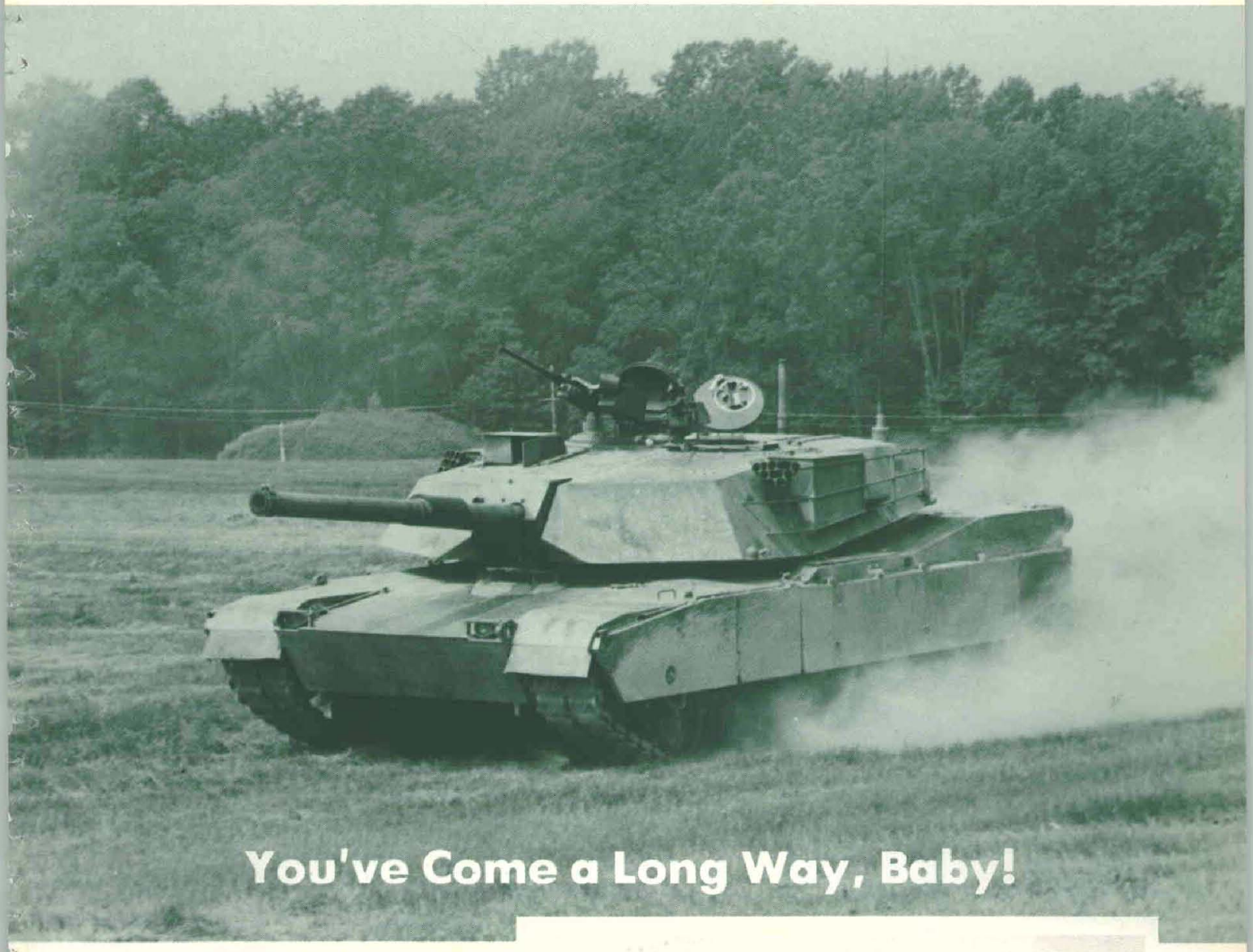
ARMY
# R,D&A
• RESEARCH
• DEVELOPMENT
• ACQUISITION

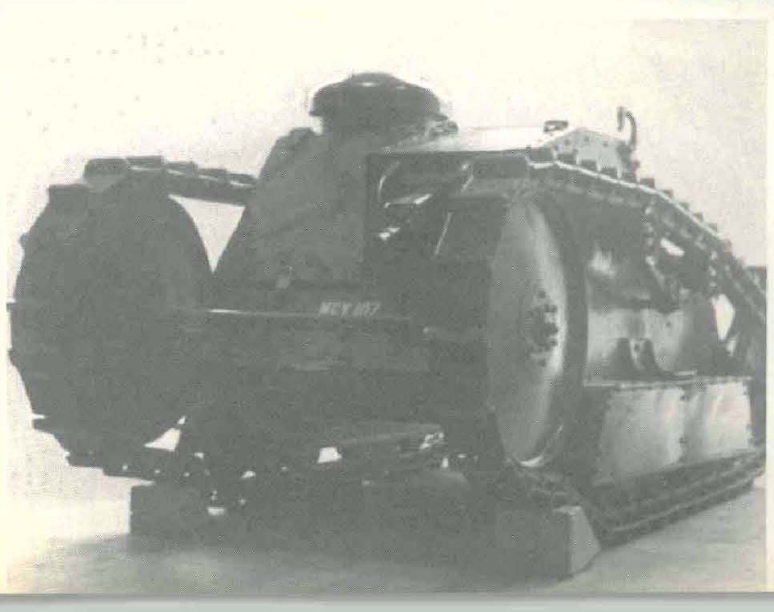
SEPTEMBER-OCTOBER 1978



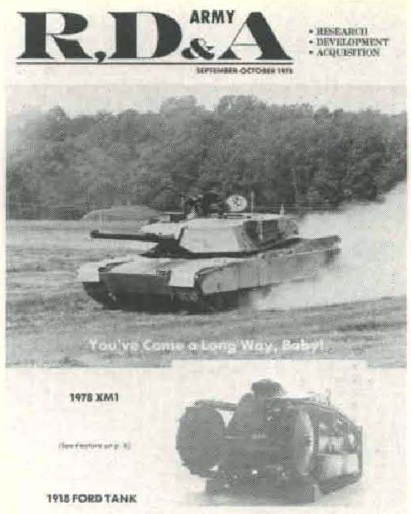
## You've Come a Long Way, Baby!

### 1978 XM1

*(See Feature on p. 6)*



### 1918 FORD TANK




## ABOUT THE COVER:

In July the Army publicly displayed the new XM1 tank. Concurrent with this showing at Aberdeen was a showing of a renovated, running-condition 1918 Ford tank. The Ford Motor Co. had been awarded a contract for 15,000 light 2-man tanks, but was able to produce but 15 when the war ended. Allegedly, several were sent to France for evaluation in late 1918. Two Fords are known to exist, the one at the Ordnance Museum, Aberdeen, MD, and a second at the Patton Museum, Fort Knox, KY.

The Ford was powered by two 45 hp Model T engines, giving it a theoretical top speed of 8 mph. It carried 17 gallons of gas for an operating range of 34 miles. It was armed with one .30 caliber machinegun, and carried ¼-inch armor frontally and .5 inch on the sides.

The XM1, believed to be the world's most technologically advanced tank, is powered by a 1500 hp turbine and is capable of travelling in excess of 30 mph cross-country. It is armed with a 105mm cannon, two 7.62mm and one .50 caliber machineguns. Its armor is highly effective against all known antitank missiles and projectiles.

By comparison with the first U.S. designed tank—the Ford, XM1 represents a leap in technology comparable to that of today's jet fighter with the 1918 U.S. designed and built Thomas Morse Scout.

**Editor . . . . . L. VanLoan Naisawald**
**Associate Editor George J. Makuta**
**Assistant Editor . . Harvey Bleicher**
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Published bimonthly by the Development and Engineering Directorate (DRCDE), HQ U.S. Army Materiel Development and Readiness Command, Alexandria, VA, in coordination with the DARCOM Public Affairs Office, the Office of the Chief of Engineers, the Office of the Surgeon General's Medical R&D Command, and the Office of the Deputy Chief of Staff for Research, Development, and Acquisition, HQ Department of the Army, to serve all elements of the U.S. Army Research and Development and Acquisition community.

Grateful acknowledgement is made for the valuable assistance of Public Affairs Offices within the Army Materiel Development and Readiness Command, Office of the Surgeon General, Office of the Chief of Engineers, Army Health Services Command, Army Training and Doctrine Command, Army Forces Command, and related activities. Use of funds for printing of this publication has been approved by Department of Army, 23 Dec. 1975.

*Purpose:* To improve informal communication among all segments of the Army scientific community and other Government R,D&A agencies; to further understanding of Army R,D&A progress, problem areas and program planning, to stimulate more closely integrated and coordinated effort among Army R,D&A activities; to express views of leaders, as pertinent to their responsibilities, and to keep personnel informed on matters germane to their welfare and pride of service.

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*Submission of Material:* All articles submitted for publication must be channeled through the technical liaison or Public Affairs Officer at installation or command level.

*By-lined Articles:* Primary responsibility for opinions of by-lined authors rests with them; their views do not necessarily reflect official policy or position of Department of the Army.

# R,D&A ARMY

**Vol. 19 No. 5** **September-October 1978**

## FEATURES



## DEPARTMENTS



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# First DOD-Wide Technical Directors Conference Held at NBS

Top government officials involved in research, development and acquisition, recently met with more than 70 technical directors of in-house laboratories, during the first DOD-Wide Technical Laboratory Directors Conference held at the National Bureau of Standards, Gaithersburg, MD.

Congressman Richard H. Ichord, chairman of the Research and Development Subcommittee of the House Armed Services Committee, was the guest dinner speaker during which he reviewed the output from in-house R&D expenditures and the role of the laboratories (see summary of his remarks on page 13).

The plenary session included six invited speakers who gave brief opening remarks.

Dr. Ernest Ambler, director of the National Bureau of Standards (NBS), welcomed the participants and in his remarks stressed the importance of interaction and relationship between NBS and DOD in research and development.

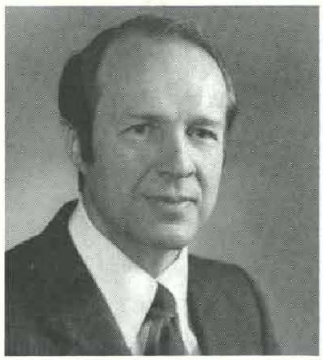
Mr. Philip Smith, assistant director in the Office of Science and Technology Policy (OSTP), gave the opening comments for OSTP and highlighted the need to strengthen the basic research support in order to maintain national technological leadership in research and development.

In his remarks, Dr. William J. Perry, Under Secretary of Defense for Research and Engineering, stated that we are being challenged by our adversaries in the quality and quantity of our R&D efforts, and pointed out that the Soviet's expenditures in the procurement of modern weapons systems is twice that of the U.S. He also stressed the need to utilize more fully R&D performed by our allies and coordinate it with our own efforts.

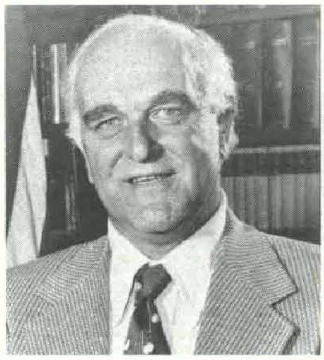
Assistant Secretaries of the Army (RDA) Dr. Percy Pierre, Dr. David Mann, Navy (RE&S), and Dr. John Martin, Air Force (RD&L) reviewed programs of their in-house activities, and noted the role the in-house laboratories must play while under the ceiling constraints of personnel and budgets.

Dr. Ruth M. Davis, Deputy Under Secretary of Defense (DUSD) for Research and Advanced Technology, who organized the meeting, opened the second session by outlining the conference objectives. Dr. Davis emphasized that while she appreciates the grade ceiling and manpower problems in each laboratory, the meeting was to be concerned with the technical formulation of the DOD Science and Technology (S&T) program.

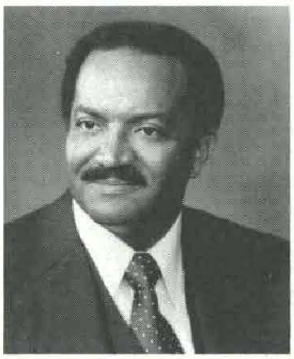
This program, which the Directors know as 6.1, 6.2, and 6.3A, starts with basic research and ends with a field demonstration system. A high priority must be placed on developing a strongly competitive environment in DOD technology, otherwise system selection is a captive rather than a beneficiary of technology options.



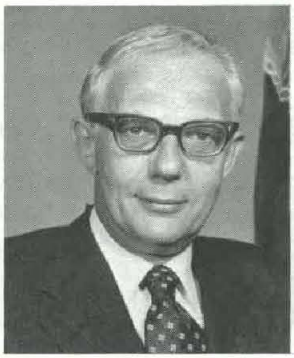
**Dr. William J. Perry**
*Under Secretary of Defense (Research & Engineering)*



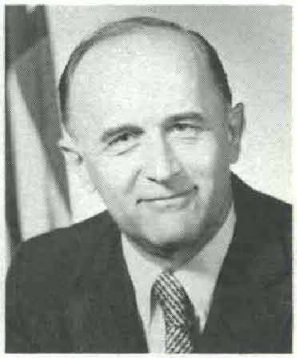
**Dr. Ernest Ambler**
**NBS Director**



**Dr. Percy Pierre**
*Assistant Secretary of the Army (Research, Development & Acquisition)*



**Dr. David Mann**
*Assistant Secretary of the Navy (Research, Engineering & Systems)*



**Dr. John Martin**
*Assistant Secretary of the Air Force (Research, Development & Logistics)*

The very existence of a S&T program is based on the assumption that by competition a better and a much less expensive weapon system can be devised. The competition in science and technology should generally be proportional to the potential operational payoff, scientific uncertainties, and the quantities planned for procurement.

In discussing the science and technology process and the complementary roles of the in-house, university, and industrial laboratories, Dr. Davis introduced the concept of "technological infrastructure." This was defined as being the underlying foundation or basic framework of the defense S&T program. The definition of this term and its application as a management concept was the subject of one of the workshops and an active point of discussion at the conference.

COL Donald I. Carter, military assistant to the Deputy Under Secretary of Defense for Research and Advanced Technology, discussed the current DOD S&T program, breaking out expenditures for FY 1978 and 1979, by category, service, and defense agency.

CPT Frank Austin, director, Office of Environmental and Life Sciences; Mr. Gerald Makepeace, director, Office of Engineering Technology; and Mr. Leonard R. Weisberg, director, Office of Electronics and Physical Sciences, spoke on technology initiatives of their respective disciplines.

Dr. George Gamota, assistant for Research to the Deputy Under Secretary of Defense for Research and Advanced Technology, gave an overview of the DOD Research Program in which he discussed funding by technological areas and the scientific infrastructure of research. He also listed examples of projects that could be categorized as incremental improvements and potential breakthroughs and research areas needing strong support.

In discussing potential breakthroughs, Dr. Gamota included the following projects: neutrino communication; spin-aligned hydrogen; X-ray laser; ultra submicron electronics; propagation of charged/neutral particle beams; high-temperature superconductivity; artificial intelligence; universal blood donor; auroral ionospheric physics; research opened up by the space shuttle; and antiviral medicines.

The DOD High-Energy Laser program and overall goals were discussed by COL Robert Poppe, ODUSDRE (R&AT). Dr. Lloyd L. Lehn, assistant for Manufacturing Technology, followed by discussing representative efforts, financial data, mission need and recent guidance on manufacturing technology.

The third session dealt with overviews of past contributions, current status and future structure and objectives of the laboratories. Dr. Marvin E. Lasser, director of Army Research, Office of the Deputy Chief of Staff for Research, Development,

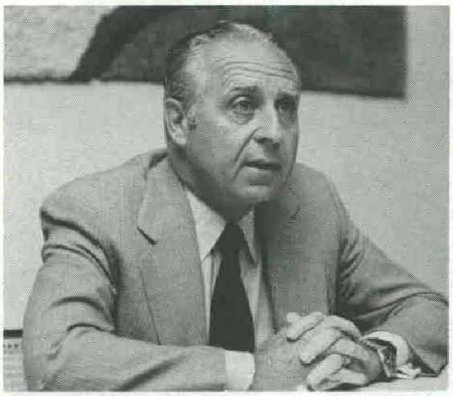
*(Continued on page 12)*

# 'Up Front is Where Dollars are Most Important . . .'

**Interview With LTG George Sammet, USA, Ret.**

*LTG Sammet, who retired in 1977 as Deputy Commanding General for Materiel Development, HQ DARCOM, had extensive experience in the Army's materiel acquisition business. He joined the R[D community as lieutenant colonel in the old OCRD staff agency, in charge of cannon artillery programs in 1959. He served in virtually every capacity, from an action officer, division chief, executive officer, director, and deputy, under every Chief of R[D from that time until he joined DARCOM in 1973.*

*Known for his forthright manner and his vast institutional memory bank of management know-how in the acquisition business, GEN Sammet is now a Director of Materiel in industry.*



**Q. General Sammet, during your distinguished Army career you came to be regarded as one of the Army's foremost experts on managing research and development. What were the areas where you saw the greatest change between the time you first entered the R&D field and the time you retired from active duty?**

**A.** I think there are two changes in the last 20 years that really make a difference today. The first is the coming of age of the Army's acquisition people. When I first became involved back in the days of General Trudeau, there were very few "Green Suiters" especially combat arms types, who truly understood how to acquire materiel. Thus, I think the most important change was the development of the Army Project Management System. The Army was not the first service to have project managers. The Navy and the Air Force both started out way ahead of the Army but in my opinion today the Army's project management system is at least equal and probably excels the other services.

The other big difference between today and 20 years ago is the involvement of Congress. Twenty years ago we used to go over and "visit with" Congress. They would ask general questions and they got general answers. Later on that evening we'd get the transcript and if our boss had made a mistake we could adjust the transcript and that was it.

Today the congressional committees have staffs far larger than they had 20 years ago, and they are far better informed. In fact, in many cases staff members know at least as much about the problems as do the Army's witnesses.

**Q. Over the 25-odd years of your R&D experience you certainly saw a number of highly successful development programs. Do you recall any one as being of particular note?**

**A.** If you'll allow me, I'd rather pick out three of them. I say three because they were successful for different reasons.

I think one of the most successful was the Pershing program. Pershing was a success maybe by accident; the accident being that there weren't enough people who knew what was going on to bother those who were doing the program. Secondly, Pershing, being one of the first missile programs, was adequately funded from the start. It amazes me how in the 1960's, when there was no base of technology, no precedent for that kind of a system, industry could develop a Pershing system and field it in less than four years. Today the Army is developing Pershing II, and it is taking twice as long. I attribute that to inadequate funding and a necessity to prove everything to the $n^{th}$ degree before flying. Both of those faults can be found in many programs today. There was a time when we understood "Advanced Development" to mean proving of components. Today "Advanced Development" is a first generation "Engineering Development." ED then becomes a 2d generation ED. Pershing is also a good example of the proper use of product improvement obviating the unnecessary expenditure of large sums of money for a new development program.

The next program which I think was a very successful one was UTTAS, or as it is now called—Black Hawk. I'm fully aware that just recently there was an accident with a Black Hawk utility helicopter, but that doesn't detract from the success of the program. I think two things contributed to the UTTAS success. The first was the very deliberate development of an engine prior to the time the Army started the system development. Secondly, the project manager was given a reasonable dollar reserve which enabled him to make timely management decisions. If you don't have that reserve there is no way but to miss some management decisions. It takes time to get money. It may even mean going to the next year's appropriation, and that may take as long as a year.

The third successful program is really a group of programs, one which I personally advocate very strongly, and that is the "Skunk Works" variety. The Army has two that are coming to fruition right now. One is the chain gun where the Army competitively selected a contractor to deliver a gun for a shoot-off competition in 24 months. The other project is the improved TOW vehicle, for which DARCOM was given the mission of developing competitively and then producing this item all in less than 24

months. The only way the job could have been done was by a "Skunk Works" program wherein DARCOM provided very clear guidelines to three contractors and then let them do their thing.

Both the chain gun and the improved TOW vehicle were delivered within the time frame specified and are now under test.

The new Air Defense Gun Program is also a skunk-like program, but this one will be more difficult to keep in that context because of its greater cost and complexity. What you're seeing, however, is the Army using the "Skunk Works" approach for programs ever increasing in size and cost. The approach is doing fine.

**Q. Does industry like the "Skunk Works" approach?**

**A.** One knowledgeable manufacturing official told me he could reduce his budget by 60 percent if he were allowed to just go and do the job with-

out all of the government procedures. Skunk works programs allow him to do just that.

**Q. What other reasons were there that lead you to believe were the reasons behind the success of these programs?**

**A.** I'll add one more. As in any activity, success is often equal to the amount of non-interference by people who contribute nothing to the product. Too many people want to be policemen, but have absolutely no responsibility or accountability for the item itself. Along with that is the fact that there are still some people in the acquisition business who like having their hand held. They like operating on a committee basis. If it goes wrong, blame the committee. In a "Skunk Works" program, nobody is allowed to even visit the contractor unless invited by the contractor himself. That scares some people who worry about supervision. First of all you pick a proven contractor, secondly you give him a fixed price contract, and thirdly his carrot is a follow-on production contract if he is successful. You would be amazed at how much more successful that approach is over detailed supervision.

**Q. The R&D story obviously had its unfortunate episodes as well. Do you recall any of these that were worthy of note—from the lessons-to-be-learned point of view? Perhaps the Mauler program is an example.**

**A.** You thought I'd say Mauler? Its only fault was it was too far ahead of its time. The Army was not ready for it, either in its sophistication or its cost. Mauler was cancelled because it appeared to be too expensive and would prove difficult to maintain in the field. What was expensive then? Mauler was to have cost $100,000 per firing unit. When it was killed it appeared the cost would be more like $1.1M. Compare that cost today with Patriot or even Roland. For what we were asking Mauler to do, that was not exorbitant—but the Army wasn't ready for it. The Army wasn't ready for that level of cost or that level of complexity at the time. With 20-20 hindsight, I believe killing Mauler set back Army air defense 20 years.

Now to answer your real question. I have to say that generically, those programs which are joint programs are the most difficult to run. Mallard and the present TRITAC series of equipment are good examples. I'm a firm believer that if you want a joint program, do not give it to one service to be the executive agent to perform the program. Instead, establish a project manager in OSD to run it. Here's why. The initial funding for the program is accommodated by OSD and given to a service. But in future years, when an overrun occurs, the dollars came out of the hide of the service which is the executive agent, and this creates an environment which is difficult to accommodate. Some would say well, you managed the program, therefore, the overrun is your problem. However, this is not always valid as many of the overruns are because of new requirements. Then, too, these are cost plus R&D programs which by their very nature will generate some overruns. If they aren't expected to be difficult they should have been fixed price in the first place.

**Q. Are there any common threads that exist in all of the other than successful development programs?**

**A.** I'd say the lack of a firm requirement—lack of total acceptance of a requirement—and lack of total dedication or support by the branch concerned. Advocates of certain proposals seem to have difficulty accepting a "final" decision if it is not in line with their thinking. I suppose this is human nature, but development programs would have more success if a proposal, once everyone has had his say and a final decision made, was backed 100 percent by all concerned.

**Q. During your long service in the R&D community you saw a number of reorganizations. Did any of these, in your opinion, assist in solving R&D management problems?**

**A.** I think every reorganization solves problems. Reorganizations elevate what the commander or somebody sees is a problem. And that's what reorganizations are designed to do—solve the problem. What did AMARC see as the problem? They saw the acquisition of materiel subordinated to the maintenance of materiel in the field. Now they did not mean to denigrate the importance of readiness. The reorganization elevated acquisition to a level equal with maintenance and readiness. That's what AMARC recommended and that's what the recent DARCOM reorganization did. As we all know, any organization will work if the people want it to work.

**Q. Have you been able to notice any trends in the types of people, both military and civilian, that are choosing to enter the R&D field?**

**A.** Today there is more "Green Suit" involvement than there was years ago. I recall when the first project manager board met in 1974, we had fewer than 100 candidates to select from, and frankly most of those 100 were not qualified. By last summer, just before I retired, the number of candidates for the board which met in July 1977 had grown to 250, all fully qualified. I have since been advised that the PM board which met on 1 May 1978 had 612 fully qualified candidates to select from.

This tells me that the Army recognizes the importance of the acquisition business, and that involvement in the acquisition business is no longer a dead-end job.

Even with the three wars we have had since 1941, an Army officer today is in combat maybe only 10-15 percent of his career, three years or so out of thirty. But project managers are in combat every day. There is no peacetime for a project manager. He never gets the chance to go out in the woods on a practice maneuver. His battles are for real, every day of the year.

**Q. Now that you have had some time with private industry, what are the major differences you see in the ways that industry runs its R&D programs and the way government handles theirs?**

**A.** Well, the first thing is that in industry if they need specific types of people they can go out and hire them right away. It still takes time, but industry can do it quicker.

The second difference is that industry recognizes that up front is where dollars are the most important. You can't start slow and catch up later, or start, then slow down, and then restart. Industry has learned that there is only one way to shorten a program schedule—put bucks up front—accept and understand the risks you are taking. One of the reasons that GSRS and ARTADS are taking so long to develop is that neither of these programs was funded properly at the start. Too often the government would like to see a riskless program, but that animal doesn't exist.

But don't let me mislead you. Industry, too, has difficulty in starting up an internal program because it takes time to get the funding squared away and find sufficient engineers. But

*(Continued on page 4)*

# Interview With LTG George Sammet, USA, Ret.

*(Continued from page 3)*

here industry does have some advantage. When additional dollars are needed, it's usually within the corporate capability to add them immediately without waiting until the next budget cycle. There are normally "new business" dollars available for this purpose.

A problem faced by both industry and the Army is that industry project managers are just as optimistic as Army project managers. They, too, are reluctant to tell the bad news. But it is like a cockroach nest—you had better get at problems early, for problems beget other problems.

**Q. Over the years of your senior level involvement in R&D, what changes did you see occur in the ways that the Services dealt with Congress?**

**A.** There are two major changes that have occurred during the period of LTG Trudeau (1957-1961) to LTG Keith (1977- ). I had the privilege of serving under six Chiefs of R&D—Trudeau, Beach, Dick, Betts, Gribble, and Deane. Year by year the changes appeared slight, but when you compare 1959 to 1977, the change is precipitous.

In 1959 we dealt in broad statements and generalities—laced with high hopes—like our 1959 thoughts on air cushion vehicles. There was little fact but great faith! And there still aren't many ground effects vehicles.

Then, too, as I said earlier, by 1977 Congressional staffs had grown tremendously, in size and in expertise. Maybe one doesn't always agree with the views of a particular staffer, but one has to admit that he is usually highly knowledgeable and his questions usually cogent.

The second change has been the role of the Assistant Secretary of the Army (R&D), now the ASA (RD&A). It used to be that he never became involved in the hearings. Not so today. This change has been a good one. I worked with every ASA (R&D) the Army had, and each had his strong points. We "Green Suit" guys had never built a thing. The Secretaries were visible evidence to the Congress of proven real-world experience. Participation by the ASA adds credibility to the Green-Suiter requests. Today the Assistant Secretary is a key figure at Hearings and I personally believe he brings a lot to the party.

**Q. As you are aware, there is now a major effort to increase standardization and interoperability between U.S. and NATO forces. From your position or advantage of seeing both industry's and the government's views, what do you feel about this effort?**

**A.** Interoperability is an absolute necessity. It is a good objective and not too hard to reach. I had the opportunity way back in 1961 to work with the British in standardizing our 155mm cannon chambers so that we could shoot each other's ammunition. That standardization spread to the other NATO nations. So it can be done.

It's absolutely mandatory that the U.S. produced Rolands be able to fire European missiles and vice versa.

As for total standardization, I don't believe it is necessary, nor do I believe we can afford it or even will achieve it. It would be too expensive. We ought to first restrict ourselves to the so-called expendables—fuel, ammunition, and food—and communications. Standardize on the interoperability of those and the battle is really won.

More important is industry's attitude toward production in another country. How do you divide the profit pie? Some corporations may take a dim view of giving away technology and business. However, they must realize that industries outside the U.S. are rapidly increasing their capabilities because their governments are collaborating to fund them.

The subject is beset with not only military difficulties, but economic and political issues—not the least of which is potential third country sales.

**Q. When you were a senior military R&D manager, how did you evaluate programs; how did you determine what programs were doing well and those you felt were bad programs, for whatever reasons?**

**A.** First off, I never permitted a rubber baseline. Measure a program constantly against what was originally proposed. If the baseline is allowed to change, due to such things as added requirements or alternative approaches, overruns are rationalized and you have destroyed any measurement system you ever had. Even potentially good changes are hazardous until the baseline system has been fielded.

Another signal is that bad programs always have the same symptoms—overruns, schedule slips, and technical problems. Very seldom does one of these occur singly. One is always a precursor of the others.

One can get a quick handle by looking at a trend. Then find out what is causing the variation. There are people who know those answers, but they often do not understand the importance of carrying the news to the top. Frequently, if top management knows about a problem area early, it can be corrected—at a minimum cost.

At my former level in the Army there was no way that I could, or for that matter should, be intimately familiar with every one of the several hundred ongoing programs. That is the project manager/project officer's job. In the Army I was forced to manage by trend indicators. One can chart a spending plan very easily. Any significant variation from that spending plan is cause for eyebrow raising and an ensuing investigation. One can do the same thing in the functional areas: if one has a continual increase in inventory, increase in number of line stoppers, sudden increase in materiel costs, it's time to re-evaluate. These things have to tell you something, or at least should make one curious enough to ask questions. The surprising thing is that no matter what questions one asks, they always elicit answers to questions which weren't asked but should have been. Very often this unsolicited information becomes more significant than that which was solicited.

**Q. What determination or measurement process does industry use to evaluate its independent R&D programs?**

**A.** There is no simple answer to that. One obvious measurement is return on investment. Profit is often, but not always, the bottom line. Industry usually conducts quarterly reviews of every program. Each will be evaluated in terms of its goal versus reality to include where does it stand on the profit line.

Another measurement used by industry is overhead. Staff is overhead. Overhead is the worst word in industry's management vocabulary. There is no intermediate layering as with government—it can't be tolerated. Even vice presidents frequently have no personal staff. If they need a study done, they have to pull people off other jobs or do the work themselves.

But I want to make it clear that companies are just as interested in delivering good equipment to the Army as the Army is in receiving it—or they won't be in the defense industry structure very long. There are even times when an industrial firm will not bid on a job if its management believes it is wrong for the Army.

Another measurement is, "is there competition?" Industry would be the first to tell you that without it you will never get the lowest price or the best product. Without it, innovation would cease.

# RDA Magazine Survey Reflects Readers' Preferences

The editorial staff of the *Army RDA Magazine* would like to express a most appreciative "thank you" to the many readers who responded to our survey-questionnaire which appeared in the March-April 1978 issue. Your views relative to what you would like to see on the pages of this publication are of great assistance in carrying out our mission.

We received a total of 787 responses, with the largest portion (49 percent) being from the Army research, development, and acquisition community, followed by "other Army" activities (46 percent), industry, other Department of Defense, and other government agencies.

The largest percentage of our respondents represented an almost equally divided active duty and civilian audience, followed by the Reservist category. Space limitations prevent us from indicating all units and offices which responded to the survey. However, we did receive a very "healthy" cross-section sampling from numerous government-nongovernment activities.

We are happy to report that more than 60 percent of our respondents received "every" issue of the RDA Magazine. The next largest group of those responding to the questionnaire indicated that they obtain "most" of the issues. Approximately one- seventh of the respondents noted that this was the first issue they had seen. A small percent also reported seeing about one half of the issues.

Relative to question five (How did you receive this copy?), our tabulations show that about two-thirds of our audience receives the magazine by normal distribution channels. The next highest portion of our readers obtain the publication by direct mail, and the remainder receive it by subscriptions, library channels, or borrow it from others.

Final computations regarding the "usefulness" of the information in the RDA Magazine reveal the category of "very" was gratifyingly the leader.

More than 90 percent of our survey respondents indicated that the type sizes used in the magazine are a good mix. We believe that this response is due largely to recent efforts by our editorial staff to make the publication "more readable." A similar percentage of readers also rated the style/format of the magazine as "very good" to "excellent."

Staff features and bylines account for 75 percent of the responses to question nine (Which sections keep you most informed?).

Among the six Departments which were listed in question 10 of the survey, the R&D News section was clearly the top choice of our readers. The other most read Departments, listed in descending order of preference, are: Conferences & Symposia, Personnel Actions, People in Perspective, Reader's Guide, and Awards.

Once again, as has been the case with past survey-questionnaires, we received a multitude of suggestions and recommended changes for the RDA Magazine. Unfortunately, it is impossible to accommodate all of these suggestions. However, we will certainly make every effort to consider as many as realistically possible. There was one overwhelming request or suggestion and that was for the inclusion of more coverage of foreign (Soviet- Warsaw Pact, NATO, and other nations) developments. The magazine has already begun to implement this recommendation. Some of the other most repeatedly asked for suggestions were as follows:

- More photos and less text.
- Less personnel and award-oriented articles.
- Show more hardware.
- Expand emphasis on acquisition.
- Future R&D trends.
- More on new policies and regulations.
- Reduce acronyms.
- More on testing and equipment.

# ACC Completes New High-Speed Digital Facsimile Project

Completion of a new communications project which permits transmission of high speed, digital, secure facsimile over the Automatic Digital Network (AUTODIN) has been announced by the U.S. Army Communications Command (ACC), Fort Huachuca, AZ.

Believed to be the first of its kind within the Department of Defense, the new facsimile system has been added as common-user terminals in telecommunications centers at HQ ACC, the Pentagon, HQ 5th and 7th Signal Commands, and HQ Communications Systems Agency.

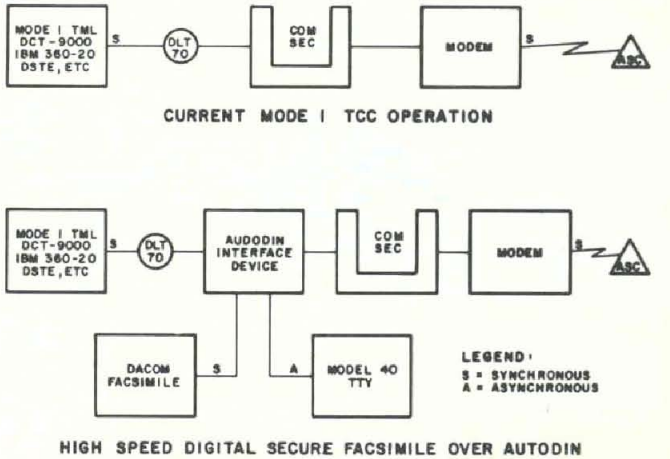
Plans call for installation of more than 100 of the terminals throughout the Army during the next few years, according to project officer Mr. M. O. "Flash" Brown, Office of the Deputy Chief of Staff for Operations and Plans, HQ ACC.

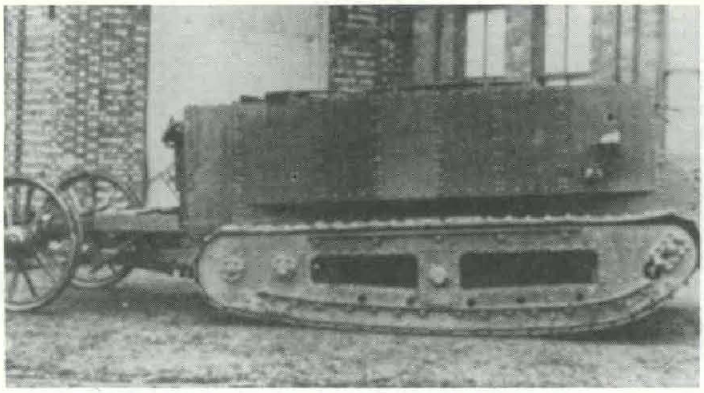
Brown noted that conventional non- secure slow speed analog facsimiles utilize dedicated Automatic Voice Network and other dial-up voice circuits. The new system, in contrast, gains access to AUTODIN by means of an interface device, thus relieving the congestion on the AUTOVON.

A programable microprocessor also permits the new system to operate at speeds of up to 4,800 bits per second. This high volume capacity allows the system to process an 8½ by 11-inch page of data in less than two minutes.

By using a sequential delivery message operation, the digital system also permits processing of traffic on an intermittent basis. This results in improved efficiency and reduced costs because additional circuits for facsimile are not required.

**CONFIGURATION of equipment ACC is using to transmit high-speed, digital, secure facsimile over AUTODIN includes DACOM Model 650 Facsimile Controller (top left); DACOM Model 412–G Digital Facsimile (bottom left); teletype keyboard and optical screen (center); and Model 40 teletypewriter (right).**





LITTLE WILLIE, first named "Tritton" after William Tritton

BIG WILLIE, known also as "Mother," "Centipede," or Wilson Machine.

First Used as Rescue Vehicle . . .

# Tank Development Traced to Royal Naval Air Service Early Efforts

If a course of events that were occurring in 1914-1915 had continued in the same direction, it might well be that the new XM1 tanks would officially carry nautical designations such as U.S.S. John James, and the current British Chieftan tanks might be named H.M.S. Hyde Park or the like, in traditional Royal Navy fashion. This would be due to the fact that if one single government agency had to be credited with maturing the centuries-old dream of fielding an armored land fighting vehicle, it would have to be the Royal Navy, and in a large part, the Royal Naval Air Service!

While Leonardo da Vinci had drawn a plan for a tank-like vehicle in the 15th Century, and the Taborites in the 13th Century had even built a few horse-drawn wagon boxes that could be fought from within, the real impetus for fielding a modern day armored vehicle began with the pilots of a Royal Naval Air Service (RNAS) squadron in Belgium in 1914-1915.

At that time the squadron had wangled a small stable of Rolls Royce cars—their purpose being to rescue downed pilots. Since the war was still fluid, the RNAS cars could roam about. But the enemy reacted quickly, and not infrequently, when the cars were spotted by German troops, they drew fire.

Naturally enough, the RNAS people countered and escalated things; they began adding machineguns to the cars. Then, one day the squadron commander decided to take things a bit farther and experimented with a car whose sides and wheels were covered by boiler plate. It was an instant success. By October 1914, the squadron had 15 such cars.

Simultaneously, the value of the armored car had even been appreciated by a few senior Army officials, and a handful of such cars had been attached to the 3d British Cavalry Division during the Ypres fighting in October 1914.

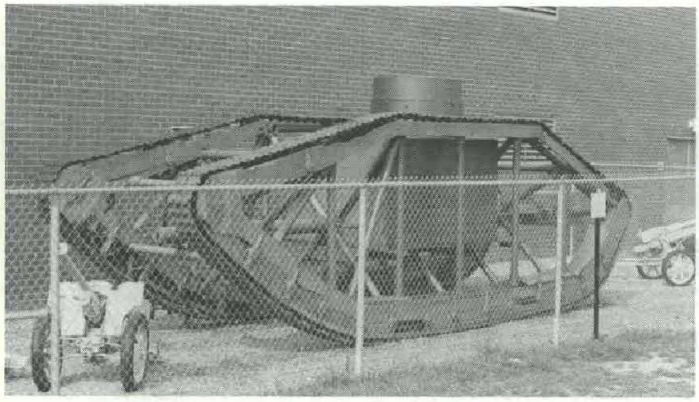
However, experience by everyone using the cars quickly brought to light their vulnerability to overhead and plunging fire. Also, the Germans had taken to thwarting them by digging ditches across roads. The car drivers responded by lashing boards to their vehicles with which to bridge the ditches. However, with the arrival of trench warfare, the armored cars, their open spaces gone, were found useless and shipped back to England.

But there were a few people who were already thinking of ways to break the trench deadlock. Some, recalling the mobility of the tracked farm tractor, began considering adding tracks to the armored cars. One such person was British Army LTC E.D. Swinton. Actually serving as an Army PIO in France and Belgium in 1914-15, Swinton had seen the early successes of the armored cars. He also recalled reading before the war about an Army test of some tracked vehicles. The idea seemed promising, so he proposed such a concept to a LTC Maurice Hankey, Secretary to the Committee of Imperial Defense.

Hankey tried to drum up enthusiasm in the War Office, but the head man of that lodge, Lord Kitchner, saw such vehicles only as vulnerable targets to cannon fire. There was little enthusiasm then, to counter the boss by his subordinates. But there was one imaginative minded member of the Committee who saw a possible pay-off. His name was Winston Churchill, First Sea Lord. Churchill prodded the Prime Minister, and the idea began the all-too-often process of wending its way from office-to-office, not eliciting much other than a perfunctory comment, despite the prominent political names associated with the idea.

But finally, the Master General of Ordinance agreed to a trial of a U.S. manufactured Holt Caterpillar Tractor over an obstacle course at Shoeburyness. The test, run in February 1915, took place in the rain. To simulate a military load, the tractor was to tow a load of 5,000 pounds of sandbags.

The initial events were a big success, and the many high-ranking officials were impressed as the tractor crawled across the sodden earth, crushing barbed wire in its way. But then it reached the simulated trench. With a snort from its exhausts and a great lurch forward, the tractor tried to cross. The trench walls crumbled, the tracks clawed frantically at the slippery earth, but the result in minutes was a hopelessly bogged-down tractor. To the War Office seniors that was enough



Pioneer Tractor Co. Prototype (1918)


Ford Motor Co. Tank (1918)

Heavy Tank, MK VIII (1919)

French Renault FT Light Tank

and the end.

But the Royal Navy, led by Sea Lord Churchill, once more up-graded the idea. Three days after the Shoeburyness disaster, Churchill created the Admiralty Landships Committee under the chairmanship of the Director of Naval Construction. The assigned mission was to develop the idea of a tracked vehicle for land combat.

But concurrently, the old RNAS people were still tinkering with the concept. The British naval officer who had originally been responsible for giving the armored cars to the squadron, Commodore Murray Sueter, was now experimenting with tracks and dreaming big. Sueter was thinking of a vehicle whose incredible dimensions were: weight—300 tons; length—100 feet; width—80 feet; height—46 feet; movement—by 3 wheels, each 40 feet in diameter; armament—two 12-inch Naval guns.

Naturally, a vehicle of such monsterous size was quickly determined to be unworkable, and Sueter fell back to more realistic concepts.

But even the Royal Navy began to tire of the game, saying that nobody had asked for such vehicles and no one really wanted them—which was true. Nonetheless, Sueter kept tinkering, albeit without much high-level support.

It seemed as if the idea would die in its infant state. Then came the great Allied 1915 spring offensive. Machinegun and wire festooned trenches doomed it to a dismal failure. New minds searched for ways to break the trench deadlock.

At this point LTC Swinton tried again, sending forward a memo on the "Need for Machinegun Destroyers," calling attention to the success of a few caterpillar tractors used to haul heavy artillery. This time the memo was received by a more receptive audience. As Swinton's paper was again twisting its way through the "in" and "out" baskets of officials at the War Office, a high-level decision turned the Navy's Landships Committee into a joint one. Churchill gave it adequate funds and an official office on Pall Mall.

Quickly, a demonstration was arranged of a Killen-Strait tractor, and in contrast to the first Shoeburyness trial, it was a success. Things now moved quickly and positively. A contract was awarded to the firm of William Foster and Co. to build a prototype armored machine on tracks, able to cross trenches and climb parapets. This was in July 1915. Construction of the first prototype began on 11 August, really a mock-up using off-the-shelf components.

Powered by a 105 hp Daimler engine that gave the vehicle an awesome speed of some two miles per hour, the beast looked like what it really was—a big armored box of boiler plate set upon a set of American Bullock tractor tracks. Steering was achieved by throwing a track out of gear. At first named the "Tritton" after the managing director of the Foster firm and one of its designers, William Tritton, the creature became known affectionately as "Little Willie." "Little Willie" began trials in September 1915, and while it showed short-comings such as being top-heavy and insufficient length to its tracks, there was enough evidence to show great potential.

Working with Tritton at the time was naval Lieutenant W.G. Wilson (later transferred to the Army as a major). Wilson was simultaneously designing his own version, and it differed from Tritton's "Little Willie" in that Wilson's track concept carried the tracks totally about the exterior of the vehicle, rather than having the vehicle rest on the tracks. In actual practice the portion of the track in contact with the ground represented the equivalent contact arc of a 40-foot-diameter wheel.

Wilson's design was also committed to prototype, and once it hit the test track it was evident that it was a far better approach. Like its stablemate, its first name of "Centipede" did not last, becoming known instead as "Big Willie" or "Mother."

"Big Willie" was just that—a big vehicle, and truly a revoluntionary one. Rhomboid or lozenge-like in body shape, with the front sloping upward from the ground and the rear sloping downward, its overall characteristics compared with the new U.S. XM1 were:

| | Big Willie | XM1 |
|---|---|---|
| Length | 33′ 3″ | 26′ 0″ (chassis) |
| Height | 8′ 0″ | 7′ 10″ |
| Width | 8′ 3″ | 12′ |
| Weight | 28+ tons | 58 tons w/105mm gun |
| Power | 105 hp Daimler | 1500 hp turbine |
| Crew | 8 | 4 |

*(Continued on page 8)*

Medium Tank, Mod A (1922)

Medium Tank, T2 (1929)


**Christie Medium Tank, T3 (1931)**

**Light Tank, M2 (1938)**

*(Continued from page 7)*

| | | |
|---|---|---|
| Speed | 3.7 mph | 45 mph |
| Armament | Two 6-pdr. cannon<br>Two .303 Vickers MG | 105/120mm cannon<br>27.62 mg<br>1.50 col MG |
| Armor | 6-10mm boiler plate capable of stopping a .30 cal. at 10 yards | Chobham-type special armor |

The two cannons were carried in naval-type armored blisters or sponsons, one on each side. There were two small fixed turrets, one up front which housed the commander and the driver with a machinegun between them, and the rear one which housed a machinegun and the semaphore arms that comprised the tank's communication system with the outside world. There was a trap door on top, and doors on the sides and rear. The interior was cramped, hot, and when underway full of fumes. The dark interior was illuminated feebly by a single naked light bulb fed from the engine's batteries.

A peculiar feature common to both Little and Big Willie was an odd looking set of large wheels that appeared to be dragged along in the rear of the tanks. Kept in contact with the ground by heavy springs, they served as added steering devices as well as an aid to trench crossing.

"Big Willie" started its trials in January 1916, under a shield of secrecy that included the use of the word "tank" to mislead German spies. A test track had been laid out on a former golf course, that included 4.5-foot parapets, 5-foot-wide trenches, simulated shell craters, marshy areas, wire, collapsed dugouts, and other impediments expected to be found on a battlefield. The initial test run was a huge success, but when one of the designers spoke out that 3,000 tanks should be ordered at once, a senior Army observer snorted a reply to the effect that no one in the Army had yet showed a desire for these beasts!

Further trials and demonstrations followed, with many of Britain's highest officials watching. Lord Kitchner, the Army's boss, remained skeptical. Even after King George V spoke out favorably, Kitchner remained utterly unconvinced of their usefulness. Such was the skepticism that rather than a 3,000 tank order, the designers condescendingly were told they could build 40 more. Only by the persistent badgering of LTC Swinton was the order raised to 100.

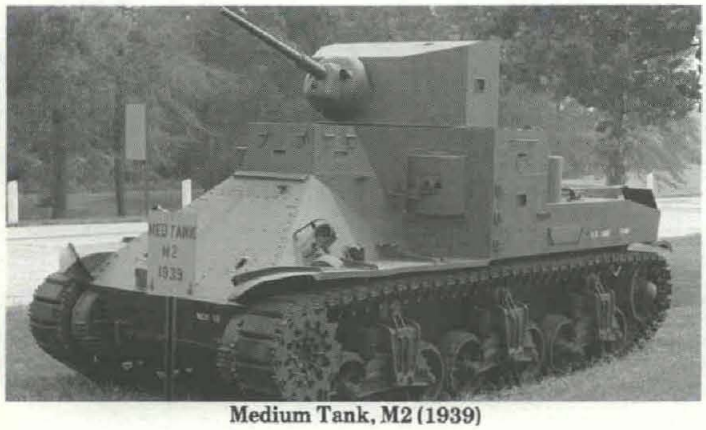
What followed Big Willie then, was the beginning of the production of the modern tank. The lozenge shape configuration would persist throughout the war in British design, though there would be a number of modifications or Mark models. These modifications over 1916-1918 included upgrading the engine to 225 hp, improving the transmission and gear system, providing armor steel rather than boiler plate, placing the gas tanks outside the hull, improving the track, installing a silencer, improving the cooling and ventilation systems, easing the escape hatch mechanisms, and providing a sliding arrangement for the weapon sponsons so they could be retracted into the vehicle for ease in rail shipment.

British practice with these heavy tanks was to build them in two versions—a male version which was armed with the two 6-powder cannon, and a female version that was strictly machinegun armed. The doctrine called for the male tanks to take on fortified positions, artillery, and other hard targets while the accompanying female provide cover against enemy infantry.

The initial commitment of a handful of Mark Is by the British to bolster their flagging Somme offensive in September 1916 indicated their potential. The larger scale commitment at Cambrai in November 1917 proved, to the most visionary, the potential of the tank.

During the course of the war both the Germans and the French followed the British lead by designing and developing tanks of their own, the Germans being the least successful.

Quite naturally American interest in tank design followed the release of stories of British tank development. In 1916 a few U.S. companies began designing prototypes out of their own resources and funds. The C.L. Best Tractor Co. placed a simulated armored shell atop one of their standard agricultural tractors and tried to interest the U.S. Army. Another company, Holt Tractor, designed several models ranging from a 1-man miniaturized version of the British heavy tanks, to an armor shell atop track design, to a vehicle powered by a combination of a 90 hp gasoline engine driving GE electric motors that in turn provided power to the



**Medium Tank, M2 (1939)**

**Medium Tank, M3 (1941)**

tracks, to a 3-wheeled steam-driven version. The Pioneer Tractor Co. of Winona, MN, came up in 1918 with a model that looked like a skeleton version of the British heavy tank, a small armored box for a 2-man crew and two small engines hanging between the tracks.

Official U.S. Army involvement in tank development had to wait until the nation was actually in the war. A number of Army in-house and contractor designs followed. The Engineers designed and built in 1918 a beast that resembled the British Mark IV, except that it was a steam powered vehicle whose boilers were also to provide pressure for a flame thrower. It never passed the prototype stage.

A second attempt to provide the Army with a tank came from an Ordnance Department 1918 design to be built by the Ford Motor Co., using standard Ford automotive parts to the maximum extent possible. It was to be a 2-man tank, armed with a .30 caliber machinegun, and powered by two Ford Model T engines in the rear, each having its own electric starter. There was a single transmission system with a gear box for each track. Resembling somewhat the French Renault light tank with which many of the AEF tank units were eventually equipped, the Ford was intended originally as a machinegun or ammunition carrier.

It was October 1918 before the first prototype was shipped to France for operational testing. The decision of the American Tank Corps was to recommend some changes but to give general approval. As a result, Ford was directed to produce over 15,000. However, only 15 were actually built before the Armistice occurred and the contract was cancelled. While some of the 15 vehicles were eventually shipped to France in December 1918 for trials as cannon prime movers, the Ford tank never saw combat. One Ford tank rests outside the Patton Museum, Fort Knox, KY, and a second is at the Ordnance Museum, Aberdeen, MD. The latter was recently put in running condition and demonstrated concurrently with an XM1 demonstration.

There was a plan to equip both the British and American tank forces with a new vastly improved model of the British Mark V heavy tank. By agreement between the two countries, 1,500 of these new Mark VIIIs were to be built at a new Allied tank factory in France. Again, the coming of the Armistice brought about cancellation of the project before any but the prototype had been fielded.

Since there was no American tank in service when the nation entered the war nor was there a production base capable of producing tanks in time for the planned initial U.S. Army combat operations, the only recourse was to use off-shore procurement. As a result the new American Tank Corps would fight its battles with British Mark V heavy tanks—an improved version of the original Big Willie, and the remarkable French Renault FT light tank.

The Renault, designed originally by Louis Renault, was built by four different French companies. It was a 6½-ton craft powered by a 40 cylinder 35 hp Renault gasoline engine. The tracks were outside the hull, and the front idlers were of steel-rimmed laminated wood. Suspension was by leaf springs combined with vertical coil to tension the upper track run. The Renault FT was the first tank to have a 360 degree turret, which in this tank carried an 8mm Hotchkiss machinegun. Some of the early models came out with molded steel turrets, but manufacturing difficulties forced a change to an 8-sided riveted turret. The little Renault would, like the British heavies, go through a number of modifications, and would remain in U.S. and French inventories almost until World War II.

**Sherman Medium Tank, M4 (1942)**

So successful was the Renault, that the newly formed American Tank Corps recommended its adoption and production within the United States. In a forerunner example of today's RSI (rationalization, standardization and interoperability) concept, manufacturer's drawings were given to the United States. Due to their metric design a virtual total redesign and redrawing to fit inch specifications was done. Modifications included steel idlers rather than reinforced wooden ones, incorporation of a bulkhead separating the engine and crew compartment, and substituting an American Buda engine for the Renault.

Called Six-Ton Special Tractors as a cover name, the initial order called for 1,200. Later the number was raised to 4,400, and three companies were given production contracts: Van Dorn Iron Works, Maxwell Motor Co., and the C.L. Best Tractor Co. By the Armistice only 64 had been built, of which 10 reportedly reached France. Some 950 were built before production ceased, and these remained the standard U.S. light tank until 1931. In 1940 over 300 were taken from storage and given to Canada under the Lend-Lease Act.

By 1919 the U.S. had cancelled all of its tank production agreements. All that remained were components of the proposed Mark VIII. These were shipped to Rock Island Arsenal where they were assembled into 100 tanks powered by American Liberty engines. Called the U.S. Heavy Tank, MK8, they would remain in active service until 1932, when they went into storage. A number of these were turned over to Canada in WWII for training.

One independent effort remained in 1919, and it was a tank design that came from the brain of Mr. J. Walter Christie. Drawing from experience gained from the construction of a wheel and track cannon prime mover during 1917-1918, Christie's concept was a vehicle that would be a wheeled and tracked one, to serve as either a tank or a truck chassis. Its low hull was divided into driver, gunner, and engine compartments. Main armament was a 57mm gun in a 360 degree turret surmounted by a smaller 360 degree turret with a machinegun. Tracks were removable and storable on the hull sides when the vehicle was in road use. Driven by a 120 hp Christie water-cooled engine, the tank had a speed of 7 mph. Built by the Front Drive Motor Co., it was called the Christie M1919, but the tank was never procured by the Army.

It was about this time though, that a post-war evaluation board recommended that the Army develop one single medium type tank to replace both the Mark VIIIs and the 6-ton U.S. Tank M1917, then the standard U.S. tanks. The board recommended development of a design originally presented by the Chief of the Tank Corps in early 1919. The new tank was to carry as its main armament a cannon of not less than 2.28 inches nor over 3 inches, its armor would defeat .50 caliber armor piercing bullets at close range, it would be able to cross a 9-foot trench, and it was to weigh about 20 tons. It would have a crew of five.

The prototype new medium tank was designated the M1921 or Medium A tank, and Rock Island Arsenal was given the job of building it. One model was completed. It turned out to be a 23-ton tank, powered by a 6-cylinder 250 hp water-cooled Murray-Tregurtha engine. Armed with a 57mm gun and .30 caliber machinegun in one 360 degree turret, with a second smaller superimposed turret atop this one, also carrying a .30 caliber machinegun. But the Congress was in no mood at that date to provide procurement funds for new tanks.

In 1920, as part of the post-war demobilization and "return to normalcy," the Tank Corps was disbanded and re-

*(Continued on page 10)*

# Tank Development Traced to Early Efforts of Royal Navy

*(Continued from page 9)*

sponsibility for the tanks passed to the infantry. In addition, new restrictive criteria were imposed on future tank designs in order to meet U.S. rail and highway limitations. The War Department policy limited tanks to 15 tons. This in effect killed any hopes of eventually getting any M1921s or its improved version, the M1922. The latter resembled the M1921 somewhat in appearance, but incorporated skirted flexible tracks and cable suspension. Also, the rear of the new track frame was considerably higher than the front, the idea being to provide greater ease of climbing out of holes and trenches.

In 1925 yet another prototype was built at Rock Island Arsenal, the Medium Tank T1. Basically an upgrading of the M1921 and M1922, it met the approval of the Chief of Infantry. However, the 22-ton vehicle weight precluded final approval.

This 15-ton limitation resulted in the Ordnance Department attempt to have a contractor, J. Cunningham and Sons, develop a tank to meet the infantry's criteria yet stay within the 15-ton limit. The result was known as the Medium Tank T2, of which one prototype was built in 1930. Resembling somewhat the M2 series light tanks that would eventually evolve from the system in the late 30s, the T2 was a heavily armed tank for its day. The 360 degree turret carried a semi-automatic 47mm gun and a .50 caliber machine gun. In the hull there was a 37mm gun and a .30 caliber machinegun, though the 37mm would later be removed. While meeting the weight limitation, the T2 was able to maintain the armor protection of its predecessor T1, even though it carried a 12 cylinder V-12 Liberty engine and a 4-man crew. But again the national climate did not favor procurement of tanks.

It was in the late 1920s and early 1930s that one of the more famous individual tank designers made his big splash. This was J. Walter Christie who had designed the Christie M1919 tank. In 1928 Christie enlarged and improved upon his original 1919 concept of a dual capability tank. His new version continued the capability of running on tracks which were stowable on shelves along the hull sides when high-speed road wheel use was desired.

The vehicle built by Christie's own company, the U.S. Wheel and Track Layer Corp., employed a new type of suspension system that carried Christie's name, and consisted of four large weight-carrying wheels on each side. The wheels were hung on arms connected to adjustable springs housed vertically inside the hull. The engine, a 12-cylinder 338 hp Liberty, and final drive were in the rear. There was no turret, though there was a fighting compartment in the center with a machinegun pedestal. In the bow Christie planned to mount a cannon. Weighing a little over 8½ tons, with ½-inch armor, the tank was listed as being able to travel at a track speed of 42 mph, and on its road wheels at up to 70 mph. Thousands of Americans saw the tank on newsreels of that day as its designer made it glide over the countryside and race down macadam roads.

In 1930 an Army board observed the Christie tank under trial and recommended five modified versions be bought for further testing and evaluation. Concurrently, two models were sold to the Soviet Union, under a license arrangement, which proved to be the origin of subsequent Soviet BT and T-34 tanks.

A year later Christie brought out his third edition, eventually called the M1931 Medium Tank T3, which were the five models ordered by the Army earlier. These contained a 360 degree turret over the fighting compartment capable of housing a 37mm gun and a coaxial .30 caliber machinegun. The bow mounted cannon was discarded, in favor of a sloping sharp, wedged-shape front.

In 1932 four of these were turned over to the cavalry which was now becoming interested in taking on a partially armored appearance. Called the Combat Car T1 in its new role, the 37mm gun was replaced by a .50 caliber machinegun.

With armor ranging from ½ to ⅝ of an inch, and a crew of three, the T3 tank or Car T1 weighed 11 tons, with its road speed cut to 46 mph but track rate given as 27 mph. While Army interest seemed high, the isolationist mood of the nation was strong. Nonetheless, five additional T3s were ordered for infantry evaluation. Christie, however, failed to meet the contract and the order went instead to the fire-engine-famous American La France and Foamite Co.

The newest model, T3E2, featured a greatly enlarged turret, a sloped and widened nose, a crew of four, a 37mm gun and five machineguns, and a new Curtiss 12-cylinder 435 hp engine. Though still retaining the Christie type track and wheel arrangement, the speeds offered an odd reversal: wheels—15 mph, tracks—25 mph.

The tank would go through one more modification in 1936, to become the T3E3. A subsequent Rock Island Arsenal model called the Medium Tank M4, of which 16 were built in 1935-36, retained the Christie wheel and track concept, but the imagination-catching Christies never worked out the way their proponent had hoped.

The Christie approach was revolutionary. Its designer had deliberately sought a vehicle that was high in mobility, with protection coming second, and armament almost an after-thought poor third. His dual track-wheel system was derived from his belief that track life would, in the foreseeable future, always be very short. Therefore, the use of wheels whereever possible would be desirable.

Since tanks were officially the responsibility of the infantry, that arm saw them as heavily protected, heavily armed beasts whose mission was close support of the infantry. Speed and agility, with minimal protection and firepower, as represented by the Christie tanks, did not fit the infantry's idea of what was needed.

Additionally, there was concern over the Christie's ability to retain its tracks in place during severe turns, and even their durability. The suspension system was certainly a good way from maturity, but its evolution into the Soviet T-34 showed that the concept had considerable merit.

The forerunner of U.S. World War II medium tanks appeared in 1938, again from Rock Island Arsenal. The Christie suspension was gone, and in its place was the vertical volute spring bogey system that would remain through the last of the famous Sherman M4 series—the M4A4E8s. Known as the Medium Tank T5, it used many parts of the Light Tank M2—a vehicle that derived from the cavalry's desire for a tracked combat car—the euphemism being designed to skirt the law giving tanks to the infantry.

A series of upgradings led from the T5 to the M2 and M2A1, then the M3s and finally the M4 line, of which some 40,000 were built, and a redoubtable few can still be found running for movies and television shows.

Today's XM1 is a far leap technologically from Big Willie, the Mark Vs and the Renaults. But the tracks, the armor, the swiveling 360° turret of the Renault are all there. No doubt a World War I tanker, seeing XM1 for the first time, would know it for what it was.

## Rocky Mountain Arsenal Begins Water Containment Operation

In an effort to prevent contaminated water from leaving its installation, the U.S. Army's Rocky Mountain Arsenal, CO, has begun operation of a pilot containment/treatment system at its northern boundary.

The heart of the system is a carbon adsorption treatment plant which is being leased for $125,000 annually from Calgon Corp.'s Environmental Systems Division of Pittsburgh, PA. Other components include a 1,500-foot bentonite (clay) barrier, and dewatering, recharge and monitoring systems.

Contaminated water is pumped from six wells—located 250 feet upstream of the barrier—into two prefilters which are filled with four feet of graded coal and sand to remove any solid materials.

The water then passes through a column containing about 20,000 pounds of granular activated charcoal which removes about 99 percent of the contaminants. Following treatment and monitoring, the water is passed into 12 wells which recharge the aquifer.

Currently processing 80 gallons of water per minute or 115,200 gallons per day, the pilot treatment system is expected to operate for a year. Construction of a full-scale system is slated to begin in late 1979.

Rocky Mountain Arsenal's contamination control program is directed by the Army's Project Manager for Chemical Demilitarization and Installation Restoration, Aberdeen (MD) Proving Ground. Local management is being carried out by RMA's Contamination Control Directorate.

Other participants in the program include: the Army Corps of Engineers Waterways Experiment Station, Vicksburg, MS; the Army's Surgeon General and Medical Bioengineering R&D Laboratory; the U.S. Departments of Health, Education and Welfare; Interior; and the Environmental Protection Agency; also the Denver Regional Regional Council for Governments, the Colorado Department of Health and the Division of Planning, Department of Local Affairs.

# Army RDTE and the Planning, Programing and Budgeting System

**By COL Richard L. Nidever***

*Not long ago, the* **Army RDA Magazine** *gave the Army Staff the opportunity to pass on to the RDTE community the Fiscal Year 1979 Zero-Base Budgeting experience. ZBB is only one of many parts of a total RDTE planning, programing, and budgeting system (PPBS). This article addresses this system and is intended, like the ZBB article, to help understand what's happening, when, and why in the annual structuring and management of the RDTE appropriation. One should remember that nearly everything in RDTE is somehow touched by the PPB system. Furthermore, the PPBS, through the RDTE developing agencies, reaches down to the command, laboratory, and bench level and has a very personal impact on nearly all of us. Gaining a better understanding of how this system works will not relieve one of its demanding requirements, but may help in coping with its frustrations and making the system work better for the reader, his project, and his agency.*

It may not be easy to sort out the differences in meaning between planning, programing, and budgeting. These functions tend to blur in a generalized "PPBS" statement or reference covering a variety of events, things, and actions. However, each word does have its own meaning and plays its own critical role in the materiel acquisition process.

Background notes supporting the ongoing OSD Resource Management Study indicates that planning "includes the definition and examination of alterative defense strategies, the analysis of exogenous (external) conditions and trends, threat and technology assessment, and any other tasks associated with looking forward either to anticipate change or to understand the longer term implications of current choices." In other words, the direction the nation is headed in the long haul, what threat and surprises may be ahead, and our plans to cope with these events.

The study goes on to say that programing "includes definition and analysis of alternative forces and weapons/support systems together with their resource implications, the analytical evaluation of options therein, and often staff efforts necessary to construct and understand the FYDP (Five Year Defense Program)."

Budgeting "includes formulation, execution, and control." It may be easier to think of planning as way out front, programing as a little closer, and the budget as right here and now. A gray area exists where programers and budgeteers are both deeply involved in at least the early years of the FYDP. This overlap will be discussed later.

A short overview of the past 20-30 years in the evolution of the PPBS process will help in setting the stage for understanding the detailed and complicated system. There is, contrary to critics, a reason for the current PPBS, and clearly, the system was not developed overnight.

During the 1950's the functions of planning, programing, and budgeting were basically disjointed. The Services were allocated fiscal bogies and argued out their materiel needs in budgetary terms. Relative to today, little effort was made to tie national strategy (plan) to some coherent approach to support that strategy (program) to the means, or procurement of forces and materiel, to back up the plan (budget).

This led to interservice rivalries, duplication of materiel development, and annual, or incremental planning and budgeting which denied the benefits of planning and integrating the total acquisition process over at least several years.

During the 1960's, these deficiencies were recognized and, largely through the efforts of Secretary of Defense McNamara, the PPBS was born. At the same time, new acquisition concepts appeared, based to a large degree on systems analysis. Technology advanced tremendously and pushed the number and cost of systems. We tried unsuccessfully to make single systems do more than one job (FB-111).

We tried to control costs and believed that a total system procurement package was the answer (C-5A). It wasn't. Defects in PPBS obviously existed. It wasn't easy to satisfy all requirements of expanding weapons system sophistication and cost, conducting a less than popular war, and being faced with an ever increasing application of fiscal constraints.

During the early 1970's strong efforts were made to tie together a PPB system that would be responsive to the nation's needs more by choice and less by accident. The National Security Council and Joint Chiefs of Staff played stronger roles (threat, strategy, plans). The Services worked hard to develop Program Objective Memorandums (POM) responsive to needs, but constrained by Defense Planning and Programing Guidance (DPPG). The Services also worked hard to convert planning decisions and fiscal guidance into budgets best suited to their mission, forces, and materiel requirements.

We can summarize these earlier years along two logic tracks: (1) The Services exist—they spend money to buy forces and things—this permits them to accomplish something (mission)—which may support national objectives, or (2) national objectives exist—this directs the Services' mission—which creates requirements for specific forces and materiel—which leads to the purchase of forces and things. I suggest the first logic track existed in the 50's and 60's, and largely as a result of fiscal constraints, we are now attempting to align ourselves with the second track.

Conceptually, what series of events permit us to accommodate the plan, program, and budget process? Consistent with tying the PPBS with national objectives, we can consider the threat, strategy, and plan and develop both general and specific areas of defense guidance. Guidance provided by OSD becomes the start point of Service planning, programing, and budgeting. The critical events, simple in concept, but more complex execution, are shown in Fig. 1.

The events in the Basic Model happen annually, and since they are repetitive, we often refer to the whole process as the PPBS cycle. It is essential to recognize that there is only one point in time that is fixed during this cycle: The President's submission of his budget to Congress in mid-January of each year. The whole PPB system is judgmental as to what is involved, what happens, and when it happens as long as it all comes together to support the President's budget.

The dialogue on PPBS deficiencies has continued through the 70's, and new procedures and concepts continue to emerge. During 1976-1977, largely as a result of change in administration, continued scrutiny of the PPBS, and some new management innovations, numerous weaknesses of the system were identified. Several of these include:

1. Guidance was fragmented and not necessarily tied together. Planning and programing guidance was not consistent with fiscal guidance, and guidance relating to force structure, materiel acquisition, and military operations was not completely integrated.

2. The budget process was oriented to individual Service needs, developed, submitted, and defended through Service channels. At the OSD level, few alternatives to Service proposals were presented or developed, which diminished decision flexibility.

3. The role of the President in top defense policy and decision making needed amplification. This is particularly important when the President desires to play a

*(Continued on page 26)*

| BASIC PPBS MODEL | FROM OSD | TO OSD |
|---|---|---|
| • Receive Guidance | X | |
| • Develop and Submit Program | | X |
| • Receive Program Decisions | X | |
| • Develop and Submit Budget | | X |
| • Receive Budget Decisions | X | |
| • Revise and Submit Budget (for forwarding to Congress) | | X |

Figure 1

*COL Nidever has been assigned to command the Mainz Army Depot in Germany. His biography is included in the January-February 1978 issue of this magazine along with his byline feature "Zero Base Budgeting."*

# DOD-Wide Technical Directors Conference at NBS.

*(Continued from page 1)*

and Acquisition; Dr. James H. Probus, director of Navy Laboratories; and BG Brien Ward, director of Science and Technology, Air Force Systems Command, represented their respective Services.

The fourth and fifth sessions were devoted to six workshops that included participation of all technical laboratory directors. Each attendee participated in two different workshops.

WORKSHOP NO. 1 entitled "Laboratory Participation in the Substantive Formulation of the DOD S&T Program Strategy", was led by COL Carter, ODUSDRE (R&AT), with Mr. Thomas Dashiell as his R&AT assistant.

The consensus of the technical directors attending this workshop was that although their participation in the formulation of the DOD S&T programs was high, more participation would be beneficial. A good bit of the discussion concerned the intermediate headquarter's influence on the communications between OSD and the laboratory directors. Other issues discussed included documentation requirements, decision authority, and the need within OSD for someone to serve as the focal point for DOD laboratory related issues and problems.

WORKSHOP No. 2 was entitled "The Proper Role of Advanced Technology Demonstration (6.3A) in the Research to the System Acquisitions Cycle". Discussion leader was Mr. G. R. Makepeace, director of Engineering Technology, with Mr. Bartley P. Osborne as his assistant.

In answer to the question of whether there was the need for Advanced Technology Demonstrations, there was a unanimous agreement to the importance of ATD's, and all felt that ATD's should shorten rather than lengthen the acquisition cycle. The criteria for success and failure of ATD was discussed and several suggestions were offered concerning improvement of their utility and acceptance.

WORKSHOP No. 3 entitled "Forecasts for S&T Breakthroughs; Strategy for Their Pursuit", was led by Dr. George Millburn, technical assistant to the Deputy Under Secretary of Defense for Research and Advanced Technology, and assisted by Dr. Frank Austin, director of Environmental and Life Sciences.

After some difficulty of agreeing on a formal definition of a "breakthrough", the panel decided that it had to be something new and different, preferably sudden, and that in some cases it could even be planned. The environment for achieving breakthroughs (mainly people-oriented factors) was examined, and a few areas in which "breakthroughs" could be expected were listed. These included: adaptive optics, cross section reduction, non-destructive testing and superconductivity.

WORKSHOP No. 4 was entitled "The DOD S&T Infrastructure: What Should it be and How Should it be Supported?". The discussion leader was Mr. L. Weisberg, director of Electronics & Physical Sciences, and he was assisted by CDR Paul Chatelier, from the R&AT staff.

"Infrastructure" was defined as being the underlying foundation or basic framework of the Defense Science and Technology program, and related to programs intended to provide a foundation for a multiplicity of applications. A lively discussion was based first on the definition of the word, and once understood, secondly on its utility as a tool in describing the DOD Science and Technology program.

WORKSHOP NO. 5 reviewed "The Military Research Forefront: What Current Areas Comprise it and How Can They be Supported?". Dr. Peter Franken, director of the Optical Institute, University of Arizona, was the discussion leader and Dr. Thomas Walsh was his R&AT assistant.

This workshop addressed the question of whether future high-priority DOD S&T areas could be identified now, and what methods should be developed in improving forecasts. The prevailing view was that attempts to forecast basic research needs and priorities are of limited value but increase in value in applied research and even more so in development. According to Dr. Franken, "if research forecasting were perfect, we would not need 6.1." Also, it was felt that foreign research and development, particularly that of our potential adversaries, should not drive the U.S. basic research effort.

WORKSHOP NO. 6—Discussions were devoted to "What S&T Strengths are Now Available to DOD From Academia and Industry?" Dr. William Nierenberg, director of the Scripps Institution of Oceanography, La Jolla, CA, was discussion leader and he was assisted by Mr. Andrew Aines from R&AT staff.

Much of the discussion by this group centered on the strengths and weaknesses of the DOD laboratories, industrial laboratories, and the university research community. Other topics included constraints on the use of personal services contracts, paid consultants, advisory committees, and sponsorship of conferences.

Following the reports of the workshop leaders, the final session was organized to permit an exchange of comments between the audience, and the entire R&AT staff assembled on stage. This freewheeling session ranged over a spectrum of topics, but most of the interest seemed to be in Project Reflex, grade ceilings, mechanisms and problems associated with technical exchange with NATO countries, and defense of the DOD's S&T program to the Congress.

Dr. Davis concluded the conference by pointing out the need for increased interaction between the laboratory directors and herself. She indicated that DUSDRE (R&AT) will be active in setting the environment for the DOD Science and Technology program. "R&AT represents the laboratory directors to the Congress, the Office of Management and Budget, and the Secretary of Defense . . . in addition to your own ways . . . (and) in the way that you can't do . . .". At the same time, she indicated that her office will be developing means of providing more decentralized control to directors, thereby eliminating intercepting constraints.

This meeting represented a first step in better interactions between ODUSDRE (R&AT) and the laboratory directors and clearly meets a need. As pointed out by Mr. Smith (Office of Science and Technology Policy, representing Dr. Press), "Now, I don't know why it has taken so long to get all of the laboratory directors together. I was quite surprised, as was Frank Press, when Ruth told us that this apparently is the first meeting that you have all had. I can't say anything other than, why hasn't it happened before, and what a terribly good idea it is. And we are looking forward to the results of this conference and hope that there will be many more."

## Engineers, USDA Study Moths For Waterhyacinth Control

As part of a continuing effort to combat noxious aquatic plants, the U.S. Army Corps of Engineers, and the U.S. Department of Agriculture will conduct field tests of a species of moth called *Sameodes albiguttalis* to determine its long-range capabilities for controling the waterhyacinth.

The Sameodes, which is native to Argentina, will be tested in parts of Florida and Argentina. Release of the moth in the U.S. was approved last fall following a careful evaluation to insure that it would not damage crops or other native U.S. plants.

Scientists at the USDA Aquatic Plant Management Laboratory in Fort Lauderdale, FL, are currently developing moth field populations to obtain data for determining population dynamics and rate of spread. This information will then be used for developing long-range control programs.

Adults Sameodes lay eggs underneath waterhyacinth leaves and the larvae hatch and feed on the leaves. The leaves eventually fall over, take on water through the holes bored by the moths, and the plant drops below the water surface.

This combination of feeding damage and submersion finally causes the plant to die. The larvae, after mining the leaves, crowd to healthy leaves, pupate inside for up to 10 days, then emerge as moths and the life cycle is repeated.

Aquatic plant control research for the U.S. Army Corps of Engineers is directed by the Corps' Waterways Experiment Station, Vicksburg, MS, under supervision of Mr. J. L. Decell.

Since 1966 the Corps of Engineers and the USDA have worked together to develop biological agents for control of noxious aquatic plants. Successful control has been developed for the alligator weed, but control of the waterhyacinth has been more difficult because of its enormous growth rate.

# Congressman Ichord Reviews Role of In-House R&D Laboratories

As dinner speaker at the first DOD-wide Technical Laboratory Directors Conference, 24 July, Congressman Richard H. Ichord, chairman of the R&D Subcommittee of the House Armed Services Committee, reviewed output and role of in-house laboratories.

After recalling past in-house accomplishments such as the Sidewinder missile which introduced the birth of a whole new era of smart ordnance, and advances in electro-optical technology, he stated, "People in general tend to be less interested in hearing about how good you were or are, but are most interested in what you can do for them now."

In giving his reasons for sustaining in-house R&D, Congressman Ichord said it is imperative for the government to have a strong in-house technical arm that can be a "smart buyer," and work in a cooperative way with industry, the military, and the academic world to give us the best military hardware and technology at the least practical cost.

Secondly, he stated, the laboratories are needed to conduct R&D in those areas where there is little or no incentive for industry because of the lack of a major commercial market.

He went on to say that the in-house labs also provide technical options and viable alternatives that preclude unwarranted sole source procurements, and can provide the kind of quick-response capability that is frequently required in time of crisis.

"I cannot imagine a Department of Defense without a strong, viable, in-house laboratory system that can work with the academic, industrial and military communities to enhance the military capability of this country. The laboratories are here to stay," he stated.

Congressman Ichord hit on the "image problem" the Civil Service faces today, which he tied-in with the "not invented here" syndrome that the in-house laboratory system suffers.

"Industry on the one hand accuses you of locking out their concepts because they may compete with an in-house idea or system, you, on the other hand, tend to accuse the industrial complex of wanting to peddle their products in a way that will maximize their profit. . . .

"Both industry and the in-house activities have, from time to time, been guilty of these allegations, and I might add that the sooner you learn to work in a cooperative manner with industry, and they with you, the sooner the best interests of the defense of this country will be served. . . .

"My view is that with few exceptions, we must continue to rely on industry as the major source for the production of military hardware. Consequently, I don't believe that it is either desirable or practical to establish major production facilities within the in-house complex."

The Congressman, now serving his 9th term in the U.S. House of Representatives, continued with his concern over the time it is taking to transition a weapon system from concept to deployment.

"Bureaucratic red tape," he said, "has taken us from the days of the 5-year development-to-development cycle that was used in the Hawk, Nike-Ajax, Polaris, and many other programs, to the current 10 or 20-year cycle that is required to give us the SAM-D, or what is now called the Patriot, the Aegis, and the manned strategic bomber that we still do not have. . . .

"While we have been studying and restudying the requirements and looking for ways to make our systems more austere, the Soviets have been deploying one system after another, and quite frankly, have wrested the lead from the United States in many, many areas of military technology and capability."

The Missouri Congressman then expressed his concern for the current acquisition process. "This year, my Subcommittee took an extensive look into the so-called new acquistion strategy—the OMB Circular A-109." (This magazine featured *Major Systems Acquisitions: A Discussion of the Application of OMB Circular No. A-109* in the May-June issue.)

"I am willing to give it a try because, frankly, something has to be done to improve the cycle. I think that a large part of the problem today has been caused by our allowing the system to run us, rather than the converse. I intend to closely watch and monitor A-109."

In discussing some specific ideas on how the in-house R&D system might be improved, Congressman Ichord stated that some serious consideration should be given to reinstituting Project Reflex.

"From what I have been able to learn about this experimental project that was conducted about seven or eight years ago, it was indeed a success. I like the idea because it places authority and *responsibility* squarely on the shoulders of you, the laboratory directors.

"To me, it sounds entirely plausible to have a contract with a laboratory to produce an agreed-upon level of work for a prescribed amount of money and leaving the means to accomplish the objectives to the man in charge.

"As a very desirable aside, we have a yardstick or a measure for evaluating the effectiveness of you, the director, and your subordinate managers. Under this system, we can reward competence and rid the system of ineptitude.

"I might add that if the present trend to move more and more of the laboratory decision-making back to Washington continues, we will within a very short period of time reach that point where technical directors can be replaced by an average clerical worker."

**Hon. Richard H. Ichord**
*House Armed Services Committee*
*Chairman R&D Subcommittee*

Congressman Ichord concluded his remarks by saying that we must recognize that we live in an age of transition and must learn to change with the times—to have an organization dynamic enough to meet the ever-changing structuring and restructuring of our defense establishment and policies.

"On this point, I hope that you don't interpret dynamic to mean the ability to reorganize, because quite frankly, I don't believe that reorganization is always the answer to solving a management problem.

"All too often, troubled organizations needlessly reorganize, which tends to only move, rather than solve, the problem. As former Defense Secretary Schlesinger once commented on a proposed Army reorganization, 'It appears to me as though we have the same monkeys in new trees.'

"Being dynamic in this contest in which I use the term means having the ability to accept change—a change in our acquistion strategy or policy—and in the face of this change, being willing and able to continue as an effective player in the Defense process no matter how difficult the path."

## Army Chemical Lab Renews Interest In Obscuration-Aerosol Research

Obscuration-aerosol, one of the older Army R&D programs, is gaining renewed emphasis from scientists and engineers at the Chemical Systems Laboratory (ARRADCOM) in the Edgewood area of Aberdeen (MD) Proving Ground.

Directed to the study of military screening smokes and dusts produced by burning battlefield vehicles, obscuration-aerosol research was the theme of a week-long conference conducted recently at the Chemical Systems Laboratory.

Attended by Army, Navy, Air Force academic and industrial R&D personnel, the meeting was initiated to discuss plans and procedures related to the Army's obscuration-aerosol research mission. Topics included optical and physical properties of aerosols, aerosol characterization methods and obscurant materials.

# BRL Studies Nuclear Weapons Effects on Materiel

"Because of nuclear weapons proliferation, there is obviously a need for many of the Army's new military systems to be designed to survive the effects of nuclear weapons that could be used against this country," stated Robert H. Raley, a veteran physicist in the Ballistic Research Laboratory (BRL), a major research activity of the Army Armament Research and Development Command.

"Although there is much talk of radiation and radioactivity from nuclear weapons, two other immediate and equally important effects are associated with blast and heat," he advised.

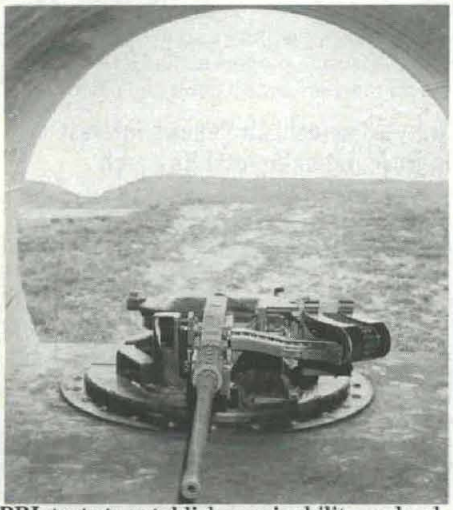
According to Raley, many of the Army's systems can be adequately "hardened" for survival, and the researchers at BRL and at the Harry Diamond Laboratories (HDL), Adelphi, MD, are among those who are continually in the process of recommending changes to enhance this survivability.

Military systems which could be subjected to nuclear weapons attack are at the forefront of current Army concerns and a Nuclear Effects Survivability Team has been established with BRL and HDL representatives to spearhead the effort.

One project of national interest is the XM1 tank, currently being evaluated by a variety of agencies as to its nuclear survivability.

BRL and the nuclear Effects Laboratory of the Army's Test and Evaluation Command, White Sands Missile Range, NM, are analyzing and testing the need for thermal/blast hardening of some of the XM1's external components.

In one dramatic test, more than 120 tons of high explosives were detonated to verify that a major portion of the XM1 Commander's Weapon Station's exterior could withstand the massive air blast.



**BRL tests to establish survivability and vulnerability of Army weapons systems to nuclear blasts include shock-tube tests in which external components, such as the XM1 tank turret above, are subjected to simulated effects to tactical-size nuclear weapons.**

Carried out by the Nuclear Effects Laboratory in Operation MISER'S BLUFF I near Lake Havasu City, AZ, the test was somewhat limited by the explosive charges that are of small yield when compared to nuclear sources.

"This limits the duration of the blast produced as well as the high velocity winds which follow the 'front' of a blast wave," Raley said, labelling the phenomenon "drag loading."

To better evaluate the nuclear effects, a BRL research team, headed by Raley, used a unique test site on Spesutia Island at Aberdeen Proving Ground, MD.

"We used a large, actually eight feet in diameter, shock tube, which was about 460 feet long to simulate the desired drag loading of the XM1 weapon station," Raley explained, "and during the test the shock tube produced a wind of several hundred miles per hour, corresponding to the fury of an intense hurricane or a nuclear blast."

Other components of the XM1's exterior, such as wind sensor and optical devices, are scheduled to be exposed to thermal, blast, and dust effects.

Raley, who is assigned to the Target Loading and Response Branch of the Terminal Ballistics Division, added, "Only within the last several months has the Army been able to expose large targets, the size of a jeep or an entire armored tank, to a thermal, or high heat, source which simulated the thermal pulse produced by a tactical size nuclear weapon.

"The present thermal source being used at BRL is produced by igniting a mixture of oxygen and aluminum dust which is contained by polyethylene bags. Such a simulator permits large specimens to be subjected to properly time-sequenced thermal/blast loading," he said.

Raley pointed out that actual testing is only a segment of the work adding that much analytical investigation including mathematical modeling is being done to provide prediction techniques for the air blast loading and response of a variety of military systems.

# New Spectacles Promise Improved Soldier Comfort

Development of new spectacles that promise to provide greater comfort and overall convenience for the combat soldier has been announced by the U.S. Army Medical Research and Development Command, Fort Detrick, MD.

The need for a new spectacles design has long been known and amply demonstrated in the optical fabrication laboratories, according to MAJ David Glick of the U.S. Army Aeromedical Research Laboratory, Fort Rucker, AL.

Currently, the Army has optical inserts for every gas mask, and the wearer is required to remove his glasses, find a place to store them and get his mask on, all in nine seconds.

The new spectacles were developed jointly by the Biomedical Laboratory in the Edgewood Area of Aberdeen, (MD) Proving Ground, and the Army Aeromedical Research Laboratory. Sierra Engineering Co., Los Angeles, CA, assisted in developing the temple strap. The prototype frame was also produced by a private firm.

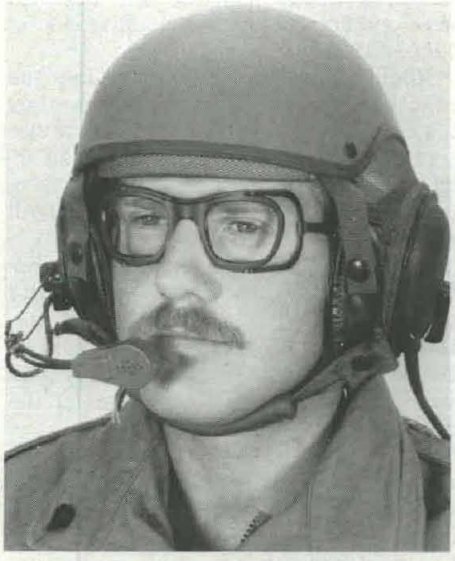
Lightweight and durable, the new spectacles feature a nylon front frame which is held firmly in place by a silicone temple strap. No temple bars or screws are required. Nylon sidepieces attached to posts on the front frame, and the silicone temple strap anchors them snugly to the head.

Since the strap is easily adjusted, the wearer determines his own comfort and fit and has no need for an optometrist to make the adjustment. The replacement of the temple bar with the sidepiece also enhances side vision and is a major factor in wearing comfort.

A potential lens candidate for the combat frame is made of a strong polycarbonate material which would pop out of the frame before it would break. A new coating is also being used to protect the polycarbonate material from scratches.

Results of current field tests are expected to be completed by early fall. Plans call for the spectacles to be available for the combat soldier in FY 1979. A patent for the combat frames has also been applied for.

It is believed that the new spectacles may eventually be used in the civilian community by football players and race drivers. Riot control personnel and fire fighters are also expected to benefit from the new spectacles design.



**Combat Spectacles Worn With DH–132 Tanker's Helmet**

# Army Developing 2 Automated Howitzer Test Beds

Two automated howitzer test beds are currently in development at the U.S. Army Armament Research and Development Command (ARRADCOM), Dover, NJ, to demonstrate the feasibility of automated fire control for artillery systems.

According to Mr. Frank Green, an engineer with ARRADCOM's Fire Control and Small Caliber Weapon Systems Laboratory, Howitzer Test Bed #1 (HTB#1) is an M109A1 155mm Self-Propelled Howitzer augmented with gun pointing and leveling servos, a modified M117 Panoramic telescope, a modified M15 Quadrant, an aiming point tracking unit, gun crew displays and several digital electronics control units, all under control of an on-board microprocessor.

To attain weapon orientation, the conventional aiming posts are replaced by an off-carriage reference unit containing a xenon lamp and a rotating laser beam. Nine separate levels of automated operation are available to the gunner to permit testing of several levels of automation with a view toward eventually determining which level is optimum.

Gun orders are transmitted digitally via wire or radio to the section chief's display from the Fire Direction Center (FDC). In the most fully automated mode, the gun is automatically traversed and elevated to the commanded values.

The section chief first verifies that it is safe to move the turret before allowing the servos to drive the gun tube. In the manual mode of operation, the gunners move the turret until the actual and commanded values of azimuth and elevation are matched. The contractor for HTB#1 is Honeywell.

Howitzer Test Bed #2 (HTB#2), according to Green, is also based on the M109A1 155mm Self Propelled Howitzer, and is a completely self-contained firing unit. HTB#2 utilizes an on-board navigation system to determine weapon position and orientation. This relatively low-cost system will allow the rapid and accurate weapon response for "hipshoot" missions.

In operation, the land navigation system provides a continual display of the howitzer position in Universal Transverse Mercator (UTM) grid coordinates. Upon command, these position coordinates are transmitted to the FDC for calculation of proper firing direction coordinates. Commanded values of azimuth and elevation for gun tube pointing are then transmitted back from the FDC to HTB#2 for display at the gunner and assistant gunner positions respectively. In order to align the weapon in the commanded direction, the gunners simply depress their weapon control handles until the set values are identical to the commanded values. Litton is the prime contractor for HTB#2.

Recently, HTB#1 was tested for verification of predicted performance parameters at Fort Sill, OK. In another Fort Sill test, the land navigation portion of HTB#2 was installed in an M113 armored personnel carrier and tested for operational performance. Further testing will be accomplished during HELBAT (Human Engineering Battalion Artillery Test), scheduled for the spring of 1979.

## Rock Island Completes Production of First M198 Howitzers

The first two production models of the M198 towed howitzer have been completed by Rock Island Arsenal, IL, and transferred to Aberdeen Proving Ground, MD, for production verification tests.

Designed and developed through cooperative efforts of the U.S. Army Armament Materiel Readiness Command, the Armament R&D Command, Rock Island, and Watervliet Arsenal, the M198 is intended for use in airmobile operations.

It provides improved lethality, range, reliability, availability and speed of emplacement and movement over its predecessor—the World War II vintage M114 howitzer. The M198 was type classified and approved for production in 1976.

Despite its improved capabilities, the M198 weighs only about 2,000 pounds more than the M114. This was acheived by extensive use of aluminum and high-strength steel throughout the weapon.

Accommodating a crew of 11, it features a maximum fire rate of four rounds per minute. The M198 is expected to provide general support artillery fire and direct support for light diversions during the post-1979 period and may replace the 105mm howitzers in those units.

Watervliet Arsenal, the sole cannon tube producer in the U.S., will provide M198 cannon assemblies, and Rock Island will build recoil mechanisms, provide final assembly and produce 19 gun carriages.

Numex Electronics, Inc., has production responsibility for the fire control equipment and Consolidated Diesel Electrics Co. will produce the remaining gun carriages. Troop tests on all M198s will eventually be conducted by the 1st Battalion, 73d Field Artillery at Fort Bragg, NC.

**Rock Island Arsenal Commander COL John C. Scholtz turns over first production M198s to Project Manager CAWS, Col Ronald E. Philipp, in recent ceremonies at the arsenal.**

## ARRCOM Plans Modifications On M109A1 Howitzer Models

Major modifications to existing and new production models of the M109A1 155mm self-propelled howitzer—intended to insure improved performance during the 1990s—are planned under a program announced by the U.S. Army Armament Materiel Readiness Command.

The upgraded M109A1 will be redesignated as the M109A3 and the new production model will be known as the M109A2. Both will feature improvements in crew safety, ammunition stowage, and engine cooling.

MAJ Carl Hubbard, chief of HQ ARRCOM's 155mm Artillery System Project Office, reports that M109A1 modifications will increse its reliability while also providing the capability of firing in the buttoned-up configuration. The goal, he said, is to have all modifications completed by 1982.

The M109A2 will be equipped to carry 22 "new family" projectiles, 12 standard projectiles, and 2 Copperheads. New family projectiles are those which, through advanced design and larger charges, have increased lethality and range.

As a human engineering improvement, the remote driver's panel will also be modified to allow the driver to monitor engine conditions from inside the turret. Handholds and step covers have been added to the cab, and door latches are more reliable.

Other improvements included warning devices to monitor engine coolant and air filter conditions, an improved counter-recoil buffer mechanism, a weapon-mounted rammer, the M140 alignment device, and a ballistic telescope cover.

A $23.9 million contract was awarded earlier this year to Bowen-McLaughlin-York, Inc., for production of 103 M109A2 howitzers. Gun tubes will be manufactured at the U.S. Army's Watervliet Arsenal and the gun mounts will be produced by Rock Island Arsenal. Engines, transmissions and fire control equipment are provided as government furnished equipment.

All of the improvements are considered to be in line with intensified U.S. efforts to increase standardization and interoperability with NATO forces. Several foreign countries, including many NATO nations, now have the M109A1 in their arsenals.

# Human Engineer Lab Tests Artillery Crewman Capabilities of Women

Do women have what it takes to become U.S. Army artillery crewmen? Can they maintain the strength and endurance necessary for loading and firing howitzers in a series of rapid-fire situations?

These were the questions posed in a recently concluded study by the U.S. Army Human Engineering Laboratory at Aberdeen Proving Ground, MD.

The 6-week experiment, which involved 13 enlisted women who normally hold administrative type Army jobs, specifically examined the ability of women to load and fire the 105 and 155 millimeter howitzers.

All participants were required to complete a comprehensive 3-week physical training program which preceeded the test. The special training program was developed by CPT Theresa Nemmers, a physical therapist with the Kirk Army Health Clinic at APG.

The first phase of the three phase physical training program dealt with the woman's aerobic capacity, or, the body's ability to use oxygen and perform. It consisted of a daily 12-minute run in combat boots and fatigues. Two women actually averaged distances exceeding 1½ miles.

Phase two incorporated strength building activities such as the deadlift, leg squats, arm curls, and forearm lifts. On the whole, the women were able to increase their weightlifting capacity throughout the course.

Phase three addressed endurance training and was comprised of exercises such as leg presses, bench presses, situps, and back extensions. Vast improvements in all categories were reported.

Nemmers stated that she felt the women's success in the actual firing exercises was definitely a result of the interrelationship of their physical conditioning and their individual and groups motivation.

The primary purpose of the pilot study, according to Test Director Frank R. Paragallo, was to determine if women, working as teams, could meet the prescribed rate-of-fire of the two howitzers.

This rate is four rounds per minute for the first three minutes, then one per minute thereafter for the 155mm M114A1 Towed Howitzer. The rate for the 105mm M101A1 is 10 rounds per minute for the first three minutes and three rounds per minute thereafter.

"Our initial goal was simply to see if the women could meet the rate of fire, depending on the caliber of the weapon," stated Paragallo. He added that the women achieved this with no problem and their proficiency was phenomenal.

LTC Robert A. Phillabaum, R&D coordinator for HEL's Artillery Team, noted that the female study was initiated as an offshoot of a more encompassing study involving the 105mm, and 155mm, and the Soviet 122mm howitzers. The female portion of that study was eventually limited to the 105 and 155.

Also, the female study was purposely limited in nature and did not encompass all tasks required of a regular artillery crewman. The test did not involve gunnery techniques, fire direction procedures, emplacing the weapon or taking it down, or real manual tasks of unloading ammunition from the trucks.

The test also had numerous built-in safety controls and checks and balances. For example, the projectiles were inert, the fuzes were dummies, and a safety officer was present at all times.

**ALL-FEMALE TEAM loads a 95-pound round into a 155mm M114A1 howitzer during a firing sequence in a 6-week experiment which established that female teams were able to meet established rates of fire for both the 155mm and 105mm howitzers. Safety inspectors watch the loading from both sides during the test at Aberdeen Proving Ground, MD.**

In general, the responses of Phillabaum and Paragallo regarding the women's capabilities were most favorable: "they were as professional as any male crew I've seen . . . they performed outstandingly . . . I couldn't tell if they were male or female, that's how good they were."

However, the reactions of the women themselves were somewhat mixed. Eleven of the 13 stated that they could handle the job, but only 5 of the 13 said they would want to. The five said they would definitely trade their present jobs to become artillery crewmen.

Typical comments from the participants, all of whom had to meet a minimum 110-pound weight requirement, were as follows: "I think we proved we could do it . . . it was hard, a woman shouldn't be put in that MOS . . . women couldn't handle it in a real situation . . . a good adventure, a good experience . . . there was a lot of bickering, a lot of complaining . . . a lot of work, but it was worth it."

Phillabaum noted that although the study didn't prove that women could perform all artillery-related functions, it did open the door for additional studies along these lines. A formal report on the study's findings will be prepared.

## Tri-Services Solicit Papers On Kinetic Energy Projectiles

A tri-service/industry SECRET- level symposium on Kinetic Energy Projectiles will be held 14-15 Feb. 1979, at the Naval Amphibious Base, San Diego, CA.

The symposium will be sponsored by the American Defense Preparedness Association (ADPA), and will be administered by the Large Caliber Weapon Systems Laboratory, U.S. Army Armament Research and Development Command.

The goal is to provide an interchange of existing technology and facilitate further advances in this rapidly expanding field.

Some areas of interest and discussion will be penetrator mechanics, penetrator materials, projectile concepts, advanced propellants, aerodynamic design, production considerations for cores and projectiles, new concepts for sabots, and advanced concepts in kinetic energy design.

Papers on these and related subjects, not to exceed 15 minutes in length, are now being solicited. Those interested should submit a one-page, 200-300 word, abstract to Commander, ARRADCOM, ATTN: Mr. G. Gray, DRDAR-LCU-CT, Bldg. 94, Dover, NJ 07801.

## Humans to Receive Artificial Tooth Root Implants

Artificial ceramic tooth roots, developed at Battelle's Columbus (OH) Laboratories through research funded by the U.S. Army Medical R&D Command, will be implanted in human patients by dentists at the Ohio State University Dental Clinic.

The tooth root implants were evaluated successfully on baboons at Battelle, but this will mark the first time this particular type and design has been implanted in the human mouth.

According to Dr. Robert H. Downes, associate professor of dentistry at Ohio State, persons needing a single tooth replacement for a nonrestorable or missing tooth are being considered as candidates for the research project. Tooth root implants in humans will be evaluated for at least two years to determine their effectiveness.

The research has been under way at Battelle for eight years. Dr. Craig R. Hassler of Battelle, who is heading the research team, said the results from the baboon study have been encouraging. "All but one of the 24 artificial roots implanted during the past year have stabilized in the baboons compared to a previous stabilization rate of only 63 percent," he said. "This is due to design and technique modifications. About 90 roots have been implanted so far."

Battelle, an internationally recognized research and development organization, experimentally produces the tooth roots, made from ceramic-fired high-density alumina, by cutting on a computer-controlled milling machine. The artificial roots are implanted in the bone in either fresh or healed extraction sites in the baboon mouth.

Once implanted, the roots stabilize for approximately two to three months. During this time, dense bone grows around the artificial root. A gold post and core are fabricated for each root and now are cemented into the implant to hold a gold crown.

Hassler said there is about a 90 percent success rate after the final restoration. Some of the artificial roots that have been implanted for more than three years are not creating observable problems, he said.

"Additionally," he said, "blood and related tests reveal that the implants do not cause any harmful side effects."

Observation and evaluation of existing baboon implants will be continued at Battelle. Baboons have been used for the implant studies because the size and root structure of their teeth are the closest of any animal to humans, Hassler said.

The research team expects even more positive results from humans than those obtained with baboons.

"People have better hygiene and eating habits which will assist in root stabilization," said Downes, who is conducting the human implants. Battelle will supply Downes and The Ohio State Dental Clinic with ceramic roots in various sizes.

Downes said that the human patient obviously will be able to answer questions about how the implant feels, if it is irritating, and what problems are associated with it.

"We're hoping that the artificial root, which may be more effective than a fixed bridge, will become the standard procedure for a person who loses a tooth," he noted.

Other key member of the research team include Mr. Larry G. McCoy of Battelle and Dr. Orville Russell, professor of dentistry at Ohio State.

## 3 ARRCOM Employes Patent New Rifle Magazine

Three Army Armament Materiel Readiness Command employes recently patented a newly designed rifle magazine to be used with their .22 caliber rimfire ammunition adapter kit for the M16 automatic rifle.

The adapter kit allows the M16 rifle to fire the less expensive and less powerful .22 caliber long rifle rimfire ammunition.

Messrs. Ronald E. Elbe, Donald W. Krolak and Philip I. Vernon designed the magazine to prevent possible runaway firing of the modified automatic weapon when firing .22 caliber rimfire ammunition. This ammunition is less powerful than standard military ammunition and its recoil pressure in the modified weapon is not always strong enough to cock the hammer.

Prior designs of adapter magazines permitted the feeding of a second cartridge into the chamber even when recoil pressure was inadequate to cock the hammer. Spring pressure on the hammer then caused the hammer to fall, firing the second cartridge. Often this cycle would continue until all ammunition in the rifle was fired, creating a dangerous situation.

The design of the new magazine allows ammunition to move into the chamber only after the hammer is cocked and locked in position, eliminating the hazard of runaway firing.

Additionally, this design facilitates loading and unloading of the magazine, and permits smoother and more reliable operation of the modified rifle.

The Air Force now uses this design and has experienced no runaway firings and less than a one percent stoppage rate in the field.

### New Kit Converts 5-Ton Trucks Into Ribbon Bridge Transporters

Development of a special kit for converting 164 Army 5-ton stake bed trucks into ribbon bridge transporters—expected to result in government savings of $4 million—has been announced by the U.S. Army Mobility Equipment R&D Command, Fort Belvoir, VA.

The kit, which was devised by MERADCOM's Marine and Bridge Laboratory, has been shipped to Germany where the conversion work will be accomplished. German production lines were recently set up with the aid of MERADCOM's Benjamin Spangler.

In addition to the conversion kit, the Marine and Bridge Lab is also credited with development of a cargo pallet which will permit the truck to carry up to 10 tons when it is not being used to transport the ribbon bridge. Both conversions should be completed by the end of the summer.

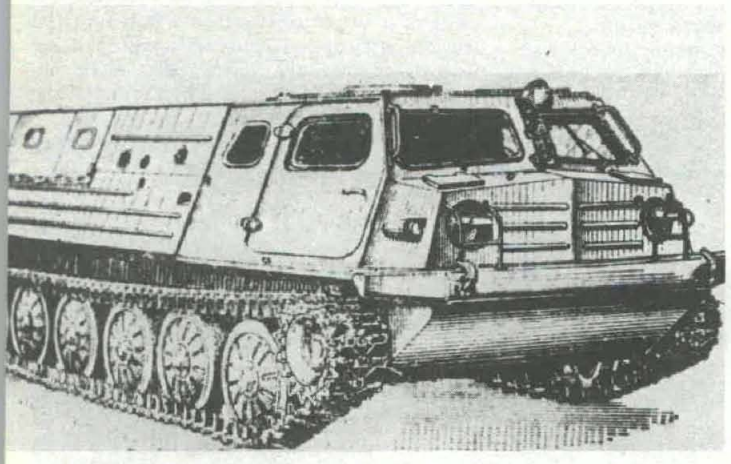
### Girder Bridge Undergoes DT III Tests at Aberdeen PG

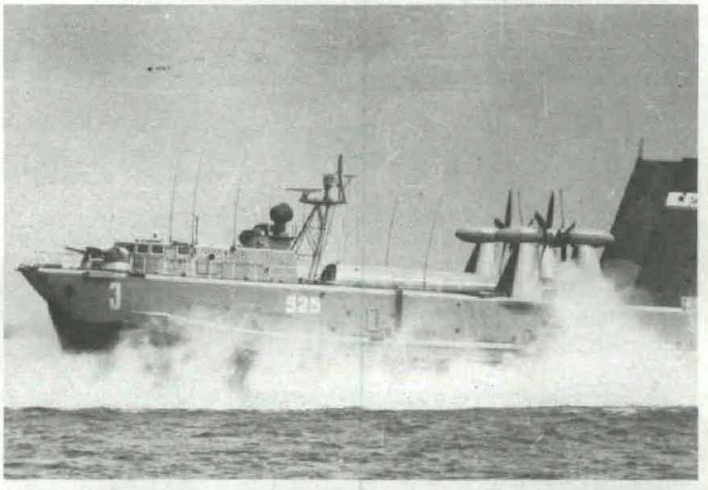
**TEAMWORK is displayed by soldiers of the Materiel Testing Directorate's Military Support Division at Aberdeen Proving Ground, MD, in disassembling the 100-foot girder bridge during final development tests (DT III) which began in April and are scheduled for completion by 30 Nov. The medium girder bridge is designed for use in crossing rivers and gorges with steep banks. Two models of the bridge are being used in the current test phase. Each will be erected, crossed and disassembled 24 times. About 2,112 vehicles will cross each bridge, which is less than one-half the life of the bridge and equivalent to 24 divisional crossings. If accepted for Army use, the British-made structure will round out the Army's bridging capabilities as it joins the ribbon bridge used in crossings with shallow banks, and the Bailey bridge that has been in the Army inventory for 50 years.**

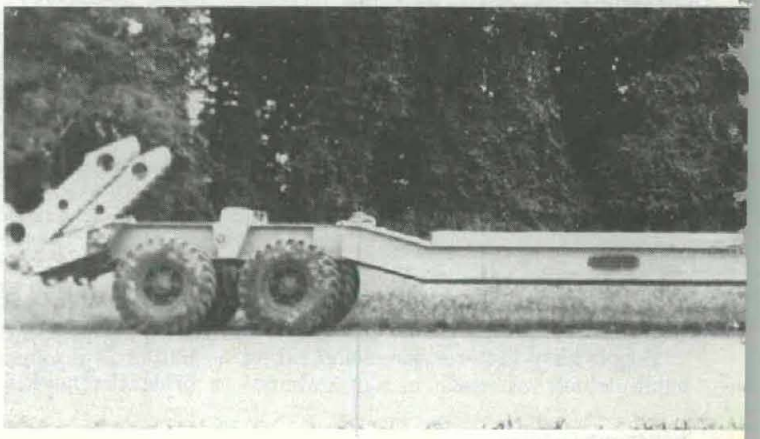
# Foreign Transpo

Second ot a series of photospreads on the U.S. Army Foreign Science ar
Photos of the 1977 Red Square parade were featured in March-April 1978
logy. Fig. 1—Czechoslovak Tatra–813, 7.5-ton payload, 8 x 8, cargo truck,
oversnow vehicle used in Sweden, Norway, United Kingdom, Finland ar
snow vehicle, with an aluminum chassis. It uses V–8 diesel fuel. 4—Swed
tractor by Saab Scania. 5—British Lancer Boss Container Sideloader
tion containers, with a maximum lifting capacity of 37 tons. 6—Soviet AIS
in amphibious assault. 7—Soviet MAZ–537 Tank Transporter is widel
System) is a jacking system designed to handle ISO containers of all siz
British military, uses advanced fiberglass shrouded fans for propulsio
Army. 11—Soviet KRAZ–260 DM prototype will probably become part
trailer wheels improve mobility for this 15-ton payload 10 x 10. 12—Sovi
the world. 13—Yugoslavian FAP–2026 is representative of East Europ
a high-performance, 6-ton payload, 6 x 6, military truck.



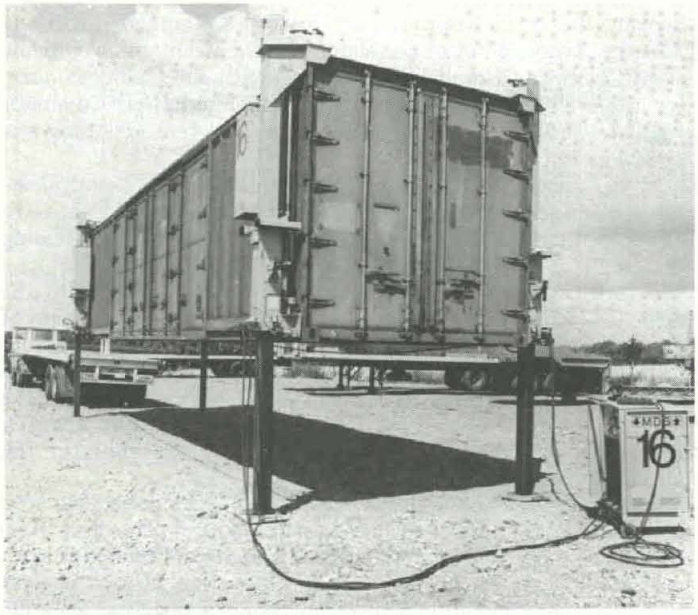




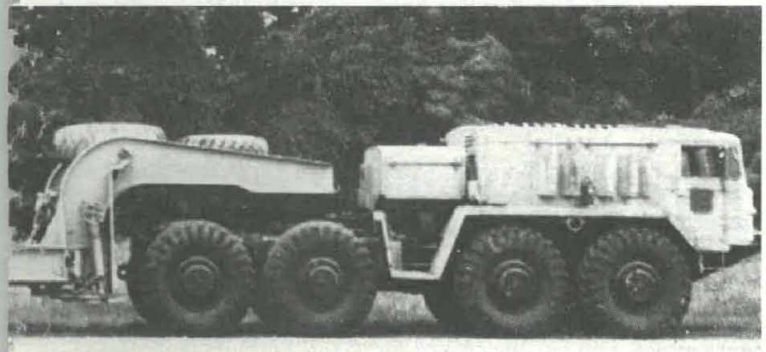



# tion Technology

nology Center's review of foreign weaponry and tactical vehicles. otos on these pages represent advances in foreign transportation techno- ign standard for off-road trucks since 1968. 2—Swedish BV–202 MK II, rkey. 3—Soviet MT–L is a 2.5-ton payload tracked adverse-terrain/over- T–III, 6-ton, 6 x 6, developed as a tactical cargo truck and artillery signed to handle 20-, 30- and 40-foot International Standards Organiza- ss Air Cushion Vehicle (ACV) is used to carry Red Army troops and tanks oloyed to support tank troops. 8—British MDS–16 (Modular Distribution weights up to 40 tons. 9—British VT–2, a 105-ton ACV being tested by —West German M.A.N., 8 x 8, 10-ton, was developed for the West German Soviet's fourth generation of military trucks during the 1980s. Powered S Class Air Cushion Vehicle is part of the largest military ACV fleet in mobility trucks. An extensive range of modern componentry provides







U.S. Adopts U.K. Device. . .

# SPAL Used for CW Defense Training

The Army's current emphasis on chemical warfare is not a holdover from World War I tactics nor is it an archaic reflection of cold war anxieties. Rather, the Army is concerned because of the great stress the Soviet Union and other Warsaw Pact countries have placed on CW.

Contrary to popular belief, chemical warfare has not been outlawed. It remains today a definite threat and an active offensive weapon in the arsenal of our potential adversaries.

To meet the need for a modern chemical defense training device, Army researchers at the Chemical Systems Laboratory (CSL) have adopted and modified a device developed in the United Kingdom. The device, known as SPAL (Simulator, Projectile, Airburst, Liquid), provides the individual soldier as well as entire Army field units with a realistic, yet safe chemical defense training system.

Indeed, the extent of Soviet CW training, believed to be unequaled anywhere in the world, suggests that they are concerned not only with defense against chemical weapons but also with the ability to attack through a contaminated area and exploit the results of their own offensive chemical operations.

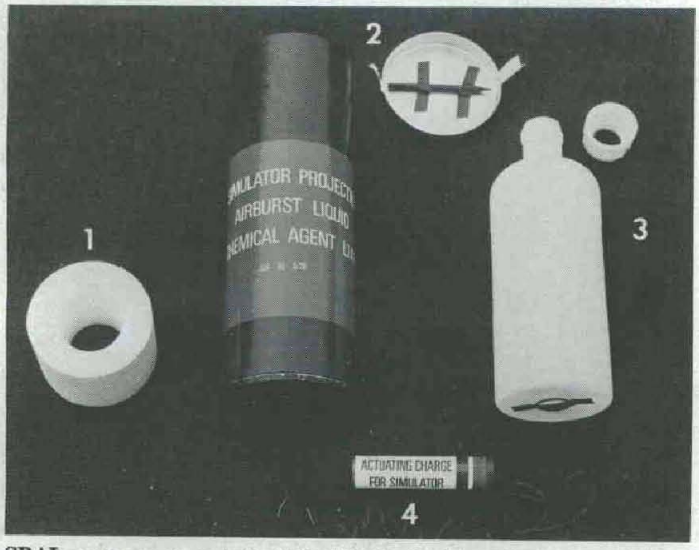
It has been confirmed that the Soviet Army uses diluted live toxic chemicals to provide realism in field training. The individual Soviet soldier is well trained in the use of protective clothing and is required to suit up often, for long periods, in exercises to increase psychological preparedness, improve combat efficiency under duress and raise his individual confidence in his protective equipment.

Until 1965, the American Army used a diluted mustard agent as a liquid agent simulant for field training, but with national policy prohibiting outdoor use or testing with actual lethal agents, the Army was forced to turn to other materials, such as molasses residum and motor oil.

The medical and enviromental suitability of these materials eventually became an issue. In addition, neither of the two materials reacted to chemical detection devices, developed earlier by CSL researchers and designed to alert an individual soldier to a chemical attack.

The Army has now adopted Polyethylene Glycol (PEG) as a simulant agent, a substance that is medically and enviromentally acceptable and reacts with detection papers as real agents would. PEGs are widely used in medical, food, and cosmetic preparations.

The SPAL system is reported to be simple, but safe and effective. It consists of the PEG simulant contained in a 1-liter plastic bottle with a propellant/burster charge and 30-centimeter (about a foot long) cardboard launch tube with a sheet metal base.




**SPAL component parts include: (1) Plastic form obturator. (2) Cardboard launch tube with cover and emplanting stake. (3) One liter plastic bottle. (4) Propellant/burster charge.**

The propellant charge is fired electrically, then the bottle is projected vertically into the air from the implanted launching tube. It bursts at about 12 meters (about 40 feet) and disseminates droplets of the simulant over an area about 10 meters wide and 50 to 100 meters long (33 feet by 164 to 328 feet).

SPAL components are easily assembled by the user in the field area, and, a multiple network of firings can be readily assembled for large area coverage.

After the U.S. rescinded the use of live agents in training, the requirement for a realistic simulant-filled training system was eastablished.

A Joint Working Group for chemical defense training representing the Army Training and Doctrine Command (TRADOC) and the Army Material Development and Readiness Command (DARCOM) was established. It subsequently directed CSL, a major research activity of the Army Armament R&D Command (ARRADCOM) to develop a total chemical defense training system by 1983.

In the meantime, the Army needed an interim chemical defense training system, so CSL researchers modified the UK-SPAL system as phase 1 of the overall program for fielding training systems for chemical defense.

Before the modified SPAL system could become part of the Army's official training equipment it had to undergo a series of extensive performance, safety, and operational tests to assure that it was suitable for U.S. use.

Troops from the 82d Airborne Division were used to assess the operational feasibility of SPAL in simulated but realistic battlefield conditions at CSL under the observation of the Ordnance Chemical Center and School.

During this test, simulated chemical attacks were delivered using SPAL. Soldiers were suited up in chemical protective overgarments, gloves, helmets, and masks and were equipped with personal decontaminating and reimpregnating kits as well as chemical agent detection kits. In addition, each soldier wore detection papers—the detection device signaling each individual soldier of a chemical attack.

The operational test demonstrated that, although SPAL is not an optimum system, it fulfills the Army's current need for an interim system for chemical defense training.

## MERADCOM Reports on New Hybrid Diesel Fuel

A new hybrid diesel fuel, which is self extinguishing if ignited by fire, has been produced by the U.S. Army Fuels and Lubricants Research Laboratory at Southwest Research Institute, San Antonio, TX.

The announcement was made by the U.S. Army Mobility Equipment R&D Command, Fort Belvoir, VA, in order to permit additional exploration regarding potential civilian applications. MERADCOM's Energy Water Resources Laboratory manages the San Antonio based laboratory.

Practically clear and consisting of up to 10 percent water, six percent additive and the remainder diesel fuel, the hybrid fuel is the result of a 10-year effort to find a substance which would be fire safe, stable, and provide good engine performance.

Beneficial effects of adding water to the combustion cycle have been reported for sometime, but the method of dispersing the water and the stability of the mixture have always presented problems. The new hybrid is entering a phase of advanced development and experiments are continuing to determine the extent of its shelf life.

Performance tests have thus far shown that the hybrid can deliver about the same power as 100 percent diesel fuel. The fuel reportedly performs well in standard diesel engines without modification, creates less exhaust smoke, and is self-extinguishing at fuel temperatures below 170°F.

The additive, which functions as an emulsifier/dispersant, is considered the key ingredient and can be produced from coal and agricultural sources which enhances the hybrid's potential to conserve petroleum energy. It should be noted that the potential to conserve petroleum has not been accurately determined.

# HEL Studies Soldier Reactions to Stress Situations

Why do some soldiers react better under stress than others? A pilot study is underway at the U.S. Army Human Engineering Laboratory, Aberdeen (MD) Proving Ground, to answer that question.

The objective, according to Dr. Jeffrey H. Lukas, director of the study in progress at the Behavioral Research Directorate, is to determine why some soldiers are better able to handle stress situations, such as encountered in combat.

Conditions of the study do not put the subject under actual stress. "It's very difficult to get a program approved where you're actually going to stress a human. So rather than do that, we're going to go about it indirectly," Lukas said.

The study uses sensory stimulation, which in this case, is optical. The pupils of the eyes are exposed to light intensities of varying degrees and the resulting brain responses are recorded on a computer print-out.

The theory underlying the study is called augmenting and reducing. After a subject is tested, it is then determined whether the subject is an augmentor or reducer.

So far the data compiled indicates that the augmentor's brain responds more when exposed to high light intensities. The reducer's brain produces less response under the same conditions.

Lukas said he believes that under the high stress situations, the reducer has less capability to respond effectively.

"I think that even in this pilot study we've been running, where we're dealing with only a few subjects, we've been able to demonstrate rather dramatic differences in how the brain responds to these stimuli. The fact is, we're controlling the stimuli very carefully, therefore, we can make very positive statements about what is occurring in the nervous system."

What they'd like to do, according to Lukas, is to gather a group of subjects determined to be reducers, and put them in a stressful or challenging situation.

One of these situations involves a computer-simulated combat scenario. The subject, acting as platoon leader, would be confronted with making a decision that would affect his platoon.

If the subject makes the right decision, the platoon is rewarded with leave, passes and time off. If he makes the wrong decision, his platoon loses benefits such as leave time.

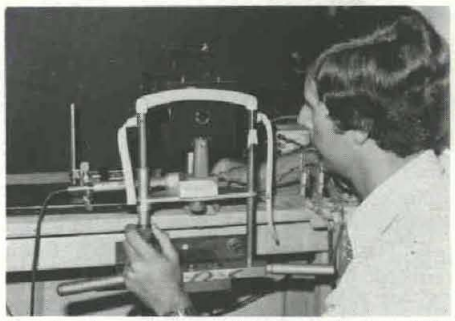
The eventual outcome, Lukas said, is still nebulous. However, the researchers would like to develop an easier test, such as a written examination, that would identify augmentors and reducers.

"The test might be used as a screening device," Lucas said, "to suggest that these individuals might be better taken out of those (stress) situations, or perhaps given more training.

"I want to emphasize that this is a long way down the road," Lukas said. "I'm trying to foresee the end of the race, but we're really at the starting line here."

The pilot study began in May, with 10 or more subjects tested so far. Lukas indicated that they still have a long way to go: "It's hard to say how many more subjects we'll have to test. Probably on the order of 50, maybe more. We're probably talking about a year's worth of effort."

Further research after the completion of the pilot study may require five years or longer.



**Dr. Jeffrey Lukas, director of the HEL study to determine effects of stress on soldiers, adjusts Maxwellian View Optical System to project light into subject's eyes.**

# WSMR Receives First DOAMS Production Model

The first of 10 production units of a newly developed twin-barreled tracking telescope system is being installed at White Sands (NM) Missile Range.

The first model of the Distant Object Attitude Measurement System (DOAMS), being erected near the original prototype built in 1976, is designed to improve missile flight data. The system, developed by the national range's Instrumentation Directorate, underwent exhaustive acceptance tests during 1976 and 1977.

Contraves-Goerz Corp. has been given the green light to begin production of 10 DOAMS. Cost of the prototype system was set at $1.5 million; the production units cost $600,000 apiece.

The new system is designed to replace the Intercept Ground Optical Recorder (IGOR) system which was an instrument assembled out of gun mounts and was used in the V-2 program in the 1940s.

The IGOR system was retired in 1974. In the meantime, cinetheodolite metric telescopes, as well as mobile systems using 180-inch catadioptric lenses were used to obtain required attittude and event data at the range.

The DOAMS is designed to take motion pictures of a missile in flight. It is equipped with an f/4 aperture and 100-inch focal length objective lens attached to a 360-frame per minute prism camera. In addition, there is a 200-inch focal length objective lens with a 125-frame per second camera. The film size is 70mm compared to 35mm used by IGOR, and frame speeds are faster.

The DOAMS offers new capabilities of automatic focus, faster lens speeds, smoother tracking, larger film size, and higher lens quality.

Richard Sandoval, task manager for the DOAMS, says automatic focus is controlled with radar data. The DOAMS receives missile position information from radar. Information is translated to focus, enabling the operator to track the missile without manually focusing. According to Sandoval, the lens has a better quality for shooting in certain light situations in which the IGOR could not operate.

The main feature is the vastly improved attitude and event capability of the new system. "We can watch an entire flight. The new system will record a tail fin falling off, and engineers want to see that," he said. "In attitude, we can see the characterictics of the missile, to check whether it's pitching, yawing or rolling in flight."

In addition, the DOAMS features quartz optics which have the advantage of a lower veiling glare and keep oblique rays off the film.

The DOAMS has two electric torque motors moving the barrels; the IGOR was hydraulically operated.

The system at Don Site is mounted on a 20- foot tower, which Lowell Yates, chief of the Optics Division, says will be a sound investment. The 20-foot height will provide a 30 percent improvement in quality due to less ground turbulence.

## 'VuPoints'

**From time to time the editorial staff of the** *Army RDA Magazine* receives correspondence, both positive and negative, regarding an article which has appeared in our publication.

Many provide an interesting perspective and warrant additional exposure. Therefore, in order to share these viewpoints with our readers, we are devoting a small portion of space in some of our future issues to a section entitled "VuPoints."

If you have an opinion regarding any subject matter which has appeared on the pages of our publication, please feel free to write us about it. Although we can't promise to publish every comment that we receive, we will certainly do our best to reprint those which we believe are of greatest interest.

**Your letters should be addressed to: The Editor, Army RDA Magazine, U.S. Army Materiel Development and Readiness Command, ATTN: DRCDE-LN, 5001 Eisenhower Ave., Alexandria, VA 22333.**

# Defense Logistics Studies Information Exchange

The Defense Logistics Studies Information Exchange (DLSIE) is tasked by the Office of the Secretary of Defense to collect, organize, store and distribute information relative to logistics and logistics management. Policy guidance for DLSIE is provided by the Director for Research and Data (OASD/MRA&L). Operational control of DLSIE is vested in the U.S. Army Materiel Development and Readiness Command, Directorate for Plans and Analysis. DLSIE is located at the U.S. Army Logistics Management Cener, Fort Lee, VA.

DLSIE's charter is DOD Instruction 5154.19. The DODI and the various service implementing directives (AR 5-7, AFR 400-51, SECNAVINST 4000.32 and DLAR 4100.1), place a "mandatory" requirement for DOD activities to use DLSIE. This mandatory requirement includes conducting a search of the DLSIE data base prior to initiating action on a study or model development in the area of logistics. The purpose of the data base search is to insure that the individual or organization about to initiate the project is fully aware as to whether the project will "reinvent the wheel," or whether it is in fact a project that will enhance the logistics system or management of the system. DLSIE does not make this determination itself, but it does provide the study sponsor with information depicting the study and modeling efforts that have been done previously in the sponsor's area of interest. From this information the sponsor can determine whether he should proceed with his study/model project.

Once the study sponsor makes the decision that the project needs to be perfomed, he has the responsibility of providing DLSIE with information relative to the planned effort (title, method of study/model development scope of the project, etc.). This information is added to the DLSIE data base and announced to the DOD logistics community, thereby allowing interested organizations to track the study/model during its various stages of development.

Once the effort passes from the planned to in-process stage, the performing organization is responsible for keeping DLSIE informed as to the progress of the project. Any significant change in the project's scope, title, estimated completion date, etc., is reported to DLSIE so that information in the DLSIE data base can be changed accordingly. Reporting requirements of the sponsor and performer for the Army are outlined in the AR 5-7.

Once the effort is completed, the report is forwarded to DLSIE to be included in the DLSIE repository. Interested parties are notified of the availability of the document through announcement of various DLSIE publications.

DLSIE also has certain responsibilities in the study/model development process. Upon receiving notification from the sponsor/performer of an initiated project, DLSIE takes actions to assist the organizations in accomplishing the project.

First, DLSIE accomplishes a data base search for the performing organization, which identifies all subject related efforts that are currently planned or in-process.

Second, a historical search of the entire DLSIE data base (approximately 34,000 references) is accomplished that identifies all subject related projects that have been accomplished previously.

The purpose of these searches is to minimize the data collection time normally required of the performing organization. By reviewing the materials provided by DLSIE, the performer is able to identify those items planned, in-process or completed that may be of value in assisting the project officer in accomplishing his project. Time saved by these DLSIE services can be used in completing the project.

Third, in addition to the specialized searches, DLSIE registers the performing organization for DLSIE's mandatory Selective Dissemination of Information (SDI) service. This service provides the performing organization with a custom data base search, on a monthly basis, that identifies all new items added to the DLSIE data base related to the ongoing project. These SDI mailings are accomplished on a monthly basis during the life of the project and are terminated when DLSIE is notified that the project has been completed or cancelled.

Probably as important as the mandatory use is the voluntary use of DLSIE. Whether an individual is assigned a staff study, writing a paper for government sponsored college credit, or just wants to stay current with the "state-of-the-art" in a given area of logistics, the products and services of DLSIE are at their disposal. All DLSIE products and services are available free of charge to DOD organizations, their contractors and grantees, and to other government agencies.

DLSIE's products and services include:

*The Annual DOD Bibliography of Logistics Studies and Related Documents.* This publication, issued in January of each year, is a "current awareness" type publication. It describes all reported planned or in-process study efforts and all reported study projects including reports generated by the service schools (i.e., Naval Postgraduate School, Command and General Staff College, Air Force Institute of Technology, etc.) which have been completed during the past two years. In addition to formal studies and theses, the publication also references audit reports of DOD logistics activities generated by the various auditing agencies (i.e., the General Accounting Office, the Air Force Audit Service, the Army Audit Agency, and the Navy Audit Service). The annual publication is supplemented by three quarterly publications (issued in April, July and October) which keep the recipient current on recently reported logistics efforts. This publication may be obtained by contacting DLSIE and requesting to be put on automatic distribution.

*The Annual DOD Catalog of Logistics Models.* This publication is also a current awareness publication dealing with logistics (operations research) models. The publication lists all logistics models, and those in other subject areas that may be of interest to the logistics community, that are planned or currently in the development stage. Further, the publication lists all models that have been recently reported as being completed and available. The publication is distributed each January, with no supplemental publications. This publication may also be obtained by contacting DLSIE.

*Custom Bibliographies/Catalogs.* Custom bibliographies/catalogs, as their names indicate, are specialized searches of the DLSIE data base to meet the unique information requirements of the requester. For instance, if the requester is interested in the subject of containerization, 261 references could be retrieved. If the term "containerization" is too general, and the individual specifically wants information on studies done in 1972, dealing with off shore discharge of containerships, the search could be refined and limited to 12 references in the studies data base. Each of these references would contain bibliographic data relative to the publication (publication date, security classification, distribution limitation, sponsor, performer, etc.) and a narrative description as to the purpose of the study, the study conclusions and recommendations. When the information is available, the reference will also indicate what changes were made in logistics operations as a result of the study. Custom searches of the models data base can be requested in the same manner. The studies data base can be searched by subject, year, sponsor, performer, security classification, or any combination of these data elements. The models data base can be searched by: sponsor/performer; user; subject/function, model category; use category, treatment of events/variables, treatment of time; security classification; publication date and solution technique. DLSIE will respond to written or oral requests for customized data base searches. However, a personal contact by telephone with a DLSIE analyst will insure that the customer is being provided with a bibliography/catalog that is better tailored to his needs. Custom data base searches rarely take more

than one working day to develop and mail. Normally, the requester will have the search in his possession within three working days after the request is orally submitted.

*DLSIE Descriptor List.* Although not a "product" per se, the DLSIE descriptor list is useful to individuals wishing to identify types and numbers of studies/models found in the DLSIE data base. The descriptor list is a representative alphabetical listing of descriptor terms used by DLSIE analysts in describing planned, in-process and completed logistics studies and other technical documents which can be found in the DLSIE data base. After each entry, a parenthetical number is shown. The number represents the total number of citations in the data base for each descriptor as of the date of the publication.

*Secondary Distribution.* DLSIE accomplishes secondary distribution through the use of microfiche. Requested documents are photographically reduced onto microfilm (fiche) and are provided to authorized DLSIE users free of charge. Authorized DLSIE users include DOD components, other federal agencies, and DOD contractors and grantees. U.S. Government organizations may obtain microfiche simply by contacting DLSIE and requesting specific documents. DOD contractors and grantees may also receive documentation from DLSIE, but only after authorization is provided to DLSIE by the DOD activity sponsoring the grant or awarding the contract.

*Selective Dissemination of Information (SDI).* There are two types of SDI—Mandatory and Voluntary. Mandatory SDI has been explained previously. Voluntary SDI consists of authorized DLSIE users registering for the SDI service. It requires that the registering activity establish an "information profile" which identifies the specific and unique logistics needs of the user. Once this information profile is established, DLSIE simply screens newly accessioned items against the customers profile. The SDI service is similar to the custom bibliographies and catalogs, but is developed and distributed automatically to SDI registrants. This distribution is accomplished on a monthly basis.

Additional information relating to the products and services offered by DLSIE may be obtained by writing to: Defense Logistics Studies Information Exchange, U.S. Army Logistics Management Center, Fort Lee, VA 23801.

DLSIE may be contacted by telephone—AUTOVON 687 and appropriate extension, or commercially by dialing Area Code 804, local exchange 734, and the appropriate extension. Extensions for DLSIE services are: Custom Data Base Searches, 4546/3570; SDI Registration, 4536/3570; Secondary Distribution, 2240/4655; DLSIE Publications, 4655.

# T700 Engine a Mechanic's Dream

**By Ken Nelson**

For six years, the Black Hawk Project Manager's Office has been working with the General Electric Co. developing the T700-GE-700 Turbine Engine to power the Black Hawk (UH-60A) and the Advanced Attack Helicopter (AAH).

One of the highest priorities established for the T700 engine, early in the planning phase, was that it must be easy to maintain by the mechanic in the Army's field environment.

How many shade tree mechanics have opened up the hood of the car and attempted to locate the fuel filter which was hidden in the carburetor or the oil pump which is buried inside the block? This is basically the same situation the Army's mechanics are confronted with when opening the access panels to the engines on the current helicopter fleet.

In recognition of past history, a common goal to eliminate these mechanics' nightmares was established. With the support of the U.S. Army Aviation Research and Development Command, U.S. Army Troop Support and Aviation Materiel Readiness Command, and other Army organizations, the Black Hawk Project Manager's Office and the General Electric Co. established a program in 1972 to make the mechanic's job simpler.

The first task accomplished was to develop an understandable set of requirements. In everyday language of the users and mechanics these included:

- Don't hide the gadgets that fail frequently; repairable with common hand tools; no safety wire; should not require an engineer to repair; make oil filter, oil drain and the likes easy to find; no special tools below the depot maintenance; minimize support equipment; provide understandable maintenance instruction.
- Guarantee the removal and replacement times for: Oil filter—2 minutes; oil pump—4 minutes; alternator—4 minutes; electrical harness—16 minutes; fuel filter—4 minutes; fuel pump—3 minutes.

Another second major understanding was that General Electric would show progress towards achieving these mechanical goals by taking the very first development engine built and actually perform all envisioned maintenance tasks.

This was accomplished using General Electric's mechanics, with Army personnel witnessing the activity. All shortcomings and concerns were documented and provided to the contractor for resolution. This process was repeated on the preliminary flight ready engines installed in the competing Black Hawk prototype aircraft.

In May 1976, and prior to the acceptance of the official Model Qualification Test, General Electric was required to furnish an engine built to the test configuration for the official maintainability demonstration. Two typical engine mechanics were selected from Fort Eustis, VA, Engine Maintenance Facility, and trained for two weeks at the contractor's plant at Lynn, MA.

*KEN NELSON served in the U.S. Navy as an aircraft structural mechanic. Upon completion of his four years service enlistment, he attended St. Louis University. He was employed by McDonnell Douglas Aircraft Co. from 1957-67. His duties included flight line mechanic, maintenance engineer, and advanced design maintainability engineer. He joined the U.S. Army Aviation Systems Command in 1967 where he was assigned to the Product Assurance Directorate and assigned to the original group to develop the Black Hawk. Assigned to the Black Hawk PM Office in 1972 where he has been monitoring both the Black Hawk and the T700 engine, Mr. Nelson was instrumental in establishing a 3-part demonstration of the T700 engine maintainability requirements to ensure ease of maintenance.*

For four weeks all maintenance actions were performed by Army mechanics and maintenance task times recorded. These actions included maintenance at all levels. During the performance of the maintenance tasks, maintenance personnel went to the General Electric plant to analyze and critique the engine.

These participants were requested to document any problems they could envision when the engine entered normal field operation. These comments were screened and submitted to General Electric for resolution prior to accepting the results.

The mechanic's dream engine will be fielded this year with numerous built-in maintenance features beside meeting the specified task times.

All line replaceable units and modules replacements can be accomplished with ten common tools, requiring no special tools or adjustments at the field level. Line replaceable units requiring drives are provided with self-aligning splines, requiring no critical dimensions or calibration check at the field level.

To assist the mechanic in maintaining the engine "on-condition" provision for borescoping, radiographic inspection, water washing and analyzing the oil condition have been provided.

In addition, provisions for condition monitoring include chip detectors, oil and fuel filter impending bypass indicators, oil sight gauges, engine mounted life counter for hours, time temperature factor and low cycle fatigue, along with the normal fuel and oil monitoring devices.

All field and electrical connectors are "Murphy-proof" against interchange and wrench damage when performing maintenance. When the mechanic is required to remove a component, no safety wire is involved and when a seal is required, it is self-retained.

The first production T700 engines were accepted by the U.S. Army in March 1978, and shipped to Sikorsky for the first production Black Hawk. Today the Army engine mechanics' dream is receiving its final touches before it becomes a reality.

# Helicopter Fault Isolation Equipment Evaluated by Army, Navy, Air Force

By William L. Andre
U.S. Army Research & Technology Laboratories (AVRADCOM)
NASA Ames Research Center, Moffett Field, CA

A portable 20-pound device called LOGMOD (Logic Model) can locate malfunctions in helicopter systems, such as gun turrets, flight control systems and electrical-hydraulic subsystems, isolate the fault, then tell you how to correct it.

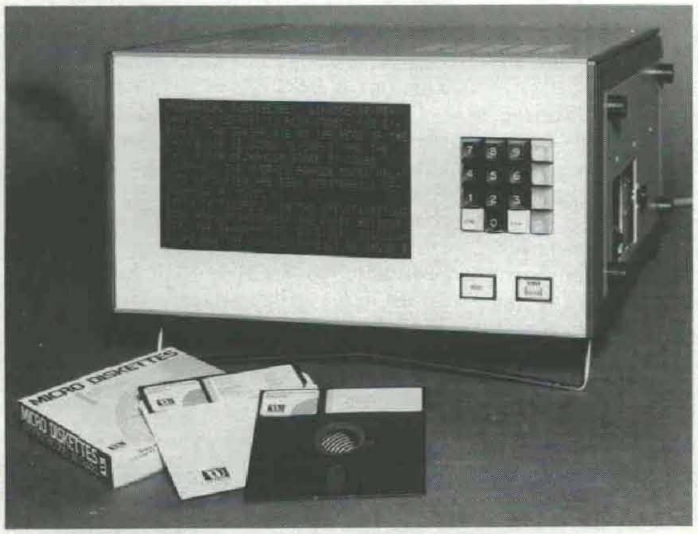



**Fig. 1. LOGMOD fault isolation equipment includes TV-type screen and push-button control panel. In foreground are floppy discs, similar in appearance to 45 rpm records, which can carry several million bits of information.**

The Air Force is using LOGMOD to check out AN/APN-147 doppler radar systems on C-141 aircraft, the Navy is using it to check out complex special underwater surveillance gear called BRD-7, and the U.S. Army Missile R&D Command (MIRADCOM) plans to apply LOGMOD to production-line electronics inspections.

Described as "putting the brains of the designer and maintenance expert into a box for use by others to perform quick, accurate equipment inspections," this versatile unit can be operated by a technician after 30 minutes of instruction. In addition to the printed directions that appear on the screen, LOGMOD will provide hard copies on request (see Fig. 1).

For the past several years, the Advanced Systems Research Office of the U.S. Army Research and Technology Laboratories (RTL), AVRADCOM, has been developing a concept for diagnosing and fault-isolating helicopter systems. This concept is considered an engineering innovation in that no prior mathematical basis existed. A theoretical basis was developed by RTL which resulted in identification of several properties applicable to a variety of systems for performing design and maintenance analyses.

The logical basis of this idea is founded on the fundamental relationship that exists between the components of a system (hardware). In implementation, it is simple to transform design information, such as that found on engineering drawings, to a set of logic data characterizing the intrinsic functional dependence within a system.

Using this data as input, a Logic Model (LOGMOD) of the hardware can be generated. This forms a road map of logical flow of functional information (see Fig. 2).

LOGMOD originally was seen as an evaluation tool to be used at the design stage to assess maintenance parameters and fault-isolation characteristics of hardware, such as the minimum number of test points required for conclusive detection of system malfunctioning, frequency of usage of each test point in diagnosing all potential system malfunctions, and the best ways to track down a malfunction. Later, it was realized that this same tool could be used by maintenance personnel for inspection and fault-isolation.

For these reasons, a logic model device was built to demonstrate how a technician can use the technology to fault-isolate complex or sophisticated systems without requiring any knowledge beyond how to perform the test measurements. Fig. 3 presents the elements of the LOGMOD technique.

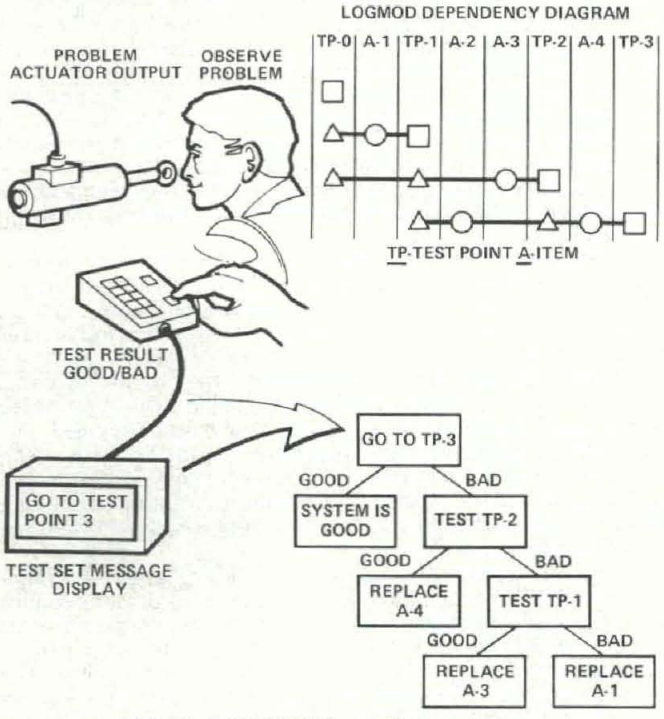



**Fig. 2. LOGMOD Flow of Information**

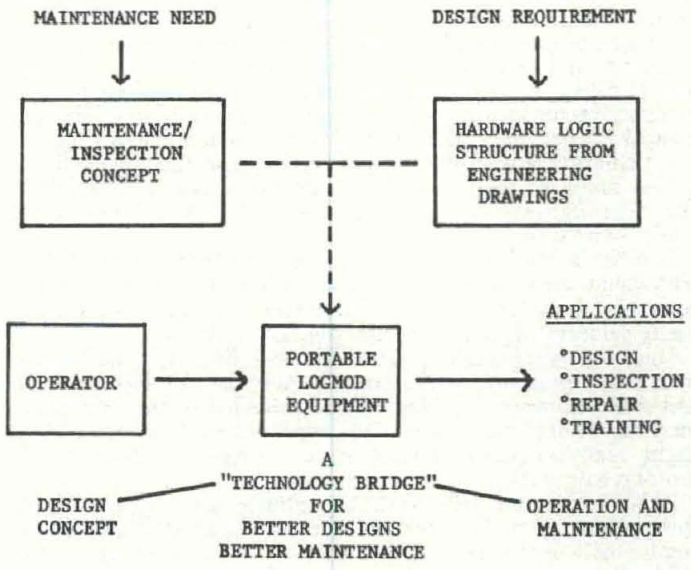



**Fig. 3. Elements of LOGMOD Technique**

LOGMOD does not simply contain a fault tree; it operates on the actual functional dependency logic of the hardware design of a unit being tested to show where and what test is needed. A large TV type screen shows testing instructions to the operator and also asks for answers to the questions it presents.

Although the LOGMOD set weighs only about 20 pounds, it can store detail logic of aircraft systems that contain thousands of parts, keep track of how each part functions and relates to every other part, and operate at a speed with accuracy far beyond that of any individual.

A logic model of an entire aircraft can be put together to fault-isolate malfunctions ranging from the black-box level to modular level to piece-part level. Thus, a maintenance manual is rarely, if ever, required.

LOGMOD was operated successfully in December 1976 and three months later was demonstrated on a 6-foot scale-model of a Cobra helicopter to show how electronic and mechanical design features can be fault isolated. The scale-model Cobra, which was flown at speeds approaching 100 mph, is shown in Fig. 4. It was equipped with more than 300 electronic and mechanical components, yet LOGMOD was able to spot every fault for any combination of manually induced malfunctions, and these tests were performed by persons who had never seen the helicopter or the LOGMOD Set.

Army research to date has been performed in-house by the Advanced Systems Research Office and under contract with Detex Systems, Inc., Orange County, CA. Mr. Bill Andre, Dr. James Wong and Mr. Mike Kodani served as the in-house research team, and Mr. Ralph DePaul and Mr. Larry Dingle have been the contract principals.

Last year the Air Force Logistics Management Center (AFLMC) established an Air Force LOGMOD Project Office to conduct an evaluation of the LOGMOD application to the AN/APN-147 doppler radar system used on the Air Force C-141 aircraft. A fundamental mathematical result of the LOGMOD theory and the unique design features of the set allow it to adapt to different systems with no hardware changes to LOGMOD.

This feature enabled the Air Force to conduct evaluations with the same set that the Army uses on helicopter systems. Air Force experiments are being conducted at Norton AFB under the direction of MAJ Billy Lacey, AFLMC, with contract funding from the Air Force PRAM Office at Wright-Patterson AFB. Technical responsibility is with the RTL.

According to the Air Force Test Plan, it is planned to compare the LOGMOD approach with existing maintenance procedures and also with other types of troubleshooting aids which the Air Force Human Resources Laboratory recently investigated. The doppler radar was chosen as the test system because it is fairly complex and a data base for comparison is available.

The Naval Electronics Command, through the Naval Underwater Systems Center and the Recon Electronic Warfare Systems Navy (REWSON) Activity, initiated evaluation efforts of LOGMOD on special underwater surveillance gear identified as BRD-7. This system contains dozens of racks of electronics aboard submarines and is considered to be extremely difficult to maintain and troubleshoot.

The Navy requirement for a small portable test set that can be carried through a submarine hatch is answered by

**Fig. 4. COBRA Scale-Model Used for LOGMOD Tests**

LOGMOD. Because of the ability to store extensive logic information on small floppy disc units, the entire BRD-7 system logic can be contained within the LOGMOD unit.

The Naval Equipment Training Center at Orlando, FL, has investigated LOGMOD as an aid in providing training and equipment demonstrations. The maintenance training implication of LOGMOD can be significant in the in-depth tutoring for learning effective repair strategies. Rapid simulation of a variety of failures and combination of failures provides faster training compared to classroom lectures or on-the-job training.

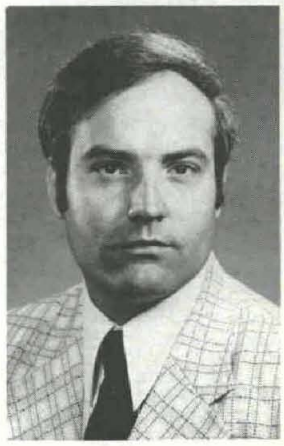
MIRADCOM plans to use LOGMOD to inspect missile electronics hardware down to the card or board level. This is oriented towards production-line inspections to assure efficient operations and permit easy tests and corrections on a production line or manufacturing basis at depot levels. Results of the AFLMC tests at Norton Air Force Base on the AN/APN-147 will be used by MIRADCOM to help evaluate this area of application.

In light of the wide interest shown for the LOGMOD technique by all three services, RTL, AVRADCOM, will continue with engineering investigations to explore and evaluate this technology.

Plans include contract work to apply LOGMOD to the M28 gun turret on the AH-1 helicopter in coordination with the Cobra Program Manager, Training and Doctrine Command (TRADOC), Army Armament Readiness Command (ARRCOM) and the 7th Infantry Division at Fort Ord, CA, which requested the M28 evaluation. The 2/10 Air Cavalry, 7th Infantry Division and the 155th Attack Helicopter Company, Combat Development Experimentation Command, are supporting the M28 evaluation at Ord.

Technology transition from the Advanced Systems Research Office to RTL's Applied Technology Laboratory, Fort Eustis, VA, will be conducted in the near future to support other technology applications and address further user evaluation with TRADOC.

*WILLIAM L. ANDRE, research engineer and technology program manager in the areas of aircraft weaponization, nondestructive testing, and reliability/maintainability, joined the Advanced Systems Research Office of RTL in 1972, and prior to that worked for the Weapons Command at Rock Island Arsenal. He holds an AA degree in general engineering from Harbor College, Los Angeles, a BS degree in mechanical engineering, Louisiana State University, and MS degree in mechanical engineering, Texas A&M University, and the Army Certificate in Maintainability Engineering. Mr. Andre formulated the Logic Model Concept for aircraft systems shortly after joining RTL in 1972.*



# Army RDTE and the PPB System

*(Continued from page 11)*

key role in defense strategy and planning and is critical to the PPBS cycle as to what point in time he makes his decisions.

4. Similarly, the role of the Secretary of Defense continued to evolve and is also critical to the decision process as to degree of participation, level and quantity of decisions made, and timing of actions.

5. The repetitive nature of the Program Objective Memorandum (POM) and budget cycles (6 months apart) was criticized as being too duplicative, too detailed in review and changes, and generally disruptive in the management of the thousands of critical defense programs.

During 1977-1978 the President and Secretary of Defense moved to correct many of the deficiencies noted above, and we have felt the impact of their actions for POM and budget submissions for Fiscal Years 1979 and 1980. OSD Consolidated guidance now ties together planning and fiscal guidance and improves the reconciliation of defense objectives and resources. Zero-Base Budgeting provides additional decision flexibility at the OSD and Presidential levels. The roles of the President and Secretary of Defense are more clear, and their decision actions are planned for during the PPBS cycle.

| Current OSD/Service PPBS | |
|---|---|
| Jan-Feb-Mar | • Presidential involvement on major issues<br>• OSD/Service jointly develop Consolidated Guidance<br>• Service develops draft POM |
| Apr-May | • Receive final planning and fiscal guidance<br>• Submit POM to OSD |
| Jun-Jul | • Review POM with OSD<br>• Discuss issues<br>• Receive initial program decisions from OSD |
| Aug-Sep | • Develop OSD budget<br>• Receive final program decisions<br>• Submit budget to OSD |
| Oct-Nov-Dec | • Defend budget<br>• Receive initial budget decisions<br>• Discuss issues<br>• Receive final decisions |
| Dec-Jan | • Finalize budget<br>• Prepare and submit President's budget |

Figure 2

The current OSD PPB system is complicated and exhausting in its effort to satisfy all legal, management, and other judgmental requirements. Of necessity, the Basic PPBS model grows and changes continously. The current OSD/Service version—which in turn guides each appropriation manager—is structured as shown in Figure 2.

By now you are somewhat familiar with what PPBS is all about. You know how it is defined, its evolutionary history, basically what it tries to do, some of its problems, and how OSD and the Services accomplish the process in general terms within the Department of Defense. Each appropriation manager lives within and is driven by the events, dates, and requirements of the PPBS as shown in Figure 2. This, in turn, requires the appropriation manager to establish a complete management machanism to support the overall PPB system. We have done this in RDTE.

Our basic objective is to develop the most effective POM and budget considering program and fiscal guidance, Army needs, technical advances, and developmental program status. Our strategy, then, is to have field input to support each cycle and to coordinate this input from all developing agencies with the Army Staff to develop the strongest possible POM and budget.

The R&D program and budget process is displayed in Figure 3, and its explanation is the basic purpose of this article. I suggest you take a moment and study the R&D schedule, even compare it to the Basic PPBS Model and the Current OSD/Service PPBS. You'll see that the primary elements of develop, submit, and defend program (POM) and then develop, submit, and defend budget are there. And that's where, on both a cyclic an continuing basis, the total RDTE community from the laboratory to HQDA is involved. I'll show you how this happens by developing first our overall appropriation management strategy and then discussing the events of each cycle (POM-budget) and how they reverberate through the community.

Please realize, our RDTE appropriation is in competition for limited funds with other Army appropriations and with other Service appropriations at the OSD level. Applying this overall strategy to the OSD and Army-developed schedule of events leads to the schedule in Figure 3.

It will become evident that these major events are not clear cut sequential in nature but in fact overlap to a great degree. Due to its cyclic nature, discussion could start at any event or any time of the year. It is, however, convenient to start in January, which coincides with the submission of the President's budget to Congress.

The basic tools of our trade consist of a tremendous amount of data, management review, and decisions. By January we have completed a major cycle and have submitted a budget to Congress. That budget starts through its Congressional approval process, and we start getting serious in developing the next submission. Our start point is tied to the RDTE January FYDP, Project Listing, Congressional Descriptive Summaries (CDS), and a Modernized Army Research and Development Information System (MARDIS) update.

A supporting Project List is prepared which reflects final funding decisions to project level and displays the appropriation by Budget Activity, Developing Agency, Mission Area, and RDTE Program Categories (6.1, 6.2, etc.). This document is the Program Element (PE) project funding level "bible" until it is updated to support the May POM.

Congressional Descriptive Summaries are functional program descriptions down to project level that are provided to Congress for review. The effectiveness of the CDS's is critical to the success of our program as it progresses through House and Senate authorization and appropriation reviews. All developing agencies are involved in providing information which goes into the CDS's. Examples of CDS data include: dollar resources required, description of mission need, basis for budget request, detailed background and

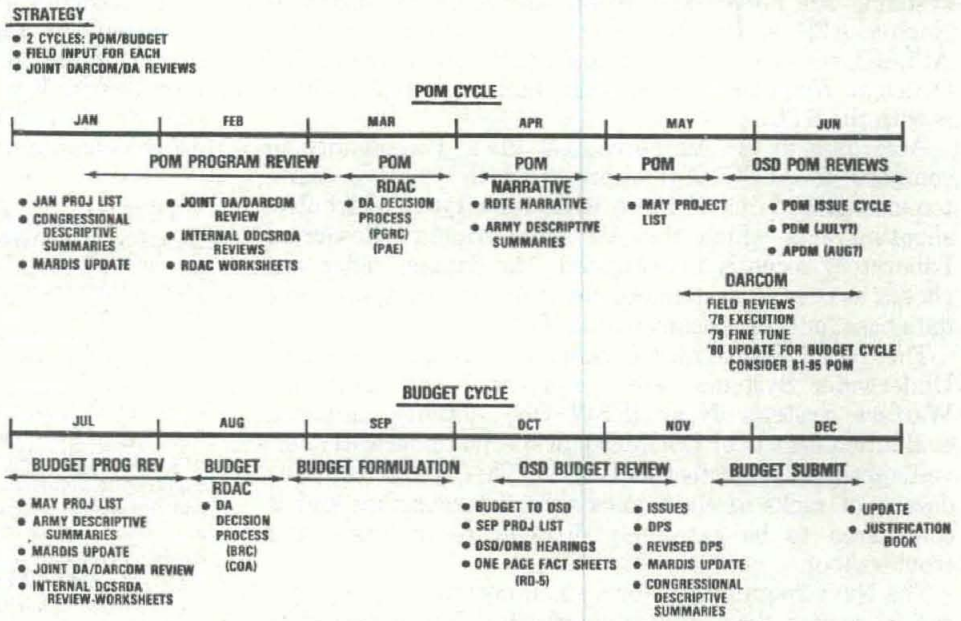



**Fig. 3. Annual RDTE Program & Budget Schedule**

description, related developmental effort, in-house and contractors involved, program accomplishments, and future plans. Nearly a thousand pages of this data supported our FY '79 budget submitted to Congress in January 1978. Failure to justify fully our programs in the CDSs guarantees funding reductions.

A word or two on MARDIS is appropriate. It is expected to be operational in August/September 1978, to be used in the fall of 1978 to support specific reporting requirements, and further, to support initial POM 81-85 development in January 1979. January, then, with its Project List, CDS, and MARDIS data provides an excellent start point for May POM development.

By February, field data has worked itself into the Army Staff, joint Army Staff and developing agency reviews are conducted, and we are receiving initial drafts of Consolidated Guidance. The Research, Development, and Acquisition Committee (RDAC) process is in high gear with the development of RDAC worksheets (based on field input, joint reviews, and ARSTAFF effort) and programing and funding issues.

During the RDAC, every program, PE, and project is subject to review by the Army Secretariat, Army Staff, the user community, and developing agency representatives. RDTE and procurement items are reviewed simultaneously to assure integration of programing and budgeting decisions. The majority of the RDTE program is formulated and validated during RDAC reviews. Some critical issues may remain for higher level DA decisions.

The RDAC is conducted during March, and the RDTE program starts up the DA decision chain. The POM is a programing cycle and is controlled by the Director of Program Analysis and Evaluation (DPAE), Office of the Chief of Staff. Through the Program Guidance Review Committee (PGRC), the DPAE assures consistency of the proposed RDTE program with funding and program guidance. Major issues are provided to the Select Committee (chaired by the vice chief) and submitted to the Chief of Staff for final resolution, if necessary.

By April/May, final decisions are made, projects lists are updated, and the POM narrative, describing the details of the RDTE program, is developed. The narrative principally addresses the primary thrusts of the R&D program related to OSD guidance and to mission area deficiencies. The details of each PE/project are described on 1-2 page Army Descriptive Summaries—again, supported by field input as needed.

The FY 80 POM was submitted to OSD on 23 May 1978, which then started the OSD POM review cycle. During June, we defend the POM often with representatives from the field making detailed program presentations. Another major event is occurring during May/June: DA/DARCOM joint field reviews. These reviews, like MARDIS, have caused concern through DARCOM and DA because they are time consuming and burdensome on R&D commands. They are also very necessary for several critical reasons.

First, in the general nature of business, the Army Staff tends to look ahead (FYDP and beyond) and is gearing toward meeting the next OSD/Congressional requirement. DARCOM, with its program execution mission, is also concerned with the future but has a more immediate challenge in preparing to receive and issue the program working through Congress and spending (executing) the programs already issued to the field.

Another good reason for the Summer Reviews is the information flow—up and down—that occurs during the meetings. Army Staff representative are better prepared to defend programs because of access to field level information and discussion, and the field is better prepared to develop more effective programs through gaining knowledge first hand on what's happening and why at Army, OSD, and Congressional levels.

Also, intermediate headquarters are in a better position to tie together a stronger total program. Considering the total events necessary to make the PPB system work, it is a very busy process. Earlier it was mentioned that a lot was going on at the same time. For example, also during May/June 1978, RDTE appropriation managers were:

1. Monitoring and executing FY 77 and 78 programs;
2. Defending FY 79 program through Congress;
3. Preparing to receive and issue FY 79 program;
4. Finalizing and submitting the FY 80-84 POM;
5. Preparing initial FY 80 budget actions; and
6. Conducting DA/DARCOM Summer Reviews.

Many of you are involved in one or more of these critical actions.

By July, the PPBS is in full swing. The POM is being reviewed by the OSD, and the Program Decision Memorandum (PDM) is due any time. The Budget RDAC process is gearing up. MARDIS input and the results of the Summer Reviews are supporting the development of RDAC worksheets and issues. All of this activity leads to the August RDAC and the Army Staff decision cycle. Unlike the POM, the budget cycle is controlled by the Director of the Army Budget, Office of the Comptroller of the Army. Budget decisions are made during Budget Review Committee (BRC) meetings with critical issues surfacing again at the SELCOM and Chief of Staff levels.

By late September the budget, in ZBB format, is submitted to OSD for review. The September Project List reflects funding levels determined during budget formulation. The one page fact sheets provide program, PE, and project narrative descriptions. From October to mid- December, the Services again defend their programs, discuss issues, receive ZBB oriented Decision Package Set (DPS) decisions, reclama, and receive final DPS decisions.

Field information, as necessary, is again obtained, program and budget data updated, Congressional Descriptive Summaries are written, the Justification Book (more formalized budget documentation) is developed, and the budget is finalized and submitted to the President. Quite a task. Quite a procedure! No doubt, to be successful, this system demands knowledge, understanding, and most important, the total cooperation and willingness to work hard on the part of all involved in it.

The current PPBS is not without continuing defects or areas where improvement would be helpful. With so many key events stuffed into a calendar year, timing is critical for any event which can impact the complete system. For example, there is no doubt that the President should play a key role in deciding critical issues if he so desires.

However, the timing of his decisions is critical to the system if their impact is going to have the desired effect and not create substantial turbulence. It is too late to make major program and budget issues late in December to support a January submission to Congress. Considering the effort spent in developing the POM, *major* program guidance decisions made after POM submission seem out of cycle and surely diminishes the importance of the POM.

Clearly, considering the PPBS process, major Presidential and SECDEF decisions and resulting guidance are needed early in the year—in February or March—and in time to be a part of the Consolidated Guidance if excessive turbulence is to be avoided.

The concept of Consolidated Guidance is a step in the right direction to avoid fragmented and conflicting guidance. To be effective, however, it must also be timely. During FY 80 POM development, final OSD Consolidated Guidance was not provided to the Services.

This is understandable considering this was the first year in which CG has been developed. The fact that it was developed is important and there is little doubt it will be more effective for POM 81-85 formulation. Again, CG needs to be developed and provided to the Services in time to be effective. February/March is the best time to support a May POM.

A major defect of the current PPBS is the repetitiveness of all the detailed actions necessary to develop the POM and budget. From an appropriation manager's point of view, there is little or no difference between the two cycles except people involved, terminology, and some boiler plate documentation. Basically, the RDAC decision process, project listings, descriptive summaries, reclamas, and final decisions are about the same.

One exception, POM decisions received in August/September come very late to impact on a budget being developed during the same time. It is questionable that there are many program changes over a 6-month period which would make the POM substantially different than the budget. This duplication problem has been recognized and there are moves both in OSD and the Army Staff to redefine POM and budget procedures to lessen unnecessary duplication.

Another problem area hidden behind the mass of schedules and events is the

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## Swept-Gain Superradiance Theory Draws Wide Acclaim

When the 1978 biennial U.S. Army Science Conference concluded in June at the U.S. Military Academy, West Point, NY, one of the most talked about papers, was, properly, the one which took top prize honors and won the Paul A. Siple Award for best paper.

The topic of the paper—"Swept-gain Superradiance"—reportedly reflects a change in the way scientists view the physical universe, especially the production and propagation of electromagnetic energy.

Described in the research paper are results of an experiment conducted by Dr. David Howgate, Dr. Charles M. Bowden and Mr. John J. Ehrlich of the U.S. Army Missile R&D Command's Technology Lab's Research Directorate and the High Energy Laser and Research Laboratory.

Acclaimed by the nation's scientific community, their experiment, according to Howgate, evinces a view of nature which goes beyond the single-atom concept. It shows atoms actually communicate with one another and act collectively.

Although the theory of swept-gain superradiance existed in different forms as early as 1975, it is Dr. Bowden who is credited with refining and extending the theory and the research team, as a whole, who proved its validity.

They caused a volume of methyl fluoride gas to radiate coherent pulses of electromagnetic energy of high intensity and short duration. This was achieved by using a carbon dioxide laser to send an energy pulse through the gas, causing individual atoms to become excited and simultaneously release photons.

These photons, or units of electromagnetic energy, were swept through the gas at the speed of light, gathering more groups of photons along the way and steadily increasing the intensity of the energy pulse.

In a laser, the radiation is coherent but the atoms which contribute photons do not act on a collective basis. Because the atoms in swept-gain superradiance do work collectively, pulses of much higher intensity are produced.

"Swept-gain superradiance," says Bowden, "provides the greatest intensity by far of any known electromagnetic energy amplification method. In fact, it gives the maximum intensity possible in accordance with physical conservation laws."

Ehrlich notes that superradiance itself is not a new type of energy amplification. It was first introduced in 1954 by a scientist named Dicke. However, Dicke superradiance is limited because all atoms must be stimulated at once, and the process works only within rather narrow volume and density restraints.

Because swept-gain superradiance sends the pulse down the major axis of a volume of material at the speed of light, there is no volume limitation. This is perhaps the most exciting thing about SGS, says Ehrlich. "The only limitation on our glass cell, which holds the treated material, is the room size."

One of the potential applications of swept-gain superradiance is in plasma diagnostics—the management of plasma factors such as temperature and density. Short pulses are required for plasma diagnostics to prevent reflection of radiation.

Since the new technique does not require mirrors, it might also be used to generate coherent directed X-rays. Coherent ultra-violet radiation might also be produced by this process.

Another potential application, reports Bowden, is controlled fusion—taking the same process that occurs uncontrollably in a hydrogen bomb and controlling it for useful energy without contamination.

Additional information on the MIRADCOM swept-gain superradiance experiment may be found in a book titled *Coherence and Quantum Optics IV.* Articles on the subject have also been submitted to several scientific journals, including the *Physical Review.*

## Army RDTE and the PPB System

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near constant need for updated information and the documentation "system" that supports this need. Whatever cohesiveness that may exist as a common thread throughout the appropriation is related to documentation that ties us together.

Our reporting requirements to Program Analysis and Evaluation, Office, Comptroller of the Army, OSD, and Congress are substantial and nearly continuous considering various drafts and data turnaround cycles leading to major POM and budget submissions. The Office, Deputy Chief of Staff for Research, Development, and Acquisition is conducting a total RDTE documentation review to try to reduce reporting requirements and make what we get more useful. To date, over 130 different reports have been identified related to RDTE efforts at the DA level.

During September 1978, initial findings of the review will be discussed, and it is expected that many reporting requirements will be revised during FY 1979. Again, we see MARDIS as the key input system from developing agencies, supporting many of our report requirements.

Even though there are efforts throughout the Planning, Programing, and Budgeting System to improve the decision process, provide more effective guidance, reduce POM and budget redundancy, and ease information requirements, it still remains a very busy process, one which involves all of us to some degree.

In reality, the PPBS is a good example of a two way street. Without development, test, and evaluation agencies and all their people doing an excellent job, the planning, programing, and budgeting effort done at commands and HQDA would effectively be wasted.

Likewise, if we did not do our best to develop the most effective possible program and budget, developing agencies could never receive adequate and timely resources. Obviously, this argues strongly for dedicated and cooperative efforts at all levels throughout the appropriation. Hopefully these paragraphs have helped to strengthen that effort.

**Drs. David Howgate, Charles M. Bowden, and Mr. John J. Ehrlich at MIRADCOM.**

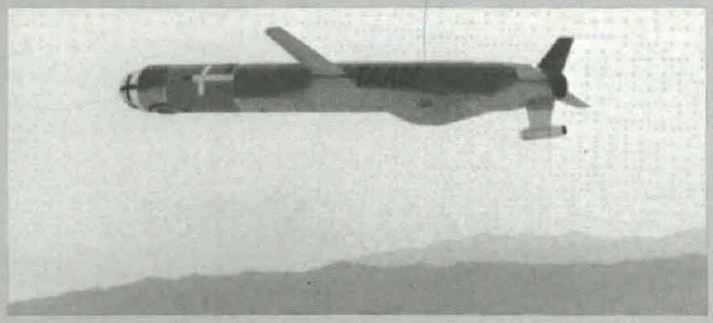
### Water Purification Unit Undergoes Tests

The Army's Reverse Osmosis Water Purification Unit (ROWPU), developed by the U.S. Army Mobility Equipment R&D Command's Energy and Water Resources Laboratory, Fort Belvoir, VA, is currently undergoing developmental and operational tests at Aberdeen (MD) Proving Ground, and Fort Bragg, NC.

Scheduled to be completed next spring, the tests include a 500 hour reliability test, low and high altitude parachute drops, transportability and durability tests, field tests with troops, and climatic and storage tests. Type classification is planned for May 1979.

# Selective Scanner . . .

## WSMR Conducts 5th Tomahawk Survivability Test



The fifth in a planned series of seven survivability flight evaluation tests of the air launched Tomahawk cruise missile has been successfully conducted at the US Army's White Sands (NM) Missile Range.

Secretary of Defense Harold Brown, who viewed the test, stated that the cruise missile, in its air launch configuration, will be a strategic weapon capable of penetrating Soviet defenses. He also said that the SALT talks will have no impact on the cruise missile R&D effort.

Launched from an A-6 aircraft, the missile reportedly executed the test plan autonomously in free flight. Data were gathered at various altitudes to define the detection and tracking envelopes which might be encountered during penetration of a defended area.

Under development by General Dynamics Convair Division, San Diego, CA, the Tomahawk is expected to be operational in the early 1980s. It will provide attack capabilities against sea and land targets.

The antiship version of the Tomahawk features a modified Harpoon missile guidance system which permits firing in the general direction of an enemy warship at low altitudes. At a programed distance, it seeks out its target with radar.

A land attack version has an inertial and terrain contour matching guidance system which contains the known location of the launch platform and the target immediately prior to launching.

When the missile is flying over land, the terrain contour matching equipment compares taped digital map references with the actual terrain and corrects its course to the target. The missile can be employed in nuclear roles such as the quick reaction alert mission.

It is also considered an important candidate for conventional use against heavily defended targets such as airfields and air defenses, and can carry a 1,000-pound warhead several hundred miles or larger payloads to shorter ranges.

The estimated cost per missile on a full production run is expected to be under $1 million, according to the Joint Cruise Missiles Project Office.

## AMMRC Examines New Torsion Bar Materials

Potential cost savings of more than $1 million and improved service life are anticipated with new torsion bar materials currently under development for future use on U.S. Army ground combat vehicles.

Conventional torsion bars are constructed from processed steels that traditionally contain imperfections such as nonmetallic inclusions and high contents of phosphorous, sulfur, and residual gases. All of these contribute to reduced fatigue life of the bars.

Increasing the fatigue lite of torsion bars and extending wheel travel can be accomplished by use of improved materials. Previous efforts have involved use of expensive materials such as titanium and high alloy steels.

However, a new joint program by the U.S. Army Materials and Mechanics Research Center, Watertown, MA, and FMC Corp. has resulted in an improved torsion bar made from high strength, low alloy steels. These steels are produced by Electroslag Remelting and Vacuum Arc Remelting.

Tests of bars made under controlled processing from 4353 Electroslag Remelting and 300M Vacuum Arc Remelting steels have demonstrated a 4-fold increase in fatigue life. Even greater improvements are anticipated when the processing techniques have been optimized.

As a result of these successes, FMC Corp. has incorporated one of the new materials (300 VAR) on their drawings as the primary material for torsion bars, thus replacing previously proposed higher cost steels.

In addition to monitoring the FMC program, the Army Materials and Mechanics Research Center is establishing a torsional fatigue specimen test criterion which will relate accurately to full size torsion bar characteristics. The 4353 ESR steel is the one which has been used initially by AMMRC.

Close coordination has been maintained to assure similar processing of the full size torsion bars and the small torsional fatigue specimens. Once established, the test will hopefully prove invaluable in predicting the adequacy of candidate materials.

## FDA Approves Use of CPD-A Blood Preservative

U.S. Food and Drug Administration approval of a new blood preservative, which extends the shelf life of transfusion blood from 21 to 35 days and reportedly improves the quality of stored red blood cells, has been announced by Letterman Army Institute of Research, Presidio of San Francisco, CA.

Identified as citrate-phosphate-dextrose-adenine (CPD-A), the preservative is a product of research efforts by the U.S. Army Medical R&D Command. Initial research was conducted from 1968-74 at Army laboratories located at Fort Knox, KY.

Those laboratories have since been relocated to Letterman Army Institute of Research, where many of the same Army and civilian contract scientists have continued the research.

By extending the shelf life of human blood as much as 67 percent, the new preservative represents a major step relative to supplying blood during military conflicts and civilian disasters, particularly in remote areas. Signficant savings of blood, materials, time, and human life are envisioned.

Physicians and scientists in LAIR's Department of Blood Research are credited with much of the biochemical and clinical investigations of stored blood and for their work in the national effort to license the CPD-adenine.

During 1974-77, these personnel, under the leadership of LTC (M.D.) Thomas Zuck, coordinated an effort to evaluate the effectiveness of blood stored in CPD-adenine. Their work culminated in the recent FDA announcement that Baxter Travenol Laboratories of Morton Grove, IL, has been licensed to market the preservative.

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That license, the Army noted, pertains only to the storage of whole blood and packed cells. The preservative is not yet licensed for other blood components such as platelets.

The new 35-day shelf life is especially important to the military because processing and transportation time previously consumed as much as two of the three weeks of the blood's shelf life. Blood often became outdated before it could be used.

The expanded shelf life is also expected to help alleviate blood shortages during low donor periods such as Christmas, and prevent the loss of much of the rare types of donated blood. LTC (M.D.) Carl C. Peck, chief of LAIR's Department of Blood Research, notes that the 35-day storage in CPD-adenine should not be considered the ultimate achievement in storage time. Within one or two years, he said, we may be able to add another week to CPD's capabilities.

Dr. Gerald Moore, a civilian chemist who has been associated with the Army blood research program for more than a decade, is currently investigating "ultra-long-term" blood preservation systems, and other procedures to improve the blood's ability to deliver oxygen.

Other ongoing areas of investigation in LAIR's Department of Blood Research include a "freeze-dried blood" project, under the direction of Dr. Frank DeVenuto, and a platelet research program, conducted by MAJ (M.D.) Robert B. Bolin.

## Contract Calls for AN/TPN-18A Radar Modernization

Modification kits and support items for modernization of the AN/TPN-18A radar system will be provided under a $6.2 million contract announced by the U.S. Army Communications and Electronics Materiel Readiness Command, Fort Monmouth, NJ.

ITT Gilfillan, a division of International Telephone and Telegraph Corp., will perform the work under an award issued by CERCOM's Procurement and Production Directorate, for the Office of the Project Manager, Navigation and Control Systems.

The modernization kits will include a newly developed and highly reliable transmitter-receiver unit and improvements to the indicator unit.

A major component of the Army's landing control central, which is used at tactical airfields and heliports, the AN/TPN-18A is a lightweight, ground-based/controlled radar. It provides surveillance, precision landing approach and altitude information.

## Army Type Classifies Mine Clearing Roller System

Type classification of the Track Width Tank Mounted Mine Clearing Roller System has been announced by the U.S. Army Mobility Equipment Research and Development Command, Fort Belvoir, VA.

Consisting of a retrofit kit, mounting kit, roller kit and fixture kit, the mine clearing roller weighs less than 10 tons and can be mounted in the field by a tank crew in less than 15 minutes for day or night use under any weather conditions.

The system is also capable of surviving blasts from two 22-pound high explosive mines. Under battlefield conditions, the rollers can be released in less than 30 seconds utilizing a hydraulic disconnect system.

During the next three years, 90 rollers will be procured for use by armored units in Europe. A production contract is expected to be awarded soon and pre-production tests will be conducted at Aberdeen (MD) Proving Ground from March-May 1979.

## Aquila RPV Guides Copperhead to Tank Target

Aquila, a remotely piloted vehicle, successfully guided a Copperhead antitank projectile to its tank target during recent tests at the U.S. Army's White Sands (NM) Missile Range.

Aquila, Latin for eagle, is a small gas driven aircraft that acts as a laser designator. After being launched it is tracked and guided by radar. The controller, behind friendly lines, seeks a target for the Aquila via a TV camera mounted on the bird. In the mid-summer test, the target was found 11 kilometers away, according to range officials.

Once the target is located, the Aquila can be locked on to it. The TV camera contains a contrast tracker. This device, once turned on, will keep the camera aimed at the object in focus if the object has enough contrast so it can be distinguished from its surroundings.

Once the Aquila and its TV camera are locked on the target, the Copperhead can be fired. This projectile, equipped with a high explosive antitank warhead, is launched from a standard 155mm artillery tube.

Aligned with the TV camera on the Aquila is a laser designator which shines on the target. In the nose of the Copperhead is a laser seeker. When the Copperhead approaches apogee, the seeker starts looking for reflected laser energy and homes in on it.

After the projectile is fired, fins deploy on its sides. The seeker can change the position of these fins to change the course of the projectile. With this system, the Copperhead boasts a one-round kill capability, says a project engineer.

If no energy is detected by Copperhead, it will continue its flight like any normal cannon projectile. The Aquila can be flown back to friendly ground and landed in a snare net for reuse.

Once fielded, this particular arrangement of laser designator and Copperhead would require from seven to nine men to operate. The Aquila is controlled from a truck mounted van which can be readily moved, along with the Aquila launcher and recovery net.

The Aquila is produced by Lockheed and the Copperhead by Martin-Marietta.

AQUILA, a remotely piloted vehicle capable of carrying a laser designator and TV camera, is launched during recent tests at WSMR. Aquila has a 12.5-foot wing span, weighs 145 pounds and flies at the speed of 60 knots.

# Awards . . .

New Cannon Firing Test Cited. . .

## Benet Scientists Win $25,000 Special Act Award

**Benet Weapons Laboratory researchers who devised a method to establish safe life of cannon barrels by simulated test firing are (seated, l. to r.) Steven J. Bell, Albert N. Reiner, Abraham Rubin and Joseph Wido. Standing are Bruce B. Brown, James F. Kelly, John J. Zalinka, Dr. Thomas E. Davidson and Donald C. Winters. Team members John F. Williams, George Sogoian and Bruno Grestini are not shown on photo.**

What is believed to be the largest monetary award in Watervliet (NY) Arsenal's history has been presented to a 12-member team of scientists for their development of a simulated test firing method for determining the safe firing life of cannon barrels.

Assigned to the Army Armament R&D Command's Benet Weapons Laboratory, the civilian scientists initially received $5,000 in September 1975, and more recently were presented with a $20,000 Special Act Award during Pentagon ceremonies.

Their technique, which replaces a major portion of previously costly tests, establishes how long cannon barrels can safely be used before metal fatigue occurs. An ultrasonic control system automatically detects the location and depth of gun tube cracks during simulated firing.

Since its adoption in 1974, the new technique has reportedly saved the Department of Defense more than $30 million and has increased the reliability of fielded weapons. The U.S. Navy and the Federal Republic of Germany have also adopted the system.

Recipients of the award are: Research Director Dr. Thomas E. Davidson; research chemical engineers Mr. Bruce B. Brown and Mr. Albert N. Reiner; research electronic engineer Mr. Donald C. Winters; mechanical engineering technicians Mr. Joseph Wido and Mr. George E. Sogoian (now retired); physical science technicians Mr. Abraham Rubin, Mr. Steven J. Bell, Mr. John F. Williams, Mr. Bruno Grestini (now retired), and Mr. James F. Kelly; and electronics technician Mr. John J. Zalinka.

## Natick Shares Award for Flexible Food Pouch

Development of the flexible retort food pouch has earned the U.S. Army Natick (MA) Research and Development Command distinction as one of three cowinners of the Institute of Food Technologists' 1978 Food Technology Industrial Achievement Award.

Presented at the Food Technology Institutes' National Convention in Dallas, TX, the award annually recognizes an outstanding food process and/or product which represents an advance in the application of technology to food production.

The development of the lightweight flexible retort pouch, which was pioneered by NARADCOM, is considered by many to be the most significant advance in food packaging since the development of the tin can by Nicholas Appert in 1809 for Napoleon's army.

Continental Flexible Packaging Group and the Flexible Packaging Division of Reynolds Metals Co., cowinners of the award, collaborated with Natick on the development of the three layered (polyester, aluminum foil and polypropylene) pouch.

The new pouch is lighter in weight than cans; allows more even precooking of its contents without loss of nutrition; does not require refrigeration; requires less storage space; and has a shelf life which is at least equal to canned items.

Following U.S. Food and Drug Administration approval in 1977, the pouches were made available for commercial use with meat and poultry products. The Army has adopted the pouch for use with the Meal, Ready-to-Eat ration.

Approximately 350 million retort pouches are being produced annually in Japan, 50 million in England, and millions throughout Europe. The pouches may also soon be available in similar quantities on U.S. supermarket shelves.

## ETL Wins Army Laboratory of the Year Award

Scientific and technical achievements in mapping, military geographic information, and geographic intelligence systems have earned the U.S. Army Engineer Topographic Laboratories, Fort Belvoir, VA, the 1977 U.S. Army "Laboratory of the Year Award."

The U.S. Army Human Engineering Laboratory, Aberdeen (MD) Proving Ground, which conducts basic and applied human factors engineering research in support of materiel development programs, was selected as laboratory of the year runner-up.

Additionally, the U.S. Army Institute of Dental Research, Walter Reed Army Medical Center, Washington, DC, earned top honors as the 1977 "Most Improved Laboratory." The runner-up in this category was the U.S. Army Combat Surveillance and Target Acquisition Laboratory, Fort Monmouth, NJ.

Other awards for Excellence will also be presented to the Engineer Topographic Laboratories; the Institute of Dental Research; the Army Research Institute for the Behavioral and Social Sciences; the Human Engineering Laboratory; Walter Reed Army Institute of Research; the Ballistic Research Laboratory; the Night Vision Laboratory; U.S. Army Missile R&D Command laboratories; and the Combat Surveillance and Target Acquisition Laboratory.

Initiated in 1974, the annual laboratory awards program is authorized under provisions of Army Regulation 672-305. Winners were selected by a special awards committee appointed by Assistant Secretary of the Army (RDA) Dr. Percy Pierre.

Those comprising this year's selection committee were: Dr. Herbert Ley, Army Science Board; Dr. Ralph G. H. Siu, Army Science Board; Dr. James Probus, director of Navy Laboratories; Dr. Robert Kahal, deputy for Tactical Systems, Office of the Assistant Secretary of the Air Force (RD&L); and COL Donald I. Carter, executive to the Deputy Under Secretary of Defense R&E (R&AT).

The 3-fold purpose of the awards program is: To provide a means of routinely critiquing and ranking each Army In-House Laboratory; to create an atmosphere in which the Army's scientific and technical capabilities can be continuously upgraded; and to recognize quality performance.

Selection of the Engineer Topographic Laboratories as the 1977 Laboratory of the Year was based on a number of key accomplishments, including ETL's progress on the Digital Interactive System. Used extensively by intelligence and mapping groups, this system provides important applications in image interpretation and special product R&D activities.

Other ETL achievements were related to the CRT Print Head System; the Digital Input/Output Display Equipment; development of prototype 35mm miniature viewers; development of an integral, full capability Rapid Geodetic Survey System; and completion of various DOD and Army feasibility studies.

## Physicist Cited for Technical Conference Paper

Mr. George E. Hauver, a research physicist in the Terminal Ballistics Division, U.S. Army Ballistic Research Laboratory

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(ARRADCOM), Aberdeen (MD) Proving Ground, was recently recognized for presentation of the best technical paper at BRL's Spring Technical Conference.

Titled "Penetrations With Instrumented Rods," the paper reported on initial results of an investigation into the deformation and dynamic properties of a projectile during penetration of an armored target.

Hauver was a 1975 recipient of an Army R&D Achievement Award and a BRL $1,000 special achievement award for earlier work associated with temperatures of shocked materials. He has a BS degree from Washington College and an MS degree from the University of Maryland, both in physics.

Systems Analysis Awards. . .

## 2 Groups, 2 Individuals Cited for Achievements

**Systems Analysis Award plaque is accepted by Bernard C. Witherspoon in behalf of the Joint Conventional Ammunition Program Decision Models Directorate, U.S. Army Armament Materiel Readiness Command, Rock Island Arsenal, IL. DARCOM Commander GEN John R. Guthrie extends congratulations.**

**Co-winners of 1977 Systems Analysis Award are (l. to r.) Roger Hoffman, Lawrence Bishop, Robert Flynn and Gary Donald, all with the U.S. Army Troop Support and Aviation Materiel Readiness Command, St. Louis, MO.**

**Individual Systems Analysis Award went to Walter E. Smythe of the Red River Army Depot, Texarkana, TX, for work at the U.S. Army Missile Materiel Readiness Command, Redstone Arsenal, AL.**

**Mathematician Jill Burt, with the Advanced Systems Concepts Office, U.S. Army Missile R&D Command, Redstone Arsenal, AL, is the first individual woman to receive the DARCOM Systems Analysis Award.**

Two groups and two individuals have been selected as recipients of the 6th Annual U.S. Army Materiel Development and Readiness Command Systems Analysis Awards.

Comprised of an engraved plaque and a citation certificate, the Systems Analysis Award is presented by the DARCOM commander, on an individual or group basis for noteworthy and outstanding achievements in Operations Research/Systems Analysis work. Consideration for the award is based on criteria in DARCOM Supplement 1 to Army Regulation 672-20.

All nominations are first reviewed by the subordinate command and forwarded to the DARCOM Incentive Award Board for command-wide competition. Winners are then selected based upon recommendations by the Board.

Aerospace engineers Mr. Lawrence L. Bishop, Mr. Roger P. Hoffman and Mr. Robert J. Flynn, and general engineer Mr. Gary W. Donald, all with the U.S. Army Troop Support and Aviation Materiel Readiness Command, St. Louis, MO, are winners of one of the two group awards.

They were recognized for their personal initiative and technical competence in conceiving and implementing the Reliability, Availability, Maintainability/Logistics Data Collection System for Army aircraft.

This system provides timely, accurate, integrated and comprehensive information in the technical and managerial areas of RAM operating and support costs and logistics. It is also considered more effective than the Army Maintenance Management System in dealing with various Army aircraft programs.

The RAM/LOG collection system was used initially on the Utility Tactical Transport Aircraft System (redesignated Black Hawk) during government competitive testing and is now under consideration for Army-wide application.

The other group award recipients are all from the Decision Models Directorate, Joint Conventional Ammunition Program, U.S. Army Armament Materiel Readiness Command, Rock Island Arsenal, IL. They are: operations research analysts Mr. Bernard C. Witherspoon (director of the Decision Models Directorate), Mr. Larry A. Guerrero, Mr. Robert L. Riedl, Mr. John B. Todaro, Mr. Kenneth W. Maly, Sr., Mr. Albert J. Patsche, Mr. Craig D. Porter, Dr. Thomas H. Short, and

Mr. Thomas D. Streeter, Mr. Norman V. Hoesly, Mr. George H. Martin Jr., Mr. Daniel R. Turk, Ms. Elizabeth M. Schwegler, Mr. James P. Watson III, Mr. George B. Bobinson, Mr. Edward J. Sharkness, and mathematicians Mr. Byron O. White, Mr. George E. Stiles II, and Mr. Alfonso G. Wright.

This group was commended for advancing the development and application of the systems analysis/operations research techniques in support of the historical transition from the Joint Service to the Army Single Manager of the Conventional Ammunition Production Base.

The Decision Models Directorate was also credited with identifying potential cost savings and deferrals of more than $440 million, and greatly influencing large-scale decisions regarding procurement, facilities construction and maintenance, materiel acquisition, mobilization and production planning, and other activities.

Mr. Walter E. Smythe, presently with the Training Center at the Red River Army Depot, was cited for earlier achievements while employed at the U.S. Army Missile Materiel Readiness Command, Redstone Arsenal, AL.

He was credited specifically for developing a computerized analytic logistics simulation program to identify missile items which could be adopted internationally on an interchangeable basis.

This program, termed the U.S. Economic and Logistics International Interchangeability Study, was published in March 1977 and has provided rationale and methodology which have reportedly been accepted without reservation.

Direct benefits of Smythe's work have provided a common methodology for evaluating the supportability of Roland hardware, and are expected to result in government savings of about $7 million annually.

Mrs. Jill Burt, a mathematician in the Advanced Systems Concepts Office, U.S. Army Missile R&D Command, Redstone Arsenal, AL, is the first individual woman to receive the DARCOM Systems Analysis Award.

She developed a force-on-force model for the analysis of land combat and multi-role weapons systems, and originated a code consistent with the existing PERCAM defense simulation. A description of her work is contained in a report titled *Development and Validation of a Land Combat Performance and Cost Analysis Model.*

## MERADCOM Presents 1978 Commander's Awards

Four individuals and one laboratory were honored on 29 September as winners of the U.S. Army Mobility Equipment Research and Development Command's 1978 Commander's Awards. Ceremonies were held at MERADCOM, Fort Belvoir, VA.

Presented annually for achievements in science, technology, leadership, and technical and administrative support, the Commanders' Award consists of a certificate, a plaque-mounted medal and a $50 honorarium, which each winner received.

This year a fifth Commander's Award was added to the list of presentations in order to provide recognition to one of MERADCOM's eight laboratories for outstanding performance. The FY 1978 winner in this category is MERADCOM's Electrical Power Laboratory.

Selected from among 35 nominees, the FY 1978 individual winners are:

**Scientific Achievement.** *Kenneth J. Oscar,* a physical scientist in the Camouflage and Topographic Laboratory, was recognized for outstanding insight and research analysis which led to establishment of camouflage scientific methodology for complex countersurveillance problems.

**Technological Achievement.** *Lynwood M. Rabon,* a general engineer in the Product Assurance and Testing Directorate, was selected for his standards of technical excellence in developing and implementing RAM techniques and methodologies.

**Leadership Award.** *David A. Vaughn,* a research physicist in the Countermine Laboratory, was chosen for his work as team leader and development project officer of the Track Width, Tank Mounter Mine Clearing Roller Program.

**Technical and Administrative Support.** *Elmer C. Sluss,* a research technician in the Camouflage and Topographic Laboratory, was cited for his outstanding contribution to the advancement of the state-of-the-art of laser interaction with materials.

Nominees in the Scientific Achievement category were: Amos J. Coleman, a research chemist in the Electrical Power Laboratory, for accomplishments in electrocalalysis as related to fuel cells; John C. Peterson Jr., Marine and Bridge Laboratory, for work in analyzing and modeling components of the "Bridging in the 1980s" program; Forrest Shaekel, Energy and Water Resources Laboratory, for his work in the structure and formulation of the fire-safe fuel program; Dr. Glenn E. Spangler, an operations research analyst in the Systems Analysis Division, for his achievements in basic and exploratory development of plasma chromatography to vapor detection and chemical analysis; and Claire L. Orth, a mechanical engineer in the Mechanical and Construction Equipment Laboratory, for achievements in adopting the Cone Index Mobility Model to rubber tired vehicles weighing over 100,000 pounds.

Nominees in the Technological Achievement category were: William R. Abell, Richard W. Helmke, James R. Bolton and Gerald F. Wilber, Marine and Bridge Laboratory, for their contributions to the design and fabrication of the Bridging for the 80s Transporter Launcher and Bridge; A. Roger Anzzolin, Daniel S. Lent, Robert G. Ross, and LTC Robert P. Carnahan, Energy and Water Resources Laboratory, for major contributions to the design, development and supervision of fabrication of the 600 GPH Reverse Osmosis Water Purification Unit; Benjamin C. Barker, Albert R. Zushin, Lawrence J. Nivert, Dale J. Rehak and 1LT Robert L. Fenton, Counter Intrusion Laboratory, for a team award for design and development of the Army's Facility Intrusion Detection System's Control, Communication and Display Subsystem; Anthony Paul Rabalais, a physical scientist in the Programs and Analysis Directorate, for his exceptional technical and analytical skills in developing a methodology which will allow the combat developer to assess fielded and developmental items to insure increases survivability of materiel on the battlefield; James T. Watson, a mechanical engineer in the Electrical Power Laboratory, for his efforts in the development of the Model D412A 10kw, 60 Hz gas turbine generator set; and Richard C. Weaver, a physical scientist, Countermine Laboratory, for his accomplishments in the engineering development of the SLUFAE Mine Neutralizer.

Nominees in the Leadership category were: Donald D. Faehn, a development project officer in the Electrical Power Laboratory, for leadership in applying solar photovoltaic power to military systems; Sideny O. Newman Jr., a general engineer, Programs and Analysis Directorate, for outstanding work as Team Leader for Engineering and Acquisition; John M. Short, mechanical engineer, Marine and Bridge Laboratory, for leadership in providing technical guidance and support to the development of the ribbon bridge erection boat; and Allan T. Sylvester, a general engineer in the Camouflage and Topographic Laboratory, for his work in coordinating the Camouflage Research and Development Program between users and developers.

Nominees in the Technical and Administrative Support category were: Helen B. Carmola, a program analysis officer in the Energy and Water Resources Laboratory, for her efforts during a severe staff shortage; Delores LePera, an administrative officer in the Counter Intrusion Laboratory, for her effort in writing the objectives of her organization; O.K. Newman Jr., a program analyst in the Programs and Analysis Directorate, for management of the In-Process Review Program; Egon Goldschmidts, Engineering and Logistics Management Directorate, for accomplishments in developing contracting procedures adapted to the Integrated Technical Documentation and Training concept; George G. Hendrickson, a logistics management specialist in the Marine and Bridge Laboratory, for logistics support to the development of the Lighter, Air Cushion Vehicle, 30T (LACV-30); and Bernard F. English, an engineering technician from the Mechanical and Construction Equipment Laboratory, for his technical support of a wide range of equipment projects.

**DR. KARY C. EMERSON (right), soon to retire deputy for Science and Technology in the Office of the Assistant Secretary of the Army (Research, Development and Acquisition), receives the Oklahoma Cross of Valor from Oklahoma Governor David L. Boren, during a recent visit to his native state. An internationally known biologist and author of a recently published account of his experiences as a prisoner of war in the Philippines and Japan during the Bataan "Death March," Dr. Emerson was cited for his meritorious and valiant military service to the nation and his state and in recognition of the privation and courage shown while a prisoner of war of the Japanese, 1942-45. He retired from the Regular Army as a colonel in 1966.**

# Career Programs . . .

## CSL Employes Get Army Training Fellowships

Secretary of the Army long-term training fellowships have been awarded to two research personnel at the U.S. Army Armament R&D Command's Chemical Systems Laboratory, Aberdeen Proving Ground, MD.

*Edward S. Bender,* a researh biologist in CSL's Environmental Technology Division began a year of studies in aquatic biology at the Virginia Polytechnic Institute and State University.

A federal civil service employe for seven years, he earned a BS degree in biology from Westminster College in 1969, and an MS degree in zoology from the University of Florida in 1971.

Prior to commencing his fellowship, he was involved in ecological surveys in support of pollution abatement, installation restoration, and preparation of environmental impact statements.

*Robert Armstrong,* a research pharmacologist in the Research Division, has begun his fellowship at the University of Maryland's School of Pharmacy. He is assigned to the University's De-

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partment of Pharmacy and Toxicology

An APG employe since 1963, he holds a BS degree in chemistry from the College of Wooster, and a master's degree in pharmacy from the University of Rochester's School of Medicine and Dentistry. He was engaged in behavioral toxicology studies prior his selection for the fellowship.

## Bunevich Begins Studies at Army War College

COL Peter C. Bunevich, deputy project manager for Programs at the U.S. Army Satellite Communications Agency, began studies in August at the U.S. Army War College, Carlisle Barracks, PA.

A 1954 graduate of the U.S. Military Academy, he holds an MA degree in economics from the Institute of Defense Analysis (Operations Research/Systems Analysis Program), and an MS degree in business management from Georgetown University. He has also completed the C&GSC, the ICAF correspondence course, and courses at the Defense Systems Management College.

Assignments during his 22 years of military service have included commander, Communications-Electronics Installation Battalion, Fort Huachuca, AZ; systems engineer, National Military Command System, Defense Communications Agency; and staff officer, Office, Chief of Research and Development, Department of the Army.

Bunevich has also served overseas tours as an adviser J-6 in Vietnam, and as a fixed plant engineer with the Communications Agency, U.S. Army Europe. He is currently responsible for planning and implementing SATCOMA's activities related to DOD satellite communications ground systems.

## Boucher Selected for Mid-Career Fellowship

Mr. Paul J. Boucher, an operations research analyst with the U.S. Army Satellite Communications Agency, has been chosen as a mid-career Fellow at Princeton University's Woodrow Wilson School of Public and International Affairs.

Paul J. Boucher

Selection for the year-long program is based upon outstanding prior performance and high potential for significant future contributions in key executive positions within the federal career service.

Currently assigned as chief, Systems/Cost Analysis Division, Boucher is credited with performing a study on the Defense Satellite Communications System which resulted in important modifications for first generation satellite communications terminals and multi-million dollar government cost savings.

Federally employed since 1965, he served earlier career assignments as a research chemical engineer at Edgewood Arsenal, the U.S. Army Munitions Command, Picatinny Arsenal, and the Systems Cost Analysis Office at the U.S. Army Electronics Command.

He holds a BS degree in chemical engineering from the University of Rhode Island, and an MS degree in operations research from Columbia University. Additionally, he has published numerous technical articles and has completed the Command and General Staff College non-credit course.

## Petrick Elected to SAE Board of Directors

Dr. Ernest N. Petrick

Dr. Ernest N. Petrick, chief scientist, U.S. Army Tank-Automotive R&D Command, Warren, MI, has been elected to the Board of Directors of the Society of Automotive Engineers (SAE). SAE is the principal technical society of the automotive and trucking industry and boasts a membership of about 40,000 worldwide.

Active in a number of SAE programs, Dr. Petrick has served also as a member of the Vehicle Research Institute and on several government advisory groups, including service as head of the Transportation Panel which is charged with initial preparation of the National Energy Program.

Prior to his employment with the Department of the Army, he was chief of Advanced Propulsion Systems at Curtiss-Wright Corp., and served as chief research engineer with the Kelsey-Hayes Co.

## CSL Names 5 Members to Interdisciplinary Board

Selection of five new members to serve on the U.S. Army Chemical Systems Laboratory's Interdisciplinary Board has been announced by CSL Deputy Director Dr. B. L. Harris.

Established in 1974, the Interdisciplinary Board provides a communications link between scientists and engineers, and promotes an interchange of technical information. Its principal function is to open a direct line of communication with the deputy director's office.

The board is comprised of at least seven but never more than 11 members who serve a 2-year term. A minimum of four, but never more than seven members can be appointed to the board during any one fiscal year.

Members are chosen from a cross-section of CSL company grade military officers assigned to research and development positions and from civilian engineers and scientists through the grade of GS-12.

The new appointees are Alexander Michiewicz, Research Division; Susan Fowler, Physical Protection Division; Bruce Lewbart, DOE Support Office; CPT Carlin V. Okerberg, Biomedical Laboratory; and Richard Simak, Munitions Division.

### Reaches 132-Mile Altitude. . .

## Navy Rocket Carries Student's Science Project

Excitement of seeing one of his scientific experiments flown to an altitude of 132 miles—as a piggyback part of the instrumentation payload of a Navy atmospheric sounding rocket, launched primarily for the National Aeronautics and Space Administration—came recently to Steven Walker, an El Paso, TX, high school senior.

Walker participated in 1977 in the Army-industry-academia sponsored 15th annual National Junior Science and Humanities Symposium at the United States Military Academy, West Point, NY. He has been interested in the U.S. space program since his grammar school days.

When he learned that NASA had scheduled an Aerobee F rocket flight from the Naval Ordnance Missile Test Facility's Launch Complex 35, Walker contacted officials about the possibility of also carrying his experiment. Dr. George Carruthers, a research physicist from the Naval Research Laboratory, Washington, DC, sponsored him and the request was approved.

Walker's interest in space science was stimulated while he was a third grader and he remembers clipping news media reports on the Gemini and Apollo flights. While he was a high school freshman he read about Russian scientists studying the effects of acceleration on algae, for possible use in a gas exchanger in a life-support system.

"I spent almost a year doing library researh before I began the laboratory work," Walker said, and this became his first high school science fair project. "Two years ago I found out that the algae cells were affected by acceleration from model rockets I was using."

Walker's purpose in the Aerobee F experiment was to collect better data on how acceleration and radiation exposure reduce gas production as an oxygen supply source for astronauts, as compared to chemical canisters. Twelve insulated culture tubes of chlorella were prepared for the test.

Walker's goal is to obtain a doctorate in biology and then to apply for the astronaut training program. If not selected as an astronaut, he says he still wants to work on the space program as a research scientist.

Currently undecided about where he will enroll as a student next fall, Walker is considering a 4-year, tuition-paid offer from Utah State University, Logan. The offer includes $500 a year for research and an opportunity to work in the university's space laboratory.

# Personnel Actions . . .

## Means Takes Over 32d Air Defense Command

MG Charles F. Means

MG Charles F. Means, commander of the U.S. Army Missile R&D Command since July 1977, has taken over new responsibilities as commander of the 32d Air Defense Command, headquartered in Darmstadt, Germany.

A major element of U.S. Army Europe and the North Atlantic Treaty Organization defense, the 32d Air Defense Command has more than 15,000 soldiers in combat ready units dispersed throughout the Federal Republic of Germany to protect NATO Forces from air attack.

MG Means, whose career has been spent largely in missile R&D or missile-armed Army combat units, was the Army project manager for the Patriot air defense system for four years prior to joining MIRADCOM.

He graduated from the U.S. Military Academy in 1950, has a master's degree in aeronautical engineering from the University of Michigan, and has completed the Army Command and General Staff College and the Army War College.

Included among his earlier duty tours were assistant deputy chief of staff for Plans and Programs, North American Air Defense Command; Army member, Weapons Systems Evaluation Group, Office Secretary of Defense; and commander of the 24th Artillery Group composed of Nike Hercules units in Connecticut, Rhode Island, and Massachusetts.

## Ragano, Lax Get New Redstone Assignments

BG Frank P. Ragano

BG Joseph O. Lax

BG Frank P. Ragano, former project manager for the U.S. Roland air defense guided missile system, has succeeded MG Charles F. Means as commander of the U.S. Army Missile Research and Development Command, Redstone Arsenal, AL. BG Ragano has been nominated for 2-star rank.

Recognized as one of the Army's leading authorities on international advanced weapons development efforts, BG Ragano has managed the Roland project since 1976 and is being succeeded in that assignment by BG Joseph O. Lax.

BG Ragano has completed more than seven years of continuous service as an Army project manager, including assignments as PM for the 2.75-inch rocket, and PM for Cannon Artillery Weapons Systems.

Initially assigned to Redstone Arsenal as a colonel in 1973, he served from June 1971 until Ocotber 1972 as director, Organization and Theory Studies, Department of Management, U.S. Army War College, Carlisle Barracks, PA.

BG Ragano graduated with a BS degree in engineering from Duquesne University and with an MBA degree from Syracuse University, and has completed course requirements at the Army Command and General Staff College and the Army War College.

His military decorations include the Legion of Merit with two Oak Leaf Clusters (OLC), Air Medals, the Joint Service Commendation Medal, Army Commendation Medal with OLC, and the Meritorious Service Medal.

BG Lax was, until assigned to his new duties as Roland PM, project manager for Viper-Advanced Heavy Antitank Missile Systems. He joined Redstone Arsenal in 1977 after serving as commander of the 7th Infantry Division Support Command, Fort Ord, CA.

Listed among his earlier tours of duty are project manager, 1¼-Ton Commercial Truck System, U.S. Army Tank-Automotive Command, Warren, MI; G-4, 4th Infantry Division, Fort Carson, CO; and commander, 705th Maintenance Battalion, Fort Carson.

BG Lax holds a 1953 BS degree in chemistry from The Citadel and a master's degree in industrial management from Babson Institute. He is also a graduate of the Army Command and General Staff College and the Army War College.

His Military honors include the Legion of Merit, the Bronze Star Medal, the Meritorious Service Medal, and the Army Commendation Medal with Oak Leaf Cluster.

## Hemphill Follows Packard as CDEC Commander

BG John A. Hemphill

BG John A. Hemphill is the new commander of the U.S. Army Combat Developments Experimentation Command, Fort Ord, CA, following the retirement from active military service of BG Donald F. Packard.

A 1951 graduate of the U.S. Military Academy, BG Hemphill served formerly as chief of staff of the 7th Infantry Division. During 1972-75 he was commander, 3d Brigade (Airborne), 101st Airborne Division, and later director, Company Operations Department, U.S. Army Infantry School.

Other career assignments have included deputy brigade commander, 173d Airborne Brigade, Vietnam; commander, 3d Brigade, 9th Infantry Division, Vietnam; deputy G3, 1st Cavalry Division, Vietnam; and assistant intelligence officer, 7th Division Headquarters.

BG Hemphill has completed requirements at the Air Command and Staff College, the Armed Forces Staff College, and the U.S. Army War College.

He is a recipient of the Distinguished Service Cross, Silver Star with Oak Leaf Cluster (OLC), Legion of Merit with three OLC, Distinguished Flying Cross with OLC, Bronze Star Medal with "V" and four OLC, Meritorious Service Medal, Air Medal with 19 OLC, Army Commendation Medal with OLC, Purple Heart with two OLC, and the Combat Infantryman Badge (2d award).

## Lycan Heads Engineer Topographic Laboratories

COL Daniel L. Lycan

COL Daniel L. Lycan, following a 3-year assignment as Rock Island (IL) District engineer, recently assumed new duties as the 11th commander and director of the U.S. Army Engineer Topographic Laboratories, Fort Belvoir, VA.

Commissioned in the Regular Army following graduation from the Reserve Officer Training Corps, COL Lycan holds a 1952 BS degree in civil engineering from the Massachusetts Institute of Technology, and MS and PhD degrees from the University of Illinois.

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A registered professional engineer in Mississippi, his military schooling includes the Army Command and General Staff College and the Army War College.

Listed among his earlier career assignments are assistant to the director, U.S. Army Engineer Waterways Experiment Station, Vicksburg, MS; and commander, U.S. Army Computer Systems Command Support Group, Presidio of San Francisco, CA.

COL Lycan wears the Legion of Merit, Meritorious Service Medal with Oak Leaf Cluster (OLC), Army Commendation Medal with two OLC, Air Force Commendation Medal, and the Vietnamese Gallantry Cross with Silver Star.

## Spence Succeeds Brooke as CSL Commander

COL John D. Spence recently succeeded COL Stafford R. Brooke as commander/director of the U.S. Army Armament Research and Development Command's Chemical Systems Laboratory, Aberdeen Proving Ground, MD.

Formerly assigned as HQ U.S. Army Materiel Development and Readiness Command associate director for Plans, Doctrine and Systems, COL Spence is a Chemical Corps officer and was commissioned through Officers' Candidate School.

Preceding his HQ DARCOM tour he was chief of Plans in the Office of the Deputy Chief of Staff for Research, Development and Acquisition, following an assignment as a battalion commander of an advanced individual training unit at Redstone, Arsenal, AL.

He has served also as chief of Unit Training, Military Assistance Command, Vietnam; chief, Materiel Branch, Chemical-Biological-Radiological Agency, Fort McClellan, AL; and as division chemical officer and deputy assistant chief of staff, G3, 7th Infantry Division, Korea.

COL Spence holds a BS degree in business from Roosevelt University, an MS degree in business management from Central Michigan University, and has completed course requirements at the Command and General Staff College and the Army War College.

Included among his military decorations are the Bronze Star Medal with Oak Leaf Cluster (OLC), Meritorious Service Medal with two OLC, and the Army Commendation Medal with two OLC.

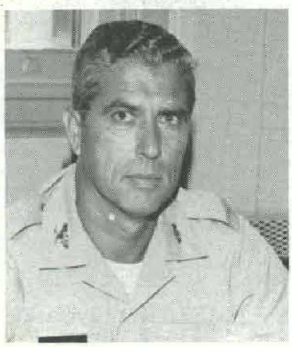
COL John D. Spence

## Denmark Heads CSL Detection/Alarms Division

COL Sumner J. Denmark recently succeeded COL John A. Mojecki as chief of the CB Detection and Alarms Division, U.S. Army Armament Research and Development Command's Chemical Systems Laboratory, Aberdeen (MD) Proving Ground.

From 1975 until his appointment to CSL, COL Sumner served as a battalion commander and later as executive officer at the U.S. Army Missile and Munitions Center and School, Redstone Arsenal, AL.

Other key assignments have included faculty advisor at the Armed Forces Staff College, Norfolk, VA, and a 2-year tour of duty in the Logistics Division, U.S. Army Military Personnel Center, Alexandria, VA.



COL Sumner J. Denmark

Graduated with a BS degree in chemistry from the University of Georgia, COL Sumner has completed the Army Command and General Staff College, the Armed Forces Staff College, the Chemical Career Course, and the Basic Infantry Course.

He wears the Bronze Star Medal, Meritorious Service Medal with Oak Leaf Cluster (OLC), Joint Service Commendation Medal, and the Army Commendation Medal with OLC.

# Army R&D — 15 Years Ago

*The Army R&D Newsmagazine reported on . . .*

## Army Prepares Pilot Program for PM Offices

Department of Defense emphasis on the project manager approach to development of weapon systems is behind a new Army pilot program, "Career System for Staffing Project Management Offices."

Approved by Secretary of the Army Cyrus R. Vance, and developed under his instructions following discussion with Secretary of Defense (Manpower) Norman S. Paul, the program is to be implemented by Army Civilian Personnel Regulation CP–2.

The Army program is designed to serve as a pattern for broader use in coordination with the Office of the Assistant Secretary of Defense (Manpower). Objectives include: To attract, develop and retain the highest quality manpower to meet staffing requirements of Department of the Army project management offices through the U.S.

Initially, the pilot program will be limited to the 35 (present total and subject to change) project management offices within jurisdiction of the U.S. Army Materiel Command headed by LTG Frank S. Besson Jr.

Selection, placement, promotion and reassignment of personnel for project manager positions will be in accordance with the Federal Civil Service merit promotion system. An Army-wide career referral system will utilize qualification inventory records within Civilian Personnel offices, to ensure that the most capable individuals are identified and considered for each project.

## STINFO Plans for R&D Engineering Data System

Activation of an R&D Engineering Data and Information System is one of the objectives in development of the over-all Army Scientific and Technical Information Program.

A letter of instructions for a planning meeting at U.S. Army Research Office Headquarters in Arlington, VA, called for representation from four elements of the U.S. Army Materiel Command—Mobility, Munitions, Weapons and Missile Commands—and Corps of Engineers.

Preliminary discussions at the meeting will be directed toward the preparation of a detailed study of the Army-wide problem of establishing a total automated Army RDT&E Engineering Data and Information System. The study is to begin the second quarter of FY 1964.

As envisioned by leaders of the Army Scientific and Technical Information Program (STINFO), the system would provide for automated encoding, storing, retrieving and transmitting of RDT&E engineering data and drawings in the form of a digital or computer language. The system would complement the microfilm facility at the U.S. Army Missile Command, Redstone Arsenal, AL.

## AMC First-Year Operation Saves $252 Million

First anniversary festivities of the U.S. Army Materiel Command were highlighted by cost reduction type savings of $252 million and increased effectiveness.

Under leadership of LTG Frank S. Besson Jr., the AMC was credited with exceeding by $25 million the $227 million goal assigned by the Department of Defense Cost Reduction Program. Authorized civilian and military personnel strength was pared from 191,000 to 179,000 by consolidation of activities and streamlining in operating procedures.

# Laser Induced Chemistry Promises Cost Reduction

**By Dr. James A. Merritt**

One solution to energy-related problems may be found in laser induced chemistry (LIC) synthesis of new materials or cheaper production of old materials.

The laser, one of the most significant scientific developments to date, has only recently begun to be exploited for use toward detailed elucidation of basic phenomena and "spin-offs" for technology, especially in the field of chemistry.

Chemical change involves energy gain or release, whether it involves the forming of one compound into another or an internal change of state. This energy corresponds to various parts of the electromagnetic spectrum from the vacuum ultraviolet to the far infrared.

It is estimated that these energy-related transformations compose 75 percent of the basic research projects supported by the National Science Foundation chemistry funds. They are the basis for most chemical research today, including synthesis, molecular dynamics, and analysis.

The fabrication of new compounds that can be used to improve human health, comfort, and well-being, is the very core of synthetic chemistry. Using laser radiation to synthesize chemical compounds in higher yield, greater purity and, with less expense than can be obtained by conventional methods, has been a possibility intriguing to many research workers.

One of the research programs in the Quantum Physics Group of the Missile Research Directorate at the U.S. Army Missile Research and Development Command (MIRADCOM) involves the above application of laser chemistry and spectroscopy to energy supply.

High performance solid propellant fueled rocket motors require burning rate stabilizers to achieve fast burn rates. New propellant compositions that have improved ballistic and mechanical properties have been developed using carborane compounds.

Carboranes are prepared by reacting the appropriate acetylenic hydrocarbon with decarborane-14. Presently, n-hexylcarborane (NHC) is considered to be a prime candidate for rocket and guided missile fuels.

The price and quantity limiting factor in the supply of NHC is the lack of a safe, clean and inexpensive industrial process for synthesizing large quantities of decarborane-14 (commercially available for about $2,000 per pound).

Thermal (pyrolysis) methods of influencing chemical processes lead mainly to the excitation of all degrees of freedom of the molecule. Both external (translational) and internal (electronic, vibrational, and rotational) degrees of freedom are usually in thermodynamic equilibrium.

In addition to being an unproductive waste of energy, reactions with equilibrium excited molecules characteristically proceed in the direction of breaking the weakest bond, have a considerable percent of back reaction, many side reactions, and produce polymers.

A new approach to the problem of chemical conversions of substances would be to consider the possibility of influencing not a molecule as a whole, but its individual bonds. Such a method of selective excitation can be realized by means of lasers.

Laser induced chemistry reactions leading to the production of solid decarborane-14 have been demonstrated by Dr. James A. Merritt and coworkers (Drs. George Tanton, Harry Meyer, Charles Bowden, and Mr. Larry Warren) in the Missile Research Directorate.

Diborane, $B_2H_6$, was irradiated in a reaction cell, with a CW $CO_2$ laser at room temperature and white crystalline decarborane-14 began to form immediately on the cell walls. The decarborane-14 was produced in higher yields and purity than has been reported for pyrolysis. This means a significant potential cost savings.

Merritt's group has been able to produce decarborane-14 using both $CO_2$ and DF laser radiation to induce the reaction. The two laser frequencies interact with different fundamental vibrations of the $B_2H_6$ and in both cases the decarborane-14 was produced with high yields and purity.

LIC has also been used by this group to demonstrate the removal of trace impurities without degradation of the host material. Boron trichloride, $BC1_3$, a material used extensively in the electronics and plastics industries, is contaminated with the trace impurity phosgene, one-tenth percent.

$BC1_3$ was irradiated with a $CO_2$ laser for 1 sec to completely remove the phosgene without any destruction of the $BC1_3$, again illustrating a cost-effective use of laser induced chemistry.

Other applications of LIC demonstrated by Merritt and his coworkers include isomerization of hexafluorocyclobutene to the hexafluorobutadiene, synthesis of the mixed halides (fluorine and chlorine) of boron from $NF_3$ and $BC1_3$ and other synthesis.

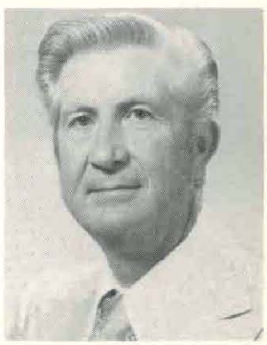
All of the above laser induced chemistry was conducted at room temperature and with a low energy flux. The results give high yields, high purity and indicate simplification of chemical engineering. Thus, a substantial cost savings can be realized.

The potential applications for LIC are diverse and offer significant advances in areas of new synthetic routes for pharmaceuticals, shaped photopolymers, metal complexes for homogeneous and heterogeneous catalysts, etc.

Many new products and processes may be anticipated to emerge shortly which owe their genesis to the unique properties of lasers. It has been estimated that thousands of materials are potentially amenable to laser chemistry and that substances costing more than $1 a pound offer promising targets for its cost-effective utilization.

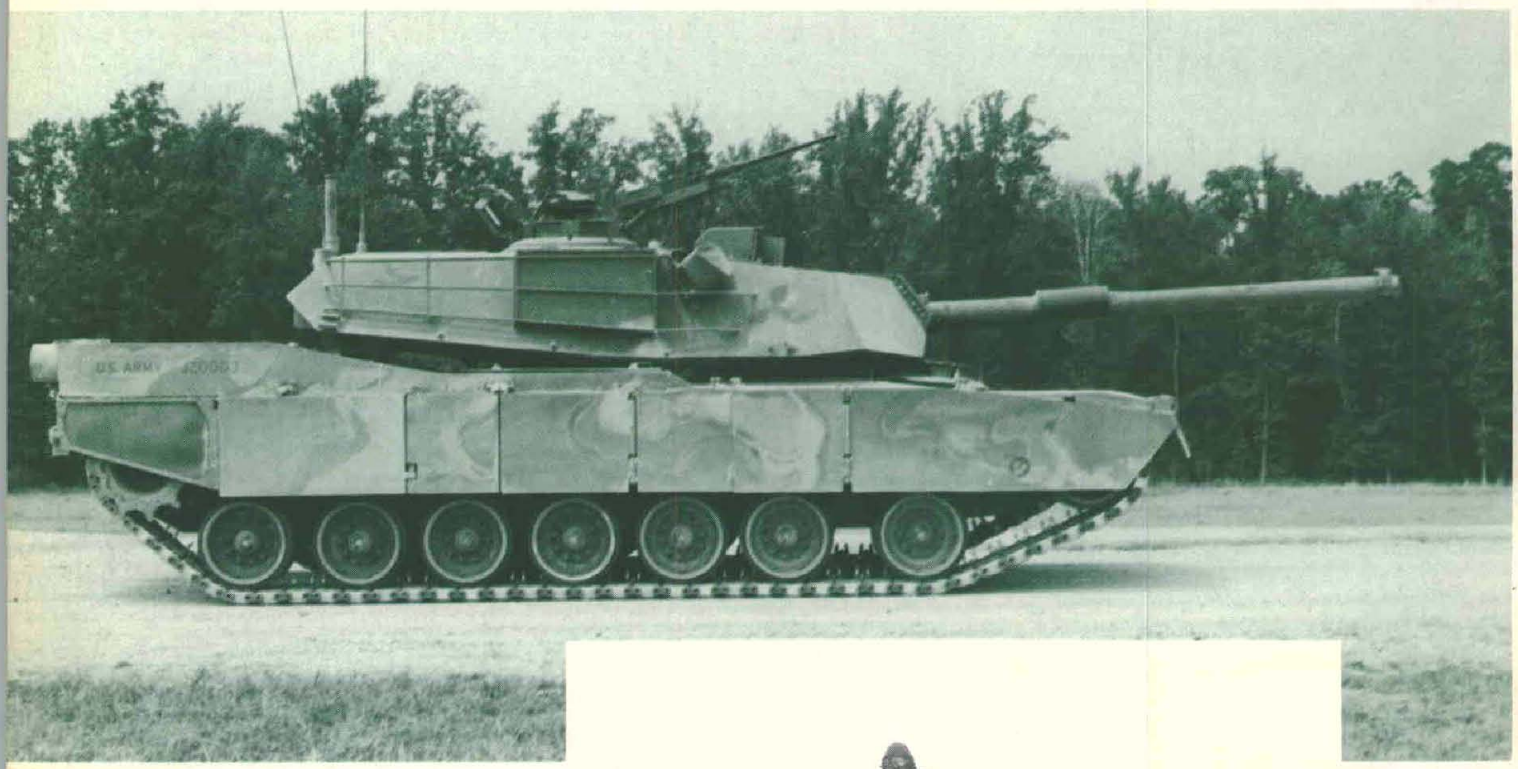
When the cross-excitation between the vibrational modes of the molecule is slow enough then laser radiation can be used to induce many chemical reactions, producing a high "pay-off" for cost-effective Army fuels materials, and missile propellants.

Merritt and others in the Missile Research Directorate are now examining other possible applications for LIC. For example, they are experimenting with the use of LIC to produce pure silicon for semiconductors and difficult-to-synthesize refractory materials, used for high-temperature linings and coatings. Many such uses for LIC are anticipated, and they can all save the Army money.



*DR. JAMES A. MERRITT is acting group leader of the Quantum Physics Group of the Missile Research Directorate at the U.S. Army Missile Research and Development Command, Redstone Arsenal, AL. Graduated with a PhD in physical chemistry from Vanderbilt University, he has been employed at Redstone Arsenal since 1959, and has served as a supervisory research chemist involving programs related to molecular structure spectroscopy, chemical laser research, rocket fuels, and laser photochemistry.*

U.S. GOVERNMENT PRINTING OFFICE: 260-828.6



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*(See Feature on p. 6)*