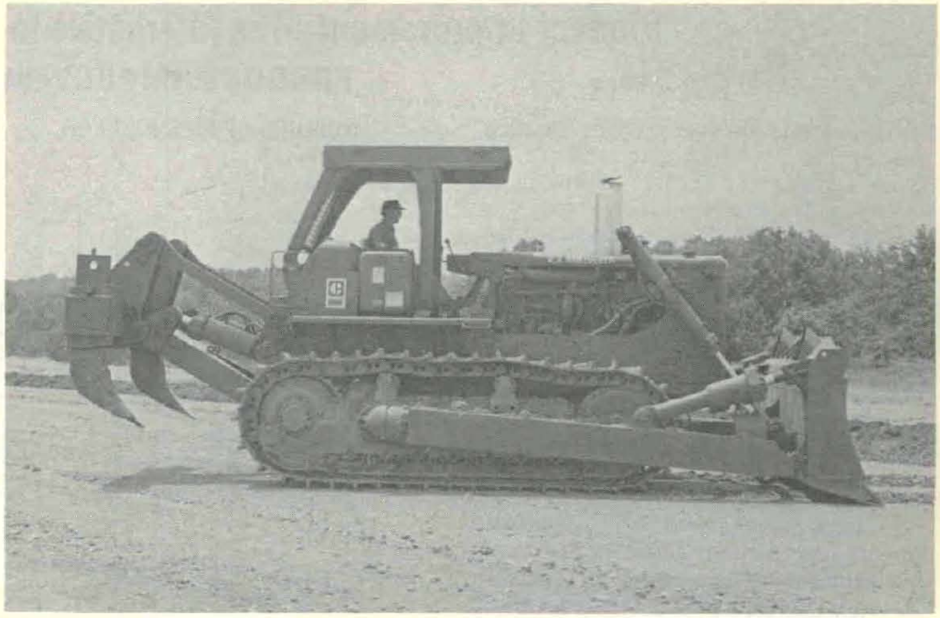


The "mule-skinner" was just giving way to the "cat-skinner" in the Army when this Caterpillar Tractor Model R–4 was photographed in the late Thirties.

The Army must again make the important decisions on the 1980 versions of the "mechanical mule." However, this time the stakes are considerably higher. Instead of dozens of units and thousands of dollars, the decisions involve hundred of units and millions of dollars.

The questions of the 1937 debate are echoed by the sons and grandsons of yesterday's engineer officers. What is tractor mobility worth? Can the Army afford to provide expensive helicopters to transport slow moving tractors to the job site? What is the most cost effective way to provide the mobility required to support stream crossings, prepare defensive positions, access roads and helipad or airstrips?

Because mobility has always been an important factor in warfare, the search for better and more economical means of supporting combat operations can be expected to continue.



D8K diesel tractor with bulldozer and ripper.

JAMES H. YEARDLEY is chief of the Construction Equipment Engineering Division, U.S. Army Mobility Equipment R&D Command, Fort Belvoir, VA. Graduated from Pennsylvania State College (now Pennsylvania State University) in 1943 with a degree in mechanical engineering, he served as an engineering officer in the U.S. Navy during World War II. He is a licensed professional engineer in Washington, DC, and has received numerous letters of commendation and outstanding performance awards during his tenure at Fort Belvoir.

Army Establishes Toxic/Hazardous Materials Agency

The Department of the Army has established a Toxic and Hazardous Materials Agency at Aberdeen Proving Ground, MD.

The new agency will assume the functions formerly tasked to the Office of the Project Manager for Chemical Demilitarization and Installation Restoration, which has been located in the Edgewood Area of Aberdeen Proving Ground since 1973.

COL Frank A. Jones Jr., the project manager since July 1976, will be the commander of the new agency. He said that the redesignation from a project manager resulted from the Army's continuing requirements for chemical demilitarization and installation restoration programs.

Normally under the Army's project manager concept, a specific PM office is disestablished when assigned tasks are completed. In this case, however, a permanent agency was established due to the long-range task of disposing of unserviceable and obsolete chemical agents and munitions and the expanding installation restoration program.

The new agency has both Department of Defense and Army-wide responsibilities, and reports to the Commander, U.S. Army Materiel Development and Readiness Command, headquartered in Alexandria, VA.

The authorized manpower requirements for the new agency, 85 civilians and 20 military personnel, are the same as they were for the former PM office. Internal organization change under the concept will be made within the next few weeks, however, no job changes will be made.

Since the Army centralized management for the demilitarization and disposal of hazardous chemical substances and munitions in 1972, the former PM office provided the technical direction for the environmentally safe disposal of the national stockpile of biological agents and munitions at Pine Bluff Arsenal, AR; Rocky Mountain Arsenal, CO; Fort Detrick, MD, and Beale AFB, CA.

In addition, it handled the demilitarization of 1.4 million gallons of various toxic agents, 1,200 pounds of non-lethal compounds and 800,000 pounds of explosives at RMA, Dugway Proving Ground and Tooele Army Depot, UT; Johnston Island in the Pacific Ocean, and the Edgewood Area of APG.

Ongoing chemical demilitarization activities include the acquisition and testing of the new Chemical Agent Munitions Disposal System for a wide-range of unserviceable and obsolete chemical munitions stored at Tooele Army Depot; the disposal of 21,500 obsolete chemical agent training sets and 180,000 gallons of carbonyl chloride at Rocky Mountain Arsenal, the development and testing of a new transportable Drill and Transfer System for the demilitarization of unserviceable chemical munitions, and the development of a portable explosive containment system.

In addition, a new protective suit for workers at Chemical Agent Disposal System and a new family of detection and monitoring devices have been developed and are currently undergoing pre-operational testing.

Laboratory studies are being performed under contract to develop disposal procedures for incapacitating agent BZ and in-house research is being conducted in an effort to advance existing demilitarization technology. For example, the Ballistic Research Laboratory at APG is conducting development studies on the use of a laser for chemical demilitarization operations.

Current installation restoration projects include the containment and treatment of migrating contamination at Rocky Mountain, Pine Bluff, and Redstone Arsenals.

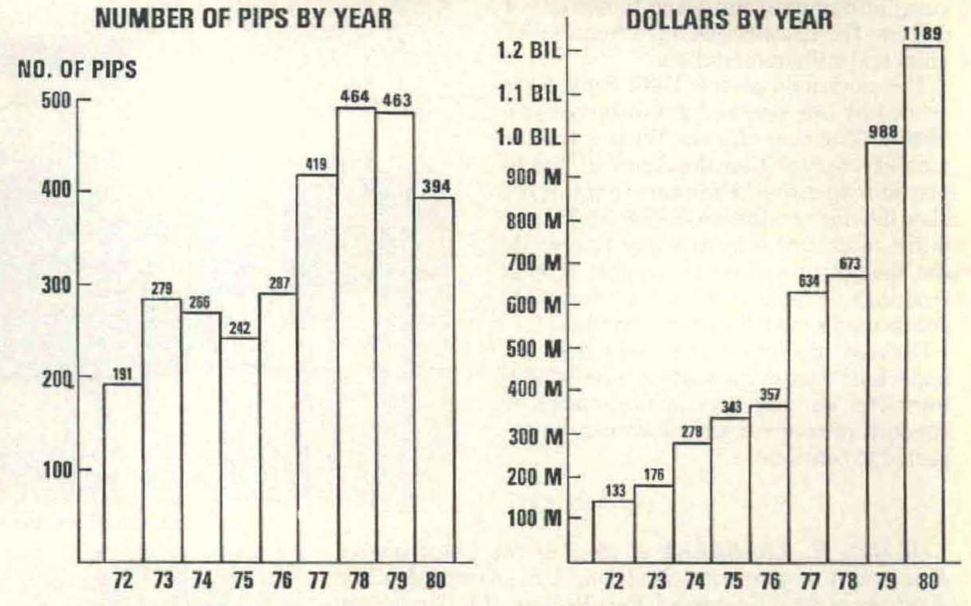
Surveys and alternative assessments for the cleanup and eventual disposition of the former Weldon Spring Chemical Plant, St. Charles County, MO, and Frankford Arsenal, PA, have been recently completed and are currently being evaluated.

The Toxic and Hazardous Materials Agency will continue the former project manager's function as the Department of Defense executive agent for developing installation restoration technology and the required cleanup for military installations in excess of needs, as well as assisting the Navy and Air Force in planning and conducting their installation restoration.

Product Improvement—The Alternative to New Development

By COL Lloyd A. Gimple

PRODUCT IMPROVEMENT PROGRAM GROWTH



Anyone who has ever thought about replacing his 5-year-old automobile or his home realizes why product improvement is so popular. Increased cost of new systems, along with inflation, has caused the Army to look more to product improvement than has even been done in the past.

Product improvement is specifically the modification, retrofit or conversion of existing type classified materiel. The process encompasses the primary mission of increasing operational capability, increasing Reliability/Availability/Maintainability (RAM), and correcting all types of deficiencies, to include safety deficiencies.

Product improvement utilizes state-of-the-art technological advances to accomplish equipment changes quickly, and this is really what the Army's product improvement program is all about.

This procedure is not a new concept, it has been going on for a long time. A classic example is the upgrading of flintlock fire arms to percussion, and the conversion of muzzle loaders to breach loading systems. The accompanying graph depicts the dramatic program growth of product improvement.

The total number of product improvement proposals (PIPs) which are being worked during any one year have been reduced, primarily due to the combining of a number of PIPs on specific weapon systems into one PIP per weapon system. This results in fewer but larger PIPs. The dollar value shown in the graph indicates the program growth.

It is frequently thought that PIPs are caused by poor research and development on the weapon system prior to fielding. This is simply not true. Fully, 65 percent of our funds are provided for the main purpose of increasing the operational capability of a weapon system through application of technology which was not available when the system went through the R&D phase.

Many older systems use the preponderance of the PIP funds, such as the CH-47 Chinook Helicopter, Cobra Helicopter, M60 Tank, Improved Hawk, M109 Howitzer, M113 Armored Personnel Carrier, etc. All of these systems have been in the field for 10 or more years but, by virtue of the PIP process, are being modernized with state-of-the-art technology.

The majority of the PIP program is comprised of those PIPs which are directed to improving operational capabilities. Several Cobra Helicopter, Improved Hawk, CH-47 Modernization, and M60 Tank PIPs are included in this category.

Only two PIP categories directly address cost reduction or cost avoidance. Cost reduction is utilized to a great extent in ammunition production because the purchase of large quantities provides a quick return on investment. Cost avoidance is accomplished through application of RAM criteria.

A substantial number of our product improvement projects are oriented towards improvements in RAM. In many cases a modest investment to improve RAM results in substantial reductions in maintenance support and operating costs.

Although all RAM PIPs do not result in direct cost savings, they do reduce failure rates and associated down-time and increase operational availability. All of these factors of course are critical to our equipment readiness. Examples of PIPs in this category are the 2½ and 5-ton truck, the M551 Sheridan, and the M60 Tank.

Deficiency correcting PIPs relate directly to the everyday readiness problems experienced by our equipment in the hands of the user. Closely associated with RAM, this category deals largely with premature failure equipment malfunctions and safety hazards.

Compatibility, standardization, environmental and simplification improvements are typified by those PIPs which provide the user with equipment which is compatible; i.e., M88A1 Tank Retriever has the diesel engine and numerous components in common with the M60 Tank. Standardization PIPs not only seek standardization within our armed forces but also with NATO; i.e., AN/TTC 38 switch for NATO interface.

A significant impact on the total Product Improvement Program results from various legislative requirements generating roll-over protective structures and noise abatement devices for construction and materiel handling equipment; water anti-pollution devices for Army watercraft; air anti-pollution for vehicles; and federal aviation regulations which generate changes in avionics and instrumentation on Army aircraft.

The PIP Program includes all types of equipment and weapon systems regardless of size, important or seemingly unimportant. The most important question is whether or not an improvement is needed.

The M109A1 self propelled howitzer will soon be converted to the M109A3 by virtue of several modifications that will provide for increased range, better combat efficiency and NATO standardization. These improvements, through utilization of the latest technology, will allow the M109 to fire the latest cannon launched guided projectile called "Copperhead," and the "new family" of projectiles, both of which provide greater range and lethality.

Additional modifications will greatly enhance the reliability of the system thus extending its useful life into the 1990s. This program will begin in Fiscal Year 1979 and be completed in three years.

Today's Cobra Helicopter *looks* similar to the original version fielded in 1967, but that is where the similarity ends. The product improved Cobra has kept pace with the increased armor threat by application of advanced technological subsystems improvements, which will fill the mission gap pending production and fielding of the Advanced Attack Helicopter. Some of the planned changes include:

- TOW missile system with its telescopic sight unit, launchers and electronics components.
- Fire control subsystem which includes the fire control computer, laser rangefind-

er, a pilots "heads-up" display and air data subsystem. The laser rangefinder, with accuracy to 10,000 meters, provides input to the fire control computer and the TOW telescopic sight unit allowing the AH-1S to stand off to the maximum range of its TOW missile.

• Universal gun turret which will accept either the 20mm gatling gun or the 30mm chain gun.

• Wing stores management system which provides pilot capability to select warhead types, firing intervals, fuzes, single or multiple rockets and rocket inventory.

• Improved main rotor blade, flat plate canopy, improved transmission and engine, nap-of-the-earth cockpit and avionics, and numerous aircraft survivability improvements.

The Yukon Stove, one of several military space heaters, has a deficient gravity flow fuel system. Several troop complaints concerning the potential fire hazard stimulated the submission of a product improvement proposal to eliminate the gravity feed adapter. Additionally, the PIP will increase the capacity of the fuel tank and modify the existing gravity flow system.

The improved system would incorporate a larger fuel can with an opening at the base of the can, in addition to the normal opening at the top, to preclude the necessity for inverting the can. This would eliminate the current gravity feed adapter and vent tube. It would also allow for refilling the can without changing any components.

The program management of the PIP process has been formalized in recent years by the establishment of a separate office at HQ U.S. Army Materiel Development and Readiness Command. This office was established primarily to emphasize the benefits of product improvement, provide policy guidance, review the achievement of technical milestones, review formal proposals, and track on expenditures of funds.

The amount of visibility now given this vital program has helped establish a new philosophy of ensuring that the Army's weapon systems remain current with state-of-the-art improvements—improvements which can be accomplished rapidly and at minimum cost.

At this point in time the future of product improvement appears bright. It is expected that technology, especially in electronics, will continue to accelerate at an extemely fast pace. This technology can be adapted to our present, and soon to be fielded weapons systems, considerably faster and more economically than the development of new replacement systems.

The most expensive weapon systems ever developed by the U.S. Army; XM1 tank, utility tactical and advanced attack helicopters, infantry and cavalry fighting vehicles, and Patriot missile will soon be fielded.

These systems must not only keep pace with the advancing technology but, additionally, must also keep pace with the ever changing threat to national security. Immediate economical changes to these modern systems will provide the capabilities required to offset new threats and, additionally, will preclude our expensive systems from becoming obsolete.

The product improvement process and philosophy will surely play an increasingly larger role in the future as more emphasis is given to this vital program.

COL LLOYD A. GIMPLE is chief, Office of Product Improvement, HQ U.S. Army Materiel Development and Readiness Command. He formed the Office of Product Improvement in August 1975. Earlier assignments included two tours in Vietnam and service as commander, 1st Aviation Maintenance Battalion, Hunter Army Airfield, GA. He graduated with a BGS degree from the University of Nebraska and has completed the Command and General Staff College.

CSL Examines Norwegian Decontamination Apparatus

SANATOR, a multipurpose, mobile water heating and pumping apparatus developed in Norway and believed to have potential for decontaminating personnel and equipment, was demonstrated recently at the Army Armament R&D Command's Chemical Systems Laboratory, APG, MD.

Pronounced SAN-ATE-OR, from the Latin, "that which cleans," the decontamination apparatus was designed and produced in Oslo, by Mr. Karl H. Hoie, a mechanical engineer. During a 2-week visit to CSL, Hoie and his production chief, Mr. Reidar Gran, provided instructions on operations and maintenance of the unit, designed to deliver hot water anywhere at any time.

The SANATOR, standard decon equipment with both Norwegian and Swedish Armed Forces, was brought here for evaluation to determine if it can be adapted to U.S. Army requirements. Tests conducted in Scandanavia proved the unit can operate effectively in extreme arctic conditions as well as in an equatorial rain forest.

The SANATOR reportedly can draw from any water source, still or running, and can deliver water at any required temperature and pressure for showers or for cleaning contaminated materials under extreme climatic conditions in summer or winter.

Mobile and lightweight, the complete pump-heater weighs about 330 pounds and the standard accessory pack, including hoses, shower, battery and cleaning jets weigh about 145 pounds.

The SANATOR operates independently of external power sources, requiring only liquid fuel. Its powerful engine operates on 2-stroke fuel provided by a jerrycan.

An adequate source of water is the heart of any operation for survival, whether a national catastrophy or a military operation. SANATOR's developers point out that it is a proven system for reliably supplying hot or cold water, requiring little personal attention. In addition, they say, it has demonstrated a versatility in providing hot water for field hospitals or for drinking water in the wilderness.

Eight Contracts Total $3 Million For Assault Breaker Research

Eight contracts totaling about $3 million have been awarded by the U.S. Army Missile R&D Command to separate firms to conduct research and technology demonstrations on a proposed new Army antitank concept known as Assault Breaker.

Assault Breaker technology is being directed specifically at a long range delivery system which can strike deep into enemy territory and knock out massed tanks and heavy armor. As the delivery system approaches the armor it will dispense several submunitions that will be guided independently to their targets.

The technology demonstration, sponsored jointly by the Army and the Defense Advanced Research Projects Agency, will focus on the terminal portion of the program which commences with submunition dispersal. Each of the eight firms will develop missile dispensing systems, seekers, air frames, submunitions and bomblets, and study cost effective delivery systems for the smart munitions.

Companies receiving the MIRADCOM contracts, which may eventually have a potential value of approximately $15 million are: Boeing Aerospace, Seattle, WA, $982,000; Martin Marietta Aerospace, Orlando, FL, $952,000; Hughes Aircraft, Canoga Park, CA, $150,000; Vought Corp., Dallas, TX, $150,000; General Dynamics, Pomona, CA, $200,000; Physics International, San Leandro, CA, $74,000; Science Applications, Inc., Huntsville Division, $100,000; AVCO Research and Systems Group, Wilmington, MA, $50,000.

Following the technology demonstration, MIRADCOM will select one or more contractors for continued advanced development of the Assault Breaker.

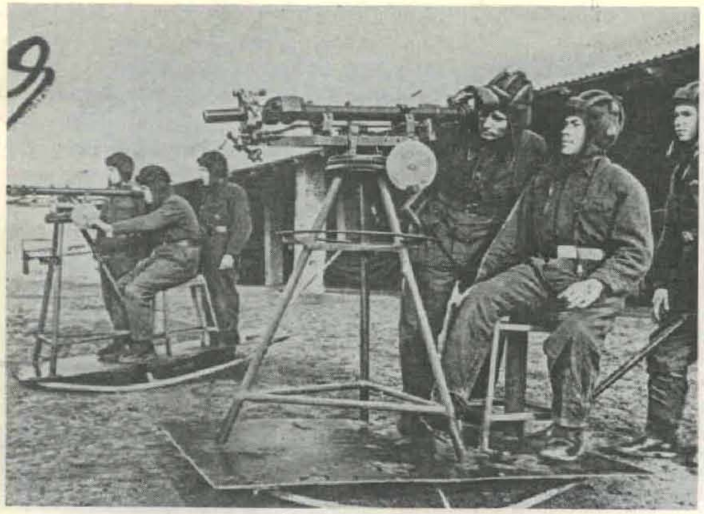


Fig. 1. Individual Rocking Platforms.

Fig. 2. Tanks on Rocking Platforms on Subcaliber Range.

Training Simulators—A Soviet Must

By John B. Halley

The modern Soviet Army has been noteworthy for its use of the principle of mass to overcome deficiencies in tactics, equipment and training. Masses of new equipment and firepower are used to simply overwhelm opponents. But the use of mass also means a corresponding increase in logistical requirements.

Supplying the basics of combat fuel, ammunition, rations, and repair parts, becomes a monumental task. To reduce their logistic load, operational readiness of combat vehicles has become a major consideration and objective of R&D and of training.

The Soviets understand that one of the major causes of parts failure is wear and tear caused by the normal use of the equipment. Even the best maintained equipment will eventually wear out. Every kilometer or hour of vehicle use erodes, irretrievably, the life of the vehicle. Therefore, strict controls are required for equipment usage (especially combat vehicles) to insure that unnecessary wear of the equipment is eliminated.

Combat vehicle crews require on-vehicle training to obtain and maintain their specialty skills. This often requires the operation of the vehicle, which automatically lowers its readiness posture. That the Soviet Army is aware of the dilemma is apparent. They have actively attacked the problem by establishing rigid usage restrictions on all vehicles.

Approximately one third of the oldest vehicles are designated training vehicles while the remainder of the unit's vehicles are placed into short term storage. Except for major field exercises these vehicles remain in storage.

Training vehicles are operated until a predetermined mileage "life" is reached. At this point the vehicle is turned in for depot refit and a new or rebuilt vehicle is issued to the unit. The new vehicle is placed in storage and the oldest stored vehicle then becomes the training vehicle.

To insure the maximum utilization and life of designated training vehicles, training simulators and aids are widely used. Tank gun tube wear is reduced by the extensive use of a 23mm subcaliber insert in lieu of service ammunition. Most maingun gunnery with actual service rounds is restricted annually to approximately 20-25 rounds per crew. Tracking and firing on the move is simulated with individual (Fig. 1) and vehicle size rocking platforms (Fig. 2).

There are several variations of this training aid, but the basic device consists of a metal frame onto which an individual or tank can be placed and rocked to simulate cross-country movement. It is used in conjunction with sighting and gun stabilization devices.

These frames are usually installed in classrooms, motor-park areas, cantonment areas, subcaliber ranges, at range facilities in the concurrent training areas, and on occasion, on the firing line. Divisional training areas are sometimes equipped with special training tanks which are used by all divisional units during their gunnery training.

Driver's training is a major source of vehicle wear and one that can only be alleviated partially by the use of simulators and training aids. To the extent possible the Warsaw Pact makes the maximum use of such devices.

High level training schools are equipped with elaborate driving simulators which attempt to duplicate various driving conditions with motion picture films, engine noise and vehicle pitch, cant and vibration. At lower levels go-carts and driveable simulators (Fig. 3), with duplicate controls, teach basic rules of the road and limited cross country navigation. The use of simulators in addition to obviously eliminating vehicle wear also provides a cost savings in fuel and parts.

Fig. 3. Driveable Simulators.

Fig. 4. Cutaway Simulator of BTR-60PB.

Some of the more common devices and aids currently in use include:

• The TOPT training turret is used to teach conduct of fire against fixed, disappearing, and moving targets during day and night. Additionally it is used to train target reconnaissance, range determination, rules of fire, loading and firing the maingun and machinegun, and radio communications.

The TOPT consist of a housing (hull) on which the turret is mounted. To simulate movement of the tank the device is mounted on a motorized rocking platform that can oscillate vertically and horizontally. The hull and turret are welded frames of sheetsteel.

Inside the turret are mockups of the gun with a pneumatic device for opening the breech and ejecting the training (dummy) round, a stabilizer, a machinegun, a gunner's telescope or a night sight, a commander's periscope, and a tank intercom system. Other training devices such as firing simulators can also be incorporated into this basic device.

• "Skeleton Operating Stands," full scale, cutaway simulators, (Fig. 4 and 5) provide a means of teaching simultaneously large numbers of trainees "how to dismantle and service air cleaners, and fuel oil and lube oil filters . . . installations and checking the adjustment of the clutch, and high-pressure fuel oil pump, proper operation of CBR and fire-fighting equipment."

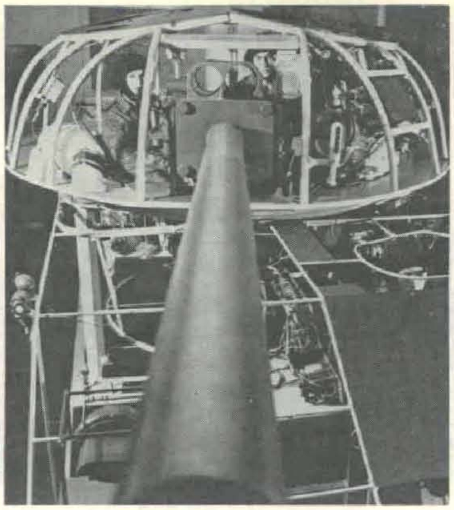


Fig. 5. Cutaway Simulator of T-55 Tank.

That these elaborate simulators are cost effective is amply demonstrated by this evaluation: "Making the design of the stands more complicated pays for itself a hundred-fold when training personnel."

JOHN B. HALLEY is an intelligence research specialist at the U.S. Army Foreign Science and Technology Center in Charlottesville, VA. He entered duty in 1962 as an Armor officer and attained the rank of major before leaving active duty last year. His assignments have included troop duty in Korea, Vietnam, and Germany. Additionally, he has been specializing in Scientific and Technical Intelligence for the last eight years.

Having the student observe and perform skills in a controlled learning environment allows him to acquire and sharpen maintenance and manipulative skills without the hazard of damaging or lowering the readiness status of a combat vehicle.

The use of these and other training aids does not eliminate the use of actual equipment. It assists in reducing the training burden the unit's combat vehicles are required to carry. This reduction, while not eliminating the fair wear and tear, does assist in relieving the pressure and helps to keep the unit's material readiness at acceptable levels.

Copperhead: Designed to Stop Enemy Armor

(Continued from page 9)

cant which maintains a clockwise projectile spin rate higher than the body natural frequency. This prevents roll resonance from occurring during flight and permits liberal tolerances in vane fabrication. The tail fins provide aerodynamic stability during the ballistic portion of flight and aerodynamic control during guided flight.

For a ballistic trajectory, the projectile will continue to fly a non-rolling ballistic trajectory until target acquisition is accomplished. If a glide (FUFO) trajectory has been selected, the seeker gyro is placed in a free mode (i.e., it acts as an inertial reference) at the same time the wing deployment command is given. Concurrently the auto-pilot initiates an attitude hold mode in which vane commands are computed to keep the projectile aligned with the gyro. In this mode the projectile will glide at an angle which is less than that established by the gyro spin axis attitude. The projectile will fly in this non-rolling glide mode until target acquisition occurs.

Target acquisition occurs when laser energy at the proper code is detected by the seeker. Upon acquisition, seeker gyro track is begun and the gyro is slewed toward the target. The guidance electronics compute torquing commands for the seeker gyro which are proportional to the line-of-sight angular error. The gyro slew mode of operation is maintained for a sufficient period of time to permit nulling of any initial pointing error, then proportional navigation guidance and gyro track are initiated and warhead electrical arming is completed. At this point the fuze arming function is complete, and the warhead will detonate upon target impact. Bias is added to the proportional navigation guidance commands to compensate for trajectory droop caused by gravity (which can result in the projectile impacting short of the target).

Warhead detonation is triggered at target impact by either a direct impact sensor mounted inside the optical dome on the laser detector assembly or by any one of the six shock wave sensors (SWS) attached to structural bulkheads. The SWS detect shock waves caused by grazing type impacts. The shaped charge warhead jet will penetrate the target, and the blast and fragments produced by detonation will assist in achieving the target kill.

Interoperability is one of the goals for Copperhead. The round which is designed for the M109A1 self-propelled howitzer and the new M198 towed howitzer has also been fit tested in the U.S. M114 towed howitzers, in the French 155 a Grand Cadence De Tir (GCT) self-propelled howitzer and the British, German, Italian SP-70 and FH-70 howitzers. Slug firings are planned and underway in these allied guns to demonstrate interoperability.

At press time Copperhead has had 16 successes of its last 18 firings. Included among these have been firings utilizing RPV designation as well as hand-held laser designation, and against multiple targets illuminated with different laser codes. Tests have been successful at ranges of 4, 8, 12, and 16 kilometers against both static and moving targets. (This was dramatically demonstrated to the Secretary of Defense in Precision Guided Munitions demonstration 12 Dec. 78 at White Sands Missile Range where two projectiles were fired for the press.)

The ability of the cannon artilleryman to add his weight as a meaningful contributor to stopping enemy armor is becoming reality thanks to Copperhead.

Headquarters of the U.S. Army Medical Research and Development Command, under MG William S. Augerson, commanding general, has relocated to Fort Detrick, Frederick, MD.

The mission of Headquarters is to direct military medical RDTE and acquisition programs in the areas of disease hazards of military operations, combat casualty care, health hazards of the environment and systems, and dental health. The command encompasses 8 CONUS laboratories, 6 overseas units and a substantial contract program.

MG William S. Augerson

Two laboratories are situated at Fort Detrick: The U.S. Army Medical Research Institute of Infectious Diseases (USAMRIID) and the U.S. Army Medical Bioengineering Research and Development Laboratory (USAMBRDL). On 31 July 1978, USAMRIID was assigned to Walter Reed Army Institute of Research in an effort to effectuate efficient use of laboratory space, to coordinate management of future research, and to create a single infectious disease program. The following is a description of USAMRIID and USAMBRDL.

The *U.S. Army Medical Research Institute of Infectious Diseases* (USAMRIID), an important component of the U.S. Army Medical Research and Development Command, has the mission to conduct studies on the pathogenesis, diagnosis, prophylaxis, treatment, and epidemiology of infectious diseases.

Particular emphasis is placed on problems associated with medical defense against biological warfare, on naturally occurring diseases of particular military importance, and on highly virulent and pathogenic microorganisms, the study of which requires special containment facilities.

A complex, sophisticated, military unique program of bioscience is conducted in two buildings totaling approximately 300,000 square feet of floor space. The main building contains 23 modern laboratories which feature the latest in functional concepts, laboratory design, and safety. Safety features built into these laboratories permit studies of highly virulent, disease agents with minimal threat to research workers and complete safety for the surrounding community.

Among the many safety features are six sealed microbiological cabinet systems, ultraviolet barriers, personnel safety suits, differential negative air balance throughout the suite systems, filtration and incineration of all exhaust air, and special clothing change rooms. These distinctive microbiological laboratories provide a unique resource among laboratories in the Free World for the safe study of highly virulent diseases.

The main Institute building contains a 15 bed general medical treatment ward, an outpatient treatment clinic and a 16 bed research ward which can be isolated into a self-contained environment for volunteer studies. Within this complex, a special P-4 patient containment area is available to safely house, diagnose and treat patients who may have been accidentally exposed to dangerous and infectious diseases such as Lassa fever virus.

The Institute Annex contains equipment for the quantitative administration of vaccines and/or microorganisms by the respiratory route to man, other primates and small laboratory animals. Two environmentally controlled aerosol chambers with connecting hood systems can safely hold 2,500 guinea pigs in individual cages, 250 primates or 25,000 mice.

Auxiliary laboratory rooms have been modernized to conform to the operation and safety standards of excellence found throughout the main building. Other annex space has been converted into a physiology laboratory where temperature, humidity and noise levels can be controlled for study of the effects of infectious diseases on cardiac, respiratory, and other physiological functions; laboratory animal holding facilities; and microbiology, virology, serology, and immunology research laboratories with supporting services and animal rooms. These can also be utilized at the P-4 containment level.

The Institute research program is designed to provide the military forces of the United States with better methods of medical protection against infectious diseases, those due to either naturally acquired microorganisms or those intentionally disseminated.

The program may be subdivided into four major areas. First, the development of immunoprophylactic measures constitutes the major portion of the research program since the ideal medical defense against disease would be to immunize an entire population. The Institute conducts a vigorous research program to develop new and improved vaccines and toxoids, and to develop the necessary methodology for large scale commercial production of these biological products.

Within this program, research is directed toward improving immunogenic response to vaccines by application of new concepts, improving the safety of the vaccines, determining their most effective route and dosage and developing information whereby irradiation-exposed victims can be immunized safely with existing vaccines. New initiatives in the vaccine program include:

• *Hexavalent Botulinum Toxoid:* A new toxoid product is being developed with improved specificity and reduced reaction rates. No other agency has the capability to perform research using this highly lethal agent.

• *Anthrax Vaccine:* Investigations are underway to improve the present vaccine in order to reduce the high rate of reactions and the time period required for the recipient to become fully protected.

• *Congo/Crimean Hemorrhagic Fever:* No vaccine currently exists for this disease. Studies are underway to develop a vaccine against these viral infections. (20 percent mortality in some outbreaks.)

• *Korean Hemorrhagic Fever:* No vaccine exists and, in fact, the virus has never been isolated nor fully characterized.

• *Rift Valley Fever Vaccine:* Although an existing vaccine protects recipients, product improvement is underway as the vaccine does not meet today's rigid safety standards. A recent outbreak in Egypt, reported in November 1977, justifies acceleration of this effort, officials say.

• *Chikungunya Virus Vaccine:* A product improvement is underway as the existing experimental vaccine confers protection but does not meet requisite safety standards. Chikungunya virus causes an incapacitating illness, capable of rapid debilitation of combat forces for several days.

• *Legionnaires' Disease Agent Vaccine:* In collaboration with the Center for Disease Control, the Institute is in the process of further characterizing this bacterium, assessment of its aerosol hazard and pathophysiology in animal models, and development of a vaccine.

• *Epidemic Typhus Vaccine:* A living attenuated vaccine is currently available, but the World Health Organization and others have reservations about its safety, and possible recrudescence of the organism. A commercially produced inactivated vaccine appears to have lost its ability to protect. This Institute will attempt to produce an effective, inactivated vaccine against this rickettsial agent. Mortality is low if early medical treatment is readily available, however, fatalities in the range of 10-50 percent may occur without treatment.

• *Ebola Virus Vaccine (Marburg-like virus):* Actual work on this agent, which emerged for the first time in Africa in 1976, where over 400 cases with 70 percent fatality were recorded, is ready to start as soon as additional P-4 biohazard containment improvements in the facility can be completed. The World Health Organization has requested the Institute to undertake work against this highly lethal agent.

• *Lassa Fever Virus:* This African virus also requires a P-4 facility for biohazard containment. Work with this highly virulent agent was initiated at the Institute when patients thought to have Lassa fever were admitted. It is acquiring human convalescent plasma for both Ebola and Lassa Virus studies to protect the staff in case of laboratory accidents and for treatment of patients. The World Health Organization also supports the urgency of this project.

The second major area of research is devoted to the treatment and management of patients with infectious diseases of biological warfare importance. A major problem concerns devising methods for providing medical care to the large number of personnel that might be involved.

USAMRIID Isolation Suit

Third, the development of rapid and accurate techniques for establishing a specific etiologic diagnosis is emphasized. In addition to immunological methods employing specific diagnostic reagents, biochemical and biophysical approaches are being explored. This host response to infection is receiving intensive study as a means of developing possible new diagnostic measures.

And fourth, a study of the pathogenesis of differences in infectious diseases is being conducted with emphasis on the use of model infections in laboratory animals. Unnatural routes of entry of infectious microorganisms or bacterial toxins are also being studied due to possible significant differences in the clinical picture of a disease when exposure occurs under unnatural conditions.

To date the Institute has developed or is in the process of developing or improving the quality of 24 vaccines and toxoids. Some of these vaccines include: anthrax, tularemia, plague, inactivated Venezuelan equine encephalomyelitis (VEE), live attenuated VEE (TC083), inactivated TC-83 VEE, Rift Valley fever, Chikungunya, Eastern and Western equine encepalitis, Rocky Mountain spotted fever and Q fever.

The most publicized use of a vaccine developed by the Institute has been the live attenuated VEE vaccine which was used to immunize horses to curb the spread of VEE from Mexico into Texas in 1972. The availability of this vaccine is credited with averting

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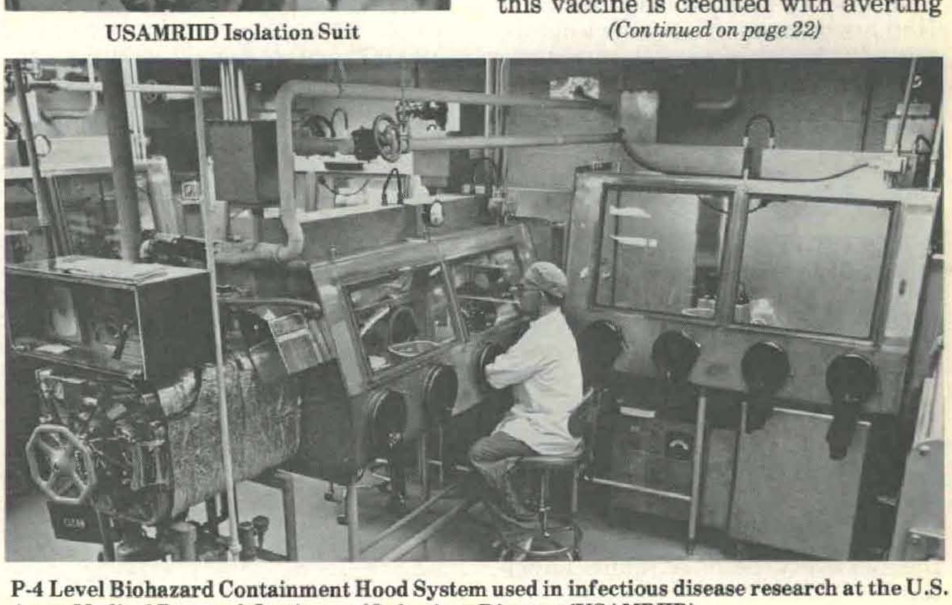


P-4 Level Biohazard Containment Hood System used in infectious disease research at the U.S. Army Medical Research Institute of Infectious Diseases (USAMRIID).

Medical R&D Command Shifts Headquarters to Detrick

(Continued from page 21)

a major animal disease epidemic. It is also demonstrated that a vaccine, though specifically developed for military purposes, can benefit the civilian community.

The Institute has made significant contributions to the study of bacterial toxins and toxoids by developing sophisticated procedures to characterize and identify physical-chemical values of the molecular structure of straphylococcal enterotoxin B (SEB).

An antigenic but nontoxic peptide fragment was identified as well as the toxic by nonantigenic fragment. It is believed that the antigenic, nontoxic peptide could revolutionize present concepts of toxin-toxoid protection.

A key factor in the study of infectious disease concerns utilizing effective agent- animal models to define basic disease mechanisms. The Institute has developed 68 models, one of the most notable being the squirrel monkey/influenza model for the study of respiratory infections. At the request of the National Institutes of Health, the Institute used this model to evaluate commercial swine flu vaccines during the highly publicized program in the spring of 1976.

Studies designed to differentiate metabolic alterations induced by septic and nonseptic stress indicate that infection initiates changes in plasma lipids, proteins, and trace metals within 24 to 48 hours which can be clearly distinguished from nonseptic stress.

These metabolic changes are being identified as early indicators of infection, leading to rapid diagnosis of infectious diseases. This knowledge reportedly can be of special importance in infections that do not respond to available antimicrobial drugs.

The Institute has an active screening program for antiviral drugs, using those which have previously been demonstrated by others to have some degree of success against less virulent viruses. These drugs are then used by the Institute of Infectious Diseases to determine their effectiveness against more virulent viruses, i.e., togaviruses and arenaviruses.

It has been shown recently that Ribavarin, known for its effectiveness in the treatment of influenza, is also effective against Pinchinde and Bolivian hemorrhagic fever infections. Because these diseases can be lethal, the discovery becomes quite important.

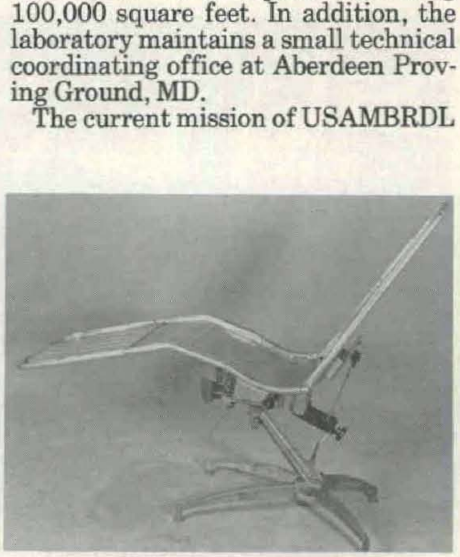
Scientific expertise and facilities at the Institute, in conjunction with the technology and safety procedures used in the study of highly infectious diseases, constitute a unique national resource which may be called upon to respond to national or international medical emergencies.

The *U.S. Army Medical Bioengineering Research and Development Laboratory* (USAMBRDL), the second subordinate unit of the U.S. Army Medical Research and Development Command at Fort Detrick, was established in 1972 by merger with the U.S. Army Medical Equipment Research and Development Laboratory.

In 1973, the Bioengineering R&D Lab was directed to absorb the resources and mission of the U.S. Army Medical Environmental Engineering Research Unit. This action was completed with the simultaneous discontinuation of the Environmental Engineering Research Unit and the formation of the Environmental Protection Research Division within USAMBRDL late in 1973. The Environmental Engineering Research Unit had been formed in 1972, and represented an Army "first," since its mission was to conduct continuing environmental health engineering research in support of The Surgeon General's responsibilities in air and water pollution control and solid waste and pesticide disposal. By September 1974, all personnel and material resources allocated to the new command had been relocated to Fort Detrick.

Today, the Army Medical Bioengineering R&D Lab facilities are housed in five separate buildings and a wastewater pilot plant on Fort Detrick, with total floor space exceeding 100,000 square feet. In addition, the laboratory maintains a small technical coordinating office at Aberdeen Proving Ground, MD.

The current mission of USAMBRDL



USAMBRDL Field Dental Chair

MEASURING dissolved oxygen in wastewater treatment projects at USAMBRDL.

includes the conduct of engineering research and development of military medical equipment on a continuing basis for the Army and on an "as required" basis for the Navy and Air Force. The lab is responsible for the construction of initial pilot prototypes, test models, and the production of limited quantities of medical materiel to support urgent military requirements.

Further, it conducts The Surgeon General's RDT&E program in integrated pest management systems to include materials, methods, equipment and concepts.

The lab also conducts environmental health research in support of The Surgeon General's responsibilities in air and land, water, pollution control and solid waste, hazardous waste, and pesticide disposal. This includes management of the intramural and extramural portions of the USAMBRDL Environmental Quality Protection Program.

The laboratory's total budget during FY78 was about \$6 million, approximately half of which was devoted to contract monitoring efforts. The laboratory functions in an unstructured manner capable of maximum responsiveness and flexibility. Structurally, the unit consists of a headquarters element and five operating divisions designed to carry out or support the various mission requirements.

The Engineering Division is engaged primarily in the research, development, test and evaluation of combat material. This program consists of exploratory development, advanced development, and engineering development.

Although some of the equipment developed by this division is used in fixed medical facilities, primary emphasis is on equipment for use in field medical treatment units.

One item which has had worldwide application is the hypodermic jet injector apparatus. Designed specifically for immunization of large numbers of people, it is used routinely at U.S. Army Disaster Assistance Relief Missions.

During the flood disaster in Malaysia in 1971, more than 250,000 people were immunized against typhus and cholera and in the Republic of the Philippines more than 350,000 immunizations were given during a 3-week period using this equipment.

A larger 3-year program was sponsored by the World Health Organization and the United States Agency for International Development. The majority of the 120 million inhabitants of Western and Central Africa were vaccinated against smallpox using this device, and more than 15 million children were vaccinated against measles.

Typical medical devices being developed or evaluated by the Engineering Division in the current program include: Casualty Cold Weather Evacuation Liner, Environmental Protection Container (for Medical Supplies for Cold Weather Operations), Modern Field Dental Assembly, Improved Field Sterilizer, Modern Field Optometry Set and Patient Decontamination Unit.

The Applied Research Division has the responsibility to conduct The Surgeon General's RDT&E program in integrated pest management systems. This includes materials, methods, equipment and concepts. This division also supports the efforts of the Engineering Division by performing developmental testing and engineering design and durability evaluations.

Some of the more significant inhouse research programs of the Applied Research Division include development of: Aerial Pesticide Dispersal System, Portable Pesticide Dispersal Units, Controlled Release Pesticide Formulations, Solid State Portable Mosquito Light Trap, Biological Control for Medically Important Arthropods, and Methods for Control of Mosquitoes in Dredge Disposal Areas.

Of particular interest is the division's effort to identify a suitable commercial helicopter-slung dispersal unit for applying liquid insecticides. What is desired is a unit capable of doing an effective job in combat situations which will not require modifications to existing aircraft.

The Environmental Protection Research Division conducts in-house research and plans and monitors contract research. Jointly supported research efforts with the Environmental Protection Agency, the National Aeronautics and Space Administration, the Department of Health, Education and Welfare, and elements within the Department of Defense are being utilized.

The research programs are reviewed for scientific credibility and approved by the Committee for Military Environmental Research of the National Research Council. Current research includes Environmental Criteria for Munitions, Advanced Wastewater Treatment, Wastewater Reuse, Microbiological Assessment and Treatability, Analytical Methods, Pesticide/Hazardous Waste Disposal and Occupational Health.

The division's work in munitions criteria development is representative and typical of these efforts. The objective is to assemble or develop the scientific data base from which environmental criteria can be established for air and water pollutants unique to the Army's munitions industry.

This data base will assure compliance with Executive Orders, the Clean Air Act, and the Water Quality Act and facilitate cost effective pollution abatement at Army Ammunition Plants.

Research for munition-unique pollutants require a chemical characterization of wastes, environmental fate/persistence studies, mammalian and aquatic toxicity studies for water pollutants, and mammalian and phytotoxicity studies for air pollutants.

The majority of the research to date has been on pollutants resulting from the production, load, assembly, and pack of trinitrotoluene, RDX/HMX, nitrocellulose, nitroglycerin, and white phosphorus. Future work will involve research on additional pollutants resulting from the manufacture of selected smokes, obscurant compounds, propellants, primers, pyrotechnics, and other explosive related chemicals.

The laboratory's Administrative and Logistics Divisions play an active role in the unit's research program. The Logistics Division is responsible for the fabrication of medical material designed by the research and development divisions. The Administrative Division is tasked with the responsibility of providing computer and statistical sciences services, technical information support and graphic arts capabilities.

The U.S. Army Medical R&D Command headquarters, the Institute of Infectious Diseases, and the Medical Bioengineering R&D Laboratory are only a small part of the complex of facilities at Fort Detrick, MD, but together they are doing their part to make Fort Detrick one of the major military-civilian research establishments in the nation.

Jack Frost-79 Tests Equipment in Cold Weather

The U.S. military's Jack Frost-79 joint readiness exercise in Alaska, 10 Jan.-15 Feb., featured the introduction, on a large-scale basis, of a number of new Army items—the TOW and Dragon antiarmor weapons, the MA-80 1¼-ton pickup truck, and an array of new medical field clearing-station equipment.

Though all the equipment has previously been tested under cold weather conditions, and is in use by Army units in certain parts of the United States, this was the first time the equipment was used on a large scale in cold-weather operations.

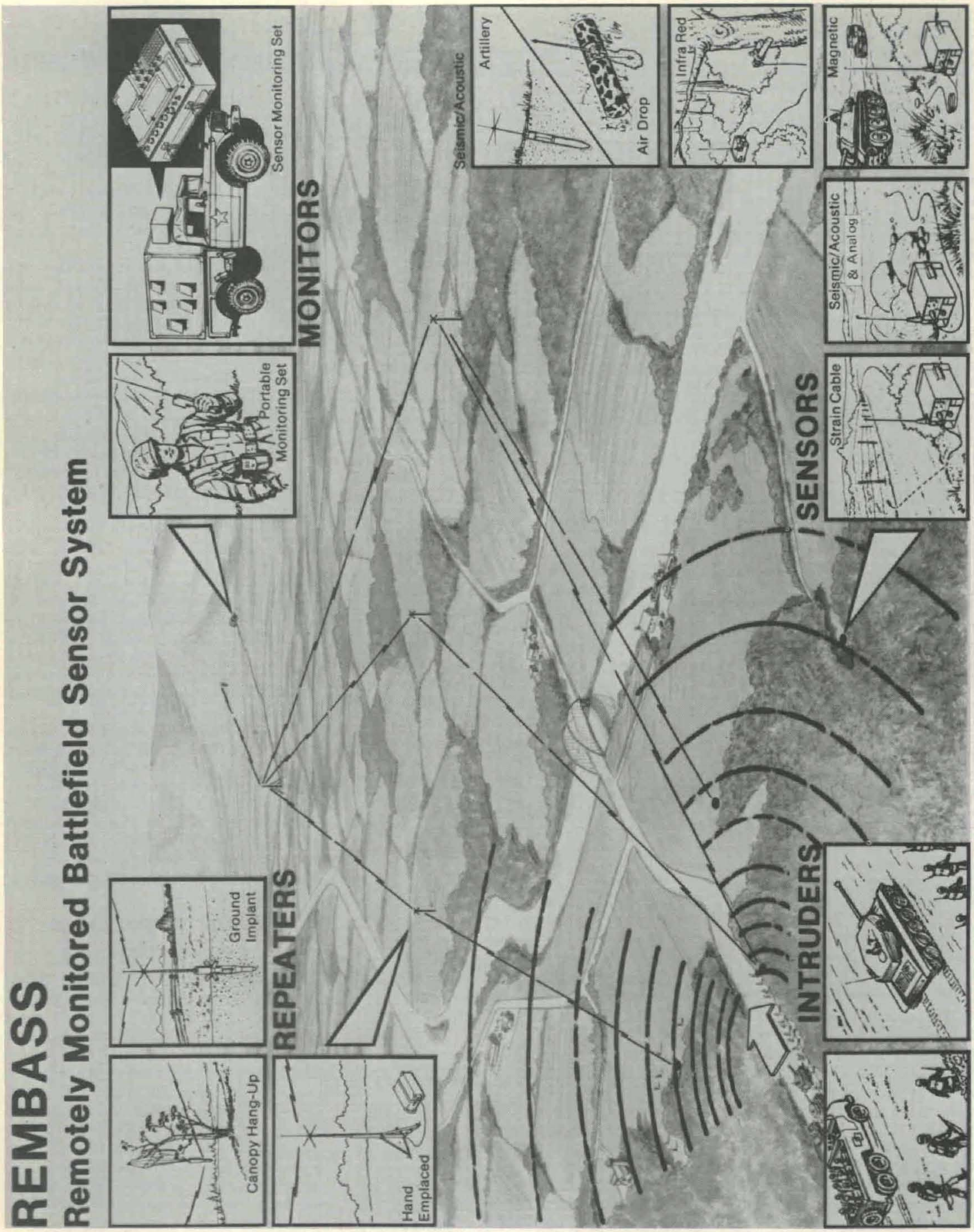
The TOW and Dragon wire-guided missiles have been in production for a number of years, but were subjected to considerable cold-weather experience in the hands of the "unfriendly" forces of the Army's 9th Infantry Division.

The "friendly" troops of the 172d Infantry Brigade deployed the new MA-80 pickup truck that is powered by a 318-cc V-8 Dodge engine. It comes equipped with both 12- and 24-volt electrical systems and a swingfire heater for extreme cold conditions. The truck currently comes in three versions: an ambulance, a personnel carrier, and as a mechanics' contact truck.

The new mobile medical field clearing station has improved equipment that vastly improves the station's capability to carry out its mission. A new X-ray unit allows rapid scanning of suspected injuries. Two new large autoclave sterilizing units capable of being run from gasoline, propane, or electricity decrease sterilization time.

Radar-Absorptive Coatings

The production of inexpensive radar-absorptive coatings for signature reduction has been a key problem area for many years. A potentially important new approach toward the solution of this problem has recently been achieved at the U.S. Army Materials and Mechanics Research Center, Watertown, MA. A new method has been established for the fabrication of radar-absorptive material (RAM) from industrial waste. Besides providing a new, inexpensive approach to RAM technology or radar-absorptive smoke, this technique also should significantly stimulate increased efforts in the ecologically important purification of industrial effluents.



REMBASS
Remotely Monitored Battlefield Sensor System
Canopy Hang-Up
Ground Implant
Hand Emplaced
REPEATERS
Portable Monitoring Set
Sensor Monitoring Set
MONITORS
Seismic/Acoustic
Artillery
Air Drop
Infra Red
Magnetic
Seismic/Acoustic & Analog
Strain Cable
SENSORS
INTRUDERS

From the gleam in the scientist's eye to tactical reality—perhaps no phrase better describes the goal of the current development of the Army's remote sensor systems. Under the management of PM, REMBASS (Remotely Monitored Battlefield Sensor System), a number of unattended ground sensor systems are being developed to provide the tactical commander with a means for extended intelligence data collection and early warning.

COL Louis Friedersdorff, REMBASS project manager, at the U.S. Army Electronics Research & Development Command, Fort Monmouth, NJ, has four sensor programs under his management cognizance. They are:

- REMS (Remote Sensors), which represents late 1960 technology, is the first generation of unattended ground sensors. REMS is a fully fielded system in use by the Army, other Services, other government agencies and friendly foreign governments.
- REMBASS I (Remotely Monitored Battlefield Sensor System) is in engineering development. Employing advanced technology, and coupled with new organizational/operational doctrine, REMBASS provides the commander with significantly better data than REMS and more flexibility in how it is collected. This system will replace REMS in the near future.
- REMBASS II, in recognition of rapidly developing technology, has been established as a separate development program. As advance sensor concepts prove their merit, they will be developed and integrated into REMBASS I, through the REMBASS II program.
- PEWS (Platoon Early Warning System), having successfully completed DT-II and OT-II testing, has entered production. It affords small operational units an early warning system which additionally helps them accomplish assigned mission objectives.

These programs owe their origin to a committee of top scientists convened at the direction of former Secretary of Defense Robert S. McNamara in 1966. Known as the Jason Committee, the committee was asked to examine and recommend solutions to a prime problem in the growing conflict in Vietnam— namely, how to halt, or at least impede, the flow of men and material from North Vietnam to enemy forces located below the Demilitarized Zone in South Vietnam.

Manpower and supplies flowed south mainly via the network of roads and paths known as the Ho Chi Minh Trail. Obscured by jungle and in generally adverse terrain, the trail was not vulnerable to normal types of reconnaissance, such as from airborne platforms.

It was clear that the problem of interdiction was one of being able to pinpoint enemy positions and movements in a timely fashion, rather than one of tactical response.

The Jason Committee recommended both an air supported barrier system and a conventional ground barrier system be established.

Based on this recommendation, the Defense Communication Planning Group (DCPG) was established at the DOD level. Cutting across Service lines, it was afforded the highest national priority, and was provided with sufficient funds for major development efforts.

The conventional barrier system was to be developed across the DMZ, using the code name DUEL BLADE. It was called the "McNamara Wall" by the press, and included pressure-type sensors, physical obstacles, mines and tactial troop units, operating from strong points. While the original concept was never fully implemented, many types of sensors were placed in operation in Vietnam on an extremely high priority basis.

The air-supported barrier system was deployed in Laos under the name IGLOO WHITE, with antipersonnel and antivehicular subsystems, and employed no ground forces.

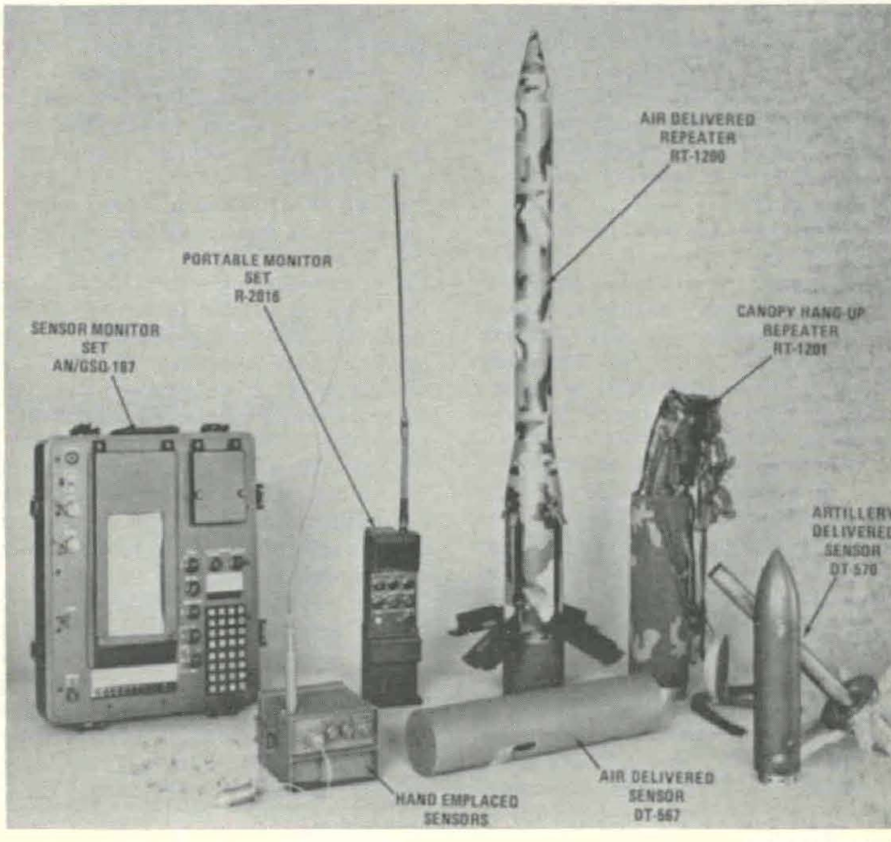
During the battle at Khe Sanh, resources intended for the antipersonnel portion of IGLOO WHITE were diverted to support the Marine Corps forces. Their success was so marked that the DCPG was directed to procure sufficient sensor equipment necessary to support the in-country sensor program recommended by General Westmoreland. This program became known as DUFFEL BAG.

Available hardware was adopted, where possible. Different technical approaches were pursued, sometimes concurrently, to insure success. DUFFEL BAG generated a requirement for sizable quantities of sensors of different types. Due to frequency band overlap, a need for a more flexible data trans-mission subsystem became obvious. The subsystem was redesigned, and a family of common modules for different types of sensors was introduced. Hand-emplaced sensors were evolved in several refinements of packaging and operational features. The Deputy Secretary of Defense, Mr. Nitze, approved General Westmoreland's plans for sensor use in a wide range of tactical applications. The ground sensor tactical mission expanded dramatically, and virtually every U.S. ground combat unit in South Vietnam used sensors to detect the enemy.

The Defense Communications Planning Group was redesignated as the Defense Systems Planning Group in 1970 and in 1971 the Group was dissolved and responsibility for the ongoing sensor programs transferred to the Services.

In April 1971, the responsibility for the sensor system assets retained by the Army was assigned to the Project Mana-

(Continued on page 26)



REMBASS

(Continued from page 25)

ger, Sensor Materiel Operations. Selected equipment components were identified and grouped as the South East Asia Operational Sensor System (SEAOPSS).

SEAOPSS was type classified Standard B, for use only in Southeast Asia, and no modifications or improvements, except as required to correct operational deficiencies, were authorized. Any further sensor system improvements necessary were to be developed as a system under the title of REMBASS.

The Army's REMBASS requirement was formally approved in 1971, with management responsibility assigned to PM, Sensor Materiel Operations in May 1971, and this office was redesignated as PM, REMBASS in May 1972.

Early in 1973, responsibility for South East Asia Operational Sensor System hardware management was transferred to several of the Army Materiel Command major subordinate commands. Subsequent responsibility for SEAOPPS was centralized at PM, REMBASS in May 1976. SEAOPSS was redesignated as REMS in 1976.

REMBASS I. Advanced Development (AD) of REMBASS commenced in 1972, with the objective to develop a system for meeting Army requirements. This included developing equipments capable of operating in worldwide military environments.

Also included was the intent to capitalize on a rapidly expanding sensor technology to develop sensors which were more effective and versatile. Of particular importance was the concept of "smart" sensors which could classify targets as well as detect them.

Because of the "newness" of the underlying technology, the development effort included many tangential aspects such as establishing a target signature data base; investigating candidate target classification and location techniques; developing high shock-resistent crystal oscillators; and developing lithium-organic batteries to meet low temperature requirements.

As a result of a 9-month DT/OT I conducted at Fort Bragg, NC, (and subsequent special testing), the decision was made to enter engineering development with a basic system (REMBASS I) and to continue a parallel advanced development effort (REMBASS II).

Three competitive contracts were awarded for an engineering development concept phase. These studies focused on recommending the design approach for REMBASS I. From these efforts, RCA was selected to enter the fabrication phase of engineering development as prime contractor.

TABLE 1 -- REMBASS I EQUIPMENT

TYPE	NOMENCLATURE	DESCRIPTOR
Sensors	DT-561/GSQ	Hand emplaced magnetic detector
	DT-562/GSQ	Hand emplaced seismic/acoustic classifier ①
	DT-563/GSQ	Hand emplaced analog sensor
	DT-565/GSQ	Hand emplaced IR detector
	DT-567/GSQ	Air emplaced seismic/acoustic classifier ①
	DT-570/GSQ	Artillery delivered seismic/acoustic classifier ①
	DT-573/GSQ	Hand emplaced wheelbase classifier ①
Repeaters	RT-1175/GSQ	Hand emplaced 1-channel digital
	RT-1200/GSQ	Air delivered 1-channel digital (spike) ②
	RT-1201/GSQ	Air delivered 1-channel digital (canopy) ②
Readouts	AN/GSQ-187	Sensor monitoring set (radio receiver, display, recorder)
	R-2016/GSQ	Portable radio receiver

Notes:

① Classify targets as falling into one of three groups: Wheeled Vehicle, Tracked Vehicle, or Personnel.

② Spike implants into ground, canopy "hangs-up" in trees.

The system selected for fabrication will include a variety of single-target classifying sensors and detection-only sensors, single-channel repeaters, a sensor monitoring set (which includes two radio receivers, a printer and a temporary visual display), and a portable combined receiver-display.

REMBASS I includes sensors that are emplaced by hand, airdropped, or delivered by artillery. The system is operable in a worldwide environment. Equipment can be selected to suit the tactical situation and operated in various system configurations to provide the field commander with an all-weather, day-night, early warning (alerting), surveillance, and target development capability.

REMBASS, in its various system configurations, will complement and supplement other manned or unmanned surveillance systems. A typical system employment concept is illustrated on page 24.

Table 1 provides more detailed information on the particular REMBASS I equipments. Representative equipments are shown on page 25. The system development has been completed through the prototype stage. A DT II and an OT II are planned for FY79 through 81, and an initial operational capability for FY83 is anticipated.

REMBASS II is really an extension of REMBASS I which allows deployment at a brigade or division level in over-the-hill, stay-behind and built-up area roles. REMBASS II contains a special processing unit, multi-channel airborne repeaters, and artillery delivered repeaters for employment in over-the-hill roles.

It contains imaging sensors for target identification, as well as commandable sensors for employment in such extended life roles as stay-behind and border-surveillance operations. The REMBASS II program is currently deferred due to funding constraints.

PEWS consists of 10 sensors, two readout units and two wire modules, all packaged in two canvas carrying bags (see photo at top of page 27). The sensors detect both seismic and magnetic signals, and through combinational logic, classify intrusions as caused by personnel or vehicular targets. The system is operable in a variety of different types of terrain and environmental conditions.

PEWS will augment listening posts, outposts and other forward area security forces. It is intended not only to provide early warning of attempted intrusions to isolated small infantry units but also to support rear-area combat operations which are the responsibility of the military police.

PEWS will permit surveillance of areas

impossible to cover with line-of-sight dependent devices, and has been found extremely effective when used in conjunction with such other devices as NODLR and ground surveillance radars. A production contract, leading to an initial operational capability in FY81, was signed with International Signal and Control Corp. in July 1978.

ORGANIZATIONAL AND OPERATIONAL CONSIDERATIONS. At this time, four Army Divisions are supplied with REMS equipment. They are the 101st Airmobile, the 82d Airborne, the 2d Armored, and the 25th Infantry. One of each type Division was selected to enable the Army to obtain a range of sensor experience and to provide the broadest possible inputs into further development.

Of these Divisions, the 2d Armored recently served as a test bed for a new organizational concept, the Combat Electronic Warfare and Intelligence Battalion. Under this new concept, the CEWI Battalion provides centralized management and utilization of organic combat intelligence systems. As such, it falls under the purview of the G2. Within the Electronic Warfare Intelligence Battalion are two remote sensor platoons. These platoons will be provided with REMBASS assets.

In actual practice the tactical use of REMBASS is limited only by the imagination of the G2. Applications are:

Area Surveillance. In a situation where the level of enemy activity over a large area (several square kilometers) is of interest, REMBASS may be emplaced in a widely spaced grid pattern to determine whether or not the enemy is maneuvering within the area.

Route Surveillance. REMBASS can be emplaced along a specific route or avenue of approach to determine the rate of movement, direction, and level of enemy activity.

Economy of Force. REMBASS can be used by the commander as an economy of force measure to provide surveillance in an area from which he has consciously shifted his forces in order to concentrate those forces in another area.

ASSEMBLY LINE for fabrication of REMBASS equipment at RCA.

PLATOON EARLY WARNING SYSTEM (PEWS) AN/TRS-2

Barrier and/or Minefield Surveillance. REMBASS can be used in conjunction with barriers and minefields to determine the level of enemy activity in and around selected areas.

River Crossing Bridge Surveillance. REMBASS can monitor river and bridge crossing sites to detect enemy crossing activities or to monitor the level of enemy activity around potential sites prior to undertaking a friendly river crossing operation.

Landing Zone Drop Zone Surveillance. REMBASS can be emplaced at positions adjacent to potential landing zones several days prior to an operation. Information furnished by the sensors can be used to decide whether or not the landing zone will be used. This application would also be useful for airborne drop zones. It can be used to provide early warning of suspected enemy activity in rear areas where air landed activities are possible.

Target Development. REMBASS can be emplaced in areas likely to be selected for use as assembly areas, headquarters and supply points to provide information on occupancy and levels of activity. Information obtained from REMBASS can be used to plan the desired type of reaction and the time the target would be most vulnerable to an attack.

Cueing. REMBASS information can be utilized to cue target acquisition systems such as SOTAS and the Battlefield Surveillance and Target Acquisition Radar which can be employed to verify or clarify enemy actions or indications.

Surveillance in Urbanized Terrain. Urbanized terrain surveillance requires a combination of the above sensor applications.

PEWS, as presently envisioned, will be organic to small cavalry, infantry, and MP units. As an early alerting system, it can be used by these units for such missions as:

Tactical Perimeter Protection. Emplaced around specific locales, such as bivouac areas or LPs, PEWS supplements sentries by alerting them when incursions occur.

Ambush Development. Emplaced along a suspected enemy route, PEWS can alert the unit as the enemy nears his position.

(Continued on page 28)

TYPICAL HAND-EMPLACED sensor, with all codes set, is planted in a hole where it will be covered by grass and leaves, leaving only the antenna exposed.

A New Approach for Treating Adhesive Capsulitis

By CPT Thomas F. Hendricks, AMSC

A new technique for the treatment of adhesive capsulitis, developed at Patterson Army Hospital, Fort Monmouth, NJ, has been remarkably successful. Capsulitis, a painful and disabling condition suffered by older people, is often referred to as "Frozen Shoulder." It usually follows a minor injury to the shoulder and subsequent reduction in its use.

The routine treatment of capsulitis is heavily dependent on ultrasonics and hot-pack heating of the affected joint combined with patient exercise. However, in the majority of cases these treatment modalities have not been successful. Patients treated at Patterson, using the new technique developed there, quickly experienced increased mobility, range and decreased pain.

Medical diagnosis of adhesive capsulitis, inflammation of the shoulder capsule, usually follows examination of a patient complaining of pain and loss of arm motion, such as the inability to raise the arm above the head or move it into the small of the back. X-rays of the shoulder display normal gross conditions and no pathological disease of the area.

The capsule is a tough, fibrous band which completely encompasses the head of the humerus. When the arm is at the side, the lower part of the capsule folds back on itself to form the inferior synovial pouch, a bulge in which the synovial fluid secreted by the synovial membrane is stored. As the arm is elevated overhead, the pouch unfolds permitting unrestricted motion and spread of the lubricating, synovial fluid.

Usually there is a considerable time delay between the onset of the symptoms and the start of treatment. Pain causes restricted activity and resulting changes in the capsule. As time passes, the condition deteriorates through loss of capsule flexibility and stagnation of the synovial fluid in the synovial pouch.

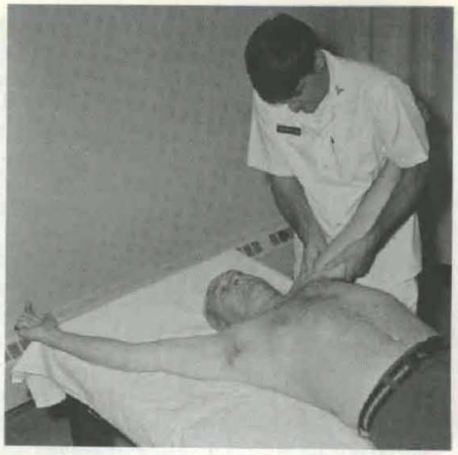
Intracapsular adhesions develop and the walls of the pouch become adherent. Extracapsular adhesions form between the outer fibers of the capsule and surrounding tissues. Arm motion becomes increasingly painful and as the patient continues to restrict mobility the capsulitis, in turn, becomes more acute. The combined effect is a tight ineffective capsule with the head of the humerous locked high in the shoulder joint.

The new physical therapy for capsulitis at Patterson Army Hospital consists of a series of manipulative exercises each designed to reduce a disabling condition in the patient's shoulder joint. Adhesions are reduced, capsule flexibility restored and recirculation of synovial fluid stimulated.

In addition, normal range of mobility in all aspects is recovered by the stretching of the surrounding muscles. Progress is limited by the severity of the condition at the time treatment is instituted and the patient's level of pain tolerance. The duration of required therapy is a function of frequency and length of treatments.

The accompanying figure illustrates generally the relative positions of the patient and therapist for the application of the exercises. Particularly important is the manner in which the patient's arm is clasped and controlled by the therapist. Exercises consist of gliding motions, thrusts, rotations and flexions applied to the arm, each time carrying the mobilizations slightly beyond the point of capsular resistance within patient's pain tolerance.

A typical case history concerns a 64-year-old male who was referred for therapy by an orthopedic surgeon one year after injuring his left shoulder. No abnormality was revealed by X-ray examination. Evaluation of the measurements of his left arm range of mobilities as a ratio of the mobility of the right arm gave approximately 50 percent in lateral elevation and 10 percent in various modes of rotation.



CPT Hendricks, AMSC, applies new physical therapy exercises designed to reduce disabling condition in the patient's shoulder joint known as capsulitis or "frozen shoulder."

The therapy described in this article was applied a half hour five days a week for three weeks. At the end of that period the patient was able to elevate his arm laterally to his ear and reach his hand to the top of the right buttock.

After six weeks the patient had recovered almost 100 percent mobility, some residual difficulty remained in voluntary internal rotation. There is ample basis for encouragement that this new therapy is effective in the treatment of capsulitis and will become accepted by physical therapists.

CPT THOMAS F. HENDRICKS, AMSC, is chief, Physical Therapy Section at Patterson Army Hospital, Fort Monmouth, NJ. He has had assignments in several military hospitals after completing his professional training at the University of Minnesota in 1971. He will welcome inquiries regarding his technique and supply further details if requested.

REMBASS

(Continued from page 27)

Rear Area Combat Operations. Protection of assets such as supply/ammo dumps may be enhanced by using PEWS.

It is considered likely that other military elements, such as artillery and signal units, will ask for PEWS in the future.

OTHER USERS. The U.S. Marine Corps now uses REMS equipment and expects to satisfy many of its future sensor requirements with REMBASS.

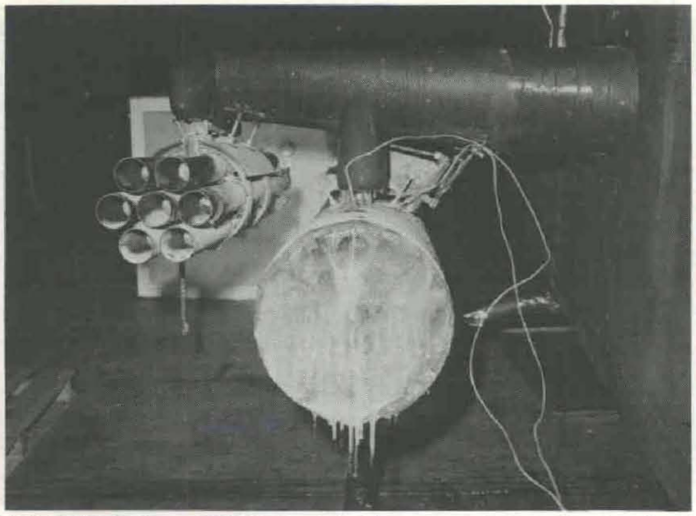
The U.S. Air Force is developing the Base and Installation Security System to meet requirements for fixed site perimeter defense and efforts have been made to coordinate REMBASS and BISS to ensure maximum commonality.

There has been a growing interest in the potential offered by REMBASS among our allies and within national, state and local law enforcement communities. Numerous requests have been received for information and/or equipment. Successful use of REMS equipment has been made by the Drug Enforcement Agency, and the Department of Justice Immigration and Naturalization Service.

The Immigration and Naturalization Service Border Patrol was provided PEWS equipment to test in the detection and apprehension of border intruders. Using a single PEWS in the Chula Vista Sector of California, they have reported the following to PM, REMBASS: "Over a 2-week period along the border under operational conditions, there were no incorrect alarms except in one instance when a large group of intruders were indicated on the receiver as a vehicle. One hundred and ten persons were apprehended during that period in an area that is normally considered to be traversed by few intruders."

Tests are being and will continue to be conducted in other Immigration and Naturalization Service Border Patrol Sectors.

The *REMBASS Project Manager* is COL Louis C. Friedersdorff, a graduate of the U.S. Military Academy, West Point, NY. He holds an MS degree in engineering from Purdue University and is a 1975 graduate of the U.S. Naval War College.



ICE BUILDUP on 2.75-inch rocket launcher, during the month of July, in Alabama, to the required thickness for tests conducted by the U.S. Army Aircraft Development Test Activity at Cairns Army Airfield near Fort Rucker, AL.

REFRIGERATION UNIT devised by USAADTA personnel to meet requirements of the Prototype Qualification Test-Contractor, to verify test criteria under a very tight test schedule, coupled with an austere test budget.

Testing the 2.75-Inch Lightweight Rocket Launcher

By Paul Revels

Aircraft ice in July? In Alabama? That was the requirement handed to the U.S. Army Aircraft Development Test Activity (USAADTA) for the Prototype Qualification Test-Contractor for the new 2.75-inch lightweight rocket launcher at Fort Rucker.

Design criteria for the launcher specified each of the 19 rockets must punch through a protective front fiberglass cover, where up to one-half inch of clear ice had adhered without destroying the protective covers of the remaining unfired rockets.

A very tight test schedule, coupled with an austere test budget, precluded dispatching a test team and equipment to a cold regions area to verify this test criteria. So, Messrs. Roy Miller and Paul Revels, from USAADTA's Advanced Methodology and Instrumentation Branch, decided to bring cold weather to the heart of the south. They included an icing subtest as a portion of the launcher flight vibration test.

The icing test was accomplished by placing an insulated box around the launcher, which was mounted on the aircraft, then cooling the box with liquid nitrogen and spraying with water to form the required ice.

Mr. James Alexander Jr., USAADTA's wood craftsman, constructed the 4-foot by 4-foot by 8-foot icebox from one-quarter inch exterior plywood with three inches of foam insulation bonded to the inside surfaces. It was constructed in two halves held together with quick disconnect fasteners to allow rapid removal from the aircraft.

A metal accumulation pan approximately two inches deep and covering the entire bottom of the box was manufactured to hold the liquid nitrogen, and a closed circuit air circulating system was devised. Approximately 40 hours were required to fabricate and test the box.

Liquid nitrogen was introduced into the accumulation pan and circulating air was blown across the pooled nitrogen to accelerate the cooling process. Approximately 12 hours and two bottles of liquid nitrogen (530 pounds) accomplished the total cooling requirement for the test.

Approximately eight hours were required to drop the core temperature of the launcher from 80° to 20° Fahrenheit, at which time water was introduced into the launcher to begin the formation of ice.

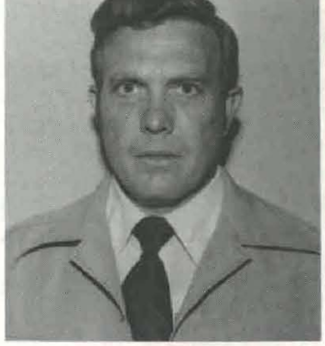
Ice accumulation was a slow and tedious process because addition of a small amount of water had a drastic warming effect on the surface of the launcher where the ice buildup was desired. Approximately four hours were required to build up the required one-half inch of ice on the launcher and cover.

During the ice buildup, the core of the launcher continued to drop in temperature approaching 10° Fahrenheit. At this point, the icing phase was complete. The box was removed in about two minutes allowing the rockets to be fired at the discretion of the test officer, CPT Patrick E. Stewart.

Normally, aircraft armament testing is done at Yuma Proving Ground, AZ, but to reduce time and transportation costs, this testing was accomplished as part of USAADTA's vibration survey.

Both sites are subordinate to the U.S. Army Test and Evaluation Command, Aberdeen Proving Ground, MD, which checks development quality of all proposed weapons and combat equipment for the Army.

The icing test for the lightweight launcher rocket firing was deemed a success and was accomplished at a fraction of the normal cost.



PAUL W. REVELS, is an operations research analyst in the Advanced Methodology and Instrumentation Branch, U.S. Army Aircraft Development Test Activity. He is responsible for advanced development test planning and coordination and evaluation of ongoing development tests. A 1965 graduate of Troy State University with major course work devoted to mathematics, physical science, and education, he has attended the University of Alabama mathematics graduate program. Additionally, he joined the NASA, Marshall Space Flight Center in 1966 and was awarded aerospace engineering status for work performed in orbital mechanics and trajectory analysis of space flight vehicles while assigned to the Aero-Astrodynamics Laboratory.

DARCOM Develops Manpower Requirement

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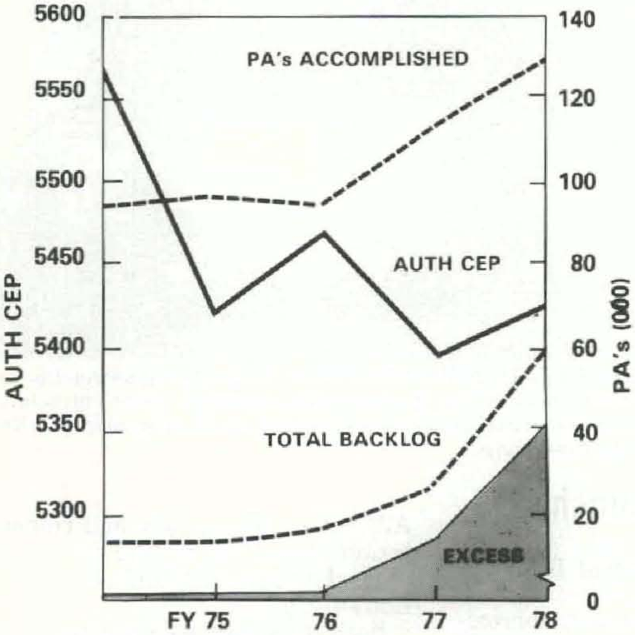
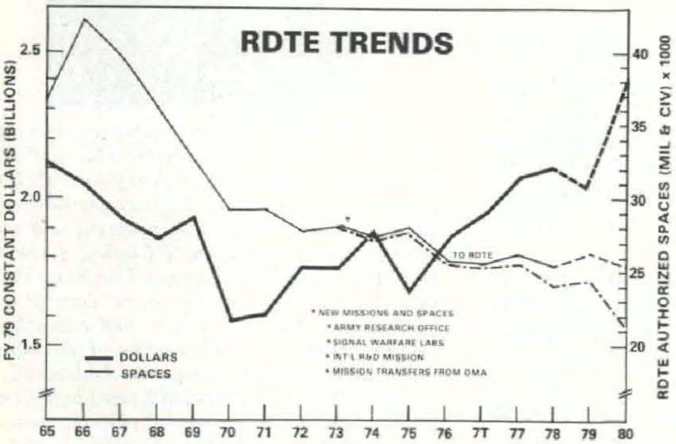


Fig. 6. Backlog of Procurement Actions

field, and the more field units use that materiel, the more workload is placed on DARCOM. The current IOE effort utilized DARCOM materiel readiness strengths over time, as compared with inventory factored by requisitions.

As before, linear regression was used, and the very high correlation resulted in an R^2 of .95—during the period 1968 through 1974 (see Figure 5). As previously stated, had the DARCOM personnel strength stabilized at the 1974 level, DARCOM's current analysis would have indicated that the command would have approximately the required staff. However, strengths continued to decline, as indicated by plot points for 1975, 76, 77, and 78 above the horizontal axis. The 12 percent deficit compares favorably with the 12.3 percent shown in Figure 3.

To lend more credence to the IOE concept, and to generally predict DARCOM's future materiel readiness workload, the Baseline study examined the historical, current, and projected numbers of line items to be managed, and requisitions to be processed. Results indicate these drivers are increasing while the numbers of people remain relatively constant.



* BEGINNING IN 1974, ADDITIONAL RDTE SPACES AND MISSIONS WERE GIVEN TO DARCOM.

Fig. 7. RDTE Trends

The study already had confirmed that mission performance was acceptable between the period 1968 through 1974. Since 1974 however, records show that workloads have increased over the '74 level, and personnel numbers have contined to decline. Since 1974, one of two situations must have happened. First, if personnel numbers had continued to decline and workloads had still been performed at an acceptable level, this would have indicated that DARCOM had had too many people throughout the 1968-1974 period. The second situation, however, would have meant that DARCOM had approximately the correct number of people between 1968 and 1974—if DARCOM's current performance is below acceptable levels.

DARCOM's performance *is* below acceptable levels, both for the materiel readiness mission and, as will be shown later, for development. Figure 6 shows the increase in the procurement action (PA) backlog due to a shortage of procurement personnel. This manpower shortage is serious because DARCOM is now serving an expanded Army force as well as armies of our allies. It is serving as the sole wholesale support element for our deployed divisions and separate brigades, and is required to respond to their demands in shorter time frames. This increased PA workload means that DARCOM is now unable to order supplies at a rate which would keep up with demands, and cannot properly perform other vitally related procurement functions required to perpetuate a viable procurement mission.

With regard to supply performance in National Inventory Control Points (NICP), there is an equally dismal picture. As we fill requisitions, depot stocks become more scarce. This results in more back orders (magnifying workload), and a general decline in our ability to process these demands within allowable time. It must be pointed out that this condition is not solely a problem of a procurement personnel shortage—there also is an understrength of the people needed in the materiel readiness commands to compute future requirements, to manage line items, catalog new lines, prepare procurement work directives, and other necessary functions.

DARCOM's depot supply system is experiencing a similar performance degradation because of a shortage of people. As an example, it now takes longer and longer to receive and report items from the manufacturer, and to stow those items into proper bins once they arrive at the dock. This results in misplaced parts, unjustified backorders, and causes wasted work and resources in the readiness commands.

Depot maintenance—another source of supply—is experiencing its share of backlogs due to the overall personnel shortage. Anything more than a 3-month backlog of materiel awaiting depot overhaul is considered to be excessive. This carryover amount remains high, and additional inhouse and/or contract people to perform this maintenance is the only answer. However, since the date of the Baseline report publication, DARCOM has received approximately 750 additional maintenance personnel, and has continued to contract out, thus the carryover is declining toward the 3-month level.

In summary, the Baseline study examined the key interrelated functions of materiel readiness. The results of that examination revealed that all important performance aspects of readiness are below standard—and attributable to a shortage of people. If a few additional people could be provided, they should be applied across the functional board, because if applied to, say, the procurement community, they would soon swamp the depot supply operation, or the NICP function. If provided the NICP, procurement or maintenance would be inundated, and result in a sort of Catch-22 problem.

Having established the fact that DARCOM's materiel readiness mission is in trouble due to a simultaneous decrease in personnel and an increase in workloads as measured by IOE, the Baseline study critically and quantifiably analyzed its research, development, testing, and evaluation mission.

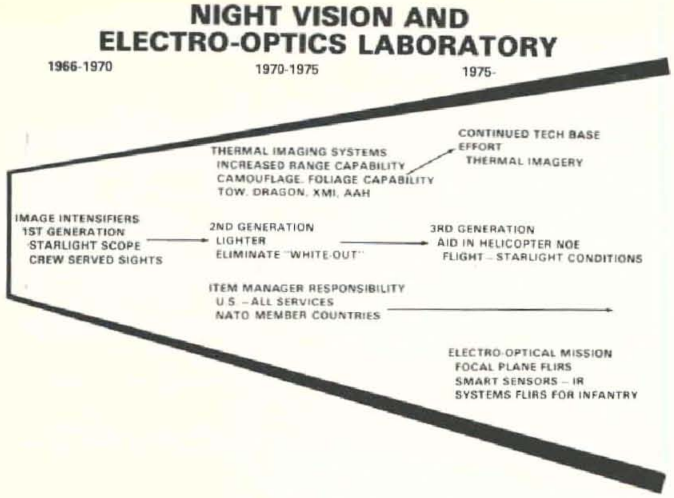


Fig. 8. NV&EOL

Figure 7 depicts the RDTE dollars and personnel trends since 1965. As was shown in the materiel readiness portion, RDTE personnel showed a steady decline since its peak during the Vietnam era. Dollars devoted to RDTE also showed a corresponding decline until 1975, at which time a sharp dollar increase occurred.

For years managers have tried to relate external drivers to the need for in-house RDTE personnel. Some have attempted to establish requirements based on total available dollars. Others have tried to relate people needs based on the numbers of weapon systems undergoing some phase of RDTE. Still others have approached the problem by attempting to relate needs to the size of the Army force, the Defence budget, or by other quantifiable means. None of these efforts, however, have paid off, and usually result in differing opinions between very dedicated people. The Baseline task group decided that the best solution would be to determine RDTE personnel requirements based on Army's responsibility to counter the national security threat.

After careful analysis, the threat can be quantified, specific scientific disciplines and technological requirements can be identified, dollar resources needed to develop/modify systems can be calculated, and both personnel skills and numbers can be determined. The careful reader will recall that DARCOM at that time, had adequate people to perform its two primary missions, to include an average of 28,840 devoted to RDTE. These development people advanced technology, developed new Army weapon systems, tested, evaluated, and otherwise set the stage for the 50 or so new systems emerging now and during the next 5-year period.

Since 1972, DARCOM's RDTE spaces have been reduced by

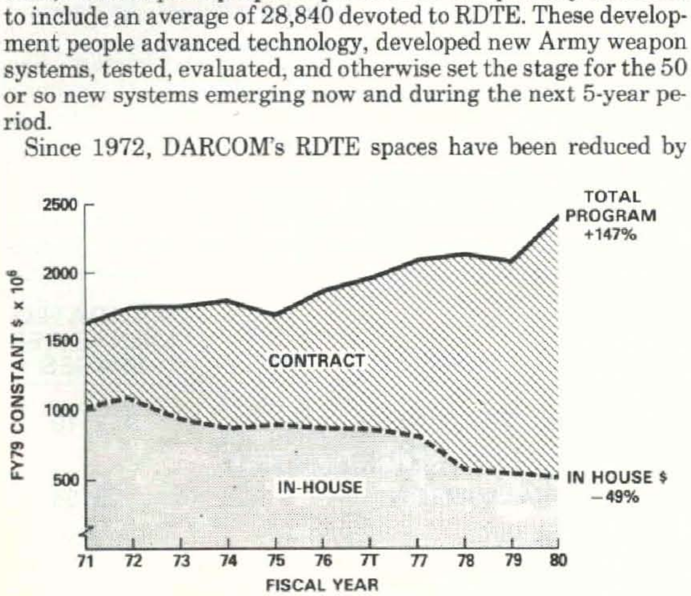


Fig. 9. RDTE Expenditures: Contract & In-House

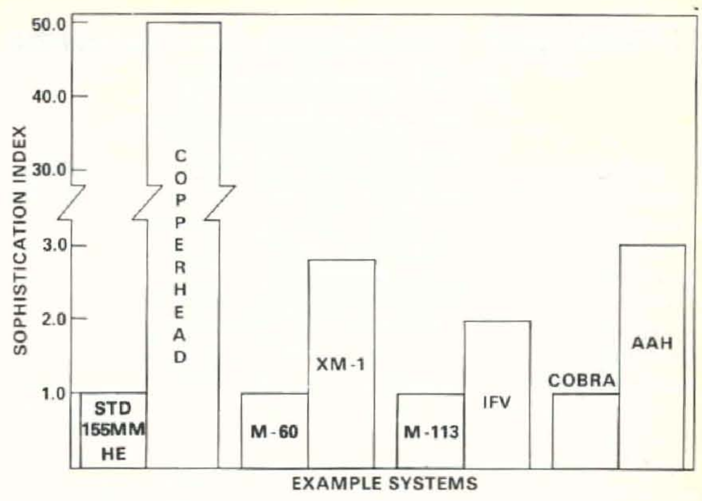


Fig. 10. Increasing Materiel Performance Through Technology

3,500, or 12 percent. This reduction would have been proper if the threat had reduced by 12 percent or more since 1972, but it has not. Instead of a decline in the threat, it has increased. The Baseline study quantified this increase, and the results of that increase are contained in a classified portion of the study. This quantification indicates that DARCOM needs more—not less—people than it had in 1972.

Technology has advanced, as it always does, since 1970-1975. Figure 8 illustrates progress made in the discipline of night vision and electro-optics. The Army needs to pursue thermal energy, 3d generation vision, smart sensors, infrared, and other efforts. In every discipline a similar need exists to continue to advance technology. With an in-house personnel decline, the RDTE community has turned to contracting out in its attempt to keep up with demands on the Army. It has been proven research and early development programs are candidates for contracting, yet, there is more to RDTE than work performed in these early phases.

Figure 9 depicts the growth in contract RDTE and a simultaneous decrease in DARCOM's in-house capability.

Mentioned earlier was the fact that today's weapon systems are continuing to be more complex. Figure 10 graphically shows this increasing sophistication by comparing the 155 millimeter

(Continued on page 32)

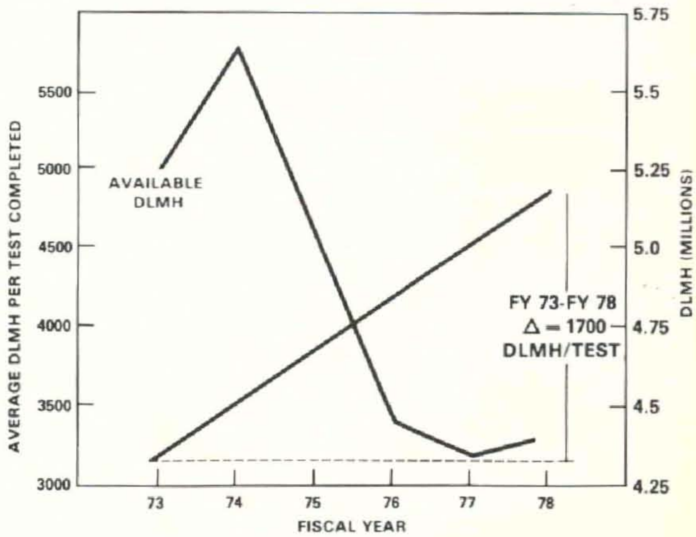


Fig. 11. Increased Complexity—TECOM Testing

DARCOM Develops Manpower Requirement

(Continued from page 31)

high explosive round with the new Copperhead—a 1 to 50 complexity factor. The new XM1 tank is more complex than the M60 now in worldwide use. The M113 Armored Personnel Carrier is much simplier than the Infantry Fighting Vehicle, as is the AH-1G Attack Helicopter when compared with the Advanced Attack Helicopter.

It is apparent that the more complex systems require not only more RDTE expertise, but also, has an increasing impact on materiel readiness requirements when viewing Integrated Logistics Support planning and execution. Fortunately, the additional line items being introduced as a result of these new systems and attendant added complexities can partly be quantified under the IOE concept; however, it is very difficult to measure the RDTE personnel requirement impact.

This is significant when examining workloads associated with functions not really suited for contracting, such as advanced development, user testing, production engineering, modification, product improvement, etc. The overall result is that DARCOM needs more skilled personnel to manage complex systems.

Another RDTE area requiring more people is in the rapidly expanding Product Improvement (PI) program being aggressively pursued throughout the entire weapon system life cycle. All major improvements result in the need to re-develop, re-test, recertify, and otherwise perform the same functions as were performed during the original RDTE cycle. Each of these which results in a repetition of RDTE tasks. Not only does this impact on the early phases of life cycle management, but it spills over into materiel readiness.

With specific reference to system (and major component) testing, the people problem is also being felt. Figure 11 shows the decline in numbers of available direct labor man hours (DLMH) between FY 1973 through 1978, and shows a simultaneous increase in testing complexity. DARCOM is now required to test integrated systems as a totality where small component shortcomings are magnified and would cause total system failures.

Another area of concern in the RDTE effort is that of DARCOM's aging scientific and engineering workforces. Under Civil Service regulations, in periods of workforce decline, incumbents having long tenure are more likely to be retained than incumbents having short tenure. This usually results in losing young, recently educated individuals who demonstrate a capability for good productivity and creativity. Although older personnel also produce and create, the younger workforce is in a unique position to advance the technological base and incorporate that technology in new weapon systems.

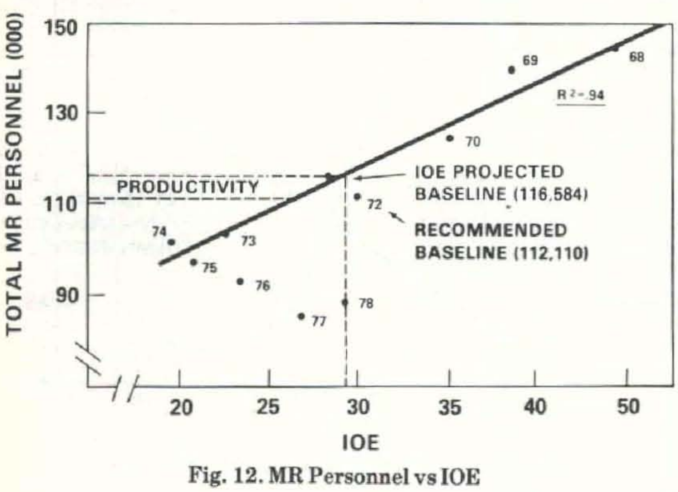


Fig. 12. MR Personnel vs IOE

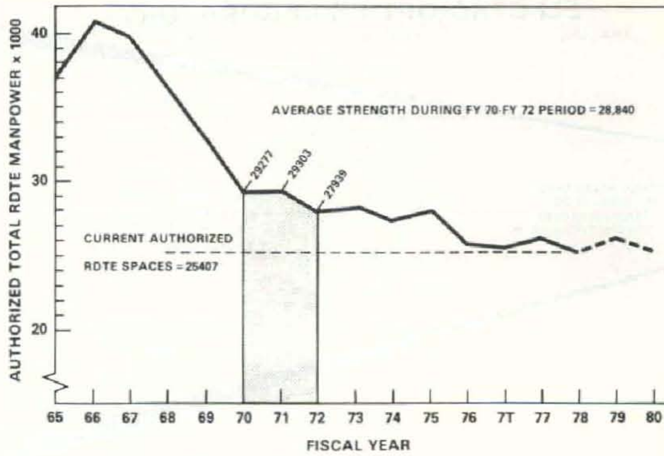


Fig. 13. RDTE Baseline

The result of a Sloan School (Massachusetts Institute of Technology) study reported that the average age of scientific and engineering personnel should be near 36. If the age would be 38 or 29, a drop in productivity and creativity would result, and would continue to decline as the average age progressed. DARCOM's personnel average age for these disciplines is nearing 44.

Summarizing the RDA aspect then, the study revealed that:

• The threat is increasing, and DARCOM needs more RDTE people to assist the Army in its vital effort to counter the National Security Threat.

• Product improvement programs are not only growing, but place more DARCOM personnel requirements on both the development and readiness missions.

• Systems continue to become more complex, which in itself, amplifies the need for additional personnel.

• Because of personnel reductions, DARCOM's RDTE capability is shrinking—and a significant portion of this requirement may not be conducive to being contracted out.

• DARCOM's scientific and engineering staffs are aging; this command requires more young talent to keep up with its needs to continue creating and producing advanced weapon systems.

The final portion of the DARCOM manpower Baseline Requirement Study then, was a roll-up of command personnel requirements as separated into materiel readiness, development, and DARCOM headquarters.

First, with specific reference to the materiel readiness mission, the study examined the volume of workload in the materiel readiness commands and the depot system to derive a personnel requirement. Central to quantification of the readiness workload is the IOE concept which uses line items managed, multiplied by requisitions processed. These two are excellent surrogates to measure the wholesale supply function, as well as the maintenance (another major source of supply) function. In addition, logistics management support staff requirements historically in-

MISSION	VALIDATED MANPOWER SPACES
MATERIEL READINESS	112110
RESEARCH DEVELOPMENT TEST AND EVALUATION	29108
DARCOM HQ	1835
TOTAL	143053

Fig. 14. FY 78 Validated Peacetime Requirement

	RECOMMEND BASELINE	CURRENT REDCON	REDCON 3 (75%) BASELINE SHORTFALL		REDCON 2 (85%) BASELINE SHORTFALL		REDCON 1 (95%) BASELINE SHORTFALL		100% BASELINE SHORTFALL	
MATERIEL READINESS	112110	3	111322	NONE	126142	14032	140961	28851	148371	36261
RESEARCH DEVELOPMENT TEST AND EVALUATION	29108	3	26093	NONE	29524	416	32955	3847	34670	5562
DARCOM HQ	1835	4	2208	373	2501	666	2794	959	2941	1106
TOTAL	143053	3	139623	373	158167	15114	176710	33657	185982	42929

Fig. 15. Total DARCOM Recommended Baseline vs Readiness

crease and decrease in proportion to changes in workloads. Thus, IOE is an excellent tool to determine total materiel readiness personnel requirements.

The volume of past, present, and projected workloads were used to determine, by linear regression, total materiel readiness personnel requirements—to include military and civilian workers—for materiel readiness commands and the entire depot system. Figure 12 shows that IOE approach projected in FY78 baseline requirement of 116,584 people. The figure, however, does not show that DARCOM had 90,279 authorized personnel assigned to the readiness mission. Thus, DARCOM needs 29,269 additional personnel to accomplish an adequate readiness mission according to standards of the 1968-1974 era.

The Baseline study, however, assumed that the workforce had gained in productivity, due in part to automation, and therefore the 116,584 requirement was reduced at 2 percent per year during FY 1975, 76, 77, and 78. This equated to 4,474 people, or a net requirement for the readiness mission of 112,110—a shortage of 21,831 people based on the FY 1978 IOE workload. The figure also shows that the FY78 workload, as measured by IOE, is equal to that of FY71 and 72.

The DARCOM development mission was next. The study established the minimum RDTE staffing required to maintain a credible RDTE effort. The study group assumed that since the threat had increased over the level of 1970-1972, the total development force should be no less than that of the same time frame. Further, the Baseline study contended that it would not be appropriate to reduce the estimated RDTE baseline for productivity since other factors, such as complexity, sophistication, test time, etc., have more than a compensating effect. Figure 13 shows that DARCOM should have at least 28,840 people dedicated to RDTE. An additional 268 people are needed to perform mandated functions vital to the development mission.

Looking at the total requirement for DARCOM then, it can be seen from Figure 14 that the Baseline Analysis established an FY 1978 validated peacetime requirement of 143,053 personnel. This includes 112,110 for the materiel readiness mission, 29,108 for the RDTE mission, and a total of 1,835 to staff Headquarters. The FY78 authorized strength is 117,200, or a personnel deficit of 25,853.

If DARCOM was provided an additional 25,853 personnel, the Readiness Condition (REDCON) of the command would be 3; Marginally Ready, as indicated by Figure 15. If DARCOM would be directed to go to a REDCON 2 condition (to be Substantially Ready), it would require a total workforce of 158,167. If the command would go to a REDCON 1 level—to be Fully Ready with at least 95 percent of the required workforce—DARCOM would require 185,982 people.

Since the completion of the DARCOM Manpower Baseline Requirement Study, the commander, DARCOM has directed the command to undertake a vigorous, all encompassing study to identify DARCOM functions which have the potential of being contracted out. Not only was it assumed that the command would not be provided the 25,853 required spaces, but with the current administration's approach to government economy, even more personnel reductions can be anticipated. Consequently, the only recourse which DARCOM has is to continue to carefully select functions—hopefully those which are mutually exclusive—and strive toward awarding those to industry, providing that accompanying economic analyses indicate that the actions would be beneficial and for the best interest of the Army.

Editor's Note: Copies of the Unclassified Baseline Study (#LD42371A) may be obtained from the Defense Logistics Studies Information Exchange, U.S. Army Logistics Management Center, Fort Lee, VA 23801

USAIDR Receives 2 R&D Awards . . .
Most Improved Laboratory, Excellence

USAIDR Commander, COL Duane E. Cutright, at ceremonies at which the Institute received Most Improved Laboratory and Excellence Awards.

The U.S. Army Institute of Dental Research (USAIDR) received two Department of the Army level awards in a ceremony held at the Walter Reed Army Medical Center, Washington, DC, 15 Dec. 1978.

Assistant Secretary of the Army for Research, Development, and Acquisition Dr. Percy A. Pierre presented USAIDR with the Army Research and Development Award for the Most Improved Laboratory. Dr. Joseph H. Yang, Principal Deputy Assistant Secretary of the Army for R&D, presented USAIDR the Army Research and Development Laboratory Award for Excellence. Also present was Dr. Eugene E. Yore, Deputy for Science and Technology.

USAIDR Commander COL Duane E. Cutright, Dental Corps, pointed out that his is the first dental unit ever to receive the Army Award for Excellence at Walter Reed. Cutright also pointed out that the enlisted troops assigned to USAIDR are among the Army's most educated. "Many hold advanced degrees, and their names appear as authors or coauthors of many of our research papers."

USAIDR is exceptionally proud of it's educational program, COL Cutright said. In cooperation with the George Washington University, the USAIDR provides a basic Army residency program for junior dental corps officers in oral pathology, periodontics, and endodontics and awards the officers a master's degree upon completion of the program. "This unique combined program allows the specialist to become intimately associated with the problems of providing dental care to combat soldiers," he remarked.

USAIDR, one of the largest dental research laboratories in the world, is one of eight laboratories organized under the U.S. Army Medical Research and Development Command, commanded by MG William Augerson, MC. USAIDR is a multi-area complex with headquarters and laboratories at the WRAMC, two laboratories at the center's Forest Glen Annex in Silver Spring, MD, and a 17-chair research teaching clinic and laboratory at Fort Meade, MD.

Among recent completed projects at USAIDR was the final testing of the "hydro scrub device." The device, invented at USAIDR, is designed to perform in slightly more than one minute the function of the traditional 10-minute scrub a surgeon performs before entering the operating room.

USAIDR is also involved in the development and testing of new dental materials. COL Cutright points out that USAIDR has emphasized research directed toward the combat soldier, and that this specific mission supports the Army's concern for the overall health of the soldier in the field.

Capsules...

Army Fields AN/TPQ-36 Engineering Models

The Army has begun early fielding to West Germany of the AN/TPQ-36, a radar that locates hostile mortars. Engineering models were flown from Norton AFB, CA, to Ramstein AFB, West Germany, where they will be deployed by crews from the 8th Infantry Division to provide operational and logistics feedback to the Army prior to the fielding of production models.

The AN/TPQ-36 radar is a highly mobile system for automatically locating hostile mortar and other high angle fired weapons and short-range rockets. It can locate weapons firing simultaneously from multiple positions, and can also be used to register and adjust friendly artillery fire. The new device is expected to greatly increase early warning capability for frontline troops.

The AN/TPQ-36 was sponsored by the Army Electronics Research and Development Command's Project Manager, Firefinder, and developed by Hughes Aircraft Co. The fully automatic battlefield radar relies on the speed and precision of a mini-computer to locate hostile weapons. It is the first such radar ever designed for use by ground combat troops.

Vehicle Transmission to Feature Metric Design

The U.S. Army Tank-Automotive Research and Development Command (TARADCOM) recently took what is believed to be a major step in the development of metric equipment.

The Command awarded a contract to General Motor's Detroit Diesel Allison Division to design and develop an advanced hydro-mechanical transmission, for combat vehicles, using metric measures (International System of Units—SI) and American National Standards Institute (ANSI) metric fasteners.

U.S. Army use of SI and ANSI metric "nuts and bolts," which meet the latest International Standards Organization standards, is considered a step toward standardization of equipment with other NATO nations and increased battlefield interoperability.

Building tank-automotive products with these metric features will not only achieve enhanced NATO standardization and interoperability but also is expected to do so at a very low cost. TARADCOM plans on using the International System of Units and the American National Standards Institute metric common-hardware, whenever workable, in all new projects.

Personnel Actions . . .

Higman Chosen as Huntington District Engineer

COL James H. Higman is the new U.S. Army Corps of Engineers district engineer at Huntington, WV. He succeeds COL George A. Bicher, who has retired.

Higman was formally the chief, Installations Planning Division, Office of the Assistant Chief of Engineers. As Huntington district engineer, he will be responsible for water resources activities and related real estate functions for central and southwestern Ohio, eastern Kentucky, a portion of mid-western Virginia, a small portion of northwestern North Carolina, and all but the northern panhandle and northeastern portion of West Virginia.

COL Higman has held staff and command assignments in the U.S., Cambodia, Vietnam, West Germany and Korea, and recently served at the Pentagon as staff officer in Requirements Directorate, Office of the Deputy Chief of Staff for Operations and Plans.

COL Higman received a bachelor's degree in chemical engineering from the University of Colorado in 1957, and a master's degree in nuclear engineering from North Carolina State University.

His military honors include the Bronze Star Medal with Oak Leaf Cluster; the Meritorious Service Medal with two Oak Leaf Clusters; and the Army Commendation Medal with three Oak Leaf Clusters.

Johnson Joins Communications Systems Agency

COL Harvey W. Johnson

COL Harvey W. Johnson has been appointed as deputy commander/deputy project manager for the U.S. Army Communications Systems Agency/Project Manager DCS (Army) Communications Systems, Fort Monmouth, NJ. He succeeds COL Francis J. Davis.

COL Johnson arrived at Fort Monmouth in October of 1978 to assume duties as deputy project manager for the Worldwide Military Command and Control Project—a position he will hold in addition to being deputy commander.

Prior to that assignment, since August 1975, he had been stationed at Sacramento Army Depot, CA, as chief of U.S. Army Communications and Electronics Materiel Readiness Command's Television-Audio Support Activity.

COL Johnson entered the Army in 1948 as an enlisted man. After basic training and communications courses at Fort Monmouth, NJ, he completed OCS at Fort Riley, KS, and was commissioned in the Signal Corps.

In 1966 he spent a year as chief, Officer Candidate Division, Fort Lee, VA. In 1968-69 he commanded the Long Lines Battalion, South, in Taegu, Korea. He was assigned to Fort Monmouth, NJ, in 1972, where he commanded the School Brigade for a period of 34 months, and in 1974 he was assigned the additional duty as secretary of the Communications-Electronics School.

COL Johnson is a master parachutist and his decorations include the Meritorious Service Medal with two Oak Leaf Clusters. He holds two master's degrees in education from Hampton Institute, Hampton, VA.

Awards . . .

BRL Selects Frankle as Kent Award Recipient

Mr. Jerome M. Frankle, a physicist and chief of the Applied Ballistics Branch at the Army Armament R&D Command's Ballistic Research Laboratory (BRL), is the 1978 R. H. Kent Award recipient. He is the 22d recipient of the award, which was established in 1956 and first presented in 1957 to honor the late Dr. Robert H. Kent, BRL's most prominent scientific leader.

The award is the highest honor presented annually by BRL in recognition of high professional achievements in science and engineering. Frankle, who has been employed for 21 years at BRL's Interior Ballistics Laboratory, now designated the Propulsion Division, was selected for his exceptional contributions in the field of interior ballistics.

Dr. R. J. Eichelberger, BRL's director, presented the award as the recipients' wife, Reva, and more than 60 fellow employes, guests and past Kent Award recipients witnessed the ceremony. A pioneer in the use of computers for simulation of interior ballistic performance of guns, Frankle developed with an associate, P. G. Baer, the first digital computer program to calculate detailed interior ballistic performance for guns.

After almost 20 years, the technical report that describes this development is still regarded as a benchmark in the interior ballistics field. Many related programs now in use by the Armed Services can be traced directly to this innovation.

In addition, Frankle devoloped a methodology for making rapid estimates of wear and service life of guns and howitzers. Used extensively since it was published in 1967, the technique was developed to improve upon R. H. Kent's 1939 method.

He is also credited with major contributions in the technological areas of recoilless rifles and high-velocity guns as well as nonmetallic rotating band technology. Most recently, Frankle has had the responsibility for the propulsion package for the Army's high priority "UP-GUN" 105mm tank gun program.


Jerome M. Frankle

Frankle graduated from the Polytechnic Institute, Baltimore, MD, in 1945 and received a bachelor of mechanical engineering degree with honors from the Johns Hopkins University in 1949. In 1973 he was elected to the BRL Fellowship.

APG Cites Achievements of 3 MTD Personnel

Three personnel assigned to the Materiel Testing Directorate at the U.S. Army's Aberdeen (MD) Proving Ground are recent recipients of awards in recognition of top performance achievements during 1977.

CPT Irwin J. Abramovitz, an electronics engineer with the Engineering Measurements and Analysis Division, received the Crozier Award for the year's most outstanding technical achievement by a military member of MTD.

CPT Abramovitz, who has been assigned to APG for almost four years, was cited for his contributions to a program in which data acquisition systems use mini-computers at test sites. He worked on the design of the system and the test prototypes.

Mr. John R. Wallace, an electronics engineer, received the Director's Award for helping develop a new tracking facility for evaluation of fire control. He was also credited with increasing MTD's data gathering through use of closed circuit television.

Mr. Dodson C. Brown was presented with the George Groak Award for "outstanding achievements" as a small arms repairer leader. His citation noted that he always met project deadlines and was imaginative in his handling of experimental projects.

Monmouth Physicist Patents New Laser Device

Dr. Aristotle Papayoanou, a Fort Monmouth (NJ) research physicist, has been granted a patent for an improved frequency-stable carbon dioxide laser, reportedly representing a significant advance in gas laser technology. The laser is useful for optical radar, laser signaling and laser communications systems.

Frequency stabilization, an important part of such lasers, is achieved with the use of boron nitride channel for containing the laser gas (carbon dioxide) and for mounting the mirrors, according to the patent.

Boron nitride is a ceramic which is easily machinable, has high thermal conductivity to carry off the heat produced by such lasers, and has a very low thermal expansion, thereby maintaining stability in the distance between end mirrors.


Dr. Aristotle Papayoanou

The laser, an acronym for light amplification by stimulated emission of radiation, is being widely applied in military communications, rangefinding and signaling.

Papayoanou, who is assigned to the Night Vision and Electro-Optics Laboratory of the U.S. Army Electronics R&D Command, has been employed at Fort Monmouth for 17 years.

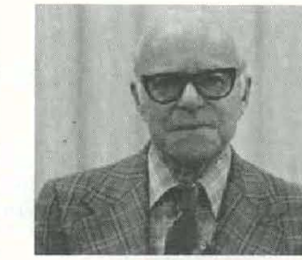
Saibel Receives ASME's Mayo Hersey Award

Dr. Edward A. Saibel, chief of the Solid Mechanics Branch, Engineering Sciences Division, U.S. Army Research Office, Research Triangle Park, NC, is a recent recipient of the American Society of Mechanical Engineers' Mayo D. Hersey Award.

Employed at ARO since 1972, Dr. Saibel was cited specifically for 25 years of outstanding contributions to hydrodynamics, lubrication, friction and tire wear, and for his service to mechanical engineering as an educator and administrator.

Graduated with a SB degree in 1924 and a PhD in 1928 from Massachusetts Institute of Technology, Dr. Saibel was an instructor at the University of Minnesota from 1927-30, and an assistant professor and professor at Carnegie Institute of Technology from 1927-57. He served also as a professor and chairman, Department of Mechanics, Rensselaer Polytechnic Institute.

Listed in *Who's Who in America* and *Who's Who in the World of Science,* Dr. Saibel has published more than 150 technical papers and has coauthored several books on elasticity and tribology. He serves on the editorial advisory board of the *International Journal of Engineering Science,* and the board of the *Journal of Mathematical and Physical Sciences.*


Dr. Edward A. Saibel

Engineer Earns Patent for Generator Switch

Development of a thermoelectric generator switch for use with systems that convert heat energy directly into electric power has earned a U.S. patent for Mr. Joseph P. Angello, an electronics engineer at CORADCOM, Fort Monmouth, NJ.

Compared to a gasoline-driven piston engine generator, the thermoelectric generator reportedly has the distinct military advantage of being relatively silent, dependable, maintenance free, low in cost, and operable with a variety of fuels.

The new relay switch has only eight component parts compared to the solid-state switch it replaces which has more than 100 parts. Other parts of the new switch include a voltage-selectable breakdown diode, a transistor switch, a relay coil, and an anti-clatter circuit.

According to Angello, his switch represents a reduction of more than 90 percent in the cost of thermoelectric generator protective devices and makes possible an 11 percent increase in generator power.


Joseph P. Angello

Assigned to CORADCOM's Plans, Programs and Analysis Directorate, Angello has published more than 15 technical papers and holds four earlier patents related to mechanical engineering devices. He holds a BS degree from Stevens Institute of Technology and an MS degree from Fairleigh Dickinson University.

New Tire Development Results in Patent Award

Mr. Aaron C. Beauchamp, a machine tool operator at the U.S. Army's Rock Island Arsenal, IL, is a recent recipient of a U.S. Patent for development of a combination highway cross-country tire. The tire is designed for maximum stability and wear on the road and maximum traction on snow and off-road conditions.

Tested at the U.S. Army Tank-Automotive R&D Command, Warren, MI, the tire has reportedly exceeded expectations. It has a conventional tread to provide a soft, smooth highway ride. Lugs project from the tire's shoulders to permit traction in mud, sand, and snow.

(Continued on page 36)

(Continued from page 35)

When the vehicle is on a hard surface, the lugs do not touch the highway, eliminating the harsh ride normally found with all-terrain tires. However, when the tire sinks into snow or soft ground, the lugs act like a paddle wheel to maintain traction.

Beauchamp developed the tire as a result of his experience with farm and military vehicles. "Tires designed for off-road use give a very harsh ride and tend to wear out very quickly," he says. "When the tires wear, they produce a rocking motion that makes control of the vehicle more difficult. The conventional tread in the center of my tire corrects all these problems."

Only about six hours were needed to plan and sketch the idea for a patent application. Beauchamp has submitted six patent applications. Included is a riot control gun powered by compressed air. It fires soft plastic balls and allows riot control without causing casualties. A patent for the gun is expected in 1979.

In Retrospect . . .

World's Largest Mortar Never Saw Combat

Little David—the world's largest mortar, a 36-inch beast designed to fire 3,750 pound shells, never saw action.

Little David was fabricated during World War II under a secret, high-priority project. But by the time he was ready for combat the Allied Army had penetrated the German fortifications Little David was designed to attack.

In 1944 Allied attention was focused primarily on the vital problems of the upcoming Normandy invasion, but there was also another problem that worried them. In the years after World War I, France, which had suffered much devastation from the many battles fought on her soil, vowed that Germany would never invade France again. In order to prevent an invasion, the French built the famous Maginot Line of fortifications along the German frontier. The French believed that it was impregnable. The Germans, in their turn, built an equally impressive series of forts called the Siegfried Line.

When WWII began the Germans found a way to overcome the French defenses. Instead of a direct assault on the French fortifications, the Germans invaded neutral Belgium, thus joining battle on a frontier that the French had left unfortified.

The Allies couldn't use the same technique in an invasion of Germany. Belgium was no longer neutral; there would be no element of surprise in a movement through Belgium. Therefore the Allies decided to devise a weapon which could breach the formidable fortification of the Siegfried Line in a direct assault.

Little David is the weapon they created, a weapon that could destroy a fort. Throwing a shell weighing nearly two tons, Little David could breach the strongest of fortresses. And Little David was mobile. The 144,000 pound tube assembly could be pulled by one "Dragon Wagon" tractor. So could Little David's 160,000 pound base assembly. Because of this mobility, Little David could attack one major target after another.

While Little David was being designed, the Allied Forces launched the Normandy invasion. As assembly and testing of the mortar progressed, so did the Allied Army—well ahead of schedule. The Allies had already penetrated the Siegfried Line by the time Little David was ready to go.

Though he never fired a shot in battle, Little David has retired. He is now part of the outdoor display at the U.S. Army Ordnance Museum, Aberdeen Proving Ground, MD.

Little David and one of its 3,750-pound shells

Army R&D — 15 Years Ago

The Army R&D Newsmagazine reported on . . .

TARC To Deal With In-House Laboratory Problems

Establishment of a 9-member Army Research Council to deal with problems of Army in-house laboratories as related to long-range planning, personnel management and optimum use of funds and facilities was effected.

Assistant Secretary of the Army (R&D) Willis M. Hawkins announced the organization of the Council (TARC), following closely upon advice of a select, high-level group of scientists, industrialists, and educational leaders.

Findings of the committee after several months of study of the needs of Army in-house laboratories served to support conclusions Hawkins had reached by personal review of the Army R&D Program since he became ASA (R&D) in September 1963.

After consulting with Chief of R&D LTG William W. Dick, Hawkins approved appointment of the council empowered to assist in formulating policy, plans and programs for Army research and exploratory development.

Director of Army Research BG Walter E. Lotz was selected as coordinator of TARC and Dr. Ralph G. H. Siu, scientific director of the Research Division, U.S. Army Materiel Command, as chairman.

ILIR Holds $10 Million Level Through FY63

Acceleration of the Army In-House Laboratories Independent Research (ILIR) Program through FY 1963 funding of $10 million has been sufficiently successful to retain that funding level for FY 1964.

Deputy Assistant Secretary of the Army (R&D) Charles L. Poor commented on Program reports from 26 Army installations by saying: "The Annual Review Committee was very well pleased with results of the first year. It is gratifying to note the wide scope and high quality of the projects undertaken by the laboratory directors.

"The Program has been successful. Many excellent new projects were sponsored and at least 400 professional personnel participated. . . . .

Objective of the Program, as set forth in Army Regulation 705-55, is to provide individual Army scientists and engineers an additional opportunity to maintain and increase their competence by doing original work in areas of their special talents—"promote a vigorous internal research program of the highest technical caliber."

Emphasis of the ILIR Program is directed to "new and challenging tasks," usually not within the scope of regular activities of the installation where the work is performed.

Army Reports Steady Gains on STINFO Effort

Multifold actions to establish Army-wide scientific and technical information systems tailored to specific requirements of various disciplinary and professional groups are making steady progress despite interagency controversy slowing some procedures.

The Army Director of Technical Information reported that advances are being made in all major areas of the effort. Included are reporting procedures for the Army Research Task Summary, the Chemical Information Data System, the Engineers Data Information System, and the On-Site Survey of personnel and resources.

Battelle Forecasts $52.567 Billion for R&D During 1979

Federal Government funding support for R&D during CY 1979 is estimated at $25,709 billion, up $1.894 billion (8.0 percent) from 1978. This represents 48.9 percent of the total 1979 national projection of $52.567 billion for R&D.

Industrial funding for 1979 R&D is forecast at $24.963 billion (47.5 percent of total), up $3.183 billion or 14.6 percent from 1978. Funding by academic institutions is projected at $1.100 billion (2.1 percent of total), and nonprofit organizations $795 million (1.5 percent).

These estimates were prepared by Dr. W. Halder Fisher and assistant Ms. Kathy S. Smith at Battelle Columbus (OH) Laboratories. Data were drawn from many sources, including National Science Foundation reports, the McGraw-Hill Annual Survey of Business Plans for R&D Expenditures, and analyses by Battelle's Department of Resource Management and Economic Analysis.

A national increase of $5.272 billion (11.1 percent) over the $47.295 billion that the NSF estimates was actually spent for R&D in 1978 is forecast. Although most of the increase will be absorbed by continued inflation, Battelle forecasts an increase of 3.0 percent in real R&D expenditures, the highest level in a decade.

While the Federal Government continues to be the dominant *source* of research funds, *performance* by industry is expected to total $37.450 billion—71.2 percent of all research performance. This compares with 13.1 percent for the Federal Government, 12.6 percent for academic institutions, and 3.1 percent for nonprofit organizations.

Four government agencies dominate the federal R&D scene and are expected to account for almost 87.9 percent of total federal R&D funding in 1979. These are the Department of Defense, 45.6 percent; the Department of Energy, 15.5 percent; NASA, 15.2 percent; Department of Health Education and Welfare, 11.6 percent; an additional 5.3 percent comes from the NSF, the EPA, and the Department of Transportation.

Defense-related R&D continues to receive favorable treatment by Congress, says Battelle, and its share in the administrative budget submissions is now rising. For example, more than two-thirds of the estimated dollar gains in total R&D are accounted for by gains in the defense share.

The NSF utilizes a master list of 15 functional categories, of which the most important have the following shares of estimated FY 1979 obligations: national defense, 49.5 percent; space, 12.1 percent; health, 10.8 percent; energy development and conversion, 10.1 percent; environment, 3.9 percent; science and technology base, 3.8 percent; transportation and communition, 3.0 percent; natural resources, 2.3 percent; and food, fiber, and other agricultural products, 1.9 percent.

The remaining six functional fields, all receiving one percent or less of the total R&D budget, are: income security and social services; education; area community development, housing, and public services; economic growth and productivity; international cooperation and development; and crime prevention and control.

Of the 15 R&D functional areas, three (energy, area and community development, and crime prevention) are expected to decline from estimate FY 1978 levels. All three increased from FY 1977 to FY 1978.

From 1969-70 to 1973-74, year-to-year changes in R&D budgets favored civilian programs over defense and space. Beginning with 1974-75, emphasis shifted back toward defense/space, especially defense. Throughout the 1970s, energy-related R&D generally has grown by larger increments than space or most other civilian programs. However, while the remainder of the energy program is expected to continue to grow, reductions in support of the breeder reactor cause the cutback in total energy support.

Industry provides almost as much R&D support as the Federal Government, and is by far the largest R&D performer. During 1978, the NSF estimates that industry will provide 46.1 percent of total funding and perform 70.3 percent of all R&D work. Battelle's forecast for 1979 raises these shares slightly, to 47.5 and 71.2 percent, respectively.

Both industrial funding and performance are expected to increase faster over 1978-79 than any other sector (14.6 and 12.6 percent, respectively). Industrial funding is projected to rise from an NSF estimated level of $21.780 billion in 1978 to $24.963 billion in 1979. Industrial performance will rise from $33.250 billion to $37.450 billion.

With respect to the composition of R&D activity, the expected pattern is one of stability or very slow change, as in the past—with energy, federal regulations and science—and technology-based problems still providing the major impetus for change. The proportionate composition of both funding and performance for R&D will change very little.

The Battelle report also compares the four performing sectors in terms of their relative costs of R&D. During the interval 1972-1979, costs of all R&D, as an average, are estimated to rise by 67.6 percent. Increases in the individual performing sectors are expected to be: Federal Government, 59.3 percent; industry, 70.7 percent; colleges and universities, 68.7 percent; and other nonprofit organizations, 37.0 percent. The 1978-79 cost increase for all R&D is estimated to be 8.0 percent. By sectors, the increases are estimated as government, 1.9 percent; industry, 9.3 percent; colleges and universities, 7.6 percent, and other nonprofits, 3.5 percent.

The report also discusses recent concerns within the U.S. about the level of R&D effort, the role of R&D as a source of economic growth, and the future of U.S. technological and economic leadership.

During 1976 and 1977, the report notes, most statements concerning the sources of technological change and economic growth tended to be somewhat naive, placing emphasis on a conceived need for more R&D expenditures. Now, the R&D situation is increasingly being reinterpreted—or at least is being viewed against a different and more realistic background. The new theme involves three lines of analysis:

- The relationships between R&D, innovation, and growth are complex rather than simple, and involve qualitative rather than quantitative consideration.
- Domestic R&D is not the only source of domestic innovation and growth.
- There are many other factors than fewer R&D dollars that explain declining R&D, fewer innovations, and reduced U.S. world leadership in technology.

Regarding the source of innovations, the report acknowledges that someone must undertake research if the U.S. is to expand its scientific horizons and develop ideas from which innovations spring. However, it is a mistake to think that this research absolutely must be domestic. Many of the more noteworthy U.S. innovations have involved adaptations to mass-production and mass-marketing of foreign discoveries.

The report cites several factors contributing to the decline of U.S. leadership in technology. A few are:

- Competitive efforts made by other developed nations—which also have "knowledgeable scientists and engineers and energetic business leadership."
- Growth of social forces (i.e., consumerism and environmentalism) that impinge on the scientific and business community and tend to inhibit R&D activity, innovativeness, entrepreneurship, and growth.
- Other barriers to innovation that arise in both business and government. (Examples include, to cite a few, rigid governmental regulatory programs, a growing insistence within industry on certainty of profits in the short term, and—one of the biggest—inflation.)

In order to optimize U.S. R&D accomplishments, the report observes, "both government and industry will have to undertake deliberate and creative changes in both their management processes and their policy criteria. Regardless of what happens to the totality of R&D funding, there will have to be a distinct improvement in the quality of both public and private R&D management. Most important, however, is the fact that, as a nation, we must take full advantage of available foreign technologies in order to maximize the effectiveness of domestic R&D efforts."

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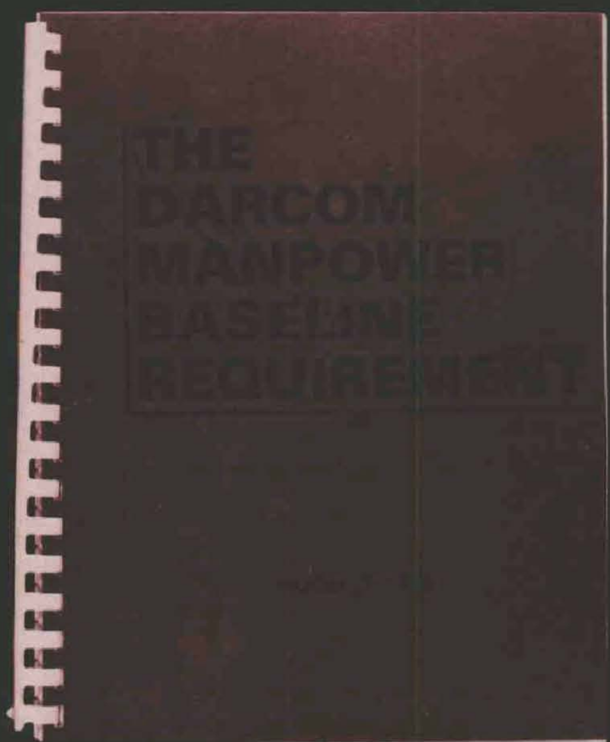

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