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PROTECTIVE CLOTHING FOR THE SOLDIER

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ABOUT THE COVER:

The new Battledress Uniform with Personnel Armor System Ground Troops (PASGT), depicted on the cover, is one of the many types of uniforms the Army is developing to provide the individual soldier with greater survivability and combat effectiveness on the battlefield.

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Interview . . .

NARADCOM Commander COL Robert J. Cuthbertson

Q. Protective clothing, generally, does not receive a very high priority when budgets are formulated. Is there a way to bring greater attention to the importance of protective clothing?

A. Assigning protective clothing the same priority as the weapons system they support would help. Maintaining a continual awareness that the Army system "buries" the individual soldier under the category of "combat support-other" would be another step in the right direction. Including a section on life support requirements in the requirements document might also be helpful.

Q. What are the major problems to be addressed relative to the development of CB protective clothing for the 1985–90 time frame?

A. Some of the major problems are reducing heat stress and bulk, increasing field and shelf life, increasing durability, reducing cost and improving maintainability, that is laundering, cleaning, and decontaminating. A recent analysis conducted by our operations research personnel has indicated that the performance degradation and the heat stress burden posed by CB protective garments may reduce personnel combat effectiveness so as to offset much of the advantage resulting from the safety from toxic threat that they offer. Extensive analysis and development is underway by our Clothing Laboratory to develop a new generation of clothing with integral chemical protection which will provide the required protection from toxic threats with a reduction of the performance degradation and heat stress.

Q. Some people contend that launderable CB protective clothing, rather than the present disposable type, would be preferable. Is Natick considering this possibility?

A. Yes, this possibility is being investigated by our Clothing, Equipment and Materials Engineering Laboratory. Consideration is also being given by our Aero-Mechanical Engineering Laboratory to the decontamination of the current Chemical Protective Ensemble. Plans are being made to determine if the recently modified Trailer Mounted Laundry Unit (using a new emulsion) can effectively decontaminate various types of clothing items which are contaminated with live agents.

Additionally, a program presently being conducted by the Operations Research and Systems Analysis office at NARADCOM, entitled, "Alternative Design Concepts for Field Bath and Laundry Complex," is evaluating, on a quantitative basis, the desirability and feasibility of the application of a number of different technologies in the area of field cleansing of personnel, their clothing and equippage. Within the context of this evaluation, the specific problems of the decontamination of clothing items, including CB overgarments which have been exposed to toxic agents, is being scrutinized.

Q. This past spring, the British put on a rather impressive display of protective clothing. One might easily conclude from that display that they are technologically ahead of us in a number of areas. Would you comment on this?

A. The U.K. products do not appear to offer any greater capability than our own products. Prior to the display, we had samples of virtually all of their items in-house, as a result of our data exchange agreements. Based on those we have examined to date, we have not found anything that is particularly novel.

A representative from the U.K. Chemical Defense Establishment visited NARADCOM recently and we reviewed our materials research program with him. He was impressed with many of the approaches we are currently pursuing and he had no improvements or suggestions to offer. Additionally, our cooperation and exchange with the U.K. and others, especially in this important area, is continuous. Of necessity, we must maintain the spirit of supportive and cooperative exchange to insure that we and our allies retain the technological edge.

Q. Former Under Secretary of Defense for Research and Advance Technology Dr. Ruth Davis, in a speech late last year, stated that what the DOD food RDT & E program needs most is greater industry involvement, greater industry participation, and greater industry responsibility. This statement seems to imply that industry cooperation has not been as great as it should be. Would you comment on this?

A. Industry cooperation has been, and continues to be, excellent. However, in the absence of any means to guarantee a company a return on investment in successful R & D programs in the form of procurement contracts, there is insufficient incentive for private investment to meet DOD-specific needs. The statement also reflects an all-too-common failure to appreciate the need for institutional in-house capability if industry and other outside resources are to be successfully motivated and challenged. In my estimation, what the DOD Food RDT & E Program needs is active DOD involvement and solid support from the services to insure that the program maintains a truly joint posture.

In both the food and clothing areas, the majority of production contracts are set aside for small business firms who have no R & D capability. As a result, industry participation will not include R & D for the Government.

Q. Natick's enzymatic process of converting cellulose waste into clean burning fuel and glucose food products has often been heralded as a potential solution to U.S. energy problems. Is this a realistic assumption, and what is the state-of-the-art of this particular program?

A. Is this a realistic assumption? No. There is no single solution to the U.S. energy problem. The enzymatic hydrolysis process, when fully applied on a commercial scale, can help utilize national regenerable resources for the production of clean burning fuels. In this capability, the system can become a viable back-up to agricultural product ethanol production. What we are now doing is concentrating on perfecting the technology that supports the cellulose waste conversion process so that it can be used as a back-up process for the agricultural process. The Department of Energy is sponsoring our work in this area.

Q. The Natick R & D Command deals largely with basic items which are designed to sustain and improve the individual soldier's well being such as better food, clothing, and shelter. Do you see anything really innovative on the hori-

zon, such as disposable underwear, or one-size-fits-all outer garments, etc?

A. One specific item which comes to mind is the so-called T-Ration, a half-steam table pan of pre-prepared food which, when incorporated with a highly mobile heating element capability, eliminates preparation and provides a heat-on-move capability. It is designed to deliver high quality hot food items to mobile troops at the forward edge of the battle area.

The flat geometry of the metal tray in which the T-Ration is packed, significantly reduces sterilization heating items, thereby permitting the packaging of an extremely broad range of high quality food items that cannot be provided in the common round can. This, then, provides the capability of delivering food items, on site to our troops in the field, that are varied as well as of high quality.

Also, the joint Natick/industry development of Gore-Tex systems may be the beginning of a totally new family of materials that are totally waterproof, but which can still breathe. Non-woven materials are also showing promise in garments, tentage and similar applications. There are also many advances in materials—such as a flame-hardened CB protective overgarment that are currently being considered for future application.

This Command is also developing a frame supported tent with a number of innovations. The following are the more significant ones:

The frame will be made of a fiberglass composite. The physical properties are equal to those of aluminum. The cost and weight, respectively, are each equal to fifty percent of those of aluminum.

The length of the tent is virtually limitless due to the modularity feature. It can be formed into a number of various configurations through the use of transition sections.

Additionally, there is a constant flow of innovations from Natick that should create major impacts in the food area. These include the new combat/operational feeding systems, special diet work for Walter Reed Army Medical Center and overall hospital food service system development; the retort flexible pouch, restructured meat, compressed foods, emergency/assault packets; XM-3 diesel burners, automated bakery, etc., etc., etc.

Q. NARADCOM, being a research and developmental activity, is obviously interested in the requirements of the user in the field so as to produce the "best" possible product. What suggestions do you have for making the user's requirements better known to the developer?

A. There is a need to have improved direct communication and contact. This includes frequent visits to the ultimate user, including participation in field exercises, as well as the need to be involved in conceptual stages of new operational systems and doctrine/scenario formulations. There is also a need for greater awareness within the Army of the Training and Doctrine Command's role in identifying the needs of the soldier, and more education as to the need for articulating requirements, given the length of the acquisition process. Increased involvement by the developer in various scenarios such as cold region warfare and desert warfare would develop a better understanding of the user's requirements.

One approach which has been particularly effective with respect to the design of new food service systems, has been that the systems designers in our Systems Analysis Office have made repeated trips to the field to gather empirical data on the operations of field, shipboard, and garrison food service systems. During these trips, our personnel have extensively interviewed and surveyed both the military customers and the food service personnel to determine their explicit needs and desires before proceeding with the systems design. This particular approach has provided the successes we have recently experienced in our food service system work.

The same approach needs to be applied to all development efforts. The plan developed as a result of this type activity defines the needs and the approaches. The requirement could be a simple statement of need while the analysis provides the definition. What we would like to see is a reduction in the requirement staffing time that presently seems to be the same for the complex system as it is for the simple end item.

Q. You served formally as chief of DARCOM's Office of International R & D. Could you discuss some of the major efforts at Natick which have RSI application?

A. NARADCOM is now developing a DOD Family of Tactical Rigid Wall Shelters. These shelters conform to International Standards Organization (ISO) requirements and can be transported like cargo containers by rail, water, highway or air. The one-side expandable shelter will be type classified in FY 81, ahead of schedule. Three remaining items—2-side expandable, non-expandable and a 50-foot accordian shelter will follow. Representatives from the German and Israeli Governments have witnessed evaluations of these shelters and expressed some interest in future coordinative efforts.

In the food area, emergency/assault packets appear to satisfy some existing NATO requirements and are in keeping with the draft NATO Standardization Agreement on Operational Rations.

In the airdrop area, many of our new container airdrop systems might be adaptable to resupply requirements within NATO. Also, in the chemical biological areas we are cooperating with several NATO nations on individual soldier protection.

Q. If you had to list the single most important achievement of NARADCOM in recent times, what would it be?

A. In general, the Command's success in making "the system" aware of the need to consider the priority of the individual soldier, and the soldier's requirements in terms of the functions to be performed, protection required, and support necessary, would probably be the most important achievement of the Command overall.

Q. Will the Army's involvement in the Rapid Deployment Force impact on your Command and cause the acceleration of any programs or change of any programs?

A. The RDF should tend to accelerate the priority for requirements in such areas as air delivery, chemical protection, improved field equipment, and the needs of the individual soldier as they relate to all environments.

Needs should be generated that will necessitate putting the most up to date modern development items in the hands of the troops.

To accomplish this, ways will have to be found to overcome the problem of purging the system of older less efficient items.

As far as NARADCOM is concerned, all of our areas of responsibility will be accelerated to insure quicker fielding so that the troops do not have to wait years to receive the best items that we can deliver.

New Concepts . . . Chemical Protective Clothing

By Dr. Malcolm C. Henry

U.S. Army chemical protective clothing, including respirator face mask, hood, footwear, handwear and overgarment, adopted in 1970, comprise, for the purpose intended, the best clothing materials system in the world today.

When properly used, protective clothing provides full protection against chemical agents for long periods of time. In the hands of well-trained troops, the chemical protective clothing system is a functional working system of general issue clothing.

However, technological possibilities not available at the turn of the decade have evolved to the point where a number of new concepts can now be considered. In addition, new requirements imposed on chemical protective clothing since its adoption in 1970 can also be addressed.

The U.S. Army Natick Research and Development Command (NARADCOM), which has the assigned mission responsibility to conduct RDT&E on personnel clothing, has been working vigorously to develop improved CB clothing for the 1980s and beyond.

Chemical agent protective clothing, commonly called CB clothing, must be designed, developed and engineered with a host of basic considerations in mind. Collectively, these considerations significantly limit and restrict the number and types of materials that can be considered.

More optimistically perhaps, one might paraphrase by stating that opportunities are available for the materials scientist to develop new combinations of materials for CB protective clothing.

Problems of physiological load and stress that current CB clothing can impose on the human thermoregulatory process have been recognized as a most serious parameter. They may even lead to possible incapacitation under severe work loads in high temperature and humidity conditions. Clothing design and judicious selection of materials can minimize this effect, and maximize the ability of the clothing to prevent chemical agent contact with the skin.

This is accomplished by presenting a barrier material between the body and the environment wherein the chemical agent may be repelled, absorbed, adsorbed, or detoxified. In each of these four cases the agent is prevented from reaching or coming in contact with the skin.

Additional materials considerations deal with durability, cost, projected shelf life, or stability, and flexibility, fit, dyeability, finishes, and launderability. One quickly becomes aware of difficulties associated with developing CB protective clothing.

All things considered, the basic role of CB protective clothing is self-descriptive. In its most simplistic terms, the role of CB protective clothing is to prevent chemical agents from coming in contact with the skin. This is particularly true with agents that cause blistering or those which can penetrate and affect normal physiological functions.

Specific chemical agents are capable, for example, of penetrating the skin readily, in amounts capable of incapacitating or killing a man in a matter of minutes. Obviously, CB protective clothing must provide maximum protection against these types of agents. Therefore, this type of clothing will be the main subject of this paper.

Protective clothing must integrate and be compatible with the gas mask or respirator. These items protect against chemical agents entering the body through the aural-nasal route. Respirator responsibility lies with ARRADCOM's Chemical Systems Laboratory.

Standard Chemical Protective Clothing System—Overgarment, Gloves, Footwear and Respirator/Hood.

One important property not addressed in the 1970 time frame, when the current overgarment was adopted, was flammability. No materials used in the current CB clothing are flame resistant. In fact, if ignited, the items will sustain combustion until completely consumed.

The need for a flame resistant system turns out to be particularly important for vehicle crewmen, tankers and helicopter personnel. For ground troops, the requirement for flame resistance is moot. However, it may well be that

flame threats are an inherent threat in any battlefield scenario.

Improvements of the current overgarment have been possible. In all likelihood, the overgarment will have a new or revised specification ready for procurement by 1981. Basically, the current outer fabric of the overgarment, a 50/50 nylon cotton blend called "NYCO" will be replaced by Nomex type 456. This is a highly flame-resistant aramid fiber used by tankers and aircrewmen in flight suits.

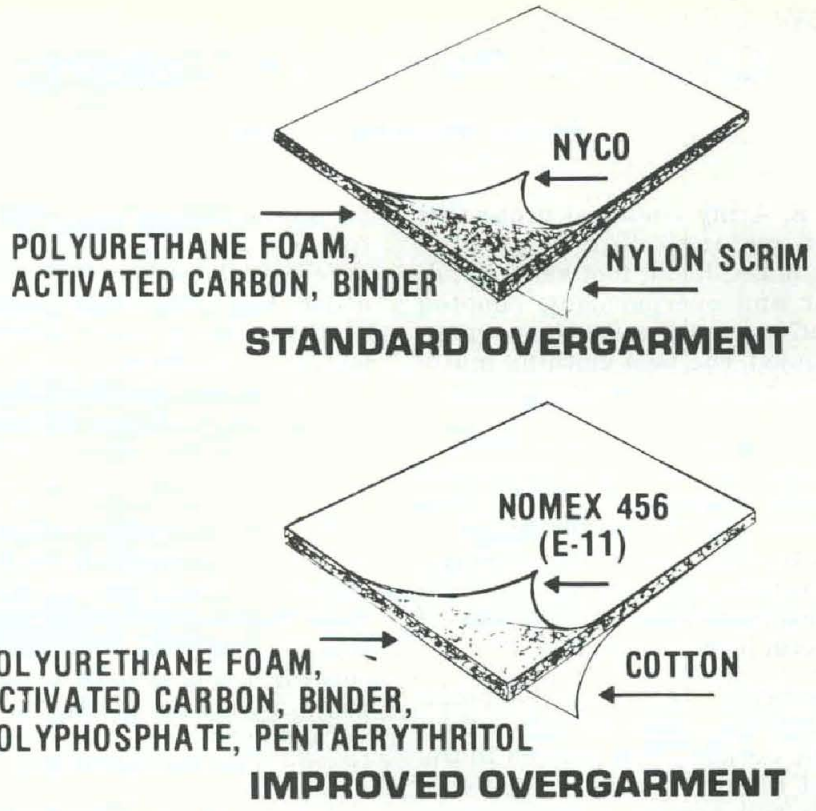
Activated charcoal-impregnated polyurethane foam, which is the functional, active layer of the overgarment, will have added a chemical formulation of a polyphosphate and a polyhydric alcohol to make the polyurethane and backing fabric flame resistant. Backing material will be a cotton scrim which, by virtue of the above incorporated chemical formulation, also becomes flame resistant.

Adsorptivity toward chemical agents is good. Results of a fire pit test, using mannikins clothed in the new CB fire-resistant materials, can only be described as spectacular.

In one case, the overgarment was run through the fire pit twice with no indication of burning. In fact, the underwear worn beneath the overgarment was not even scorched. It would appear that, for the overgarment at least, the subject of flammability is no longer a problem.

Concurrently, work has been going to develop a replacement or improvement for the standard butyl rubber handwear, footwear and hood. Butyl rubber is normally considered an easily combustible material. Neoprene rubber is being considered as a temporary replacement until an improved glove material can be developed. Elastomer compounding studies show promise.

Filler materials such as platelets of aluminum oxide, when incorporated in rubber compounds, make the passage of chemical agents through the rubber more difficult.



A second alternative is entirely new elastomers, such as inorganic polyphosphazenes. These latter materials are composed of repeating phosphorous-nitrogen backbone chains. Unlike conventional carbon chain polymers, they completely resist combustion.

Attention is now turning to the next generation of CB clothing for the 1985–1990 time frame. The problem of developing a launderable item instead of a disposable one, which is currently the case, is being studied.

Increased shelf life over and above the current five years, and improved comfort and reduced heat stress are other problems to be addressed. Protective features thus far incorporated in the standard clothing will be maintained.

Activated carbon-based fabrics probably will be the answer. Activated carbon can exist in a particulate or fibrous state. It is not the same as carbon used as fibers in high strength composites which are highly crystalline. High strength materials are used in structural applications because of their properties of high strength to weight ratios.

Activated carbon, on the other hand, is a material processed specifically from an organic precursor such as polyacrylonitrile followed by a carefully controlled stream treatment. Activated carbon fibers are very weak. They are highly porous with enormously large surface areas for absorbing chemical agent molecules. They are not suitable for use as fabrics by themselves.

The overriding property of activated carbon is that it is a general adsorbent for all polar organic molecules. It will predictably absorb, on its surface, all known chemical agents and also, any yet to be developed. This is important since CB clothing must be stockpiled for use sometime in the future.

One must be confident that the clothing will work and be functional when it is issued. Such a safety factor cannot be made with any other material. Activated carbon has both a high external surface area and a high internal surface area. This, in a practical sense, assures that

chemical agents will be adsorbed and only with difficulty, desorbed.

Activated carbon is a one-way street for chemical agents. Other known adsorbents adsorb, albeit less readily, but also desorb readily. In the case of chemical agents, this means they would not be held tenaciously enough, as is the case for activated carbon.

Basic and applied research efforts are concurrently being mounted to explore ways to make future CB protective materials more effective. These new principles or materials will replace current concepts or be built into existing material composites. This will assure progressive development of CB protective clothing.

How do we make use of these desirable properties in a clothing system? Specifically, how do we minimize heat stress or radically improve our current systems? Four possibilities are being considered.

- Use activated carbon fibers or yarns in a sandwich or some other construction, relying on the composite strength of an outer layer of a material to give strength to the carbon fibers.
- Use a solid fibrous core of an organic polymer surrounded with adhered activated carbon particles.
- Suspend activated carbon particles in an organic polymer then draw the polymer in fibers and weave into a fabric.
- Prepare hollow fibers filled with activated carbon particles, using the hollow cored/carbon-filled fibers to prepare the desired fabric.

All things considered, the hollow cored fiber approach is the most attractive. It is best if the wall of the fiber can be made thin enough or porous enough to allow chemical agents to penetrate readily. This is of utmost importance since one must consider not only the total adsorption, but also the rate of adsorption.

Clearly, if the latter is not high enough, the former is of little value since the agent would have penetrated the fabric to the skin before it was adsorbed. Hollow core fibers and fabrics have been prepared and evaluated with promising results.

Covered, braided activated carbon yarns and wrapped carbon yarns have been prepared using cotton braid or wrapping. In these cases the chemical agent is more accessible to the activated carbon and here also preliminary results look promising.

Carbon yarns have also been sandwiched between Nomex flame-resistant scrims. This resulted in very lightweight porous structures which have high adsorptivity and excellent nonflammability properties. These latter constructions should have long shelf life, and may be able to be laundered or regenerated if contaminated with soil or chemical agents.

In all these cases it is anticipated heat stress will be markedly reduced over current materials. This is because the constructions are those of textile materials and not barrier constructions such as the current polyurethane foam.

It is felt that the butyl hood might well be replaced by one of the activated carbon fabrics described above. This is because the requirement for a butyl rubber item is basically for a barrier material which will not be susceptible to penetration from a chemical agent. This is particularly critical for footwear and handwear but not the hoods.

For footwear and handwear, the requirement for a barrier material probably will stand the test of scrutiny. The problem of improved materials for handwear and footwear is a difficult one and could conceivably require considerable research and development effort.

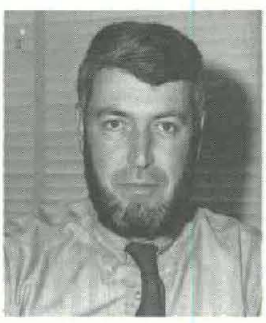
The current butyl rubber is used since no other known glove material will meet current requirements of six hours protection. Additionally, this can only be achieved by a .025 in (25 mil) thick film which is at best, only marginally acceptable, from a tactility point of view.

Notwithstanding these difficulties, cotton liners must be worn to absorb moisture and a leather glove worn over the butyl rubber for extended or improved durability. Footwear currently used is nothing short of a design abomination with all due deference to an item that has to have been selected by committee action.

An Edisonian approach wherein one tries new compounding techniques, surface treatments and even new elastomers may "luck out" as it were. However, concurrent efforts are being expended to better understand the mechanism of the penetration of molecules through selected polymeric materials.

This more basic approach will accumulate knowledge that will make it possible to design and develop a "better idea" for improved handwear and footwear. The goal is to develop a material that would either detoxify the chemical agent or prevent the agent from penetration or both. The material should also allow moisture vapor to move away from the skin to the external environment.

Development of new CB protective clothing for the 1985–1990 time frame will depend upon the successful completion of the above studies. Scientists at NARADCOM are confident the desired goals can be achieved by a concerted R&D effort. Our troops must survive any chemical attack and continue to perform their assigned missions, should this become a necessity.



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RSI and Combat Clothing for the 1980s

By Dr. Robert S. Smith and Leonard F. Campbell

Perhaps you haven't given it much thought, but there are many RSI implications in the area of combat clothing and life support equipment. Imagine a situation where Danish forces run critically short of field trousers during a winter war in Europe.

U.S. forces in the same sector have an abundance of field trousers available and could help the Danish forces out of their dilemma. However, Danish clothing is sized using a numerical metric system while U.S. sizing is based on an adjective system comprising fifteen sizes ranging from an X-short, small to an X-large, long.

How does the Danish supply sergeant know what size U.S. field trouser to issue his soldiers? The answer to this question has been addressed by the NATO Combat Clothing and Equipment Working Party (CCEWP).

A standard NATO sizing system has been developed for combat clothing and a label in each U.S. field trouser also specified the appropriate NATO size in addition to the adjective size. In this way the Danish supply sergeant can now identify the appropriate size trouser to obtain an acceptable fit on Danish troops.

In April 1980, the CCEWP held its 21st meeting in Koln, Germany. A major highlight of this meeting was a large exhibit by each of the participating countries which displayed the items of combat clothing and equipment to be fielded in the 1980s.

The U.S. display was prepared and supervised by delegates from the U.S. Army Natick R&D Command (NARADCOM). The authors of this article were the principal delegates, assisted by CPT William Conard and SGT Dave Cheney. Mr. Pete Pfeiffer and Mr. Bob Schlegel represented DARCOM's Office for International R&D.

The U.S. display was unique in its size, 40×20 feet and the wide variety of developmental items exhibited. The theme of the U.S. exhibit was the combat uniforms for the 1980s. The Combat Vehicle Crewman's Uniform depicted in Figure 1 was the focal point of the exhibit. This uniform will provide the vehicle crewman with a great improvement in protection against flame, ballistic, and environmental threats.

Not only will the use of these items increase the survivability of crewmen on the battlefield and provide protection from the elements, but they will also improve the interface between the crewmen and the vehicle because for the first time he will be wearing clothing which was designed with specific crew functions in mind.

One novel component is a ballistic undergarment made of Kevlar which provides protection against fragments and spall. It contains two ballistic inserts, each with 8 plies of Kevlar giving a total of 16 plies. The idea of the two inserts is that the crewmen can adjust the level of protection depending on the climatic conditions. In hot climates he would be less likely to wear the total ballistic protection.

The coverall is a basic item of wear

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MR. LEONARD F. CAMPBELL *is chief of the Clothing Branch, Clothing and Equipment Division of the Clothing, Equipment and Materials Engineering Laboratory at the U.S. Army Natick R&D Command. He has a bachelor's degree in textile engineering and design. He has over 30 years of research, developmental and procurement experience in the clothing and textile field.*

Fig. 1. Combat Vehicle Crewman Uniform

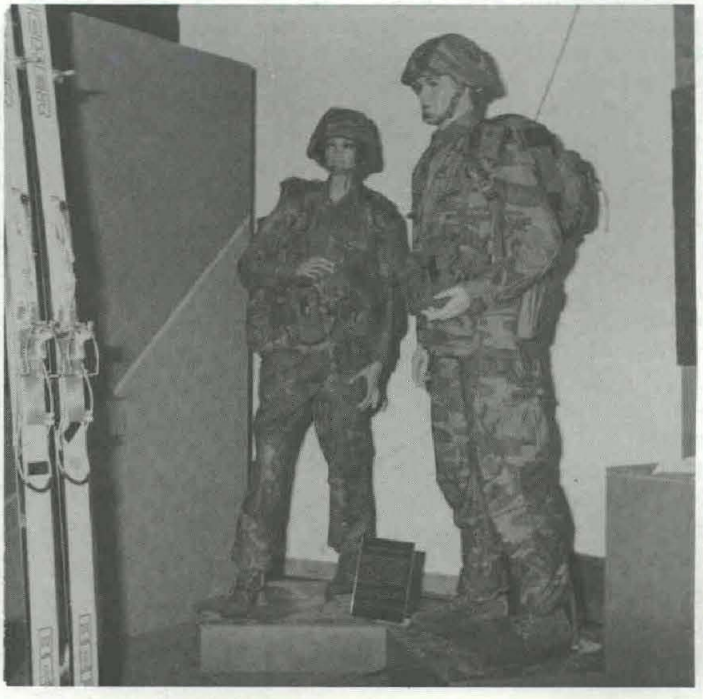

Fig. 2. New Battledress Uniforms

no matter what the climatic conditions. It is fabricated from flame retardant Nomex fabric and will accept a removable liner which adds insulation. The liner is also made of Nomex. An extraction strap is incorporated into the coverall to facilitate removal of injured crewmen from vehicles. The coverall also has a drop-seat which is a feature highly desired by crewmen.

As the temperature drops, a winter weight Nomex jacket is added. This is a modified version of the current aviator garment. It includes an opening in the back to provide access to the coverall strap. In addition to these items, other components of the CVC uniform include bib overall, Nomex gloves, Kevlar helmet, summer and winter boots, balaclava and face mask.

The CVC uniform was adopted in September and some components should begin reaching the field in mid 1981, with the complete system scheduled for introduction in 1983. All items of clothing, with the exception of the underwear, are fabricated from flame retardant Nomex fabrics.

Another very popular exhibit was the new Battledress Uniform shown in Figure 2. This uniform will be worn by men and women soldiers and is designed to provide a greatly improved ability to defeat enemy visual detection at ranges of 50–250 meters. In addition, dye formulations have been optimized to prevent detection by infrared devices.

The uniform coat is designed with breast and lower pockets. The trousers contain four standard type pockets with large thigh bellows cargo pockets. The uniform is designed to provide for optimum body ventilation while maintaining its military appearance.

Reinforcement patches have been placed at the normal wear points; elbows, knees, and seat. The fabric is nylon/cotton, twill weave weighing 7–7.5 ounces per square yard. The camouflage pattern represents the current state-of-the-art in passive countersurveillance and is known as the "woodland pattern."

Soldiers operating in desert areas will wear a similar uniform having a different camouflage pattern. The desert battledress is shown in Figure 3. Also shown in Figure 3 is the latest uniform for protecting our soldiers against the extreme cold encountered in the Arctic.

Another major element of the exhibit was the display of combat footwear (Fig. 4). This display included the new ground soldier's boot, the CVC winter boot, the lightweight polyurethane insulated boot, the mountain-ski boot, and the recently introduced vinyl overboot.

Many of the visitors showed a great interest in the new ground soldier's boot. Not only has the color been changed from black to brown for improved camouflage, but also the leather is rough side out which significantly improves water resistance and eliminates the need for shining.

Other features of this boot include a fiberglass protective toe and a new sole design to improve traction and durability. Use of a soft leather lining will improve comfort. Although at present there is no NATO standard sizing system for combat footwear, one is expected to be adopted within the next few years.

The CCEWP meeting provided an excellent opportunity to compare the clothing developments of the various NATO countries. One of the most noticeable differences between the U.S. items and those of other NATO countries was the climatic ranges for which clothing was designed.

Virtually all NATO countries design for operations in northern Europe whereas the U.S. items are designed to provide environmental protection against worldwide climatic extremes.

In conclusion, the combat uniform for the 1980s will provide significant improvements in two main areas—survivability of the soldier on the battlefield and combat effectiveness resulting from reductions in weight and bulk. Cooperation among the CCEWP members will help assure that NATO forces are provided with the most advanced clothing materials and designs available within the state-of-the-art.

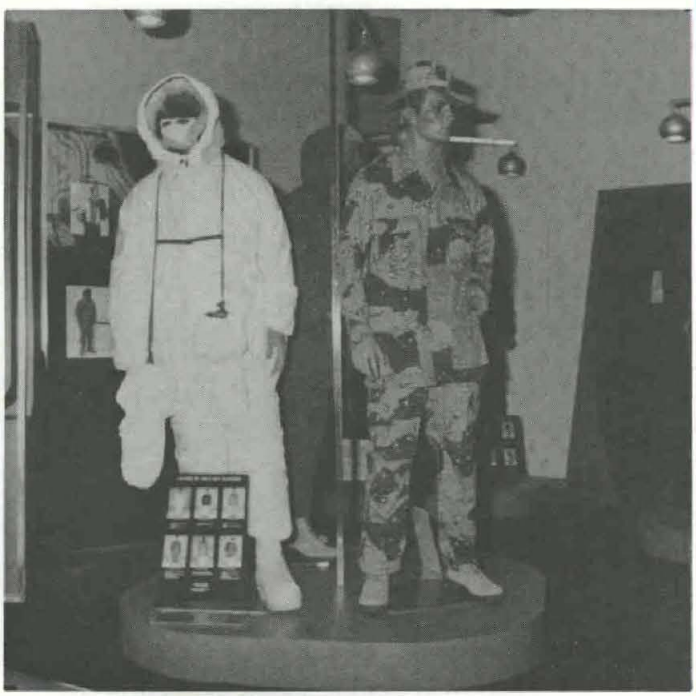

Fig. 3. Arctic and Desert Battledress Uniforms

Fig. 4. Combat Footwear Display

ON YOUR FEET !!!
A History of the Combat Boot

By Douglas S. Swain

Military footwear has traveled over many roads since George Washington's soldiers wore bought or home-made buckskins. Often, when those wore out, rags wrapped around their feet were used. This was a far cry from the highly efficient and functional footwear designed and developed by the Natick R&D Command (NARADCOM), Natick, MA.

Modern boots and shoes began with a Civil War innovation. Prior to the war, the wooden block or last, shaped like a foot over which footwear uppers are formed, was "straight"—making no distinction between the left and right foot. A shoe could be worn on either foot and was made with little regard to fit or comfort.

It was during the War Between the States that the Union Army, for the first time, issued footwear made on individual lasts specifically produced for each foot. These were received with enthusiasm by the men in blue and the postwar demand was so great, the shoe industry had an eager civilian market desiring only the new footwear with lefts and rights—items since taken for granted.

However, if we go back in history a bit, we find, according to *Hides, Leather and Shoes Encyclopedia*, the "cooked" lasts, as they were called, were not actually such a unique innovation. The shoemakers of the Greek and Roman Empire days commonly made shoes to fit the foot.

"At what point in time the right and left shoes of those early days were abandoned and "straight" shoes were introduced," the Encyclopedia observed, "is not recorded. But, their revival, at about 1850–1860 when the makers of men's fine shoes began to use the 'crooked' lasts, . . . was one of the most important developments in present day shoe making."

"An Infantry Soldier with his clumsy boots is unable to do more than a portion of the work he can when properly shod," declared a report by the U.S. Army Surgeon General in 1886 when four basic footwear items—campaign shoes, leather boots, barrack shoes and Arctic overshoes were issued to soldiers. All but the last item were fashioned of thick leather which became almost rigid after repeated wetting and drying.

Overshoes for wear in extreme cold, had semi-water-repellent tweed cloth uppers and rough rubber soles for ice and snow traction. None gave adequate protection against wet and cold conditions. Frostbite victims were numerous. Heavy wool or cotton socks were supplied with these boots and shoes. Hand laundering was the rule and sock shrinkage, to the point of uselessness, was common.

Not until shortly before World War I when LTC Edward Munson, Army Medical Corps, conducted a comprehensive study, was any further thought given to soldiers' feet. That study resulted

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Lightweight, Unicellular Plastic Insulated Boot

Tropical Combat Boot with steel plate insert to protect against punji stakes and spikes.

in the design of the "Munson" last for a new combat boot.

Although this was a vast improvement, later studies made during and after World War II, disclosed that many of the foot problems experienced at that time were related to the inadequacies of the Munson last and the failure to design protective footwear for existing combat environments.

The American soldier entered World War II wearing the service shoe and canvas leggings of World War I. Early in the War, the U.S. Army Quartermaster Corps issued a new all-leather combat boot with an upper buckled cuff. The shoe and boot aggravated foot cold injuries.

Besides being too close fitting for comfort or warmth, the footwear leaked through the welt inseams and upper leather. Footgear and socks were soaked quickly by wet conditions and foot perspiration, and the leather was slow to dry. Soldiers complained of the futility of putting on fresh dry socks that soon became soggy. Rubber overshoes and shoepacs were not completely satisfactory attempts to relieve the problem.

It was not until 1951 when the sealed insulated boot was introduced to Korea that an improvement of "breakthrough" proportions was achieved. For the first time combat soldiers fought in footgear that protected their feet from injuries induced by wet and cold field conditions. In fact, prior to issue in Korea of the new sealed insulation boot, the frostbite/trench foot problem was of staggering proportions.

The new boot, soon called the "Mickey Mouse" because of its shape, was radically different from existing military or even commercially available footgear. The key to its superiority is its unique construction utilizing the double vapor barrier principle.

Stated simply, an air chamber and insulating material are sealed between two impermeable rubber barriers. The outer layer keeps out environmental water while the inner layer, next to the foot, protects the insulation from foot moisture.

Successful incorporation of this principle into a boot that practically eliminated frostbite injuries, was largely the work of a team led by the later Dr. Paul A. Siple, geographer, climatologist and advisor to the U.S. Army Quartermaster Corps on cold weather clothing and foot protection.

The post-Korean War development of Direct Molded Sole (DMS) construction for the Army's tropical and all-leather combat boot also represented a further major advance in military footwear construction. In the DMS process, sole and heel are molded directly to the boot upper by high-pressure vulcanizing machines, thus eliminating stitching and nail failures at the boot bottom.

DMS boots offer greater durability, comfort and economy. The process also made the incorporation into combat footwear, special protection features such as a steel innersole which resists penetration by punji stakes and a metal wedge insert for deflecting and absorbing the blast from anti-personnel land mines.

At the Army's Natick Research and Development Command, whose mission includes footwear R&D, work to improve the insulated boot is continuing. Currently undergoing Arctic test and evaluation is an extremely lightweight boot that weighs three pounds per pair—half as much as the existing standard item.

The new boot will have the effect of taking nine pounds from the already overburdened muscle of the combat soldier. The experimental boot is made of a unicellular plastic material whose insulating values remain unimpaired, even when punctured.

Among recent developments is a light weight vinyl plastisol overshoe made of fuel oil resistant materials with a slip resistant outsole design to replace the 5-buckle rubber overshoe. The vinyl overshoe represents nearly a 50 percent weight savings as com-

(Concluded on page 11)

Combat Vehicle Crewman Boot

New combat boot, with suede-like appearance, incorporates spike-protective insole, a reinforced fiberglass toe for impact protection, and won't require polishing.

The Environment, the Soldier and His Equipment

By Thomas Niedringhaus

The Corps of Engineers, with its complementary mission to develop America's water resources and perform engineering missions that contribute to the nation's economic well-being, is also working to protect the American soldier from adverse environments.

Environmental protection for the soldier, referring to protecting a soldier and his equipment from the environment, is contrasted to the present-day connotation of protecting the environment from man.

A quick, hard-hitting force needs materiel that can be used any place, any time. Weapons must function with precision and speed in all climates. Soldiers in formidable surroundings without this advantage may not survive.

During World War II, equipment malfunctioned, frustration mounted, and precious time was lost. To make sure this doesn't happen again, the Environmental Effects Group (EEG), U.S. Army Engineer Topographic Laboratories (USAETL) provides much-needed environmental information for the design, development, and testing of materiel. This group, a part of the Geographic Sciences Laboratory, traces its lineage back 35 years to the Environmental Protection Section of the Quartermaster Corps.

During these early years, this section provided information that was used as a basis for issuing uniforms, food, and equipment. The layered concept, pegged by today's fashion designers as the "layered look" grew out of climatic studies performed by the World War II Environmental Protection Section.

Today, new developments such as the Shea report on cost-drivers among Department of Defense specifications and standards, and the Kerwin message on realistic battlefield conditions, both of which are discussed later in this article, propelled the EEG into new programs indicative of changing Army requirements and interests.

These programs prompted basic research on worldwide weather extremes and applied research that relates this knowledge to the design, test, storage, issue, and use of materiel.

The EEG's largest single effort to date is a series of studies on natural environmental conditions that cause problems for Army Vertical/Short Takeoff and Landing (V/STOL) aircraft during times of hover, landing, and takeoff.

Analysis of environmental conditions produced data that the Army Air Mobility Research and Development Laboratory used as criteria for standards in the design and testing of V/STOL aircraft systems.

Over the years, other environmental studies have aided the Test and Evaluation Command in their analyses of environmental risks to materiel; an analysis of environmental effects on missiles; a report on surface materials and terrain features of Yuma Proving Ground, and a study of the damage potential of winds to Army field shelters.

The EEG's environmental studies are now focused in five major areas where the environment and the military are linked: relationships between environmental factors and materiel design problems, frequency and distribution of natural battlefield obscurants, improving the technological base of environmental effects on materiel, development of a glossary of environmental engineering terms; and research on climatic testing levels.

The ability to predict environmental problems that materiel might face is an asset for any army on the move. In pursuing such analysis, it is paramount to assume that materiel will be needed under the most severe weather conditions that can occur.

Essentially, a matrix or table that identifies the contributing environmental conditions, the problems produced, suggested countermeasures, and, in qualitative terms, the consequence of ignoring the problems are considered.

The Kerwin message, distributed while GEN Walter T. Kerwin Jr. was the Army Vice Chief of Staff, pointed out that an integral part of the materiel acquisition process should include a study of the battlefield environmental conditions.

Kerwin maintained that environmental conditions, degrading the performance of electro-optical sensors, were being treated as unusual occurrences and were not being incorporated into all facets of development, testing, training, and operations. If this situation continued, Kerwin concluded, the Army might find itself unable to win on a modern battlefield.

Several Corps of Engineers' laboratories are involved in terrain and climate aspects of this important research effort. The EEG plans to investigate the frequencies, types, and distribution of fog as a potential battlefield obscurant, particularly in relation to electro-optical sensors. Subsequently, it is expected that other obscurants such as precipitation and water content of the atmosphere will be examined.

Relationships between environmental factors and materiel design problems are investigated in order to establish a rational basis for the selection of environmental design criteria. This new effort will result in an automated data base of 100 "benchmark" meteorological stations intended to be representative of all the earth's climates.

Methods of presenting critical environmental data are being improved. New techniques for determining stresses and suitable existing data transformations are also being developed.

Research to improve the technological base of environmental effects on materiel is intended to insure that the criteria for Army materiel reflect conditions the materiel is likely to encounter. One stimulus toward research in this area is based on the con-

clusions drawn by the Shea report, named after Joseph F. Shea, chairman of the Task Force on Specifications and Standards, and prepared for the Defense Science Board.

The Shea report indicated that, in many cases, environmental requirements documents made unreasonable demands on contractors leading to increased purchase costs. By improving the technological base of environmental effects on materiel, it will be possible to achieve the most cost-effective application.

As part of this thrust, documents oriented toward environmental engineering will be prepared in the form of Military Standards (MIL-STDs) and Military Handbooks (MIL-HDBKs). The EEG's efforts are in support of the Defense Materiel Specifications and Standards Office (DMSSO) program plan for Environmental Requirements and Related Test Methods documents.

A major part of this endeavor will be the preparation of a new military handbook on environmental effects on materiel. This handbook will provide basic environmental design principles and will be related to the entire range of environmental requirements documents. It will provide a much-needed bridge between climatic criteria and environmental testing documents.

Complementing the handbook project will be an effort to revise MIL-STD-1165 as a new glossary of Environmental Engineering Terms. This will provide official definitions of the terminology that applies throughout the diverse environmental engineering and scientific areas.

Better guidance for test methods is another aim of the EEG. Research on climatic testing levels is based on the recent discovery that relatively little information is available on the relationships between field tests and simulated (chamber) tests.

Experiments will be conducted to see if it is possible to find high correlations in materiel effects between accelerated chamber tests and exposure to natural conditions. Materiel will be tested, under controlled observations, in both natural and chamber conditions.

On the international level, the EEG is contributing to DOD documents that will include environmental design criteria and serve as guidance for cooperating countries in the design of materiel. These documents include Quadripartite Standardization Agreements (QSTAG) and NATO Standardization Agreements (STANAG).

Today's soldier, equipped with more sophisticated weapons than ever before, will benefit from requirements calling for design, development, testing, and field operation information of those weapons.

This past September the EEG saw their revised Army Regulation (AR 70-38 Research, Development, Test, and Evaluation of Materiel for Extreme Climatic Conditions) go into effect.

A new document to use when considering climatic design criteria, the revised regulation has a different format for presenting design criteria that is more in line with the way developers actually use the document. People who use such criteria will understand the rationale for each of the values given.

Providing environmental information is not as glamorous as other areas in Army research and development. Even though the environment is not the most important factor considered in the design of materiel, it cannot be neglected. If it is, it could be the decisive element in the success or failure of a mission.

Although times change and the Army's needs are not the same as they were during World War II or even five years ago, it seems very likely that there will be a continuing demand for environmental information. The EEG at the Engineer Topographic Laboratories is one place where that demand will be met.

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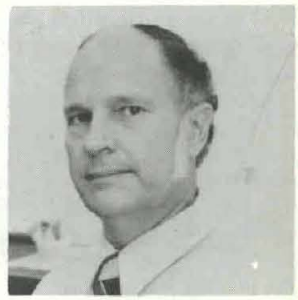


On Your Feet! A History of the Combat Boot

(Continued from page 9)

pared to the old rubber overshoe. Weight is particularly important in footwear since each ounce of weight borne on the foot is equal to six ounces on the back.

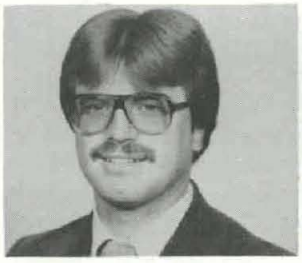
The new Infantry Combat Boot, fabricated of highly water resistant leather, flesh-out earth brown color provides increased environmental and camouflage protection. A resin impregnated fiberglass box toe for impact protection against falling objects and a "Vibram" cleat design outsole providing improved traction are also features of the boot.

To supplement the recently adopted combat vehicle crewman uniform, a new taker boot, incorporating a "wrap around" strap and buckle closure system for ease in donning and doffing, is under development. The outsole incorporates a "chevron" design and a semiwedge heel to reduce "snagging" while traversing in and on armored vehicles. A cold weather version of this boot includes a wettable insulation to provide protection to −24° C.

As technology improves and new materials and methods are developed, the ultimate goal—an ultra light weight, waterproof, breathable combat boot which has inherent resistance to penetration by chemical warfare agents—will be attained. Footwear specialists at the Natick R&D Command are working on it.

REQUIREMENTS: Key to Success

By Jerry L. Stahl



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What does buying an automobile have in common with the Army's materiel acquisition process? Perhaps a better understanding of this process will aid in answering this question.

Many adjectives can be used to describe the Army's materiel acquisition process, some of these are: lengthy, cumbersome, complicated, and complex. One such adjective which cannot be used, however, is unstructured.

The materiel acquisition process is definitely a structured set of phases and decision points necessary to insure the economic, logistical, and operational effectiveness of major as well as non-major weapon systems. The key to the entire materiel acquisition process is materiel requirements documents. Without a requirement, the acquisition process cannot even begin.

One of the basic steps in understanding the role of requirements documents, as they pertain to the materiel acquisition process, is to gain an insight into the missions of the combat developer and the materiel developer. These roles are normally performed by TRADOC and DARCOM, respectively.

TRADOC, the user's representative, conducts the majority of the Army's combat development activities. These include the formulation of concepts, doctrine, organization, and materiel objectives and requirements for the employment of U.S. Army forces in a theater of operations.

DARCOM, the Army's principal materiel developer, performs research, development, test, and evaluation (RDTE), acquisition, and logistic support of materiel, systems, or techniques in response to approved Army requirements.

Close and synchronous interaction between TRADOC and DARCOM is probably the single most important factor in identifying user needs and capabilities, generating requirements documents, and managing the acquisition of an effective and supportable weapon system.

In addition to understanding the combat/materiel developer relationship, one must also possess a basic insight into the process of identifying a potential materiel requirement. Although any individual or organization, including the materiel developer, logistician, user, tester, or industry, can propose a potential requirement, the combat developer must validate this need.

The combat developer is typically viewed as the Army's principal generator of materiel requirements documents. This process of identifying and validating requirements is complex and requires a coordinated effort by many organizations.

A Mission Area Analysis (MAA) is a structured method of examining functional areas within the Army force structure to identify weaknesses or "holes." However, simply because a weakness has been identified does not necessarily dictate that new or upgraded materiel is the only possible solution. Possibly a simple change in tactics, doctrine, or organization, identified through the MAA, can solve the problem.

If, however, the MAA identifies new or upgraded materiel as the best solution, the sources of these requirements can be narrowed to one of four general areas: a validated threat or capability, an operational inadequacy in existing equipment, a high consumption of resources, or an opportunity to exploit a breakthrough.

Regardless of the source of a materiel requirement, there are several methods of satisfying user needs: improve existing systems, procure commercial or foreign systems, modify commercial or foreign systems, or develop a new system. Developing a new system is the least preferred alternative. Many requirements leave no choice other than initiating a developmental program. In this case, a more detailed understanding of the RDTE process is needed.

The RDTE program is divided into the following six categories: Research (6.1); Exploratory Development (6.2); Advanced Development (6.3); Engineering Development (6.4); Management and Support (6.5); and Operational System Development (6.7). Normally only the first four specifically relate to materiel requirements documents.

A basic understanding of the combat/materiel developer relationship, the sources of materiel requirements, the alternatives available in fulfilling these requirements, and the RDTE program categories form a basis to discuss materiel requirements documents.

It must be understood that the materiel acquisition process, from inception to deployment, requires specific requirements documents to support each phase of development and/or procurement.

The Science and Technology Objectives Guide (STOG) is the principal document for the formulation and prioritization of operational capability goals for mid- to long-range planning. The STOG serves as the requirements document for structuring the RDTE programs for entry into the Science and Technology (S & T) base.

For the purposes of the STOG, the tech base typically includes 6.1 Research, 6.2 Exploratory Development, and 6.3A Nonsystems Advanced Development. Prioritization of the S & T Objectives (STO) focuses basic and applied research efforts on user capability goals deemed most essential to the future. It also provides for initial definition of technological advancements before they progress into viable system application.

A STO is normally written in broad, general terms as compared to follow-on requirements documents which support more near-term objectives. A STO may be originated by any individual or organization and, when approved, a solution may be pursued by Army labs, industry, universities, and nonprofit organizations.

Most new or upgraded weapon systems result from science and technology, which permits concept feasibility demonstrations and supports generation of requirements documents towards a specific end item.

The STOG is published annually by Headquarters, Department of the Army (HQDA) and has the following basic goals: To provide prioritized STOs from the user proponents to the developer; To provide information upon which the STOs are formulated; To provide a means for user/developer dialogue; and To provide the criteria on which the accomplishments of the tech base can be evaluated.

The science and technology base program contributes to the MAA process and the formulation of Mission

Element Need Statements (MENS). A MENS is a requirements document which supports program initiation for the Office of the Secretary of Defense (OSD) major programs only.

The combat/materiel developer jointly prepare a MENS, which identifies and supports the need for a new or improved mission capability. It does not limit the system solution by specifically stating the need in terms of capabilities and characteristics of a hardware or software system.

A MENS, by itself, does not support the RDTE process, but, when approved by the Secretary of Defense, does provide program initiation approval towards exploring alternative system solutions and development of subsequent requirements.

For most non-major programs and those major programs whose final approval rests with the Secretary of the Army, the approval of a Letter of Agreement (LOA) constitutes program initiation into 6.3B system advanced development or possibly 6.3A nonsystem advanced development when the conceptual application can be defined.

An LOA is jointly prepared and approved by TRADOC and DARCOM. However, HQDA retains approval authority in those cases in which the projected advanced development costs exceed $15 million, or in other unusual circumstances. An LOA describes the nature and characteristics of a proposed system and the research needed to develop and validate the system concept.

In addition, the LOA defines the associated operational, technical, personnel, training, and logistics support concepts. After approval of a MENS for perceived major programs, an LOA is needed to support work in 6.3 advanced development.

It should be pointed out, however, that 6.3 advanced development is not necessarily required by the materiel acquisition process. Under certain conditions, proceeding directly to 6.4 engineering development is perfectly acceptable and cost effective.

Entry into 6.4 engineering development is normally supported by the HQDA approval of a Required Operational Capability (ROC). A ROC is jointly prepared by TRADOC and DARCOM and concisely states the minimum essential operational, technical, personnel, training, logistic, and cost information necessary to pursue engineering development and/or acquisition of a system.

A ROC is also the requirement document which supports the acquisition of nondevelopmental materiel. For other than OSD major programs, a ROC constitutes program initiation if 6.3 development is by-passed.

A Letter Requirement (LR), which is jointly prepared and approved by TRADOC and DARCOM, may be used in lieu of a ROC when the total RDTE expenditures will not exceed $2 million and procurement expenditures will not exceed $3 million for any one fiscal year or $15 million over the 5-year program period.

Although there are several other types of materiel requirements documents, the ones described in the preceding paragraphs make up the majority of those used within the Army's materiel acquisition process.

Every requirements document, whether approved by OSD, HQDA, or TRADOC and DARCOM, is assigned a Catalog of Approved Requirements Documents (CARDS) reference number and is published in the CARDS document by HQDA. The CARDS document also provides a list of all materiel requirements deleted within the past 12 months and why.

Now that a better understanding of requirements documents and their relationship to the materiel acquisition process has been achieved, it should be apparent that there is, in fact, a definite relationship between buying an automobile and the Army's acquisition process.

Although we may not realize it, normally our thought process which leads to a decision to purchase or not to purchase a car follows a systematic and structured pattern quite representative of the materiel acquisition process.

To elaborate, a perceived need for a new car normally originates from a source. These sources could be poor reliability, high fuel consumption, or the opportunity to purchase an automobile that has the latest innovations we've always wanted.

Regardless of the source the economic and operational feasibility is mentally examined and the requirement is validated and approved. The next step in the process is to determine the acquisition strategy.

We could improve our current car by installing a new engine, mounting new tires, or getting a new paint job. Other alternatives might include purchasing a new Datsun or purchasing a Datsun only when modified to include Goodyear tires.

The last alternative is probably to buy or make new parts and build our own car from the ground up. As is the case in the Army's acquisition process, the last alternative normally represents the most costly decision.

Although purchasing a new car is a simplistic analogy to the Army's procedure, it clearly demonstrates the structured thought process used to generate and validate requirements. If the requirements generation process is a viable approach to materiel acquisition, then why are so many derogatory adjectives used to describe the overall acquisition process? Although the answer is not clear-cut, the solution is to approach the problem on a step-by-step basis, such as examining the requirements generation process on an individual level.

Affordability should be the prime consideration in the preparation and validation of requirements documents. The Army simply cannot afford everything it believes it needs. Although a materiel requirement may be validated and approved, each program must compete against the others for funds.

Many approved requirements continue unfunded in order to continue development of higher priority Army programs. A solution to this is to initiate fewer programs and, once initiated, eliminate the tendency to alter or modify the requirements because of technological advancements.

Requirements documents should transition into "living" documents. They should state the essential operational characteristics and capabilities as well as the desired growth capabilities, based upon the technological advancements showing a high degree of promise.

A living requirements document would not only support the product improvement of fielded systems once the feasibility of technological advances has been demonstrated, but also eliminate the need to generate a new requirements document to support such an improvement. In a nutshell, the Army must strive towards fielding original conceived operational capabilities and pursue improvements after fielding.

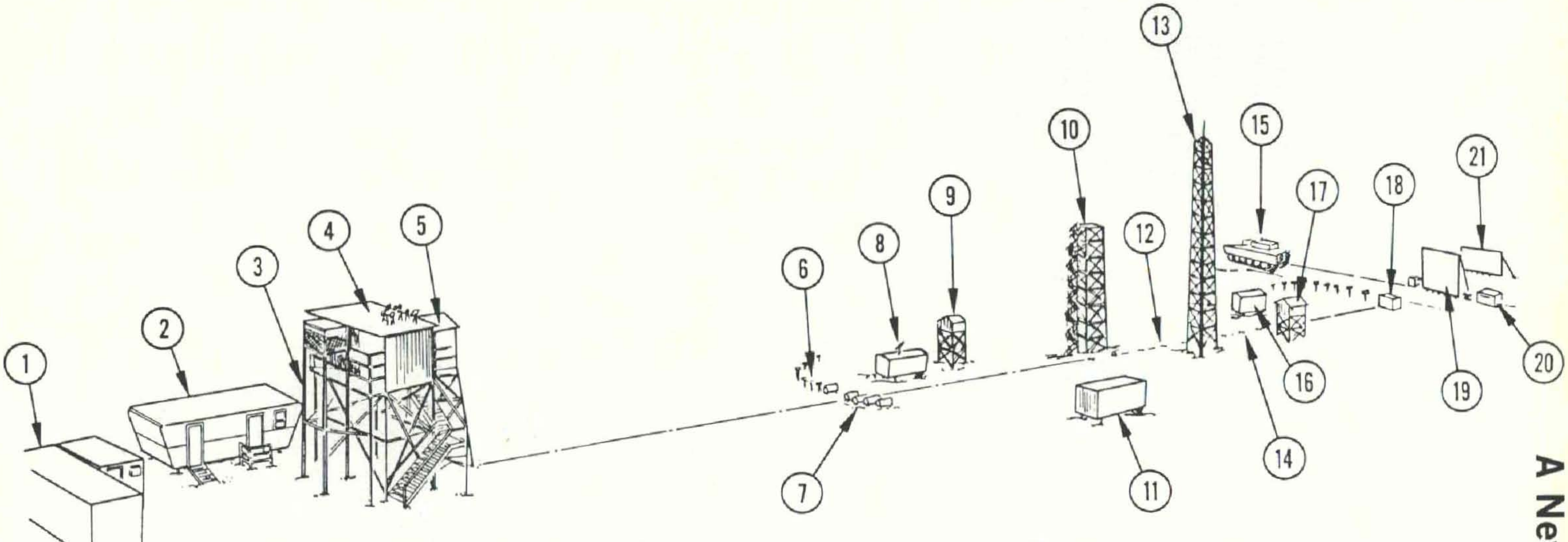
Since it is natural to request champagne in hopes for beer, DARCOM must challenge user requirements to separate the essential capabilities from desirable ones. TRADOC must also direct its efforts towards an accurate statement of operational characteristics and capabilities so as not to limit technological solutions.

A close working relationship between TRADOC and DARCOM needs to be maintained to permit the tailoring of acquisition strategies to the complexity of materiel development.

Although materiel requirements documents are only a subset of the Army's materiel acquisition process, without them the process is nonexistent. Close and synchronous interaction between TRADOC and DARCOM in preparing materiel requirements documents will improve the Army's materiel acquisition process.

A New Simulation Technique . . . BELDWSS

By Dr. R. E. Yates



(1)	DATA REDUCTION AND ANALYSIS	(8)	BACKSCATTER TRAILER	(15)	TARGET VEHICLE
(2)	TEST MANAGEMENT	(9)	20-FT MET AND SEEKER TOWER	(16)	FORWARD SCATTER TRAILER
(3)	CONTROL TOWER	(10)	60-FT MET AND SEEKER TOWER	(17)	20-FT MET AND SEEKER TOWER
(4)	TADS	(11)	TRAILER	(18)	AUTOMATIC CENTROID TRACKER
(5)	GLLD	(12)	AEROSOL PHOTOMETERS	(19)	TARGET BOARD
(6)	RADIOMETERS	(13)	100-FT MET AND SEEKER TOWER	(20)	NPGS AND TRANSMISSOMETER
(7)	TRANSMISSOMETERS	(14)	AEROSOL INITIATION POINT	(21)	C_n^2 MEASUREMENT AND TRANSMISSOMETER

NOTE:

RANGE DATA

CONTROL TOWER (3) TO TARGET (15) = 2.5 km
20 FOOT TOWER (9) TO TARGET (15) = 800 m
100 FOOT TOWER (13) TO TARGET (15) = 475 m

Figure 1. MICOM's Battlefield Environments Range Facility

Laser-guided weaponry first came into prominence during the Vietnam war with the use of the so-called "smart bombs." Subsequently, technological advances came rapidly, allowing adaption and modification down to much smaller size weapons, as well as by weapons that incurred high G-forces in use.

The Army found itself by 1976, responsible for the development of a number of systems intended for multi-service use: designators, Hellfire, Cooperhead, and 5 and 8-inch laser guided cannon projectiles.

However, at this same time the Congress and OSD both expressed concern over the proliferation and potential duplication of laser semi-active weaponry. It was quickly evident, in the light of this concern, that optimizing the tactical value of the total investment required assessment and trade-off techniques considerably beyond those applied to earlier systems.

In the Army, as well as in the other services, weapons were being developed under management units separate from those developing the laser designators on which they rely. The establishment of weapon system effectiveness and system and subsystem interoperability and compatibility had to utilize joint testing and simulation to avoid excessive costs and to assure that integrated systems effects were accounted for.

This meant that new analytical tools, lab and field instrumentation, and simulation models had to be developed. As a result, an element of MICOM has come up with the new Battlefield Environment System Simulation—BELDWSS.

The new system is basically an expansion of an existing in-house simulation capability, but it now provides the vital conditions of operator designation effects and improved subsystem models. The simulation consists of probability of hit (P_H) and all delivery system conditions required to determine the probability of attaining a kill given a target hit ($P_{K/H}$).

The original clear air system simulation has been enhanced by adding models of six different conditions.

The first involves the incorporation of what are called transient aerosols. This includes things like smoke and dust. The second group are natural or steady state aerosols, and here one finds fog, rain, sun, etc.

Third, there are the human factors involved with designation system performance using systems such as TADS and GLLD. The fourth condition is that ensuring from the respective Red and Blue forces fire and maneuver. Next are the electronic warfare effects of such things as laser repeaters. And finally, the conditions of terrain and forest masking must be taken into account.

This greatly enhanced simulation is presently running on a Laser Designation Battlefield Obscuration Simulator (LDBOS). Since performance credibility is a critical concern for any program which uses simulation in lieu of unaffordable live firings, an extensive model validation field experiment is a major part of the BELDWSS program.

This validation effort has both a subsystem and a system level field experimentation program. Subsystem tests include system hardware such as designators and seekers transient aerosols-smoke and dust natural or steady state aerosols-rain, snow, etc. Systems level validation will include eight live firings in the various environments.

BELDWSS actually simulates a one weapon on several targets engagement. It is not a force-on-force simulation such as CARMONETTEE which calculates exchange ratios, costs, etc. Rather, it models all known effects in the engagement of targets with laser semi-active systems in a battlefield environment.

In addition to the conditions for probability of attaining a kill given a hit, of the simulation, BELDWSS provides capability to determine target availability, conditions along the line of sight to the target, target aspect, target ranges, etc. These conditions can easily be used for parametric studies of other Electro-optical or Radio frequency systems. Other engagement scenarios can be accepted.

In determining targets there are two aspects concerning targets which must be modeled. First, how the targets are presented to the weapon, i.e., the tactics employed by the Red and Blue forces. Second, the laser energy reflectance characteristics must be known and modeled.

BELDWSS presently uses the "TRASANA Smoke and Obscuration I" scenario which has prepared defensive positions within a Brigade area which are being attacked by a Combined Armor Mechanized Infantry Division.

The target signature model includes several Warsaw pact vehicles for which the reflectance properties are modeled for any designator target aspect. The simulation "moves" the targets along the attack routes into the defended area over a digitized terrain model. In addition to the TRASANA Smoke and Obscuration I Scenario, north of Hunfeld, there is a Hunfeld South scenario which was developed by AMSAA prior to the TRASANA scenarios being available. Both scenarios have been used.

As for the terrain, that presently modeled is a subset of the SCORES 2A area, and is quantized in 12.5 × 12.5 meter blocks. Urban, built up areas and forests are modeled. The BELDWSS terrain model is used to determine line of sight to the targets on the various attack paths. As a result of the terrain/target movement models can be used outside the BELDWSS to study target exposure time and number of targets.

In addition to terrain obstruction to clear line of sight from the various designation positions to the various targets, HE dust and debris, countermeasure smoke, and burning vehicles may also obstruct that line. BELDWSS uses the Blue and Red fire plans generated by TRASANA to determine numbers, types and location of the various HE dust and debris events. The CM smoke occurrence is handled in a similar manner. The occurrence of the burning vehicles is determined by repeated running of BELDWSS and estimates of the effectiveness of other weapons.

When a transient aerosol event occurs, aerosol propagation models are utilized in the calculation of the concentration and path length of the line of sight through the aerosol from designator to target. This information is then used to determine the various laser energy returns off the aerosol, from the target, etc.

Also, the performance of the various viewing systems (TADS, FLIR, TV, DVO, GLLD, etc.) are determined by this concentration, path length function. Models of these processes are being evaluated and will eventually be validated by a series of field experiments at Redstone Arsenal.

Wind effects on the transient aerosols are modeled. The direction and magnitude of the winds as well as other atmospheric effects are determined as will be explained.

The occurrence description of the various weather conditions producing fog, rain, or snow are being provided by Atmospheric Sciences Laboratory. These consist of 10 day "slices" for each season of the year in the Hunfeld area. BELDWSS can be exercised for each of these conditions or randomly drawn from any atmospheric condition set to determine system performance.

There are many possible EW devices which can be postulated to be used by the Warsaw Pact Nations, and the Countermeasure Office (CMO) at Harry Diamond Laboratory has developed susceptibility models for many of these techniques.

The CMO has also agreed to pro-

vide estimates, based on intelligence information, of type and number of the various devices to be employed. BELDWSS will incorporate models of these devices along with the susceptibility models developed by OMEW to predict system performance.

As for human factors, two types of models of the designator operator performance are available. BELDWSS can accept either actual field tracking data to determine spot location on target or models based on empirical fitting of field data which have been developed. These models are being expanded to include target transition and operator performance when wearing protective clothing, effects being evaluated at MICOM.

The Night Vision Laboratory target acquisition model is being used to determine acquisition times in the various visibility conditions.

There are two delivery systems modeled in BELDWSS—Copperhead and Hellfire. Both have been subjected to extensive laboratory and field experiments to develop and validate both their seeker and dynamical models. The designation systems modeled include both airborne and ground systems.

The TADS airborne system has also been extensively tested, and there have been limited RPV and mast mounted sight parametric studies conducted using specification values. Further, the ground systems GLLD, MULE and LTD have been modeled, with data on the GLLD being more complete than either that of the MULE or LTD.

The LDBOS software is composed of three separate and distinct large-scale computer programs: the Target Signature Model (TSM), the BELDWSS Terrain Model, and either the Hellfire or Copperhead Six-Degree-of-Freedom Flight Simulation (HF6DOF). Although each of these can operate as stand-alone programs, when operating in the LDBOS, they all reside in memory and communicate with each other on a laser pulse-by-pulse basis. For example, HF6DOF interrogates the BELDWSS Terrain Model, giving it the current missile position.

BELDWSS moves the target along the attack path and determines its heading and position relative to the designator and the missile. BELDWSS then interrogates the TSM, giving it the designator and missile LOS information.

The TSM uses this information to determine the amount of laser energy reflected from the target, the reflected centroid location, and the amount of energy underspill/overspill and transmits it to BELDWSS.

BELDWSS uses this data to determine the strength and location of all energy returns (including obscuration effects) and transmits these and the target locations back to HF6DOF. HF6DOF processes this information and at the next laser pulse time, transmits missile position to BELDWSS and the process is repeated.

Although the above is a much simplified description of the LDBOS operation, it does indicate the way in which the three programs are interrogated, exercised, and data transferred. The inter-process communication capability and memory feature of the LDBOS allow the three programs to execute in this manner.

Because the BRL CYBER 76 does not have this inter-process communication capability, in order to operate the LDBOS software on it, the three programs would have to be combined into a single program. Each of these programs requires extensive computer memory.

The TSM, as modified for the BELDWSS application, requires in excess of 30,000 (octal) words, the BELDWSS Terrain Model requires 200,000 (octal) words, and HF6DOF requires 150,000 (octal) words.

A cost effective solution to the memory requirements of a combined program, if one exists, would require significant expert programing resources and, very likely, would require unacceptable limitations and assumptions.

The LDBOS is dedicated to BELDWSS and its economics of performance have been verified. Because the LDBOS is dedicated, all program development, checkout, and validation will be performed on it.

The field experiments are now being conducted in subsystem and system level phases. The subsystem tests are conducted on a MICOM range depicted in Figure 1. The TADS, GLLD and Hellfire seeker hardwares are being evaluated in this range facility.

A typical experiment is as follows: A transient aerosol event (i.e., smoke) is initiated at Point 14 on Figure 1. The aerosol dynamics are measured, and the concentration path length of the aerosol along a line of sight are determined. The propagation and scatter of the projected laser energy is measured. The transmission at visible, laser, television, and FLIR wavelengths are measured, as are the laser energy returns and seeker response to these returns. The target illumination/tracking performance of the TADS and/or GLLD are measured against a variety of targets including a Soviet tank. Extensive meteorological data is taken.

This test process involves approximately 250 simultaneous measurements 20 times per second. Each of these data is time correlated with range IRIG timing. The collection, verification, formatting and combination of these data are automated and processed via three slave and one master digital computers.

This facility enables, for the first time, the collection of a minimum set of data sufficient for development and validation of the BELDWSS subsystem models.

The system level validation process will be accomplished through a missile live firing program to be done at Eglin AFB, and a limited subset of the subsystem experiment instrumentation will be used in the system level program.

The BELDWSS program theory is a scientifically sound effort enabling credible prediction of laser guided weapons system performance in the realistic battlefield. Extensive care is being taken in development and validation of both models of physical processes of the various hardwares and environments as well as the scenario related events of battle.

There has been extensive involvement of the various DARCOM agencies in the accomplishment of this program. AMSAA has been chartered by DARCOM to act as critical customer of program methodology and validation. This extensive intra-agency contribution has greatly facilitated program accomplishment as well as insuring unbiased treatment of all program aspects.

The BELDWSS approach can be extended to accommodate new weapons systems with new scenarios. New weapons systems would require additional field experiments for hardware model validation with minor effort to accommodate scenario changes.

DR. ROBERT E. YATES is a research aerospace engineer in the Guidance and Control Directorate of the U.S. Army Missile Command. He is responsible for BELDWSS simulation studies and model configuration management. He received his BS and MS degrees in electrical engineering from the University of Tennessee and his PhD in electrical engineering from the University of Houston.

Army Evaluating New Automatic Map Reader

The Army is considering a new tracking system which will enable helicopter pilots in tactical situations to pinpoint at a single glance their exact position on a map.

The U.S. Army Human Engineering Laboratory, Aberdeen Proving Ground, MD, is conducting tests on an Automatic Map Reader, and will make recommendations to the system's manufacturer, Marconi Avionics of England, regarding human engineering design principles.

"The Army asked for a navigational system for tactical situations," said MAJ Thomas Frezell, project officer for the tests, and an Army pilot. This map reader, says Frezell, is basically a very inexpensive map reader that answers part of the present navigation problem. HEL looks at the human engineering factors involved in using the map reader.

Several pilots will use the device and get a basic idea of how it works and provide some user comments. The ultimate goal is to have an ideal piece of navigational equipment.

The map reader is relatively small, can be handheld, and is portable. It is attached to a doppler navigation interface panel inside the helicopter and is capable of several modes of operation.

Besides tracking the aircraft's current course and giving its exact location in 8-digit grid coordinates, the reader can also provide coordinates of an enemy target. This enables the pilot to either store the information in the computer, or radio the enemy position to other aviation elements, or to adjust artillery fire against this position.

Operation of the reader is fairly simple, Frezell said. First the pilot or the navigator positions the map inside the reader and sets the reader to grid north. Next, he slews the cross hairs to denote his exact ground location before take-off. In the present position mode, the reader will track the aircraft's flight course.

Another feature of the automatic map reader is its ability to store up to 16 waypoints. If you know or suspect an enemy position or enemy anti-aircraft location, Frezell explained, you can store them in the waypoint mode, so you'll be able to avoid those areas.

The reader has been undergoing tests at HEL in a JUH-1H helicopter at Phillips Army Airfield for approximately two months. He noted, however, that the system will work as well in any suitably equipped aircraft.

Frezell said he expects to complete the testing in another month, and will forward HEL's recommendations to Marconi Avionics in a laboratory report.

Natick Tests XM1 Crewmen Clothing System

The U.S. Army Natick (MA) R&D Command has designed and is field testing a new clothing system that will provide crewmen of the new XM1 tank and other ground combat vehicles with protection from flame, shrapnel and fragmentation, in addition to protection from the elements.

The new clothing system consists of the following items:

- Standard two piece cotton/wool long underwear for use in the winter and cotton underwear for summer wear.
- A ballistic undergarment to protect the upper torso from fragments and small particles as well as small caliber, low velocity bullets.
- A bib overall with insulated liner which is sized for wear over the coverall for added protection against the cold.
- A coverall with a removable two piece insulated liner.
- A jacket with liner.
- An improved CVC helmet which provides for increased bump protection and a 100 percent increase in ballistic protection from fragments.
- Two pair of boots, one for summer and an inuslated version for winter. Both boots provide for toe protection, are designed to be put on quickly and have a wedge type heel for better traction on the deck surfaces of the vehicle. When worn with the new vinyl overboot better foot pedal dexterity is provided during winter operations.
- Protection to the hands from flame are provided by two types of gloves (summer and winter). These gloves use a thin cattlehide leather on the palm to minimize their effect on the tactility (feel) of the wearer. The winter type have insulation for added protection from the cold.
- Face and head protection are provided by: a face mask for fragmentation, flame, dust, and wind protection; a balaclava to protect the head and neck from wind and flame.

The close fit of all components reduces the possibility of snagging while in the vehicle and the uniform can be adjusted to temperature changes by adding or removing the coverall liners, bib overall and jacket.

An extraction strap is located in the shoulder portion of the coveralls to assist in the removal of an injured crewman. This strap can also be reached through the jacket. Throughout the design process, protection of the individual and interchangeability of the system was stressed.

Except for the underwear and ballistic undergarment, all clothing components are fabricated from Nomex fabrics which have outstanding resistance to flame. The added protection against battlefield threats will result in decreased injuries which is said to justify the $1,200 cost to outfit each crewman.

Preliminary reports from test sites at Fort Knox, KY; Fort Drum, NY, and U.S. test troop in Germany indicate the system is meeting all expectations.

Moving—Being Transferred?

To ensure continued receipt of the magazine, persons, both Active and Reserve, who are authorized individual copies, should give timely notice of their new address. Instructions on where to send address corrections are given on the inside of the front cover. DO NOT SEND CORRECTIONS to the magazine editorial office, as mailing labels are provided the magazine by the agencies mentioned in the instructions. Changes of address must be given to your duty station military personnel office. Regulations also require that you receive the magazine at your duty station address, not your home.

The U.S. Army's Alternative and Synthetic Fuels Program

By Maurice E. LePera

Fuels for Army materiel diverge from those being used within the civilian sector. Needless to say we cannot merely procure fuels from our friendly service station and at the same time achieve combat effectiveness and operational readiness.

Recent emphasis by DOD has focused on development and implementation of a Defense Mobility Fuels Action Plan. It is directed towards minimizing potential loss of military effectiveness from a disruption of energy supplied under foreign control. The program, as developed, is responding to this DOD thrust.

The current Army Fuel Policy as listed in AR 703-1, Coal and Petroleum Products Management, identifies three major types; gasoline, turbine fuel, and diesel. Table 1 shows the product type, the appropriate specification and the primary use of that fuel. As is noted, all our tactical fuels have NATO interchangeability and interoperability, and the NATO Code Number identifies the interchangeability agreements.

Within our current inventory of mobile equipment, a wide variety of powerplant systems exist which must be satisfied by the fuels types shown on Table 1. Fuel requirements obviously must satisfy the wide mixture of systems. These range from small 2-cycle spark-ignition engines to large 2-cycle and 4-cycle compression-ignition engines found in self-propelled guns and tactical support equipment.

Additionally, gas turbines now being introduced into power generation equipment and the new main battle tank, are found in fixed/rotary wing aircraft.

In discussing the wide mixture of powerplant systems which must be satisfied by those military fuels previously mentioned, there also exists unique requirements for mobility fuels which are incorporated into an RDTE effort. These requirements can be summarized as follows:

- Survivability—Fuels must be designed to reduce the threat/vulnerability of fuel fires produced by ballistic penetrations.
- Commonality—Fuels must have interchangeability and interoperability characteristics to comply with NATO standardization policies.
- Storage Stability—Fuels must be formulated to possess enhanced storage stability characteristics to minimize potential for deterioration/degradation. Unusually long use intervals exist for military fuels because of intermittent operation of Army equipment, storage requirements, etc., all of which stress fuel in terms of auto-oxidation.
- Multipurpose Use—Fuels must be capable of being used in operations worldwide. One cannot accurately predict changes in geographical/climatogical environments as fuels must provide satisfactory operation.
- Unique Inhibitor Requirements—The types of operational/environmental situations dictate the use of specific inhibitors. Examples are fuel system icing inhibitors, antioxidants, lubricity additives, biocides static dissipator additives, etc.

Responsibilities for the fuels research program are an integrated activity within the Army community. Effective coordination between the Mobility Equipment R&D Command, Tank-Automotive R&D Command, and Aviation R&D Command is accomplished by semi-annual technical program reviews with MERADCOM functioning as the lead agency in mobility fuels RDTE.

Coordination is essential to insure development, execution, and completion of the program in question. Likewise, coordination within DOD, NATO, and industry is accomplished through active participation in a variety of industry activities, i.e., ASTM, SAE, ASLE, etc.

Our activities within the ASTM D-2 Committee on Petroleum Products and SAE's Technical Fuels Committee assure our active coordination with industry in developing fuel stan-

TABLE 2
Previously Evaluated Synthetic Fuels

SYNCRUDE SOURCE:	PROCESS:	FUELS:	WHEN TESTED:	PRODUCT QUALITY:
Coal	C.O.E.D. (Pyrolysis)	Gasoline Distillate	1973–74	Marginal Marginal
Tar Sands	Steam Extraction (Gulf Canada)	Aviation Turbine (JP-5)	1975	Excellent
Shale	Parahoe (Above-Ground Retort)	Gasoline Diesel Aviation Turbine (JP-5/JET-A)	1976–77	Marginal Poor Marginal
Shale	Parahoe (Above-Ground Retort)	Aviation Turbine (JP-5 & JP-8) Diesel	1979–80	Satisfactory

TABLE 1
Army Fuel Policy (AR 703-1)

PRODUCT:	MILITARY SPECIFICATION:	PRIMARY USE:
Aviation Gasoline (AVGAS)	MIL-G-5572, 100/130 (NATO F-18)	Reciprocating Engine-Powered Aircraft
Automotive Gasoline: (MOGAS Unleaded) (MOGAS Leaded)	 VV-G-1690 MIL-G-3056 (NATO F-46)	 Mobile & Stationary Spark Ignition-Powered Ground Equipment
Turbine Fuel	MIL-T-5624, JP-4 (NATO F-40)	Army Turbine Engine-Powered Aircraft
Diesel Fuel	VV-F-800 (NATO F-54)	Mobile & Stationary Compression Ignition & Turbine-Powered Ground Equipment

dards and, at the same time, provides a strong link to industries current thinking and major thrusts in these areas.

The current thrusts within the U.S. Army's Alternative and Synthetic Fuels Program encompasses the following efforts: Develop Capability for Using Synthetic and Alternative Fuels; Develop New, Accelerated Fuel-Engine Qualification Procedure Methodology; and Conduct Gasohol Evaluation in Tactical Equipment.

The first two efforts have evolved from the recent emphasis within DOD as was stated previously. The third thrust is in response to recent Congressional legislation, the Defense Authorization Act of November 1979, which now requires DOD to procure under competitive bid, domestically produced alcohol or alcohol-gasoline blends.

It should be noted that synthetic fuel evaluations are not new areas of research for Army laboratories. Table 2 provides a brief summary as to product evaluations in which the Army has been a participant. As this shows, our initial exposure to synthetic fuels occurred in 1973 as a participant to the U.S. Navy COED effort.

The Navy has been designated as the focal point within DOD on synthetic fuels RDTE. They have maintained this effort and were responsible for the generation of the synthetic fuels shown. This lead responsibility has now been transferred to the Defense Energy Task Group.

Prior to discussing the synthetic fuels program, a brief explanation of the systematic process is needed to identify those steps needed prior to field or fleet testing a new or modified fuel. This process, shown in Figure 1,

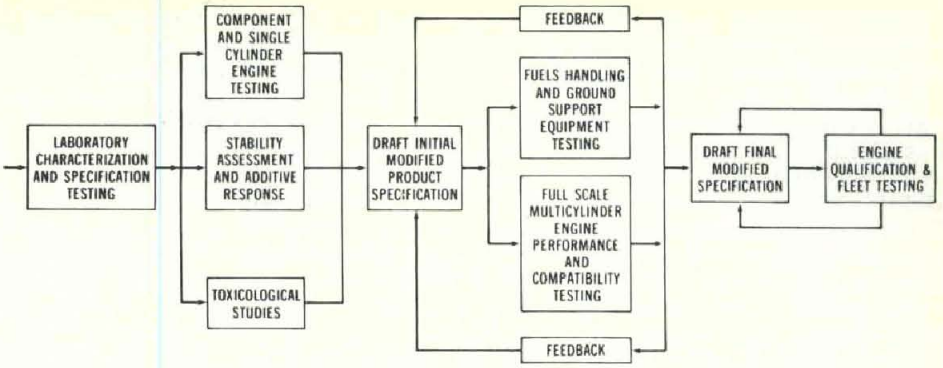


Fig. 1. Process for Evaluating New/Synthetic Fuels

has been developed over the past several years, and illustrates the process which has been and will be followed for evaluating and qualifying new/modified fuels.

The initial characterization phase up to the drafting of the initial product specification, requires relatively small amounts of test fuel, i.e., up to 10 drums. However, the second phase involving compatibility testing requires considerably larger quantities (i.e., in the order of 3,000 to 3,300 drums).

Considerably large quantities are required for the full-scale engine endurance testing. To further explain the need for the relatively large quantities, Table 3 provides a listing of engine types and their consumption rates. These quantities reflect, however, single engine durability tests for those items listed do not represent the complete engine testing required for certification.

The process followed in evaluating new/synthetic fuels allows for the defining of problems in performance prior to the procurement of the large quantities required for engine/component durability testing. Total emphasis and direction leads to the development of fuel specifications which can be used for procurement of products refined from the synthetic crude source which in the near time frame will be shale.

Limited quantities of JP-5 turbine fuel and diesel fuel have been obtained from the Parahoe above-ground retort system. This product is being used in the laboratory and component-type RDTE. During FY81, larger quantities of shale-derived product will be available for the durability and endurance testing. These products may be refined from a modified in-situ retorting process.

Also during late FY81, following completion of the engine durability and fuel handling/distribution test phases, field user acceptance tests will be initiated. These tests will continue through FY82 with additional testing in the laboratory being conducted as needed.

Field tests will terminate at the end of FY82 with the development and issuance of fully-coordinated fuel specifications for combat gasoline and diesel fuel. This, in turn, will be used by Defense Logistics Agency for procurement of shale-derived product.

In addition to shale-derived synthetic fuels, we anticipate the potential availability of fuels derived from coal liquefaction processes. For this reason, our program has identified the laboratory and component testing phase to start in mid-FY81 with coal liquefied fuels.

Two major processes are being researched within DOE. These are the solvent extraction process and the catalytic hydrogenation process. Demonstration pilot plants for the solvent extraction process are Gulf's SRC-II facility located in Washington and Exxon's Donor Solvent unit in Texas. The H-Coal unit in Kentucky is the pilot plant reflective of the catalytic hydrogenation process.

These units should be producing limited samples of product during FY81 for the initial portion of the laboratory characterization testing. There is a feeling within DOE that if shale oil becomes the commercially-

TABLE 3
Engine Types & Fuel Consumption Rates

ENGINE:	TYPE:	VEHICLE/ AIRCRAFT:	RATE OF FUEL CONSUMPTION:		TOTAL FUEL QUANTITY REQUIRED:		
			MPG	GPH	Gallons	Drums	(BBLS)
Hercules, L141	4 cyl, 4 cycle S.I.	Truck, Utility, 1/4-T, M-151	16	4	1800	33	43
Continental, LDT-465	6 cyl, 4 cycle C.I. (Mann System)	Truck Cargo, 2 1/2-T, M34/ M/35	5	10	4500	83	107
Cummins, NHC 250	6 cyl, 4 cycle C.I.	Truck, Cargo 5-T, M-813	4.2	10.5	4725	88	113
Detroit Diesel 6V53T	6 cyl, 2 cycle C.I.	Armored Assault Vehicle, M-551	1.9	15	6750	125	161
Continental, AVDS-1790-2C	12 cyl, 4 Cycle C.I. Air-Cooled	Main Battle Tank, M-60/M-48	0.7	40	18,000	333	429
AVCO-Lycoming AGT-1500	Gas Turbine, Recuperated	XM-1 Tank System	0.54	46.3	46,300	857	1102

produced "synfuel," coal liquefaction will not approach any degree of commercialization until the late 1990s.

However, within our RDTE program, we cannot afford to wait until that point in time and then plan a program. For this reason, RDTE on coal liquefaction will begin during FY81 and continue on to FY83 or later depending on whether DOE pursues coal as a mobility fuel.

The last type of synthetic fuel identified within the program is that which is termed "Biomass Derived Fuels." This means essentially using alcohols derived from wood, vegetation, etc., which can be blended into petroleum distillates as a means of extending the availability of petroleum crude.

Biomass Derived Fuels are targeted primarily for compression-ignition and turbine engine systems. Initial laboratory and component testing will be initiated in FY82. In this area, wood itself may be considered as a mobility fuel using novel liquefaction techniques.

The second major thrust within our Alternative and Synthetic Fuels Program involves the parallel development of a new accelerated engine-fuel qualification procedure methodology. The task which DOD specified in late 1979 was "to develop more efficient military fuel qualification procedures to effect capacity to react quickly to changes encountered in the petroleum refining industry.

The normal time required for qualification of a new fuel for the engine and powerplant accessory systems is approximately five to eight years. As an example, the transition to unleaded gasoline within the Department of the Army took four to five years.

The program underway involves five tasks. These tasks initially address the survey of what propulsion and accessory systems currently exist within our fleet/equipment inventory. This will be followed by an assessment of the current procedures now employed to qualify/certify these systems.

For example, there are military specifications, military standards, industry standards, etc., which are now part of the current procedures. Following this task, an effort will be made to establish relationships/correlations between fuel property characteristics and engine and/or hardware components.

Certain types of aromatics in jet fuels affect fuel lubricity characteristics, sulfur/nitrogen compounds affect deposition rates in critical area environments, etc. Within this task, new instrumental analyses techniques will be developed to determine/identify hydrocarbon and non-hydrocarbon constituents in fuels that then can be used in the development of more accurate predictive correlations for performance.

The fourth task will involve the development of referee and reference fuels which would be used in the accelerated qualification procedure systems. Use of these fuels is most critical in any accelerated evaluation as they would assure the adequacy of any developed qualification/certification test.

The last task would essentially involve the development of the accelerated qualification procedure methodology. This methodology, once developed, would be updated with new test techniques, software and modeling procedures as these become available. The procedures would also be used to evaluate the resultant performance of alternative/emergency type fuels that become available.

The third thrust within our Alternative and Synthetic Fuels Program involves the Gasohol evaluation. This effort was initiated this fiscal year as a result of the passage of the Defense Authorization Act of November 1979 which mandates the use of Gasohol by federal agencies wherever possible.

The program involves an initial laboratory phase which will address materials compatibility and storage stability assessments. This laboratory phase is being followed by an engine/component endurance test and evaluation phase which will address the performance of Gasohol in military standard engine generator sets, vehicle engine dynamometer testing, evaluation of Gasohol in soldier support equipment which consumes gasoline, and testing of Gasohol in fuel handling and distribution equipment.

The third phase will involve fleet testing of Gasohol in tactical vehicles to address aspects such as performance, fuel economy, potential lubrication problems, etc. The culmination of this 2-year program will be the development of a fully-coordinated Gasohol specification allowing its use in all military equipment which now uses gasoline.

Major reasons for our immediate concern are Material Compatibility Problems with Elastomers, Filter Media, Plastics; Performance in Military Designed Engine Systems and Storage Instability Due to Vehicle Use, Long Residence Times, and Water Contamination. Additionally, there is concern over Phase Separation, Increased Solvency Creating Particulate Contamination Problems, Marginal Lubrication Under Intermittent Operation, Field Mixing Problems, and Vapor Recovery Requirements.

Within our program, we are only addressing use of Gasohol in tactical equipment. Regarding administrative equipment, we have not included these within our fleet test programs since there are active ongoing programs within Department of Energy, state governments, and some DOD agencies that are looking at Gasohol use in commercial-designed vehicles. We are coordinating very closely with these ongoing efforts to supplement our Gasohol evaluation.

In compliance with the Defense Authorization Act of November 1979, Defense Logistics Agency (DLA) requested that we prepare an interim purchase description to allow their initial procurement of Gasohol wherever applicable.

A Purchase Description PD ME-102b dated 29 March 1980 was prepared and is now being used by DLA. This document, however, is only intended for use with administrative vehicles, and has been coordinated with ASTM Technical Committee A-1 on Gasoline Specifications and their Oxygenated Task Force who collectively are developing a Gasohol standard.

In summary, the Alternative and Synthetic Fuels Program shows (1) the increased emphasis in synthetic fuel RDTE, (2) a certain degree of flexibility for addressing all types of synthetic fuels, and (3) the new effort to reduce the time required for qualifying new fuels on engine/component systems. Lastly, our Gasohol Evaluation is in compliance with recent Congressional legislation.

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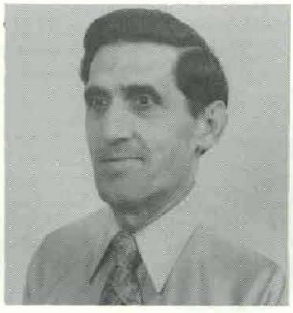


DADS Termed 'Valuable Tool' for Weapons Analysis

A new computer code developed jointly by the U.S. Army Armament R & D Command and two universities—the Dynamic Analysis and Design of Systems (DADS)—may be a "valuable tool" in the future for speeding up the analysis of many kinds of mechanisms, including weapon systems.

Developed by members of the Technology Branch of ARRADCOM's Fire Control and Small Caliber Weapon Systems Laboratory, in conjunction with the Universities of Iowa and Michigan, DADS will allow engineers to enter only the most basic input into a computer.

DADS will rapidly do the work that up to now has been done by the individual—that is, deriving the equations that are necessary for determining the precise relationships between the various components of a mechanism and the nature of the forces acting upon them.

Until now, the computer has only been used by ARRADCOM for the last part of the analysis procedure—solving the equations to get the desired information on displacements, velocity and acceleration of weapon system components such as the bolt, bolt carrier, or striker of a weapon.

The DADS code derives, verifies and works out equations with the engineer only inputting information such as the relationship of each component to every other component and the overall mechanism design.

Now the engineer tells the computer what forces will act on the system, the initial force being labeled the disturbing force. DADS then takes over and assembles the entire weapon system.

Thus far, the code has been tested on the M16 rifle and a 25mm automatic cannon mounted on the Fighting Vehicle System. Both have been previously analyzed using the manual analytical procedure. The DADS results have been compared to the verified results to determine the accuracy of the new computer code.

CSL Preparing Improved Decontaminating Apparatus

An improved version of the Army's current power-driven decontaminating apparatus is in the final stages of engineering design at the U.S. Army Armament R & D Command's Chemical Systems Laboratory. It should offer an improved capability for decontamination of equipment on the nuclear and chemically contaminated battlefield.

According to Mr. Richard Dewey, project engineer for the vehicle-mounted apparatus that was conceived in CSL's Physical Protection Division, the new version provides an improved decontamination capability and increased system mobility.

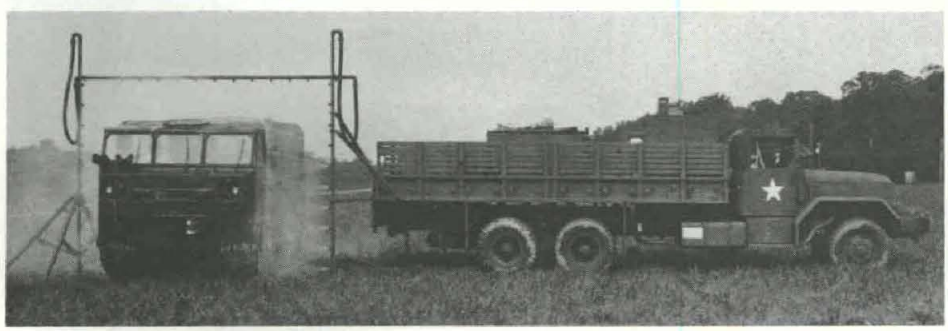
The updated unit is permanently mounted on a 5-ton cargo truck. Features include a steam and high pressure water cleaning capability with an onboard generator, an increase in output from 50 to 100 gallons per minute, and an easily-erected wash/rinse rack for quick rinsing of vehicles.

"With the rack assembled adjacent to the truck, vehicles can drive through to rinse off the decontaminant, much like a car wash," Dewey says.

"Furthermore," he states, "we have a more reliable power source, by having the unit derive power from the vehicle through a power take-off." It will also be capable of limited terrain decontamination.

Four hand-held hoses with nozzles and brushes are provided for convenient decontaminating of difficult-to-remove substances on vehicles. A troop shower frame allows for mass showering of up to 25 personnel at a time at a decontamination station.

Installation of the newly designed apparatus onto cargo trucks is scheduled to begin next year.



Vehicle-mounted Decontaminating Apparatus

Improved Graphite Fibers Sought by MERADCOM Lab

The U.S. Army Mobility Equipment R & D Command's Material Technology Laboratory is participating in a developmental program to improve the capabilities of high toughness graphite fibers and evaluate their potential application in Army materiel.

Past efforts to improve the modulus strength, or stiffness, of graphite fibers, resulted in a loss of tensile strength. At the same time, efforts to improve the tensile strength resulted in a loss in fiber stiffness.

MERADCOM and their contractor, Fiber Materials, Inc., are developing a boron strengthened graphite fiber which, for the first time, promises to give both improved strength and stiffness characteristics.

The toughened graphite fibers are made from a commercially available organic precursor fiber which is drawn down to approximately five microns. It is then further reduced in size to approximately three microns during graphitization and is alloyed with boron at a temperature of 2,300 degrees Celsius.

The high toughness graphite fibers can then be used in either a plastic or metal host material to form a matrix composite. These boron strengthened graphite fibers offer lightweight composites with increased strength and toughness.

Lightweight composites may be used in a variety of military equipment. MERADCOM'S Marine and Bridge Laboratory is especially interested in the application of the improved graphite fibers in future Army bridging equipment. Other possible applications include military vehicles and helicopters.

Boron strengthened graphite fibers have already been produced with a significantly improved modulus strength or stiffness, and with almost twice the tensile strength of untreated fibers. Expectations are that fibers will be produced of 500,000 to 600,000 p.s.i. tensile strength with a 60 million p.s.i. modulus level.

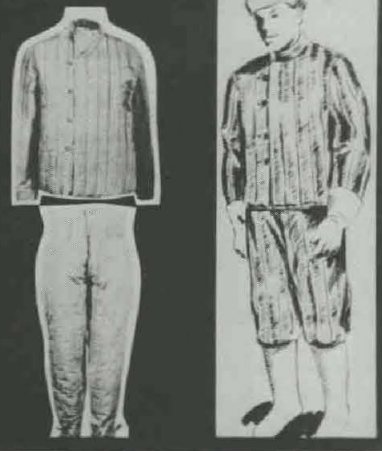
The fiber is being scaled up from the experimental stage to a pilot production rate of one pound per hour.

Warsaw Pact

Shown on these pages are some of the various WPC field uniforms and protective garments. According to the U.S. Army Foreign Science and Technology Center, which provided these photos, WPC clothing design philosophy stresses simplicity, functionality,

SOVIET EVERGREEN CAMOUFLAGE UNIFORM

SOVIET WINTER QUILTED UNIFORM



SOVIET WINTER FIELD UNIFORM

SOVIET SHEEPSKIN OVERCOAT

SOVIET COMBAT VEHICLE CREWMAN'S WINTER UNIFORM

SOVIET "STIPPLED" CAMOUFLAGE UNIFORM

SOVIET WINTER OVERCOAT

Our RDS Office in Canada

By COL James F. Bleecker

Editor's Note:

The following feature is a corrected version of that which appeared on pp. 22–24 of the July–August issue, wherein the last 12 paragraphs of COL James F. Bleecker's article on "Our RDS Office in Canada" were inadvertently omitted.

Readers interested in keeping a complete record of Army Out-of-Country Research, Development & Standardization Agencies features, can lift out this centerfold (addendum) and insert it in the July–August issue, to replace the incomplete article. Others may wish to remove this addendum and still retain the complete September–October issue.

Our RDS Office in Canada

By COL James F. Bleecker

Any article on the U.S. Army Research, Development and Standardization Group-Canada must begin with some comment on Canada itself, a vast country with the world's largest natural coastline, a population and GNP about one-tenth of the United States, and a fine military heritage.

The Canadian soldier has a proud history of battle accomplishments. Canada's regular forces are small in comparison to the United States, but they are highly professional and are backed by a dedicated reserve force (the Militia).

Canada has requirements to field and support military forces at home and abroad, in a wide variety of environments, in performing their mission of defending national sovereignty, being a partner in the defense of North America, participating in NATO, and contributing to UN peacekeeping forces.

These requirements often give rise to their own special types of equipment and materiel. However, Canada is a dedicated partner in the overall goal of standardization and interoperability, as well as cooperative efforts in the R&D area.

The origin of the U.S. Army Research, Development and Standardization Group-Canada, like the ABCA program, goes back to the close cooperation between the allies during World War II, when liaison officers were exchanged between Canada and the U.S. After the war, it was decided that the close cooperation should be continued.

In 1948 then, U.S. Army personnel in Canada were designated "Standardization Representatives" and were assigned to the "U.S. Army Interchange Group."

The "Plan to Effect Standardization" was repleced by a "Basic Standardization Concept" in 1950, and later by the "Basic Standardization Agreement" in 1954. When Australia joined the program in 1964 it became known as the ABCA program. This group of standardization representatives in Canada were officially designated "The U.S. Army Standardization Group, Canada" in 1953.

U.S. Army Standardization Group-Canada. Seated: COL James F. Bleecker, senior standardization representative. Left to right: LTC Leo A. Kramer, standardization representative; Douglas B. Killeen, assistant; Lloyd M. K. Campbell, administrative officer; Viola Pilon, secretary; Wendy Broneder, secretary.

The mission assigned to the Group then, is today essentially the same, with one exception. That mission, simply stated, is to provide U.S. Army representatives in Canada for coordinating the ABCA program.

In order to accomplish this mission, the Group must maintain an awareness of Canadian and U.S. Army requirements and research and development actions so that they may promote exchange of information between the two countries, cooperative development, and standardization of equipment, tactics and doctrine.

This requires the performance of unglamourous but vital administrative functions such as processing standardization loans of equipment and processing requirements for visits by U.S. personnel to Canada for ABCA and research and development activities.

The Group does have one unique mission in that it is charged with coordination of the U.S.-Canadian Development Sharing Program (DDSP), this is a bilateral U.S.-Canada program which had its beginning in 1954, following a decision by the Canadian Government that it was no longer practical to undertake the development of major military hardware to meet purely Canadian military requirements. It followed a series of agreements between the two countries in the field of economic cooperation.

The DDSP affords Canada a fair opportunity to share in the development and production of U.S. weapons and equipment. That is, Canadian industry is given a chance to develop and produce weapons and equipment to meet U.S. military requirements. In return for this opportunity, the Canadian Government is willing to assume up to 75 percent of the total development cost, with cost sharing

of 50 percent being the norm.

The DDSP is administered in the U.S. by the Department of Defense (DARCOM for the U.S. Army), but in Canada it is the responsibility of a department separate from the Department of National Defence—the Department of Industry, Trade and Commerce (DITC). This department is in some respects similar to the U.S. Department of Commerce as it is charged with industry and commerce development, export development and international trade relations. But it also has major responsibilities in defence production, research and development, and international marketing of defence items, as well as commercial items.

The DDSP program is managed by the Defence Programs Branch of DITC, specifically the U.S. Marketing Division. This requires the Group to maintain liaison with two departments of the Canadian Government which makes it unique among the Research, Development and Standardization Groups.

The policy and procedures for conduct of the DDSP program are contained in AR 70-66. Basically, a developing agency identifies a project to be provided for nomination, evaluates the project against the nomination criteria contained in AR 70-66 and holds discussions with DITC representatives (Canadian Trade Commissioners located throughout the U.S.) to ascertain Canadian interest and technical capability to do the required development. If agreed upon at that level a draft project agreement is jointly prepared and staffed for final appproval by the U.S. Army and the Canadian Government.

To carry out their mission, the Group was originally authorized 15 officers, one non-commissioned officer and one civilian chauffeur. A small element consisting of the senior standardization representative, a combat development representative, an administrative officer and the chauffeur were located in the Army Headquarters.

A group of technical service officers (including a medical service colonel), and standardization representatives, represented the various technical services and were physically located with their corresponding Canadian technical service counterparts.

With the signing of the Memorandum of Agreement for DDSP, one standardization representative was assigned as a full time liaison with the Department of Industry, Trade and Commerce and was physically located with that organization. All the standardization representatives were supported administratively by the Canadians, and the Group reported to the Chief of Research and Development, Department of the Army.

Through the years, the size of the Group has gradually been reduced. The current organization consists of two standardization representatives, one colonel and a lieutenant colonel, a Canadian civilian administrative officer, and a chauffeur.

With the unification of the Canadian Armed Forces, the Group is now headquartered with the Department of National Defence. However the main interface is with the Land element of the headquarters. Secretarial support is provided by the Canadian Forces.

The Group's first assistant, Mr. Douglas B. Killeen, who joined in 1952, is still serving. Douglas, a native of Ottawa and an ardent Ottawa Roughrider football fan, recalls well the first sedan provided—a 1951 Chevy painted olive drab, with large white identification numbers and carrying diplomatic license plates—a feature that caused much attention. At the request of the U.S. Ambassador, later sedans were unmarked.

Doug can describe each car, and its idiosyncracies as well as the ten senior standardization representatives he has served with.

The fact that the mission of the Group has not changed with the drawdown is an indication of the effectiveness of the Group over the years in establishing direct communication links between the Canadian Forces and U.S. Army elements.

Today, most of the routine day-to-day activity that takes place in the ABCA program, cooperative R & D, and the Development Sharing Program is between action officers of the two countries following established standard operating procedures that the Group has established.

This relationship allows the two standardization representatives to concentrate their efforts on high priority projects and new initiatives. In addition, the representatives are "on the scene" to facilitate the free exchange of information by removing administrative and bureaucratic roadblocks that periodically crop up.

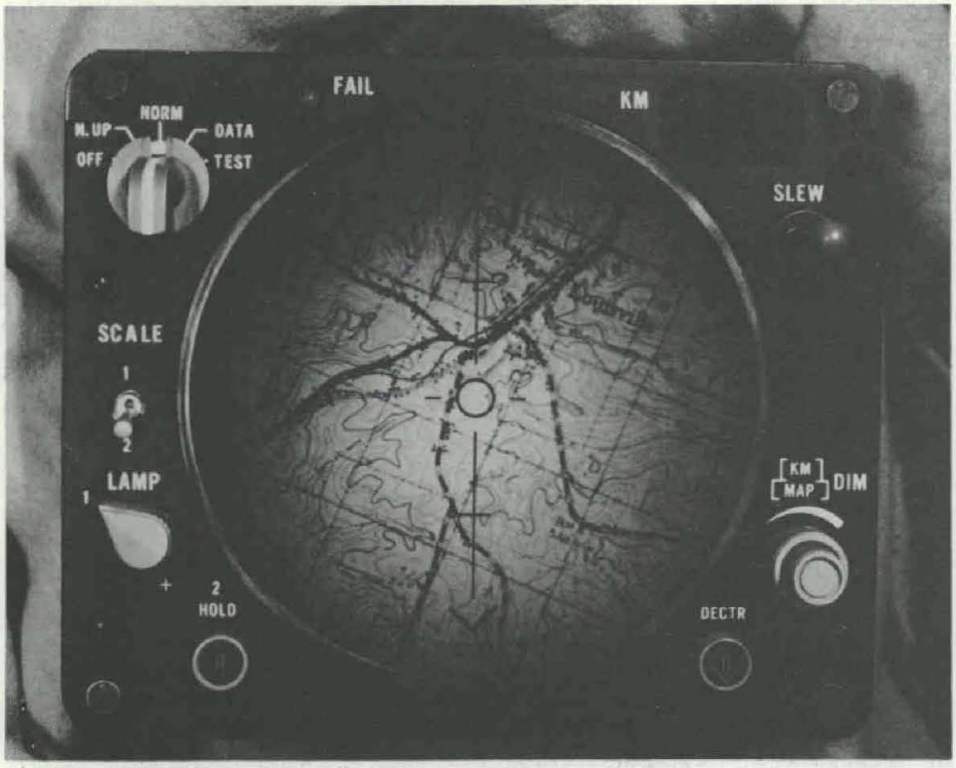
The Group's success in accomplishing its mission is measured in the success of the ABCA program. There exists today several hundred Quadripatite Standardization Agreements (QSTAGS) which cover a wide variety of areas of equipment and procedures, to include such items as weapons, ammunition, nuclear hardening criteria, radio telephone procedures and conduct of artillery fire procedures.

Some significant examples of joint U.S. Army-Canadian Standardization Agreements are: the TOW missile, U.S. Anti-Inversion Net, T10 parachute, Canadian load carrying equipment, Arctic troop snow shovel and the XM29 Individual Protective Mask.

In the latter program, the U.S. is developing the mask and Canada the

XM30 PROTECTIVE MASK is being developed jointly by the U.S., which is developing the face piece, and Canada developing the canister. The mask features a clear face piece that allows greater visibility than current masks and, if adopted, will replace the M17A1, M24, M25A1 and M9A1 masks.

PLASTIC FUEL CAN, a candidate of the U.S./Canadian Development Sharing Program, is designed to fit standard bracketing of military vehicles. If adopted, this 20 liter can will replace the standard 5 gallon metal can.



PROJECTED MAP DISPLAY (PMD) gives a pictoral display of a helicopter's position and progress directly related to terrain or airway structures. The system has applicability to helicopter operations in forward areas, and there is a possibility of procurement for use with AAH and ASH.

canister. In addition, the Canadian C1 canister is used on the current U.S. Army protective mask.

Some examples of the U.S.-Canadian Development Sharing Program are the Caribou transport aircraft, M571 Tracked Vehicle, AN/GRC-103 radio, and the Lance Lightweight Launcher. Currently being negotiated is the possibility of development and procurement of the Canadian plastic gas can, a helicopter wire cutter, and Advanced Map Display for helicopters.

However, the real success of the ABCA program is in the free exchange of information between the Armies. There are many obstacles to international standardization such as each country's own political and financial restrictions.

The free exchange of information has the effect of establishing a single data base which leads to similar requirements and thus forces standardization.

Many times three or more countries may not agree on something, but two can get together on a bilateral agreement. It's like a jogging routine we have here in Ottawa. LTC Bud Kramer and I meet daily, schedule permitting, with the Australian representative, MAJ Brian Armour, and Canadian Standardization Coordinator, MAJ Jim Pugh for a 3-mile jog on the picturesque Rideau Canal in Ottawa.

The United Kingdom representative, LTC Mike Hall, on the other hand, prefers a longer run. Three out of four isn't bad. Maybe Mike's replacement will be a jogger and not a runner and we can sign a QSTAG.

For the future, our hope in the Group is that we can get a meaningful dialogue started between the U.S. and Canada on the organization and equipment for the Rapid Deployment Force. In 1965, Canada formed their Mobile Command in recognition that a new force structure of combat ready land and tactical air forces was required in order to provide flexible, rapid response to Canadian defense commitments.

Over the years a lot of time has been spent studying how this Mobile Command should be organized and equipped, given severe fiscal restraints. The recent decision to procure a wheeled armored vehicle, the Armored Vehicle General Purpose (March–April 1979 *Army RDA Magazine*), is an example of the result of these deliberations.

The wheeled versus track controversy exists in Canada also, so the decision wasn't easy. The opportunity exists now for the U.S. and Canada to "compare notes" on the possibility of even greater cooperation.

In summary, the success of cooperative R & D between the U.S. and Canada is due in part to the presence and achievements of the U.S. Army Research, Development and Standardization Group-Canada. These achievements, in turn, have resulted in a stronger combat capability for both countries.

COL JAMES F. BLEECKER is the commander/senior standardization representative, U.S. Army Research, Development and Standardization Group–Canada. He is a graduate of the U.S. Military Academy where he was commissioned in the Field Artillery. He holds a master's degree in mechanical engineering from the University of Southern California. He has served in a variety of command and staff assignments in both the continental United States and overseas.

Military Clothing

durability, low maintenance, comfort, lightweight, and is systems oriented. Clothing R&D however, of low priority, features indigenous design, but monitors and capitalizes on Free-World technology.

SOVIET LIGHTWEIGHT RUBBERIZED COVERALLS

SOVIET PARATROOPER'S WINTER UNIFORM

SOVIET TWO-PIECE WINTER FLIGHT SUIT

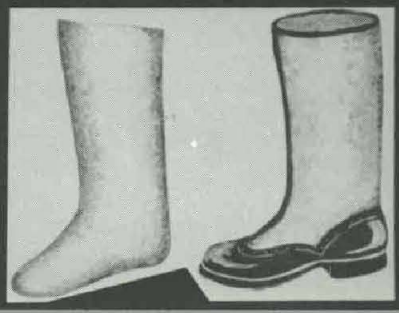
FLAME PROTECTION

SOVIET LEATHER BOOTS WITH SHEEPSKIN LINING

SOVIET LEATHER BOOTS WITH DOG-FUR LINING

SOVIET COMBINED ARMS RUBBERIZED PROTECTIVE SUIT

SOVIET FELT BOOTS



Army R&D Achievement Awards . . .

Efforts of 64 Scientists, Engineers Recognized

Sixty-four Army in-house laboratory scientists and engineers will receive U.S. Army R&D Achievement Awards for their achievements that have advanced capabilities of the U.S. Army and contributed to the national welfare during 1979.

The 20th annual awards, consisting of a wall plaque and a 2-inch cast-bronze medallion, will be shared by 56 personnel attached to activities of the U.S. Army Materiel Development and Readiness Command, 5 from the Corps of Engineers, and 3 from the Office of the Surgeon General.

Army R&D leaders will present the awards to the winners, at appropriate ceremonies during the next few months, at the activities where they are employed.

Listed within their major commands, subcommands and/or installations, the award winners and brief excerpts from their nominations, justifications and citations include:

U.S. ARMY MATERIEL DEVELOPMENT AND READINESS COMMAND (DARCOM)

• **U.S. Army Armament R&D Command (ARRADCOM) HQ, Dover, NJ.** Four members of the ARRADCOM Large Caliber Weapon Systems Laboratory (LCWSL) will receive the Army R&D Achievement Award for development of a kinetic energy (KE) projectile that will allow training of armor forces on ranges previously restricted because of the extreme safety range requirement and high cost of service ammunition.

The success of the XM797 cartridge has resulted in the request for information and a demonstration by our NATO allies. "The foreign sales potential," the citation states, "could easily amount to hundreds of millions of dollars."

The team members are Messrs. *Ralph Campoli, John Bannat* and Ms. *Renata Price* of the Munitions Systems Division, and Mr. *Edmund Falkowski*, Applied Sciences Division.

• Two ARRADCOM mechanical engineers from the Fire Control and Small Caliber Weapon Systems Laboratory (FC&SCWSL) were commended for their leadership of a team of engineers and technicians engaged in development of a totally new heavy general purpose machinegun known as the "Dover Devil."

Mr. *Curtis Johnson*, of the Armament Division, is the inventor of this unique weapon system that has a potential for application in combat vehicle and ground-mounted roles.

Mr. *Phillip Baker*, Armament Division, is honored for his "inspirational and professional leadership" of the team of engineers and technicians who developed the concept to a firing prototype weapon.

• A 6-man team of scientists and engineers from ARRADCOM will receive the award for demonstrating the technical feasibility of a Sense and Destroy Armor (SADARM) munition concept, which promises to enhance the Army's capability to defeat armor by indirect artillery.

Selected to receive awards are the LCWSL team of Messrs. *Theodore J. Malgeri, Paul Granger, Daniel B. Griggs*, and *Roy W. Kline*, along with Mr. *Richard A. McGee* of the Ballistic Research Laboratory (BRL), Aberdeen Proving Ground (APG), MD, and LTC *Jerry D. Hornor* of the ARRADCOM Armaments Concepts Office.

Successful demonstration of SADARM is the culmination of several years of exploratory development to apply new and diverse technologies to provide intelligence to long stand-off artillery ammunition. The concept is the forerunner of a future family of Improved Sensing Munitions (ISM).

• Another 6-man ARRADCOM team will be honored for scientific and engineering contributions to development of the Smart Target-Activated Fire and Forget (STAFF) weapon system.

Conceived in 1976, the STAFF concept successfully shows the capability to destroy tanks in defilade at ranges beyond that of the tank's capability to effectively return fire. This concept provides a fire and forget system that minimizes gunner exposure, allows a higher rate of fire and gives the capability to destroy tanks at a range where only guided missiles previously had any capability, at a fraction of their cost.

Selected to receive awards are Mr. *Lewis C. Cole*, who was responsible for the program in the Systems Development and Modeling Division; Mr. *Malcolm K. Dale*, who helped design the weapon system in the test; Mr. *Andrew J. Hunton*, responsible for the sensor work; Messrs. *Arnold A. Novak* and *William Moscatiello*, who were responsible for mechanical design of the projectile.

Mr. *Robert T. Gschwind*, of BRL, was selected for his team leadership in system engineering and system performance studies of the STAFF antitank weapon concept.

• A 3-man team from ARRADCOM's Chemical Systems Laboratory (CSL), APG, will receive the award for discovery and development of a technique to spontaneously align liquid crystals.

According to their citation, "This discovery has opened up a new dimension in fundamental studies of oriented spectra and surface-molecule interactions . . . and it has established a scientific basis for new concepts and potential improvements in chemical detection and optical display devices."

Cited for this effort are Dr. *Edward J. Poziomek*, physical science administrator; Mr. *Thaddeus J. Novak*, research chemist; and Dr. *Raymond A. Mackay*, consultant.

• CSL research by Dr. *Charles S. Harden* earned an R&D Achievement Award for his technical contributions which have led to significant advances in the defensive posture of the United States against toxic chemical agents.

"Through his fundamental studies on the kinetics and mechanisms of gas phase ion-molecule reactions, his imaginative interpretation of data, and his creativity in applying basic research to practical problems he has been able to establish the operational mechanisms and identify ionic species causing responses in chemical agent detectors based on ionization phenomena.

"The understanding of these systems has instilled confidence in the reliability of the detectors and has had a major impact on ionization detector development programs in the United States and the United Kingdom."

• BRL engineers Messrs. *Robert L. McCoy* and *Chester L. Grabarek* will receive awards for their contributions in developing a high muzzle velocity, sabot projectile that can penetrate light armored targets.

"Innovative approaches and the combining of expertise in the fields of flight and penetration mechanics have allowed this development to be successful. The result of these efforts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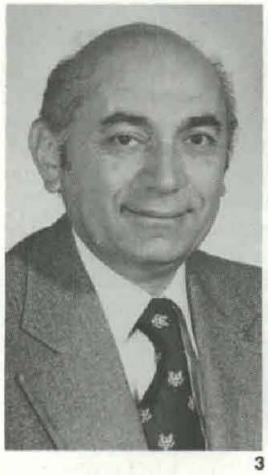
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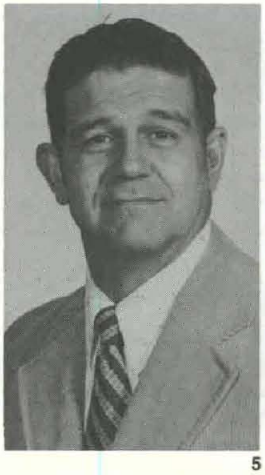
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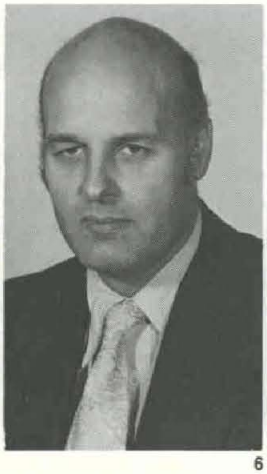
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R & D Achievement Award Winners

U.S. Army Armament R&D Command (ARRADCOM) HQ, Dover, NJ— (1) Top (l. to r.) are Edmund Falkowski and John Bannat; below, Renata Price and Ralph Campoli. (2) Curtis Johnson and Phillip Baker. (3) Theodore J. Malgeri. (4) Paul Granger. (5) Daniel B. Griggs. (6) Roy W. Kline. (7) LTC Jerry D. Hornor. (8) Richard A. McGee. (9) Andrew J. Hunton. (10) Lewis C. Cole. (11) Malcolm K. Dale. (12) Robert T. Gschwind. (13) Arnold A. Novak. (14) William Moscatiello.


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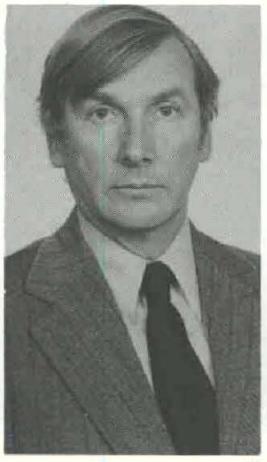
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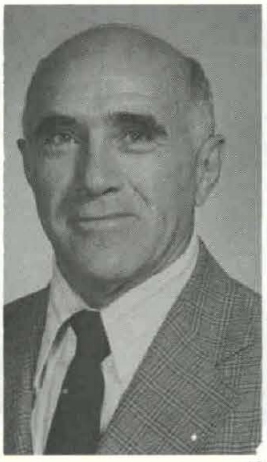
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is that U.S. forces now have the technology to defeat light armored targets using current individual infantry small arms weapons."

• BRL's Dr. *Bruce P. Burns* will receive an R&D Achievement Award for furthering the Army's technology of modern projectiles.

Dr. Burns was cited for "development of a technique that enables estimates to be made of the in-bore integrity of complicated projectiles. This work greatly expands the scope of the analysis of joints between either similar or dissimilar material components. The technology improvement has been incorporated in the analyses of three different projectiles and has also been applied to studies of an improved pressure gage."

U.S. Army Electronics R&D Command (ERADCOM), Fort Monmouth, NJ. Nine R&D Achievement Awards will go to 16 ERADCOM personnel. Of these, six awards were earned by laboratory scientists and engineers at ERADCOM HQ, Fort Monmouth, and three by employees of ERADCOM's Harry Diamond Laboratories (HDL), Adelphi, MD.

• Dr. *Arthur Ballato* and Mr. *Theodore J. Lukaszek*, with the Electronics Technology & Devices Laboratory (ET&DL), will be commended for major contributions to the state-of-the-art of high precision frequency control.

"As an outgrowth of this breakthrough," the citation states, "it is now possible to produce quartz resonators that are immune to the effects of accelerations in any direction, and simultaneously immune to static stresses transmitted by their electrode and mounting systems.

"Although primarily directed at making possible combat hardened communications under the severest conditions, this achievement is also applicable to a wide variety of high precision frequency control uses, such as oscillators in shock/vibration environments (tanks, helicopters), sensors, position location (GPS), and collision avoidance systems."

• Dr. *Joseph C. O'Connell*, a physicist at the ET&DL, will receive an award for developing a new, highly efficient, longer-life IR radiator.

The summary of achievements states: "The new emitter is based on selective radiation characteristics of boron nitride and when used in the AN/ALQ-144 Countermeasures Set, will enable the system to provide a superior airborne countermeasure capability against missile threats without requiring additional power.

"As a result of this effort, the AN/ALQ-144 effectiveness has been significantly improved with respect to mission, operational costs, and reliability."

• Mr. *Paul Fisher*, ET&DL, is commended for a major contribution to the understanding of the operational performance characteristics of high power microwave crossed-field amplifier transmitter tubes.

"A substantially more reliable, efficient, stable crossed-field amplifier tube that maintains full power output over the entire operating band has been designed and developed in accordance with his derived theory. These tubes significantly improve radar system performance with regard to sub-clutter visibility, target discrimination, and range."

• ET&DL chemist *Otto C. Wagner*, with the assistance of an engineer of the Navy Sea Systems Command, successfully conceived, developed and tested a stable zinc anode for silver-zinc and nickel-zinc batteries with improved performance.

The citation states, in part, "his discoveries have demonstratably enhanced the state-of-the-art in the U.S. battery community and put the Army at the cutting edge of technology in the secondary battery system which will replace the present low-energy systems such as nickle-cadmium and lead acid.

"His development has had immediate use in solving a critical Navy problem on submarines and has direct application for improving the performance of high-energy nickel-zinc batteries, foreseen as having widespread use in electric vehicles, combat vehicles, aircraft, and other military applications."

• R&D Achievement Awards will be presented to a supervisory electronic engineer and a meteorologist with the Combat Surveillance & Target Acquisition (CS&TS) Laboratory, ERADCOM.

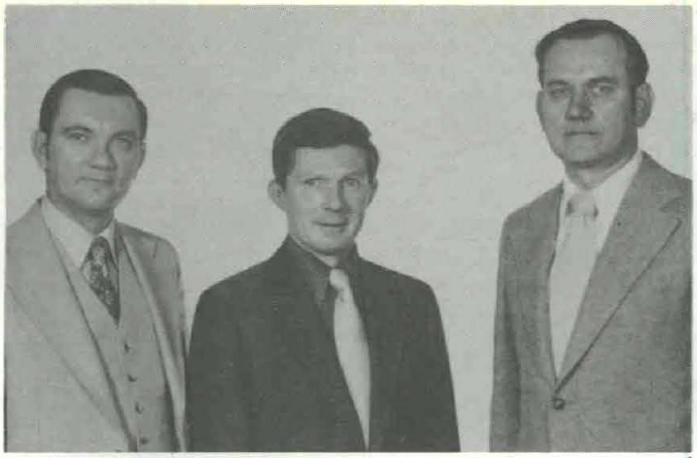
The awards are in recognition of Mr. *Marvin J. Lowenthal's* outstanding leadership and Mr. *Raymond Bellucci's* outstanding technical contributions in developing, testing, producing and fielding the Meteorological Data Processing Group OL-192.

This item provides, for the first time, a high degree of automation to the Field Artillery Met Sections who have the responsibility to provide upper air measurement data for field artillery ballistic corrections, sound ranging, nuclear fallout, and air weather operations.

The major impact of the OL-192 is to significantly improve accuracy of artillery by reducing met message staleness from approximately 2 hours to 2 minutes after completion of the balloon/radiosonde flight.

• CS&TA's supervisory electronics engineer Mr. *William Fishbein* will receive an award in recognition of his outstanding scientific and engineering contributions which provided the basis for the successful acquisition of the AN/TPQ-37, the Army's first ar-

U.S. Army Engineer Topographic Laboratories (ETL), Fort Belvoir, VA. (1) George S. Barber. (2) Gwynne H. Jones Jr. (3) Robert S. Pazak. (4) MAJ Samuel Stoddard III. U.S. Army Engineer Waterways Experiment Station (WES), Vicksburg, MS. (5) Steve L. Webster. Walter Reed Army Institute of Research (WRAIR), Washington, DC. (6) John H. Jacobi.



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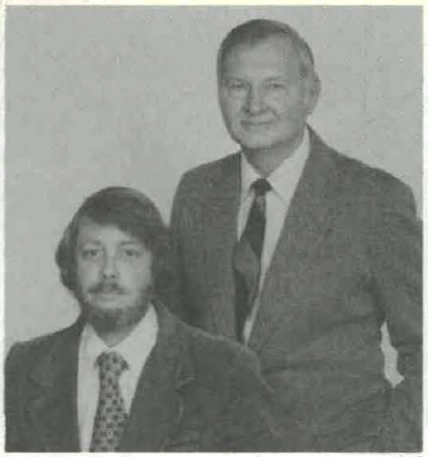

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R & D Achievement Award Winners

U.S. Army Armament R&D Command (ARRADCOM) HQ, Dover, NJ—(1) From left, Dr. Raymond A. Mackay, Dr. Edward J. Poziomek and Thaddeus J. Novak. (2) Robery L. McCoy and Chester L. Grabarek. (3) Charles C. Harden. (4) Dr. Bruce P. Burns. U.S. Army Electronics R&D Command (ERADCOM) Fort Monmouth, NJ—(5) Dr. Arthur Ballato. (6) Theodore J. Lukaszek. (7) Dr. Joseph C. O'Connell. (8) Marvin J. Lowenthal and Raymond Bellucci. (9) Paul Fisher. (10) Otto C. Wagner. (11) Osualdo T. Dellasanta. (12) Norman J. Doctor. (13) Robert N. Johnson. (14) Joseph W. Miller Jr.

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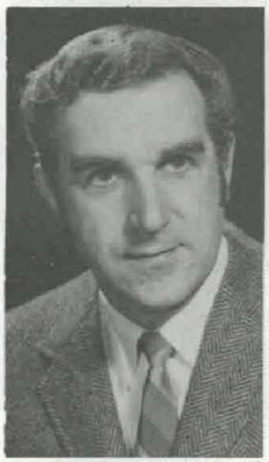

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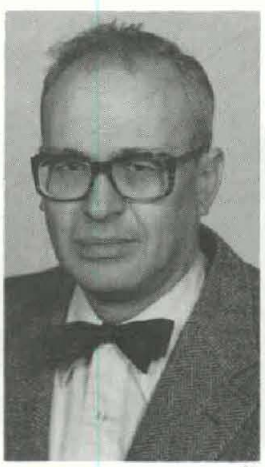

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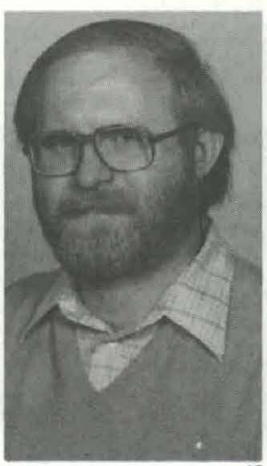

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tillery locating radar, part of the Firefinder System. This radar provides the Army with a quantum jump in its ability to effectively counter enemy artillery operations.

• An HDL 4-man team from the Ordnance Electronics Development Laboratory will receive the award for outstanding contributions to the successful development of the first digital electronic time fuze for artillery projectiles and its novel fuze setter, the M587/M724/M36.

"The availability of this fuze will permit use of the U.S. electronics industry and its viable manufacturing base as an alternative to the horological industry manufacturing mechanical precision time fuzes.

"In addition, this ET fuze system permits rapid, simple setting; superior accuracy; exceptional reliability; unrestricted use with rocket-assisted projectiles because of the rugged timing module; and the opportunity to provide direct setting by field computer."

The team members are Messrs. *Osvaldo T. Dellasanta, Norman J. Doctor, Robert N. Johnson,* and *Joseph W. Miller Jr.*

• A 3-man team from the Radar & Fuze Development Laboratory, HDL, was selected to receive an award for outstanding contributions to the successful development of the M735 safing, arming and fuzing system and the XM38 setter for the XM753 nuclear projectile.

"This achievement results from innovative implementation of a state-of-the-art fuze concept of a complexity never before attempted for gun-fired application. Because this fuzing system is vastly more accurate and reliable, and, because of its unique safety and operational features, a smaller number of weapons can be planned for the desired target effect than would be needed with fuzes of current capability."

Team members include Messrs. *Charles W. Crickman, John J. Cullinane* and *John M. Miller.*

• An individual award will be presented to Dr. *Mary S. Tobin,* a physicist at HDL, in recognition of her discovery of 25 new frequency sources of coherent radiation in the 100 to 1000 GHz range and of her innovative adaptation of new experimental techniques that led to these discoveries.

These new coherent frequency sources significantly increase the range over which the discrete frequency response of components may be determined and heterodyne detection may be achieved.

• **U.S. Army Mobility Equipment R&D Command (MERADCOM), Fort Belvoir, VA,** employees with the Energy & Water Resources Laboratory, LTC *Robert P. Carnahan,* 1LT *Ernest D. Smith,* and Messrs. *Daniel S. Lent, Robert G. Ross,* and *A. Roger Anzzolin* were selected for their team effort in developing the 600-gallon-per-hour Reverse Osmosis Water Purification Unit (ROWPU), which provided a significant increase in the Army's water purification capability.

The unit replaces four currently existing hardware items, Erdlators, Distillation, Ion Exchange, and CW-BW Pretreatment Equipment. The ROWPU produces potable water from any source, sea, brackish, or fresh, and removes Nuclear, Biological, and Chemical contaminates. Since it is self-contained, air transportable, and air droppable, it can be used anywhere even in remote areas.

• An individual award will go to Mr. *Hubert Comminge,* an engineer with the Countermine Laboratory, MERADCOM. Comminge was selected for "qualitative and effective engineering leadership that resulted in successfully demonstrating an innovative tank roadwheel and track design resistant to mine blasts.

"This provides the main battle tank with a tremendously increased battlefield survival capability, by facilitating its continued mobility and capability to fight."

• **U.S. Army Missile Command (MICOM), Redstone Arsenal, AL.** Aerospace engineers Messrs. *Pat H. McInvale* and *William W. Malcolm,* with the U.S. Army Missile Laboratory, were selected to receive awards in recognition of the analysis, design and development of an automatic target handoff correlation system for the IRIS/Hellfire/TADS/AAH weapon system.

It is reported that the unique, technically advanced concept will serve as the design standard to be followed by fire and forget weapon fire control designers for years to come.

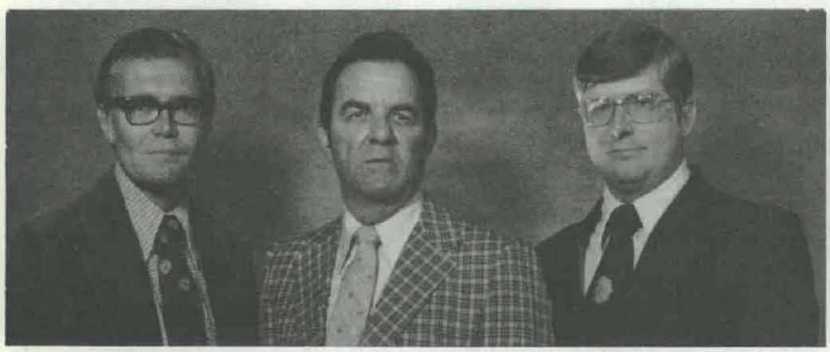
• Mr. *Richard J. Thompson* was selected as a recipient of the R&D Achievement Award while serving as a research aerospace engineer with the U.S. Army Missile Laboratory where he designed a concept for a shoulder-fired, low-signature rocket for operations in urban terrain.

"Through innovative engineering, a concept was developed which allows a rocket with a significant payload to be shoulder fired from an inclosure without adversely affecting the gunner."

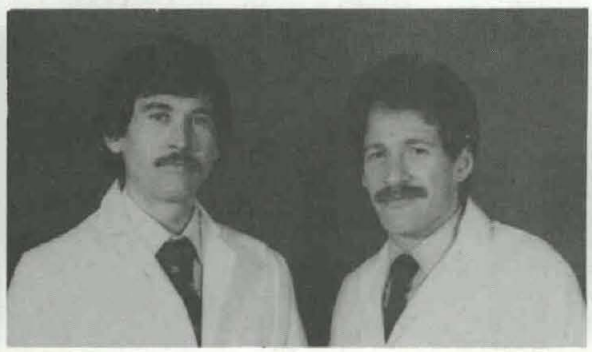
• **U.S. Army Aviation R&D Command (AVRADCOM), St. Louis, MO.** Mr. *William L. Andre,* Dr. *James T. Wong,* and Mr. *Hifu Mike Kodani* were nominated and selected for developing a unique new helicopter fault-isolation method for Army aircraft systems called Logic Model (LOGMOD). The method represents an important advance in the technology of diagnosing and defining solutions to helicopter system deficiencies.

• **U.S. Army Materials & Mechanics Research Center (AMMRC), Watertown, MA.** Messrs. *Albert P. Levitt* and *Eugene DiCesare,* Metals & Ceramics Laboratory, were selected to receive awards for pioneering research that resulted in development

R&D ACHIEVEMENT AWARD WINNERS. U.S. Army Electronics R&D Command (ERADCOM), Fort Monmouth, NJ—Charles W. Crickman, John J. Cullinane and John M. Miller.



Walter Reed Army Institute of Research (WRAIR), Walter Reed Army Medical Center, Washington, DC—Dr. John W. Holaday and MAJ Alan I. Faden.

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R & D Achievement Award Winners

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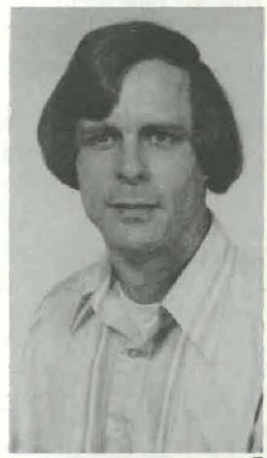
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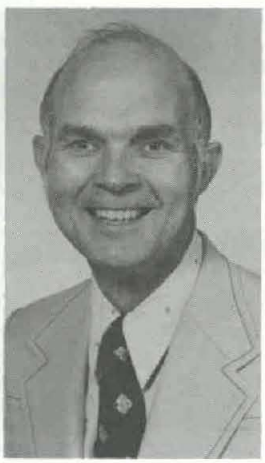
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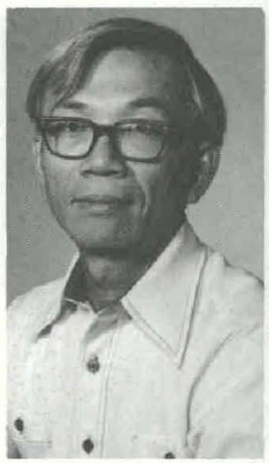
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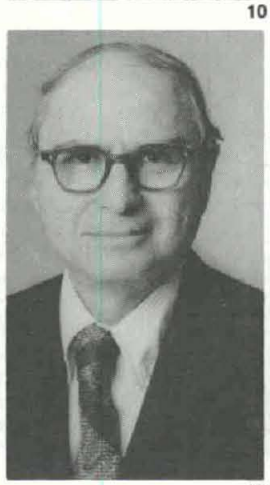
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and patenting of a new composite material (graphite fiber reinforced magnesium) having unique properties which enhances the Army's technical capabilities.

• Selection of Mr. *George E. Gazza*, Metals & Ceramics Laboratory, AMMRC, was based on his "exceptional contributions to the Army's Science and Technology base in developing new methods for producing near net shape Si_3N_4 based ceramic components for heat engines.

"The methods he has developed have been critical to providing experimental hardware to key Army engine development programs and will lead to new generations of fuel efficient engines."

U.S. ARMY CORPS OF ENGINEERS

• **U.S. Army Engineer Topographic Laboratories (ETL), Fort Belvoir, VA.** A 4-person team from the Computer Sciences Laboratory, ETL, will receive an Army R&D Achievement Award for their joint effort in developing a special purpose data processing system and demonstrating the concept for tactical utilization.

Team members Messrs. *George S. Barber, Gwynne H. Jones Jr., Robert S. Pazak*, and MAJ *Samuel Stoddard III*, contributed to this system, which represents a significant milestone in the development of improved tactical intelligence capabilities.

• **U.S. Army Engineer Waterways Experiment Station (WES), Vicksburg, MS.** Mr. *Steve L. Webster*, civil engineer, employed by the Geotechnical Laboratory, WES, was selected for his effort in developing and demonstrating the sand-grid confinement concept for constructing high-quality foundation layers for pavements.

The sand-grip concept improves the Army's capability to construct military roads through swamps or across unstable beach or desert.

OFFICE OF THE SURGEON GENERAL

• **Walter Reed Army Institute of Research (WRAIR), Walter Reed Army Medical Center, Washington, DC.** Dr. *John W. Holaday* and MAJ *Alan I Faden* were nominated and selected to receive Awards for their contributions to biomedical research.

This was done through their "demonstration that the opiate-antagonist naloxone, by antagonizing endorphin systems, improved both blood pressure and survival in shock states and significantly reduced the paralysis that resulted from spinal-cord injury.

"This work is of direct relevance to the care and management of battlefield injuries. Pending the successful clinical demonstration of the therapeutic effects of naloxone in human patients suffering from shock, it may be possible to significantly improve survival and recovery in the wounded soldier."

• WRAIR associate chief for Engineering, Department of Microwave Research, Mr. *John H. Jacobi* is commended for his development of a water-coupled microwave time-delay spectrometer that allows previously unattainable resolution in differential propagation delay measurements and its application to microwave imagery in order to produce images free from multipath contamination.

This achievement has permitted analysis of microwave interaction with biological objects for purposes of hazard analysis in the case of high-power levels and for purposes of mapping dielectric discontinuities when low-power levels are applied.

"The achievement greatly improves microwave hazard analysis by improved dosimetry which is both non-invasive and of high spatial resolution. This work significantly reduces the problem of multipath contamination and thereby improves the quality of microwave images so produced."

Nondestructive Pavement Tests Studied

The U.S. Army Waterways Experiment Station, Vicksburg, MS, has undertaken an investigation of the use of nondestructive pavement test methods for the U.S. Army Forces Command (FORSCOM), Facilities Engineering Support Agency, and the U.S. Army Training and Doctrine Command.

The purpose of this study is to provide test techniques and an analytical methodology for nondestructive evaluation and overlay design for Army roads and streets. The evaluation procedure developed during this study will encompass those pavements that are designed to support the traffic at Army installations.

Research will be divided into four phases: equipment studies, data collection and analysis, development, and implementation. The equipment studies phase has been completed. The data collection and analysis phase is ongoing.

The nondestructive test device will be the Model 2008 Road-Rater (NODET) which has been purchased by FORSCOM. The NODET is an electrohydraulic vibrator with a 4000-lb mass. It has a digital control system that prints the force, frequency, and deflections from four velocity sensors on a paper tape.

A sinusoidal variable-frequency, peak-to-peak force of 7000 lb is input to the pavement through an 18-inch diameter plate. In order to understand the reliability and repeatability of the deflection measurements, the NODET was evaluated to determine the accuracy of the velocity, frequency, and load measurement subsystem. System modifications were designed and implemented to correct deficiencies found.

A new method of calibration of the velocity sensors and load cells was developed. It lets the operator periodically check these measuring devices to insure accurate reproducible measurements. A separately obtained device (with digital display) for measuring distance was integrated into the NODET towing vehicle. It provides a reasonable estimate of location for each test.

Finally, a field operation manual was developed that will provide the operator with all necessary information concerning maintenance, operation, calibration, and emergency field repair.

Tests with the NODET will be conducted on representative pavements that encompass the full range of load-carrying requirements of the Army's pavements. California Bearing Ratio (CBR) and water content and classification tests will be made on each pavement layer. Undisturbed samples of each pavement layer will be obtained for laboratory resilient modulus testing.

Temperature adjustment factors have been developed for other pavement testing devices, but their applicability to the NODET has not been verified. Therefore, tests will be conducted on these sections at different times to determine the effects of temperature and seasons.

After collection of these data, an evaluation procedure will be developed. The evaluation procedure will guide the user in fully assessing the structural capacity of his pavements. This evaluation manual will also provide the methodology for designing overlays to support the anticipated traffic to be applied to the pavement.

A computer program will also be developed to provide the user with a fast, accurate method of handling the data, correcting for temperatures, predicting allowable loads, and calculating the required overlays for the pavement system.

Upon completion of the research, a training school will be conducted at the Waterways Experiment Station for the personnel who will actually conduct the tests, handle the data that are generated, and maintain the NODET. A demonstration will then be conducted at an Army installation to be selected by the sponsor.

Based on the results of the training school and the demonstration, the field operation manual and the data interpretation manual will be modified as needed and furnished to the users as fulfillment of the requirements of the project.

XM753 Joint Army/Marine Corps Operational Test

By Carmine J. Spinelli, MAJ James R. Thomas and CPT Glendall C. Monigold

For the first time ever, the U.S. Army and Marine Corps have successfully participated in a joint Operational Test (OTII) of a developmental Artillery Fired Atomic Projectile (AFAP) Program. The test involved the new XM753 Improved 8-Inch AFAP and was completed on 8 November 1979 at Yuma Proving Ground (YPG), AZ.

The XM753 Projectile, which is ballistically similar to the new conventional 8-Inch M650 Rocket Assisted Projectile, consists of the W79 Warhead developed by Lawrence Livermore National Laboratory and Sandia National Laboratories, Livermore, the M735 fuze developed by Harry Diamond Laboratories, ERADCOM; and the rocket motor developed by the Large Caliber Weapon Systems Laboratory, ARRADCOM.

The total projectile management is the responsibility of ARRADCOM under the direction of the project manager for Nuclear Munitions. It is compatible with the M115, M110 and M110A2 8-Inch Howitzer systems and provides a maximum range capability of 30,000 meters out of the M110A2 when fired in the rocket-on mode.

The M613 Shipping and Storage Container, another ARRADCOM development, contains the LLNL and SNLL Command Disable system and Permissive Action Link (PAL) interface connector.

The purpose of the XM753 OTII Test Program was to verify that Army and Marine Corps' personnel can safely and effectively handle, maintain, store, transport, perform prefire operations and fire or extract the XM753 Projectile.

The test program was also designed to verify the adequacy of the ancillary equipment associated with the system; verify that firing tables are adequate for use by typically trained field artillery personnel; provide information on the reliability, availability and maintainability characteristics of the XM753 System; provide information on the tactical transportation of the XM753; and validate XM753 maintenance and operational procedures.

The XM753 OTII test, performed by Army and Marine Corps' field artillery personnel in a parallel effort, required an extremely comprehensive test program. The effort had to be integrated and orchestrated between the two Services to achieve maximum test results.

Planning started in January 1979, with the predicted test firing date of early November 1979. In March 1979, Army and Marine Corps personnel participated in a prototype war reserve and training hardware review with draft technical publications at ARRADCOM, Dover, NJ. Changes were then incorporated into the final OT hardware and technical publications.

In July 1979, New Equipment Training, using the M754 Trainer with war reserve handling and test equipment, was conducted at YPG by Armaments Readiness Command (ARRCOM) New Equipment Training Detachment instructors, for both the Army and Marine Corps.

The M754 Projectile is an inert, not to be fired, trainer designed to permit performance of all operations and handling procedures expected to be experienced by the user prior to ramming. Training with this system enhances improved reliability and personnel safety with respect to the man-machine interface. This is achieved through the use of realistic inert equipment.

Those in attendance for the new equipment training at YPG were Army key instructor personnel from Fort Sill, OK; Marine nuclear ordnance platoons from 29 Palms, CA; and Camp LeJeune, NC; representatives from the Nuclear Weapons Training Group Pacific, San Diego, CA; and Marine Corps Development and Education Command, Quantico, VA; and Marine Corps artillery teams from 29 Palms, CA.

Following briefings and instruction, all personnel conducted hands-on exercises with all ancillary equipment, including ram and extraction with inert M650 projectiles and the M110A2 howitzer.

At the completion of training, Army and Marine Corps' representatives were given copies of the Program of Instruction, complete with visual training aids. Army key instructor personnel then conducted second generation training at Fort Sill, with the actual player participants for OTII.

Multiple-load M613 Container tie-down certification tests had previously been conducted with ground vehicles at the U.S. Army Materiel Development and Readiness Command (DARCOM) Ammunition Center, Savanna, IL, in June 1979 and in Army and Marine Corps' helicopters by the U.S. Army Airborne Board at Fort Bragg, NC, in August 1979.

Approved tie-down procedures were then incorporated into the XM753 Organizational Maintenance Manual. Road tests were performed with multiple tie-down configurations (one, two and three containers) secured in the various vehicles.

Tests were also performed with complete mission loads. They consisted of M650 Registration Projectiles and the necessary propelling charges along with an XM753 Projectile/M613 Container System.

These tests were performed in a number of tactical and commercial vehicles on a course consisting of two sets of railway ties, each 50 feet long with a 75-foot flat space in between the sets. One set of ties was spaced eight feet apart while the second set of ties were spaced 10 feet apart.

The test also consisted of 30 miles of travel over gravel, concrete and asphalt roads with numerous stops and starts along the way. Tie-down and rigging procedures tested at Fort Bragg were for internal and external air transport and also included Army mission loads. Tests were conducted with Army UH-1 and CH-47 helicopters, and Marine Corps CH-46 and CH-53 helicopters.

Test hardware, which was produced for the OTII and the ballis-

tic similitude portion of the Development Test (DTII), served as an initial pilot lot assembly line checkout for war reserve production, with the exception, by requirement, that no nuclear material was used.

Rocket motor bodies produced by Ferrulmatic Inc., Paterson, NJ, were delivered to Union Carbide Corp.'s Y-12 facility in Oak Ridge, TN, for mating with the warhead bulkhead. This subassembly was then delivered to ARRADCOM for final assembly of the rocket motor propellant and bulkhead.

The M735 Fuze produced by Motorola Corp., Scottsdale, AZ, and the M613 Container produced by Container Research Corp., Glen Riddle, PA, were delivered directly to the Department of Energy (DOE) assembly plant as were the rocket motor assemblies.

Final XM753 prototype assemblies were then delivered to Army and Navy depot facilities. All hardware was produced on schedule and within budget constraints.

The first phase of the OTII was initiated in mid-October 1979 with beach and surf operations at Camp Pendleton and tactical ground movements at 29 Palms by the Marine Corps. Simultaneously, Fort Sill personnel were conducting tactical ground movements and firing battery operations at Fort Sill and then at YPG.

This initial portion of the test consisted of receipt and verification inspection, tactical movement of items in various vehicles and tie-down configurations over various terrains, extractor evaluation, night operations and human factors evaluations (hot-cold).

Transportation testing was conducted in the M35 2½-ton truck, M54 5-ton truck, M561 Gama Goat and M105 1½-ton cargo trailer.

Firing tables had previously been established by the Ballistics Research Laboratory using correction data from the 55 round XM753 Projectile and 220 round M650 Projectile Ballistic Similitude test. Results indicated that the XM753 is very close to a ballistic match to the M650, thereby meeting the user's requirement of ballistic similitude.

Small allowable corrections for the XM753 will be incorporated into the M650 Firing Table; therefore, no additional firing tables will be required.

The U.S. Army Field Artillery Board was responsible for the actual conduct of the Army portion of OTII which addressed the issues and criteria developed by the U.S. Army Field Artillery School.

Test data have been published by the Artillery Board and submitted to the Artillery School for evaluation in support of key decision reviews concerning each test item's military utility, operational effectiveness and suitability.

Parameters examined in OTII included physical characteristics, precision, maximum range capability, adequacy and accuracy of firing tables, safety, human factors and the functioning reliability of the total XM753 system.

Ancillary equipment tested included the M754 Type-X training projectile, M38 Fuze Setter, M613 Container, T1533/T1554 PAL controller, H4272 Power Extractor and H4278 Spanner Wrench.

Publications that were validated included associated draft technical manuals, Army training and evaluation programs, and soldier's manuals. OTII was conducted in conjunction with the DTII, in order to evaluate the weapon system in the most cost-effective manner.

The Army test was conducted under simulated tactical battlefield conditions available at Fort Sill and YPG. Typically trained field artillery troops were used to perform tactical handling, tie-down, transportation, extraction, pre-fire and firing procedures during both daylight and darkness conditions.

The XM753 was employed using standard field artillery gunnery procedures as specified in FM 6-40. Climatic conditions used during the test included −25° F, 70° F and 125° F. The issues tested and criteria to be met were:

- Verification that ballistic similitude with the M650 rocket assisted projectile had been achieved.
- Verification that typically trained field artillery troops could safely and effectively handle, maintain, transport, extract, pre-fire and fire the XM753 projectile.
- Verification that the firing tables can be used to accuratley deliver the XM753.
- Verification that pre-fire procedures can be conducted within two minutes following PAL unlock.
- Verification that compatibility with existing logistical systems and operational concepts had been maintained.

Naval Weapons Station, Seal Beach, Weapons Quality Evaluation Center, in coordination with ARRADCOM, initiated the Marine Corps participation in the XM753 OTII program. U.S. Marine Corps participation can only be described as "total satisfaction."

After approximately one year of planning for this program, Marine air and ground forces demonstrated their Stockpile-to-Target Sequence (STS) during the OTII for the 8-Inch Nuclear Projectile.

Based on an invitation from the U.S. Army, 30 Marine nuclear weapons inspectors/instructors/technicians/supervisors were able to get in on "the ground floor" of the development of this new weapon system.

The Marine Corps STS began at a Navy depot. Two XM753 prototype projectiles were picked up from the depot by Nuclear Ordnance Platoon personnel and transported to a beach adjacent to the Marine Corps Base, Camp Pendleton, by Marine CH-46 helicopters with an escort of AH-1T helicopters.

One CH-46 transported one projectile, while another carried one XM753 prototype and one M754 (trainer). A third CH-46 transported a portion of the security force (the remainder of which was split between the weapons aircraft), project personnel and observers. During this "leg" of the movement, draft tie-down procedures were evaluated.

Shortly after arrival at the beach, all weapons were carried (five Marines per) from the helicopters, through ankle-deep sand, to awaiting landing vehicle tracked personnel—7, an amphibious tractor (AMTRAC). These vehicles are unique to the Marine Corps, as they are one of the Marine's modes of transportation from ship-to-shore.

At this point, the weapons were loaded aboard the AMTRACs (a single XM753 prototype in one AMTRAC and two weapons (XM753/M754) in a second AMTRAC). The scenario directed not only beach and surf operations, but also called for an overland trip by AMTRAC. These were accomplished to introduce the weapons to the AMTRAC environment and thus evaluate the draft tie-down procedures.

Weapons were again placed aboard the CH-46 helicopters (at the beach) and transported to the Expeditionary Air Field at the Marine Corps Air-Ground Combat Center/Combined Arms Command, 29 Palms, where they were met by additional NOP, and Artillery Battery personnel.

The weapons were transferred to M54 (5-ton) trucks and transported to a tactical Special Ammunition Supply Point. During the next nine days, the weapons experienced not only the storage environment but were introduced to the following tactical transportation evaluations: M35 ($2^1/_2$-ton) truck, M54 truck, M105 ($1^1/_4$-ton) trailer, and M561 ($1^1/_4$-ton) truck.

Distances covered with each mode of transportation were approximately 25 kilometers, over a combination of paved road, unimproved dirt road and cross country. An unusual technique used by the Marines is to sandbag, vice tie-down, the weapon(s) in the modes of transportation listed above.

This technique accomplishes two things: sandbags are readily accessible in the combat environment, while tie-down straps can be hard to find; and the sandbags provide the weapon a degree of protection, not otherwise realized, from small arms fire. The shock mitigation features of sandbags also affords the weapon(s) a relatively smooth ride.

Following the evaluations above, the weapons were subsequently transported to YPG by CH-53 helicopter, again with an escort of AH-1Ts. Upon arrival at YPG, the weapons were turned over the YPG personnel for storage until the firing dates.

This completed the STS, except for the final preparations required just prior to firing. During the next eight days, human factor evaluations were conducted in hot (125° F) and cold (−25° F) chambers (with 50 percent of all operations conducted while wearing the M17A1 field protective gas mask. Numerous RAM and extraction operations (both day and night) were accomplished, and final training was completed.

The first day of the week of the actual live firings of the XM753 prototypes, Army and Marine personnel reviewed test and safety procedures and received final briefings. the OTII concluded 8 November 1979 with the successful M650 registration, and subsequent transfer on to targets both long and short of the registration point with four prototype XM753 projectiles.

Two projectiles each were fired by Army and Marine Corps' Artillery personnel. Two rounds were fired from a new gun (90 percent remaining life) tube and two from a worn gun tube (20 percent remaining life).

All four projectile firings were unqualified successes. All were fired with maximum propellant charges in the rocket-assisted mode to ranges of 28-30 kilometers. With the exception of recommendations for minor cosmetic changes in the design of some ancillary equipment, both the Army and Marine Corps were satisfied. They stated that the current XM753 system design represents a quantum jump forward in the state-of-the-art technology and far surpasses the capabilities of the currently fielded M422A1 Nuclear Projectile.

Both the Army and Marine Corps performed all their operations without problems. Troop morale and enthusiasm were very high on both sides with the typical friendly rivalry between the services.

Completion of this test was a major event in the XM753 program and is a significant accomplishment. These tests qualified the test and handling equipment and the entire projectile system, fuze, nuclear package, rocket motor, howitzer, and fire direction control procedures.

CARMINE J. SPINELLI is development management officer for the XM753 Program at the U.S. Army Armament Research and Development Command, Dover, NJ. He received his BS degree in metallurgical engineering from Purdue University in 1958, and has been involved with munitions R&D throughout his professional career.

MAJ JAMES R. THOMAS, USMC, is assigned to the First Marine Division, Fleet Marine Force, Camp Pendleton, CA. He holds a BS degree from Sam Houston State University, Huntsville, TX, and has extensive experience with the M422, M454 and XM753 nuclear projectiles as well as nuclear demolition munitions.

CPT GLENDALL C. MONIGOLD, USA, is a nuclear and conventional field artillery weapons R&D program manager in the Directorate of Combat Developments, U.S. Army Field Artillery School, Fort Sill, OK. His academic credentials include a BS degree in mathematics and physics from Southwestern Oklahoma State University and a MS degree in nuclear/atomic physics from North Texas State University.

Experimental Field Exploitation of Elevation Data (FEED)

By CPT Thomas O. Tindall

The modern battlefield presents the field commander with situations and problems requiring timely and accurate terrain information. Friendly and enemy avenues of approach, key terrain and obstacles must be identified.

To develop interlocking fields of fire, to position observation posts and forward observers and to solve similar problems requires careful, time-consuming analysis of the terrain. The commander in the active defense must at least double his terrain planning workload by preparing for alternate battle positions.

The commander's primary source for terrain information is the standard topographic map sheet. Analyzing the topographic map can present problems. The Earth's 3-dimensional surface is symbolized on the map sheet by contour lines.

Training, experience and time are required to interpret the meaning of the map's contour lines. Many soldiers have trouble visualizing what the terrain looks like as depicted on the map, and this may result in faulty decisions.

Using a map sheet to determine whether line-of-sight exists between two terrain points is a time-consuming job. To select good direct fire weapons positions and observation posts and forward observers positions, a line-of-sight determination covering an area fanning out 360° from a particular point must be made for each position.

A battlefield computer system which stores terrain information and then on command produces 3-dimensional terrain graphics, line-of-sight calculations and graphic overlays could greatly help the commander control his area of operation.

Researchers at the U.S. Army Engineer Topographic Laboratories (ETL), Fort Belvoir, VA, have been conducting experiments in the area of computer-generated terrain graphics and the application of the computer to battlefield terrain problems.

ETL research has led to the development of a 6.2 experimental system capable of providing near-real-time depictions of the terrain in three dimensions. The system lets the user view a CRT display of the terrain as seen from any direction.

The system can produce a variety of graphics which are useful for support to tactical field operations. This van-mounted test bed is called the Field Exploitation of Elevation Data (FEED) system. It is designed to link laboratory-generated graphics and battlefield-generated graphics.

Technology which has led to development of the FEED system has been evolving over 20 years. As a result of the need to automate the process by which a standard topographic map is produced and to support the digital terrain data requirements of modern weapons systems, such as the Pershing II missile, digital elevation data bases (DEDB) have been produced. They cover extensive portions of the Earth's surface.

DEDBs are formed from terrain elevation values obtained at regular grid intervals. Data bases have been produced with intervals ranging from approximately three meters to 100 meters between points on the surface of the Earth.

A hypothetical portion of the Earth covered by a DEDB is shown in Figure 1. Elevation values included in the DEDB lie at the intersections of the grid lines. DEDBs are usually stored on tape.

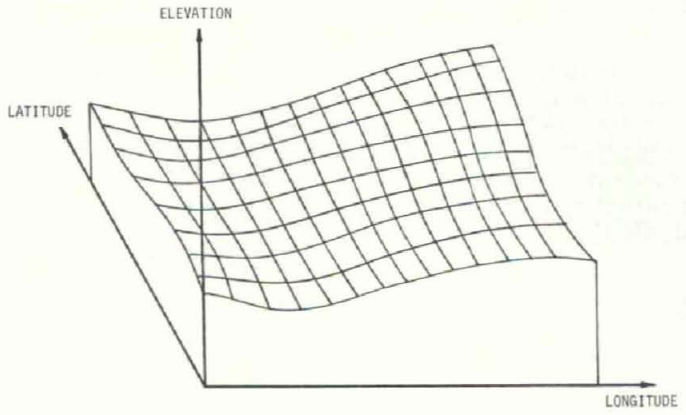


Fig. 1. Digital Elevation Data Base (DEDB), which covers the hypothetical area shown above, will contain elevation values at the grid line intersections.

Traditionally, ETL has conducted research and developed computer software and hardware for displaying a representation of the Earth's surface using digital elevation data. In the past, this research was conducted largely to develop techniques for validating data and providing interaction with the data base for editing purposes in a large, strategic-level base plant mapping facility.

In recent years, considerable effort has been directed toward using DEDBs to produce near-real-time terrain graphics for use on the battlefield. Practical battlefield exploitation of DEDBs for terrain graphics has recently become possible. This is a result of three significant developments.

The first development has to do with the widespread availability of digital elevation data produced by the Defense Mapping Agency. Low-resolution data with grid spacing of approximately 100 meters have now been prepared, covering the entire U.S. and Central Europe.

Low-resolution DEDBs covering essentially all of Europe and Asia will be available by the end of Fiscal Year 1982. High-resolution data with a grid spacing of 12.5 meters or less have been prepared. They cover several major stateside training areas and large portions of Germany. Production of other high-resolution data bases is continuing.

The second development is in computer hardware technology. By using the recently developed militarized minicomputers and associated computer peripherals it is possible to assemble a sophisticated and rugged system. The system is capable of operating outside of the strict temperature- and humidity-controlled environments associated with standard computer equipment.

Power of the minicomputer, for many applications, rivals that of the large fixed installation type computers. These minicomputers are designed for mobile operation under a variety of conditions. They are suited for the battlefield environment.

To take advantage of the advances in minicomputer technology, software had to be developed which would in effect compact the elevation data to

a manageable size and also increase graphics processing efficiency. To understand why this is necessary, consider a DEDB covering a 10-kilometer-square area with 12.5-meter grid spacing.

At 16 bits per elevation point and with 640,000 elevation points in the DEDB, the computer must store and process 10,240,000 bits of information, exclusive of the processing software. Because of the large amount of data, processing DEDBs on minicomputers is not practical without the software advances.

This computer software advance is referred to as polynominal terrain modeling (PTM). PTM was developed at ETL and essentially involves the preprocessing of gridded elevation data. The result is a mathematical model of the terrain.

The mathematical model can predict the elevation of any point within the area covered by the model. PTM has resulted in good compaction of the data (as much as 80 to 1) and quicker and more efficient processing of accurate terrain graphics.

Components that make up the FEED system are shown schematically in Figure 2. The CPU (central processing unit) is the heart of the system. Commands are entered into the system at the graphics terminal, and the CRT (cathode ray tube) display provides a screen for viewing the graphic.

The digitizing table allows the operator to annotate or modify the graphic that appears on the screen. The hard copy unit provides a paper copy of the graphic. The magnetic tape unit loads the system with elevation data for the area of interest.

Working elevation data and programs are stored on the 80-megabyte disk storage unit. The floppy disk provides backup storage capability and a means of improving data transportability. The line printer is strictly an alphanumeric output device.

The FEED development program is funded by the Office of the Chief of Engineers. Current system hardware was procured and integrated for ETL by the Electromagnetic Compatibility Analysis Center (ECAC) in Annapolis, MD.

ETL software was modified by ECAC to be compatible with the AN/UYK-19(V) general-purpose MIL-SPEC minicomputer used in the system. ECAC has a wide range of experience with digital terrain data and mobile computer systems.

The test bed system is mounted in a van which serves as a self-contained mobile demonstration facility with live-in accommodations for the operators. It provides more than ample work space for the operator and room for five to seven people to view a demonstration of the system.

Power is provided by an on-board 3-kilowatt generator. An auxiliary generator is available for backup. Although its mobility over rough terrain is limited, participation in field exercises is anticipated.

Although scheduled for delivery in October 1980, the FEED system was made available to ETL by ECAC in June 1980. It was demonstrated at ETL's 60th anniversary observance. In preparation for this demonstration, operators at ETL became familiar with the FEED hardware and interim software by producing copies of each type of graphic.

During the familiarization, a minor problem with some of the graphics was noted. This problem dealt with the slower than expected speed at which the graphics are plotted on the CRT. These software problems are being addressed by ECAC.

The familiarization period covered two weeks prior to the demonstration. Although not an extensive test, the system operated for more than 80 hours without failure. For part of the demonstration, the system was powered solely by the on-board generator and at times operated with ambient temperatures inside the van in excess of 90° Fahrenheit. A DEDB covering an area in South Central Iran was selected for the test.

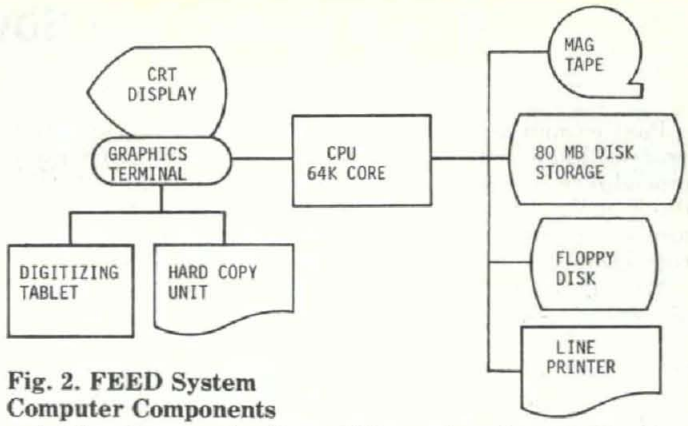


Fig. 2. FEED System Computer Components

FEED system graphics can be used as a general planning tool for battlefield terrain analysis. Olique and perspective graphics enable the commander to view his area of operation from any angle, allowing fast and accurate determination of avenues of approach and key terrain.

Line-of-sight graphics can be used to quickly identify the most favorable position for direct fire weapons, observation posts and forward observers. They could help the field commander locate optimum positions for communication facilities and short-range radar.

Line-of-sight graphics can also be useful for planning ground and flight routes that are masked by terrain from direct observation and fire from known enemy positions. The FEED system can provide a solution to almost any problem involving determination of battlefield intervisibility.

The system was returned to ECAC in July 1980. Minor changes and refinements to the graphics software will be made. The system is scheduled to be back at ETL in October 1980.

An active schedule of tests and demonstrations of the system is planned for Fiscal Year 1981. Primarily, the system will be tested to determine the reliability of the hardware and software under adverse conditions. Additionally, the accuracy of the digital elevation data and graphic outputs will be assessed.

Following a successful testing program, the system will be demonstrated to potential users through September 1981. Commanders and their field staffs will have the opportunity to evaluate the FEED system. These field demonstrations will be the true test of the experimental FEED system.

CPT THOMAS O. TINDALL JR. is a research and development coordinator at the U.S. Army Engineer Topographic Laboratories. He was commissioned through the ROTC program at UCLA in 1971 and has served in a combat engineer units in Germany and FORSCOM. A graduate of the Engineer Officer Advanced Course, he holds an MA degree in geodetic science.

R & D Within the Soviet Ministry of Defense

By Andrew W. Hull

ANDREW W. HULL is a research scientist at the Columbus (OH) Laboratories of the Battelle Memorial Institute. He has a BA degree from Adrian College and an MA from the William Andrew Patterson School of Diplomacy and International Commerce, University of Kentucky.

Past examinations of the Soviet weapons acquisition process have focused on the requirements-generation procedures, and have concentrated on the relationship of the Ministry of Defense (MO) with the defense industrial ministries. Such research is important, but it overlooks the significant R & D conducted within MO itself.

The magnitude and impact of this in-house R & D is indicated in part by a comment from Deputy Minister of Defense for Armaments N. N. Alekseyev that the introduction of invention and rationalization proposals annually saves MO "Tens of millions of rubles." (The Soviet term "rationalization" most closely corresponds to the Western concept of an efficiency proposal.)

Another Soviet article provides a clue as to the extent of inventiveness of military personnel by disclosing that the 1978 Scientific-Technical Creativeness of Youth exhibit displayed 1,173 works by servicemen.

MO's charter of operations specifically authorizes its function to conduct R & D. As explained by the *Soviet Military Encyclopedia*, MO is charged by Soviet law with undertaking "scientific research, experimental design, efficiency improvement and inventiveness, in implementing plans and coordination of these works in branches of the armed forces, in central and chief administrations."

The Ministry's Department for Inventions, headed by Major General Engineer A. Safronov, provides general guidance to military inventors and rationalizers in accord with MO regulations on innovative work.

The Department of Inventions also coordinates its efforts closely with the Central Council of the All-Union Inventors' and Rationalizers' Society (i.e., a civilian body established to promote inventions throughout the USSR).

MO has an active program to encourage individual soldiers and sailors to engage in creative pursuits. MO regulations make it incumbent on each unit or ship commander to direct innovative activity and to promote the implementation of rationalization proposals. This usually means in practice that the commander organizes a rationalization committee which encourages service personnel to participate on a voluntary basis.

Many unit commanders additionally set aside a special room for rationalizers to conduct fitting and assembly operations. At other times, the individual services hold reviews and contests to solve specific technical problems.

The policy of motivating individual servicemen to conduct R & D on an off-duty basis has paid handsome dividends to the Soviets in the past. The case of M. T. Kalshnikov is particularly illustrative.

Kalshnikov served as a Senior Sergeant in the Red Army during World War II, was wounded at Bryansk, and given six months convalescence leave. Kalshnikov used his leave to design a new submachinegun which showed great promise. He then went on to become a full-time designer of small arms and the creator of the famous AK series of Soviet assault rifles and machineguns.

The ingenuity of soldiers sometimes has amusing results. Soviet chroniclers of small arms developments recount the story of an unnamed World War II soldier who succeeded in modifying his semi-automatic rifle into a fully automatic weapon. Higher military authorities directed that the man receive a decoration for his inventiveness. Concurrently, these same authorities ordered the soldier jailed for several months for defacing government property.

Besides urging individual soldiers to conduct inventive work on an off-duty basis, the Ministry of Defense expects instructors at military academies to undertake R & D as part of their job. Consistent with this policy, the Academy of Armored Troops imeni Malinovskiy is described by Soviet sources as "a research centre" for perfecting armored equipment.

Other military schools, particularly military engineering academies, also have become major research centers for their respective branch or service. Additionally, academy students are encouraged to join military scientific societies to do voluntary research work.

It appears that the Ministry of Defense has its own research institutes. The Soviets are very reticent about discussing either the existence or activities of these facilities in recent years and yet there are clues that they have existed in the past. Usually this information comes out as part of a biographical sketch of a prominent Soviet officer or as part of an obituary. For example, the obituary of General Engineer N. A. Kononov and the biography of Major General of Aviation A. V. Lyapidevskiy in the *Soviet Military Encyclopedia* mention that both men served at one time in "research institutes of the Air Force."

Other open source articles suggest the existence of MO scientific research institutes for communications. These examples are probably the proverbial tip of the iceberg and so scientific research institutes may well exist within each of the services and in many of the branches of the Ground Forces.

It is unlikely that the Department of Inventions has jurisdiction over institutionalized research conducted in either military academies or in scientific research institutes. Instead, it seems more likely that there is a division of responsibilities with the Department of Inventions having primary responsibility for invention and rationalization work done by individual soldiers in units and Chief Technical Directorates of the services controlling the institutionalized research programs at military academies and research institutes.

Chief Technical Directorate control of institutionalized research programs makes sense since they are known to oversee similar research, development, and design work contracted to the defense-industrial ministries.

Regardless of where the research, invention, and rationalization takes place, it can be broken down into three general classes of activity according to N. N. Alekseyev:

- Problems of improving weapons and military equipment, increasing the effectiveness of their utilization, and reducing times for placing them in a combat-ready condition.
- Creation of new training facilities or improvement of existing ones.
- Raising the effectiveness and quality of equipment maintenance and repair, improving medical and supply-everyday services to personnel, and saving state funds and physical assets.

Alekseyev further explained that a recent review of invention and rationalization proposals (sponsored in part by the Department of Inventions) revealed that 30 percent were devoted to category one activities, 30 percent to category two, and 40 percent to the third category activities.

An examination of the Soviet press often turns up specific examples of invention and rationalization work that fall under each of Alekseyev's three general classes of activity. Examples of the first category include: new communications and control systems; a device for recharging batteries; an automatic cartridge loading device; mechanized equipment for loading and unloading transports; and monitoring, testing, and inspection apparatus.

The Soviet press has also mentioned the creation of electrically powered simulators and demonstration training aids as illustrations of the second category. In the third category of invention and rationalization activity, Soviet writers most often call out examples of methods developed by servicemen to decrease the military's consumption of energy.

The recent Soviet review of military invention and rationalization proposals mentioned earlier also reached conclusions regarding the most effective services and military districts. According to this survey, the Strategic Rocket Troops and Air Defense Forces attained the most success. The survey also heaped praise on the Moscow, Leningrad, Turkestan, and Kiev military districts as well as on the Group of Soviet forces in Germany and the Pacific Fleet.

Although Soviet commentators generally express MO's satisfaction with internal invention and rationalization efforts, they acknowledge that some problems exist and so the program could be more effective. The most common complaints are that valuable proposals do not receive widespread dissemination and that some ideas are slow to be implemented.

Additionally, military inventors and rationalizers often have difficulty obtaining information about the activities of other inventors and rationalizers. All this leads ranking Soviet military spokesmen to conclude that a good program can become even better in the future.

Natick Studying Liquid-Cooled Garments

Liquid Cooled Garments (LCG), a new technique for easing heat and humidity problems for crewmen in tanks and other closed combat vehicles, are currently under evaluation at the U.S. Army Natick (MA) R&D Command.

Although a number of methods have been used in the past to circulate and cool air in closed vehicles, no method has been satisfactory. High temperatures and humidity are known causes of crewmen fatigue and heat stress. As a result of this, missions have sometimes been shortened.

These problems have been compounded with the recent emergence of a chemical/biological threat. This is because crewmen are now compelled to wear CB protective clothing in addition to their normal coveralls, flight suits, and other protective gear.

However, researchers believe that Liquid Cooled Garments offer a good solution to these problems. These garments utilize a cooling agent that provides conductive cooling to the torso, neck and head. Cooling of these areas has been shown to be an effective method in reducing heat stress.

The most significant feature of this clothing system is the use of a new lightweight material which has liquid flow channels built into its entire surface. This material is not bulky, is highly flexible and conforms easily to the body for comfort. Because of its thin and flexible construction, the LCG may be worn easily with the crewmen's standard clothing, helmet and equipment.

The circulation of the coolant through the LCG conducts heat away from the contact surfaces of the wearer's body. Because the liquid flow channels are in close contact to the surface of the body, high heat transfer and efficient cooling is achieved.

To operate the LCG, the crewman must use a portable heat exchanger outside the vehicle or a central console unit inside the vehicle. The crewman simply dons the LCG under combat clothing and connects to the Liquid Microclimate Control Cooling Unit and starts the fluid pump. The cool fluid is circulated through the LCG channels, providing increased comfort to the overheated crew member.

Natick scientists will have an opportunity this summer to demonstrate the Liquid Microclimate Controlled Clothing System in the Army's new XM1 tank in a simulated chemical environment. Plans are also being developed to have this item developed for high performance aircraft. The Aerospace Medical Command of the Air Force has been working with Natick for several years, recognizing the potential of this system for high performance aircraft crews.

Liquid-Cooled Garment

For future vehicle operations in a chemical environment, an ancillary cooling system of this type appears to be the most attractive. As a spokesman for Natick has put it, "It is far more efficient to cool the man than the entire (vehicle) environment."

Ultraviolet Photos Record Andromeda Galaxy Images

Ultraviolet photographs of a galaxy two million light-years from Earth were taken during a recent NASA test conducted at White Sands (NM) Missile Range.

An Astrobee F sounding rocket fired from WSMR's Launch Complex 36 carried test equipment to an altitude of 133 miles where the experiment took place. The entire flight reportedly lasted approximately 850 seconds.

The Astrobee payload, prepared and packaged by NASA scientists, was designed to photograph M31, better known as the Andromeda Galaxy. The M31 designation refers to a catalog number devised by the French astronomer Messier in 1782.

Visible to the naked eye, Andromeda is similar to Earth's milky way. It is the closest galaxy to Earth, according to officials.

Ultraviolet photographs taken during the experiment should give NASA scientists greater insight concerning the internal structure and physical nature of Andromeda. Images were recorded on film via a microchannel plate image intensifier tube. The nose cone containing the camera and equipment was aimed at the galaxy using STRAP IV control.

The payload impacted 53 miles up range and parts were recovered at the first light of day. Two hours prior to launch the Aerobee 350, 4A and 4A extension areas on the western portion of the range were evacuated as a safety precaution.

12th Army Science Conference Features 96 Technical Papers

PAUL A. SIPLE AWARD is presented by Assistant Secretary of the Army (RDA) Dr. Percy A. Pierre to R. Alan Kehs (right) for *The Generation of Gigawatt Power Levels of Microwave Radiation* technical paper coauthored by Mr. Kehs, Dr. Howard E. Brandt, Alan Bromborsky and CPT George Lache, all of the Harry Diamond Laboratories, Adelphi, MD.

BRONZE MEDALLION for Scientific Achievement, certificate for outstanding achievement, and a monetary award of $750.00 were awarded to MAJ Alan I. Faden (left) and Dr. John W. Holaday of the Walter Reed Army Institute of Research for their technical paper presented at the 12th U.S. Army Science Conference. ASA (RDA) Dr. Percy A. Pierre (center) presented the awards.

Ninety-six technical papers, selected from more than 340 narrative summaries submitted from the Army R&D community, were presented during the 12th U.S. Army Science Conference at the U.S. Military Academy, West Point, NY.

Sponsored by the Office of the Army Deputy Chief of Staff for Research, Development and Acquisition, the conference drew more than 250 scientists and scientific administrators from Army R&D major commands, laboratories, activities, and agencies.

The 96 papers selected for presentation, along with 16 supplemental papers, were reviewed by the Army Science Board which selected 18 additional papers for special recognition. The Honorable Dr. Percy A. Pierre, Assistant Secretary of the Army (RDA), presented the awards to the winning authors.

The coveted Paul A. Siple medallion, bronze medallions for scientific achievement, and certificates signed by Dr. Pierre and LTG Donald R. Keith, Deputy Chief of Staff for Research, Development, and Acquisition, HQDA, were awarded.

The Paul A. Siple silver medallion award and a $1,000.00 cash prize was presented to R. Alan Kehs, Dr. Howard E. Brandt, Alan Bromborsky, and CPT George Lasche of the Harry Diamond Laboratories, Adelphi, MD, for their paper on *The Generation of Gigawatt Power Levels of Microwave Radiation.*

A bronze medallion, a certificate of outstanding achievement, and a monetary award of $750.00 was earned by Dr. John W. Holaday and MAJ Alan I. Faden of the Walter Reed Army Institute of Research for their paper on *The Role of Endorphins in the Pathophysiology of Shock and the Therapeutic Benefit of Opiate Antagonists.*

The following authors received certificates of outstanding achievement and a $250.00 monetary award in addition to a bronze medallion: Raul Machuca and Alton L. Gilbert, White Sands (NM) Missile Range, for *Finding Edges in Noisy Scenes;* William P. Ashman, William Thornton, Paul H. Broome, James W. King, and William J. Sacco, Chemical Systems Laboratory, Aberdeen Proving Ground, MD, for *Pattern Recognition Applications in Chemistry and Pharmacology: A "Pharmacophore Acetylcholinoreceptor" Subunit Environment Model;* Norman J. Berg, Irwin J. Abramovitz, John N. Lee, and Michael W. Casseday, Harry Diamond Labs, Adelphi, MD, for *Acousto-Optic Time Integrating Correlator for Detection and Characterization of Broad Band LPI Communications;* and

Charles M. Bowden and David W. Howgate, U.S. Army Missile Command, Redstone Arsenal, AL, for *MICOM Program in Optical Bistability;* Peter G. Canonico, James S. Little, Peter B. Jahrling, and Edward L. Stephen, Medical Research Institute of Infectious Diseases, Frederick, MD, for *Mechanism of Action of Ribavirin: An Antiviral Drug of Military Importance;* and David C. Heberlein and Roger M. Atkins, U.S. Army Mobility Equipment R&D Command, Fort Belvoir, VA, for *Projection of Vehicle Magnetic Signatures for the Defeat of Magnetic Mine Influence Sensors.*

Certificates of outstanding achievement were awarded to: William K. Cadwallender, Kimball Kramer, Paul Jankowski, and Paul J. Kisatsky, U.S. Army Armament R&D

SPECIAL RECOGNITION of service to the Army R&D community, in the form of an engraved plaque, was given to Dr. Ivan R. Hershner (left), assistant director for Research Programs, Office of the Deputy Chief of Staff for RDA, upon retirement from government service. Dr. Hermann R. Robl, technical director, U.S. Army Research Office, presented the award.

Command, Dover, NJ, for *Full Field Interferometry Applications to Army Problems;* Gaelen R. Daum, Ballistic Research Laboratory, Aberdeen Proving Ground, MD, for *Broadband Absorption Studies;* William A. Huber, U.S. Army Communications R&D Command, Fort Monmouth, NJ, for Coding and *Processing for Reliable Data Transmission;* Dirk R. Klose and William J. Skudera Jr., U.S. Army Electronics R&D Command, Fort Monmouth, NJ, for *Dual-Channel SAW Compressive Direction-Finding Techniques;* James W. McCauley and Normand D. Corbin, U.S. Army Materials and Mechanics Research Center, Watertown, MA, for *Transparent, Polycrystalline Cubic Aluminum Oxide;* and

Gerald L. Moss, Ballistic Research Lab, for *Armor Design Based on Material Properties;* Janet S. Perkins, U.S. Army Materials and Mechanics Research Center, Watertown, MA, for *Laser Interaction with TBR Materials;* Raymond L. Ross, Thomas R. AuCoin, Robert O. Savage, John J. Winter and Roger J. Malik, Electronics Technology and Devices Lab, Fort Monmouth, NJ, for *Semi-Insulating Gallium Arsenide for Millimeter Wave and High Speed IC Device Applications;* James J. Savage and Roy E. Shaffer, Chemical Systems Lab, Aberdeen Proving Ground, MD, for *Multispectral Screening Agent Studies;* and Thomas W. Wright, Ballistic Research Lab, for *Penetration With Long Rods: A Theoretical Framework and Comparison With Instrumented Impacts.*

Presiding chairman of the conference, Dr. Marvin E. Lasser, Director of Army Research, DCSRDA, HQDA, introduced LTG Keith who presented this year's keynote address. LTG Keith began by saying, "we have set goals for fielded technological equivalency by 1985, and fielded technological superiority by 1990."

LTG Keith set a tone of urgency when he stated, referring to the Russian and Warsaw Pact nations that, ". . . the truth is they have succeeded in achieving quantitative superiority in weapons over the United States Army and Marine Corps. Thankfully, our Navy and Air Force may be low in quantity, but their fielded quality still goes unchallenged."

LTG Keith asked "In what area is my Soviet counterpart envious of me? He responded by saying it is in the scientific and technical area and in our national and allied industrial might. If it were not for these, we might have gone under a long time ago. Believe me, the Soviets respect and fear these assets," said Keith.

The General noted that new equipment to be fielded in quantity in the next half decade include the XM1 tank, the Advanced Attack Helicopter, Copperhead, Hawk, Patriot, Roland, and Stinger. LTG Keith also touched on the infantry calvary fighting vehicle, surface to surface rockets and missiles, and command control. "Ours is truly an Army in transition," Keith added, "and the next two or three years will be the most critical in its peacetime history. The stumbling block that threatens to wreck a decade of outstanding development work is affordability. We simply do not have sufficient dollars in the pot to buy all of these new systems at the rate our military judgment dictates we need."

Relative to long-range planning, LTG Keith said, "the goal will be to identify Army needs early, articulate these needs clearly, and provide timely links in the change from R&D to procurement, for a stable military acquisition process."

LTG Keith said the days of 10 to 15 year R&D cycles are past, the half life of some of the technologies we are dealing with is so short that we must design everything with as much growth potential as possible. When budgets are tight, added Keith, the tech base becomes an inviting target for the knife; its value must be made more apparent to the decision makers. He did indicate that our forces enjoy a definitive lead in micro electronics, computers, and sensors.

LTG Keith closed by stating that "everywhere I go, no matter who the audience, I see a definite desire on the part of our people to create a stronger defense force. We need to make a better case with the administration, before Congress and to the American people. I don't believe that the American people will stand for a second rate Army, and yet as far as equipment goes, they have one right now."

Vice Chief of Staff GEN John W. Vessey Jr. followed LTG Keith with some of his feelings in the area of R&D. James E. Spates, Assistant Director for Laboratory Activities, Office, DCSRDA, discussed "The Planning Challenge" and Dr. Robert S. Wiseman, Assistant Deputy for Science and Technology, U.S. Army Materiel Development and Readiness Command spoke on "The User/Developer Response."

LTG Andrew J. Goodpaster, Superintendent of the U.S. Military Academy, provided the closing banquet address on "Security Needs in the 80s." He provided the attendees with a comprehensive overview of the "big picture" and the relationship of the military to the vital interests of the United States.

COL Anthony P. Simkus, commander, U.S. Army Research Office, was master of ceremonies at the banquet. Dr. Ivan R. Hershner, Assistant Director for Research Programs, Office, DCSRDA, received special recognition for his years of service to the military R&D community.

Dr. Hershner received plaques on behalf of the Office, DCSRDA, and the U.S. Army Research Office, upon his retirement from government service.

6 NJSHS Winners Receive London Trip

More than 200 of the nation's brightest and most highly motivated young scientists gathered at the University of South Carolina earlier this year for the U.S. Army's 18th National Junior Science and Humanities Symposium (NJSHS).

The participants journeyed from throughout the U.S. and Europe as a reward for their scientific excellence demonstrated at the 42 regional symposia held annually as part of the Army's JSHS program. At each regional symposium, one student was selected and he or she presented their paper at the NJSHS.

The 18th NJSHS is the culmination of an annual program sponsored by the U.S. Army which embraces over 6,000 participants. Completing its 22d year of continual operation, the JSHS program enjoys the reputation of being one of the premiere national efforts designed to encourage and stimulate the future scientific talent of the nation.

Six students were selected at the NJSHS to represent the U.S. at the London International Youth Science Fortnight, which was held at the University of London, 29 July through 13 August. One student was selected to attend the Weizmann Institute, Rehovot, Israel, as a guest of the Institute.

MG James H. Patterson, director of Battlefield Systems Integration, U.S. Army Materiel Development and Readiness Command, presented awards to those selected to attend the London International Youth Science Fortnight and Weizmann Institute. The winners were: Stephen K. Kornfeld, St. Louis, MO, for "A Determination of the Oligosaccharide Binding Specificity of Lectins from *Pisum sativum* and *Lens culinaris*"; David Sheff, Barrington, RI, for "Isolation of the Tissue Regeneration Agent in Nerve"; Shawn R. McGillivrary, Reno, NV, for "Biomass Conversion: A Study of 'Gum Weed' "; Pamela Lynne Epstein, Merritt Island, FL, for "Unlocking the Key to the Seed Germination Phenomenon"; Eric van Venrooy, Media, PA, for "A Fluidized-Bed Solar Collector"; and Ellen Weinstein, Springfield, NJ, for "Immunomodulation of Antibody Responses." Joel Freidman, Evanston, IL, was selected to attend the Weizmann Summer Science Institute activities for his paper on "Optimal Control for Cooling Problems." This year, for the first time, the Academy of Applied Science, the prime contractor for the Army JSHS program, initiated a $100 scholarship award to each runner-up. Mr. Howard Curtis, executive vice president of the Academy, presented the awards.

Capsules . . .

U.S., U.K., Germany Sign Missiles MOU

The defense establishments of the Federal Republic of Germany, the United Kingdom and the United States have announced the signing of a Memorandum of Understanding (MOU) for development and production of air-to-air missiles.

This MOU is considered unique since it describes one of the first major programs in the Family of Weapons concept—an initiative to avoid duplicative development costs in the Atlantic alliance countries.

Under the air-to-air MOU, the U.S. will develop and produce the Advanced Medium Range Air-to-Air Missile (AMRAAM) whereas a European Consortium will develop and produce the Advanced Short Range Air-to-Air Missile (ASRAAM). France has special status as a signatory government with the option of becoming a full participant at a later date if these missiles meet its requirements.

Both sides of the Atlantic will eventually produce both systems since the developing contractors will license coproduction rights to their counterparts overseas. The U.S. AMRAAM contractor will license an industrial consortium of European firms to produce AMRAAMs. The ASRAAM consortium will in turn license U.S. industry to produce that missile.

The Family of Weapons approach to international defense cooperation provides a number of advantages to the alliance. Estimated savings to the U.S. from elimination of duplicative development costs are at least $200 million.

These standard air-to-air missiles also facilitate cross-servicing of armaments within the European theater, enhance interoperability among various nations' aircraft, and substantially reduce logistics costs. Other weapons systems are being considered for this Family of Weapons concept.

AMMRC Uses Diffusion Bonding Method

The rotating band of a projectile performs the important function of providing spin and also obturating the propellant gases that launch a projectile into flight. The band must remain securely attached to the projectile. Infallibility is needed to attain the spin and velocity for range accuracy.

Traditionally, these rotating bands of copper have been attached to steel projectiles mechanically, by swaging. More recently they have been attached to the steel base metallurgically, using weld overlay and also friction welding techniques. The development described in the following however is of attachment to a titanium shell by diffusion bonding. This was performed by AMMRC for ARRADCOM in support of the XM 785 program.

Diffusion bonding, according to Mr. Jacob Greenspan, chief, Engineering Materials Branch, Army Materials and Mechanics Research Center, Watertown, MA, in the present sense is defined as the intermingling of atoms of two adjoining surfaces under heat and pressure. The diffused region generally consists of a range of compositions, microstructures, and phase structures, characteristic of the alloying behavior of the constituent atoms.

From the metallurgical standpoint, the diffusion bond must be structured to carry the relatively high loads encountered in the gun tube. Early characterizations of microstructures and of the strength of diffusion bonds formed from Cu and Ti constituents were favorable, in spite of uncertainties associated with intermetallic phases of the Cu-Ti binary system.

From the processing standpoint it was necessary to produce a bond of required infallibility on the full scale geometry of the XM 785 components. For this a hot isostatic pressing (HIP) approach was selected. This process employs an isostatic pressing medium of hot inert gas, which acts effectively on the present configuration.

In practice, the band-shell assembly was sealed in a jacket impervious to the pressing medium, and was subjected to a specific temperature-pressure-time cycle in a HIP autoclave chamber. In this way bands of conventional copper or copper-10% zinc alloy (gild metal) were diffusion bonded controllably to shells of tough, high strength Ti-6-6-2 alloy. Mechanical properties obtained initially in the shell by a hot forge-solutionize-age approach were unaffected by the superimposed HIP cycle.

Though feasibility was evident early on simulated components, it was not realized for test fired prototypes until a number of processing details were satisfactorily developed. A prototype projectile proof was tested very recently. The effort initiated in 1978 from conception through experiment to prototype processing is now in final stages of optimization.

New Facility Designed for Weapons T & E

The Office of the Test Director, Joint Services Electro-Optical Guided Weapons Countermeasures Test Program at White Sands (NM) Missile Range has accepted delivery of a new Operational Test and Evaluation Facility. It is designed for field testing and evaluating present and future electro-optical weapons systems.

The modern and highly sophisticated system, built into seven mobile vans, was constructed by New Mexico State University's Physical Science Laboratory (PSL) under a $5.4 million contract. The contract was believed to be the largest competitive contract ever awarded to PSL.

Officials at PSL said several hundred persons, including students involved in work-study programs, were engaged in project development and project support, as well as direct labor. More than 76 man-years of labor were involved in the project, NMSU officials estimated.

The seven Operational Test and Evaluation Facility vans are designed for worldwide operation under varied operations and storage environments. Since they are self-contained, with their own power source, the vans require little logistical support from host test areas.

Each of the seven vans has a specific function in electro-optical testing. In addition to the control van, there are video, sensor, source, countermeasures, telemetry and characterization vans. Each van is equipped with special electronic devices to perform its particular test role.

PM Announces AN/TTC-39 Major Milestone

COL Donald J. Callahan, CORADCOM Project Manager for Multi-Service Communications Systems (MSCS) has announced a major milestone in the AN/TTC-39 Program. The Defense Systems Acquisition Review Council approved the AN/TTC-39 Circuit Switch for production.

The AN/TTC-39, a major Army program, is compatible with the Defense Communications System (DCS) Automatic Voice Network (Autovon) and existing tactical voice switching systems of the services as well as the AN/TYC-39 message switch which was approved for production earlier this year.

The AN/TTC-39 are hybrid, modular, transportable, tactical automatic switching equipments. They use microelectronic components and design techniques, are stored-program controlled and are mounted in S-280 shelters for high mobility.

Capabilities have been incorporated for utilizing the switches in strategic, as well as tactical applications. The 600-line and 300-line switches have electrically and mechanically interchangeable switch matrices which can be either analog (space division) or digital (time division).

This architecture provides for analog switching, and for connections between analog and digital subscribers and trunks, and extends the life of the AN/TTC-39 switch equipment. This DSARC decision marks the go-ahead for the second major item in the TRI-TAC program for Army communications of the future.

CH-47D Undergoes Icing Conditions Tests

The Army's modernized medium light cargo helicopter, the CH-47D Model is currently being tested to determine the relationship between fiberglass rotor blade icing and the flight envelope.

The objective of this test, the second of its kind using Chinooks, is to determine the aircraft's ability to fly in icing conditions with fiberglass rotor blades with and without de-icing systems.

Effectiveness of the rotor blade de-icing system could permit this type of aircraft to operate in severe icing conditions. During the first icing program last year second tanker helicopter, equipped with a spray system was used to induce icing on the test aricraft.

According to COL Terry L. Gordy, CH-47 Modernization Program Project Manager, the fiberglass rotor blades are less likely to ice-up than the standard metal alloy blades. During the testing the helicopters could be observed flying at low levels or hovering over isolated areas. Part of the testing program includes transport of large objects slung behind the aircraft on it's external cargo hook system.

Engineers Define Pilot Simulation Training

Army, NASA and NATO engineers met earlier this year at NASA Ames Research Center, Moffett Field, CA, to define the "Fidelity of Simulation for Pilot Training." The Army Aeromechanics Lab and NASA Ames cohosted this meeting of the AGARD Aerospace Medical Panel-Flight Mechanics Panel Working Group No. 10. AGARD is the Advisory Group for Aerospace R&D and responds to the NATO Military Council.

The training flight simulator can help develop flying skills and also save flying time, flying space, fuel and aircraft life. It also enables trainees to conduct aviation operations which otherwise could be fatal to life and aircraft.

Although flight simulation is widely used in pilot training, simulators are becoming as complex and expensive as the aircraft they duplicate. Questions have been raised as to the complexity of simulation required for effective pilot training. To investigate these problems, AGARD established Working Group No. 10 in March 1978. A report on these problems and suggested solutions, is expected this fall.

Awards . . .

5 Honored for Distinguished Service

Deputy Secretary of Defense W. Graham Claytor recently presented 1980 Department of Defense Distinguished Civilian Service Awards to five outstanding employees in a ceremony at the Pentagon.

The Distinguished Civilian Service Award is the highest award bestowed upon civilian employees who, during the preceding year, made the greatest contributions to efficiency, economy and other improvements in the operations of the DOD. The 1980 recipients are:

Dr. Joseph Sperrazza, director, U.S. Army Materiel Systems Analysis Activity, received the award in recognition of outstanding managerial, technical, and scientific accomplishments. He reportedly made significant contributions to the improvement of the Army's systems analysis capabilities. Dr. Sperrazza identified and eliminated serious technical gaps in weapons development to satisfy critical combat needs.

Dr. Herbert Rabin, associate director of Research and director of Space and Communication Science and Technology, Naval Research Laboratory, was cited for his exceptional scientific leadership. He directed and managed a broad program of basic and applied research which led to breakthroughs in outerspace living, lunar exploration, upper air characteristics, and advanced technology in space systems.

Mr. Harvey J. Gordon, deputy for Acquisition in the Office of the assistant Secretary of the Air Force (Research, Development and Logistics), was praised for exceptional contributions to Defense acquisition programs. He conceived and introduced the principle, now accepted as basic to acquisition policy, that business strategy should be co-equal with technological development.

Mr. Richard R. Violette, director of Security Assistance Operations, Defense Security Assistance Agency, received the Department of Defense Distinguished Civilian Service Award in recognition of his outstanding contributions to the Security Assistance Program.

Miss Ann Z. Caracristi, senior cryptologic manager, National Security Agency, was recognized for her outstanding service in the field of cryptology. For more than 37 years, Miss Caracristi has been in the forefront of cryptologic developments. She is personally responsible for many major decisions affecting cryptologic production techniques, and helped shape national cryptologic policies.

Isker Award Goes to 5 Natick Employees

Five researchers of the U.S. Army Natick (MA) Research and Development Command were awarded the 1979 COL Rohland A. Isker Award by the R&D Associates for Military Food and Packaging Systems, Inc.

Selected for the prestigious award, which recognizes outstanding contributions to national preparedness in the fields of food and containers, were Mr. Richard P. Richardson, program manager; Dr. D. Paul Leitch, principal investigator; operations research analysts Mr. Brian M. Hill and Mr. Paul M. Short, all of the Operations Research and Systems Analysis Office (ORSA) and Mr. George Turk, food service equipment specialist, Food Engineering Laboratory. The 5-man team had developed a significantly improved feeding system which has been adopted by the Navy and installed aboard aircraft carriers.

Competition for the award is open to all civilian and military personnel of Federal Government agencies, as well as personnel in industry and academia involved in basic or applied R&D.

Responding to a request from the Navy Food Service Systems Office, the NARADCOM team conceived a new feeding system to expedite service and improve customer satisfaction aboard the *USS Saratoga*. They completely redesigned the forward enlisted dining facility of the carrier and established a new menu consisting of popular and high quality fast food items. Serving time was greatly reduced, waiting time in lines shortened, and the crew responded most enthusiastically to the new offerings.

As a result of the overall success of the concept on the *Saratoga*, The Chief of Naval Operations has authorized implementation of the fast food service system aboard all other aircraft carriers in the fleet, and selective parts of the concept are also being installed on other types of ships.

Vervier Receives 1979 Campbell Award

Mr. Joseph J. Vervier, a physicist assigned to the Armament R&D Command's Chemical Systems Laboratory (CSL), has been selected as the 1979 recipient of the Campbell Award.

The annual award, named in honor of LTG Kevin Hicks Campbell, was established to recognize significant achievements in support of the mission of ARRADCOM, CSL's parent command.

Vervier was commended

Joseph J. Vervier

for outstanding technical competence, dedication and leadership demonstrated in the successful implementation of ARRADCOM's smoke/aerosol research and technology programs.

He was specifically praised for his technical direction that resulted in major advances in the science and technology associated with the military application of obscurants.

Vervier developed a 5-year technology program in 1977 that established CSL as a national focal point for aerosol and obscurant research. He is currently serving as chief of the Obscurant Sciences Section in CSL's Research Division, and is a member of The Technical Cooperation Program working panel on visible and infrared screening and decoys.

He is the author of more than a dozen technical reports and papers and previously served as an aerosol/smoke technology consultant to the Army Test and Evaluation Command, the Combat Arms Test Activity, the Army Atmospheric Sciences Labortory and the Army Research Office.

Engineer Honored for Tank Gun Research

Dr. Bruce Burns, a mechanical engineer assigned to the Army's Ballistic Research Laboratory (BRL) ARRADCOM, has been honored for his publication dealing with tank gun research and technology.

Burns, author of "Recent Tank Gun Technology," was awarded "Best Publication in Interior Ballistics Division" by Dr. R. J. Eichelberger, BRL's director and Mr. Leland A. Watermeier, the division's chief.

He was praised for his overall ability to assess past and ongoing research as well as project future trends and requirements in the technology.

According to Dr. Burns, of all the armament technology areas being examined by the Army, few have been as dramatic and rapidly growing as the technology surrounding tank guns, particularly the technology for kinetic energy ammunition.

"My publication presents the technology ingredients used in the most recent international competition in the U.S. and the most recent BRL successful thrust," says Burns.

Currently deputy chief of the Mechanics and Structures Branch, he leads research in areas of solid mechanics, structural dynamics, and accuracy related phenomenology. He has authored 28 technical papers and reports.

Personnel Actions . . .

Lunn Named DC for Materiel Development

LTG Robert J. Lunn, former assistant deputy chief of staff for Research, Development and Acquisition, HQ DA, has succeeded LTG Robert J. Baer as deputy commander for Materiel Development, HQ DARCOM, concurrent with his promotion to 3-star rank.

LTG Robert J. Lunn

LTG Lunn served at HQ DARCOM from September 1977 to January 1979 as director of Development and Engineering. Prior to his DARCOM tour he commanded the U.S. Army Air Defense Center and Fort Bliss, and from 1974–76 he was assistant commandant of the Army Air Defense School.

He is a 1950 graduate of the U.S. Military Academy and holds a master's degree in aerospace engineering from the University of Arizona. He has also completed requirements of the U.S. Army Command and General Staff College, the Armed Forces Staff College, and the U.S. Army War College.

LTG Lunn's military honors include the Legion of Merit with Oak Leaf Cluster (OLC), Meritorious Service Medal, and the Army Commendation Medal with OLC.

Bratton Succeeds Morris as Engineer Chief

MG Joseph K. Bratton

MC Joseph K. Bratton, South Atlantic Division engineer, has been nominated for 3-star rank and selected to succeed LTG John W. Morris, as chief of the U.S. Army Corps of Engineers. LTG Morris retires 30 September.

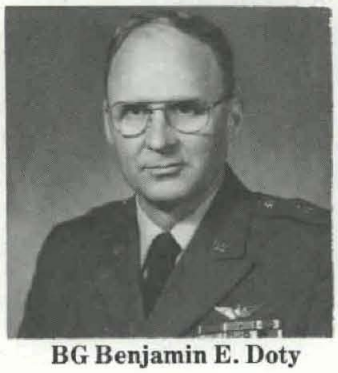
A 1948 graduate of the U.S. Military Academy, MG Bratton holds a master's degree in nuclear engineering from Massachusetts Institute of Technology. He has also completed requirements of the Army Command and General Staff College and the Army War College.

His command assignments have included the 24th Engineer Batallion, 4th Armored Division, Europe; and commander, 159th Engineer Group, Vietnam. He also served in the War Plans Division, Plans Directorate, Office, Deputy Chief of Staff for Military Operations; and with the Division of Reactor Development, Atomic Energy Commission.

Staff assignments included director of Military Application, Department of Energy; chief of Nuclear Activities, Supreme Headquarters of Allied Powers, Europe; executive to the Supreme Allied Command in Europe; secretary to the Joint Chiefs of Staff; and military assistant to the Secretary of the Army.

MG Bratton is a recipient of the Defense Distinguished Service Medal, the Army Distinguished Service Medal, three Legions of Merit, two Bronze Star Medals, Joint Service Commendation Medal, two Air Medals, and four Army Commendation Medals.

Doty Assumes Duties as CDEC Commander



BG Benjamin E. Doty

BG Doty has assumed command of the Combat Developments Experimentation Command, Fort Ord, CA. BG Doty was formerly the assistant division commander of the 2d Armored Division at Fort Hood, TX.

Commissioned a second lieutenant after graduation from the University of Idaho in 1953, BG Doty is a graduate of the Command and General Staff College and the Army War College, and he holds a MS degree in public administration.

BG Doty has commanded the 5th Training (Missile) Battalion, Fort Sill, OK; the 7th Battalion, 11th Artillery, 25th Infantry Division, Vietnam; and the 3d Armored Division Artillery, Germany.

He served as deputy and later assistant chief of staff, G-3, 3d Regional Assistance Command, Vietnam, and as project officer for long-range educational development plans at the Army War College.

Before joining the 2d Armored Division as assistant division commander in July 1978, he spent three years at the U.S. Army Military Personnel Center as chief, Field

Artillery Branch; chief, Majors Division; and director of Officer Personnel Management.

He wears the Senior Army Aviator Badge, and his decorations include the Legion of Merit, the Bronze Star Medal with Oak Leaf Cluster (OLC), the Meritorious Service Medal with OLC, two awards of the Air Medal and the Army Commendation Medal with three OLC.

Wetzel Gets Watervliet Arsenal Command

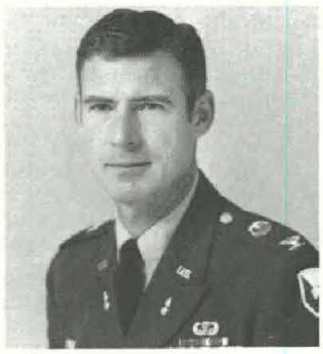
COL Gerald R. Wetzel recently succeeded COL Robert W. Pointer as commander of Watervliet (NY) Arsenal. COL Pointer has become project manager for Cannon Artillery Weapons Systems at the U.S. Army Armament R&D Command, Dover, NJ.

Formerly assigned as executive officer to commander of the U.S. Army Materiel Development and Readiness Command GEN John R. Guthrie, COL Wetzel has a BS degree in chemical engineering from Notre Dame and a master's degree in business administration from George Washington University.

His military training includes the Industrial College of the Armed Forces, the Armed Forces Staff College, the Ordnance Officer Basic Course, and the Ordnance Officer Advanced Course.

During 1976–78, COL Wetzel was chief of the Support Forces Group, Concepts Analysis Agency. From 1972–76 he served in Germany as chief of supply for the 2d Support Command, as commander of the 87th Maintenance Battalion, and as assistant G-4 (MODLOG), VII Corps.

Other key assignments have included deputy chief of staff, 1st Regional Assistance Command, Vietnam; executive officer and commander, 8th Support Battalion, 196th Infantry Brigade, Vietnam; and staff officer, Office, Chief of R&D, Department of the Army.



COL Gerald R. Wetzel

White Assumes Command of AVRADA

COL LeRoy White, project manager, Navigation/Control Systems (NAVCON), AVRADCOM, Fort Monmouth, NJ, since 1976, has assumed command of the U.S. Army Avionics Research and Development Activity (AVRADA), Fort Monmouth. NAVCON and AVRADA will be combined into a new agency and headed by COL White. The new agency will be responsible for research, development, and acquisition of aviation electronics systems.

COL White's previous assignments have included a tour with the ECOM Avionics Laboratory, overseas tours in Europe and Vietnam. He also served a tour with the Office of the Assistant Chief of Staff for Communications-Electronics, Department of the Army.

A dual-rated master Army aviator with more than 20 years flying experience, he has a bachelor's degree from Tennessee Polytechnic Institute and a master's degree from George Washington University.

COL White wears the Legion of Merit, Bronze Star Medal with Oak Leaf Cluster, the Air Medal (five awards) and the Army Commendation Medal with two OLC. He is also the president of the Army Aviation Association of America Monmouth Chapter and is a member of the Institute of Navigation.

COL LeRoy White

Mikula Selected as TSA Director

COL J. George Mikula recently took command of the U.S. Army Electronics Research and Development Command's (ERADCOM) Technical Support Activity (TSA), Fort Monmouth, N.J. He succeeds COL Lynn W. Wiegand who retired following 28 years of active service.

TSA provides support services to ERADCOM's laboratories, directorates, project managers and other customers in the functional areas of engineering support, logistics management, metrology and calibration and maintenance of technical data.

Prior to assuming command of TSA, Mikula was commander of ERADCOM's Combat Surveillance and Target Acquisition Laboratory, Fort Monmouth. Before joining ERADCOM he was assigned to the Army Materiel Development and Readiness Command, Alexandria, VA, where he was acting associate director for the Battlefield Automation Management Office. He also interacted in the areas of Foreign Science and Technology and Countermeasures/Counter-Countermeasures.

COL Mikula graduated from Rutgers University in 1954 and was commissioned a second lieutenant in the Army Signal Corps and entered active duty at Fort Monmouth. Prior to the DARCOM assignment, Mikula was a staff officer, Office of the Deputy Chief of Staff for Research, Development and Acquisition, Washington, DC.

Other assignments have included command of the 67th Signal Battalion, Fort Gordon, GA, two tours in the Republic of Vietnam, and European assignments where he was the G-2 for Headquarters Seventh Army and was with the 4th Armored Division. He has also been with the Army Signal Center and School, as a student and staff member.

Mikula attended the Signal Officer's basic and advanced courses, several aviation schools and is a Master Army Aviator with over 4,000 flying hours. He is a graduate of the Army Command and General Staff College and earned a master's degree in technology from Georgia Southern College.

Included in his decorations are the Legion of Merit, Meritorious Service Medal, Bronze Star, Air Medal with 13 Oak Leaf Clusters, and the Army Commendation Medal with two OLC.

COL J. George Mikula

Kublin Chosen as Acting CSTAL Director

Mr. Vincent J. Kublin has been named acting director of the Army Electronics Research and Development Command's (ERADCOM) Combat Surveillance and Target Acquisition Laboratory (CSTAL), Fort Monmouth, NJ. He succeeds COL George Mikula who is now the commander of ERADCOM's Technical Support Activity.

CSTAL is responsible for improving the Army's capability in battlefield surveillance, target acquisition and designation. The primary focus of the Laboratory is on radar and sensor data development.

Kublin has been CSTAL's deputy since 1975. His previous assignments have included chief of the Systems Development Division, Research Development and Engineering Directorate; associate director of the Electronic Technology and Devices Laboratory and acting director of the Electronic Components Laboratory.

He holds a BSEE degree from the College of the City of New York and has published extensively in the fields of component assembly techniques, transistor components and microminiaturization.

Kublin is an active member of many professional so-

cieties and has received numerous awards and honors, the most recent of which are the Army Meritorious Civilian Service Award and the ERADCOM Commander's Award.

Bell Directs ERADCOM Operations

COL James C. Bell Jr.

COL James C. Bell Jr. recently became the director of Operations at the U.S. Army Electronics Research and Development Command (ERADCOM). He succeeds LTC Herbert W. Head who has been reassigned to Camp Smith, HI.

Bell came to ERADCOM from the U.S. Army Intelligence Center and School at Fort Huachuca, AZ, where he served for three years as a U.S. Army Training and Doctrine Command systems manager.

He was commissioned a second lieutenant in 1955, and holds a bachelor's degree from Presbyterian College and a master's degree from Pepperdine University. He is also a graduate of the Command and General Staff College; Army Security Agency Basic Officer Course; 82d Airborne Division Jump School; and the Army Signal School (Electronic Warfare) Officer Career Course.

COL Bell has served with the 307th U.S. Army Security Battalion, Germany; the 317th Battalion at Fort Bragg, NC; THE U.S. Logistics Group Detachment, Turkey; the Army Security Agency, Europe; and the Army Security Agency, Washington.

His military decorations include the Legion of Merit, Bronze Star with Oak Leaf Cluster (OLC), Meritorious Service Medal, Joint Service Medal, and Army Commendation Medal with OLC.

Duggan Becomes WSMR Deputy Commander

COL Daniel E. Duggan has been named deputy commander of White Sands (NM) Missile Range. He replaces COL Patrick Wilson who has retired from active Army duty.

COL Duggan, who served four years at WSMR beginning in June 1961, comes to his new assignment from Redstone Arsenal, AL, where he was commander of the School Brigade, U.S. Army Missile and Munitions Center and School.

He began his military career in September 1955 when he was named distinguished military graduate of the University of Oklahoma ROTC and commissioned a Regular Army second lieutenant of Ordnance.

Stateside assignments included staff officer (Plans) of the Safeguard System, Arlington, VA, and as commander of the Scranton Army Ammunition Plant, Scranton, PA. COL Duggan attended the Army War College and completed Army installation management and defense procurement management training.

Other Army schools completed by Duggan include the U.S. Army Command and General Staff College, the Ordnance officers' basic course, guided missile course for both the Corporal/Sergeant and the Nike-Hercules missile systems and ordnance advanced (officers') course.

Crawford Takes Over as ERADCOM DC

Deputy commander, U.S. Army Electronics Research and Development Command, Adelphi, MD, is the new title of COL William R. Crawford. He served formerly as commander, 1st Signal Brigade and assistant chief of staff for Communications, Seoul, Korea.

COL Crawford holds a BS degree from Auburn University, and MBA and PhD degrees from the University of Alabama. His military schooling includes the Army Command and General Staff College, the Industrial College of the Armed Forces (distinguished graduate), and the Basic and Advanced Signal Officers Course.

Listed among COL Crawford's key assignments are comptroller, U.S. Army Armament R&D Command; staff member, Tactical Compatibility Branch, Office of the Joint Chiefs of Staff, Washington, DC; management officer, Military Personnel Center; command signal officer, 32d Army Defense Command; and commander, 11th Air Defense Signal Battalion, Kaiserlautern.

COL Crawford is a recipient of the Silver Star, Legion of Merit, Bronze Star Medal with two Oak Leaf Clusters (OLC), Meritorious Service Medal with two OLC, and the Army Commendation Medal with three OLC.

Demick Named CORADCOM Chief of Staff

COL Harold B. Demick

COL Harold B. Demick has been assigned as the new chief of staff of the U.S. Army Communications Research and Development Command, Fort Monmouth, NJ, following a 3-year tour as chief of staff, HQ 5th Signal Command, Worms, Germany.

During 1974–77, COL Demick served in the Office, Deputy Chief of Staff for Operations, HQ DA, following an assignment as division chief, Applied Communications Division, Officers Department, Fort Gordon, GA.

In 1969, he was assigned as deputy assistant chief of staff, Communications-Electronics, HQ, 185h Airborne Corps, Fort Bragg, NC, and later assumed command of the 82d Signal Battalion, 82d Airborne Division.

COL Demick's military award and decorations include the Legion of Merit with Oak Leaf Cluster (OLC), Bronze Star Medal, Meritorious Service Medal with OLC, Army Commendation Medal with OLC, Combat Infantry Badge, and the Senior Parachutist Badge.

Career Programs . . .

Butler Begins Sloan Fellowship Program

Mr. Bryan W. Butler, an employee at the U.S. Army Materiel Development and Readiness Command, recently began nine months of intensive study under a Sloan Fellowship Program for Executives at Stanford University.

Nominated for the program by the Department of the Army, Butler joins a highly diversified but select group of 42 Sloan Fellows representing government and industry organizations from the U.S. and abroad. His academic credentials include a BSEE from the University of Florida and a master's degree in industrial engineering from Texas A&M University.

Prior to his acceptance into the Sloan Program, Butler was the HQ DARCOM Development Manager for TECOM and AMSAA in the Office of the Associate Director for Test and Evaluation, Directorate for Development and Engineering. He has also served in DARCOM's Quality Assurance Directorate; as ARTADS PM; with the Army Night Vision Lab; and with the Electronics Command's Stano Production Engineering Division.

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