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ABOUT THE COVER:

Displayed on the front cover is the AN/MLQ-34 TACJAM—a high powered UHF communications jammer. This photograph relates to a feature article on tactical intelligence/electronic warfare. The back cover shows four operating positions of a scroll compressor/expander (air conditioner). A detailed description of this drawing appears with an article on the same subject in this issue. Cover designed by Christine Deavers, HQ AMC Graphics Section.

FEATURES

DEPARTMENTS

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Exclusive Interview . . .

GEN Maxwell R. Thurman
Army Vice Chief of Staff

Q. You have expressed strong support for downsizing equipment in order to enhance deployability. What do you have in mind?

A. Well, I'll give you the case of TACFIRE. TACFIRE is a revolutionary piece of equipment for the U.S. field artillery. TACFIRE was a long time in being produced. It is fielded in a five-ton truck on a 280 shelter. Commercial computers are available that would do the same job and fit in a 250 shelter, which goes on the back of a HMMWV.

The instant that the system was brought into the inventory, we should have downsized it with the immediately available computer. However, people might say more R&D would be needed because the computer wasn't adequately tested. I don't buy that. I think that's a copout. I think we must place a premium on smallness, and structure the procurement strategy so that we can pre-qualify the smaller computer.

The Army inherently believes that bigness is good and that it's perfectly all right to have a large logistical tail because we assume in the end that transportation is free and human labor is free. We must change our thinking on this because labor is not free, it's very expensive. The fixed end strength of 780,000 active military is a fact of life and we've got to learn to be a better Army within that limitation.

The Army must get things slimmed down. One way to do that is to write contracts that place a premium on smallness. NASA understands how to do this. They want miniaturized components because extra size and weight for them is very expensive. So they get it small.

We don't have that notion. Our notion is, gee whiz, let's get the Navy to drive up six more ships, get the Air Force to drive up another 10 airplanes and we'll somehow get all that stuff deployed. We can't afford it. We have to think small.

". . . we have very high quality people, and very high quality people ought to have the very highest quality equipment that American industry can produce."

Q. Can you report on any new developments relative to the establishment of the Army's new Light Infantry Division?

A. Yes. As you know, we are now getting some very high quality equipment to make our current heavy divisions the world's best heavy divisions. This equipment includes the M1 tank, the M2 and the M3 Bradley Fighting Vehicle, the TPQ36 and 37 artillery locating radars, the Apache attack helicopter, and the Blackhawk utility helicopter. All of these items are coming off American assembly lines as a result of the the great work of the Army Materiel Command and American industry.

Having done that, I want to emphasize that we are directing our efforts at reducing excess equipment and minimizing manpower while maximizing the division's ability to perform its mission. Therefore, in the Light Infantry Division we laid the marker down to get the number of C141B sorties down below 500.

The redesign of that division calls for the principal weapon to be the world's best infantryman who can live on the ground, go to ground, and use infantry weapons and night vision devices in order to operate as well at night as during the day.

Critics may very well say that the mechanized forces have all the edge. I would respond by stating that they don't have the edge in restrictive terrain, or in urban areas.

So, we are establishing light forces that can be deployed with minimum airlift, get where they're going and do a dynamite job. Now, the innovations necessary to get the equipment light are what I talked about in downsizing. For example, we are not going to put the ordinary, garden variety TACFIRE into the Light Division. What we're going to use is the Battery Computer System. It's going to be used for the initial deployment and then, when we get a "suitcase" TACFIRE, we'll give that to the light forces.

We are going to restructure the 7th Infantry Division as our first light division. They're going to get priority on receiving a relatively standard fleet of light vehicles like the HMMWV. They will also have a few five tons in the support elements. The overall quantity of vehicles in the Light Infantry Division is significantly reduced when compared to the standard infantry division. This, in its own right, will begin to reduce the spare parts problem and the logistical tail. For example, PLL and the ASL will not be computed or stored in the same manner, as it would be in a standard division.

We will lease some British light howitzers to see if they meet our requirements. If they do, then we will consider fielding them with our units.

We are also challenging AMC to expand its efforts in the composite materials field in order to produce a lighter howitzer.

Q. **The Army is now fielding a substantial amount of advanced technology equipment. Do you believe this is going to require higher quality individuals to operate it?**

A. I guess I might turn this question around by stating that we have very high quality people, and very high quality people ought to have the very highest quality equipment that American industry can produce. General Vessey often comments that he has a son who is a helicopter pilot and he hopes that he will fly the very best helicopters that can be produced by American ingenuity.

I don't believe it is possible to have too many high quality people. The real question is how do we determine if we have high quality people? We can measure the number of high school graduates, or we can measure the number of people who score in the upper half on various types of tests, such as armed forces qualifications tests or scholastic aptitude tests.

A final point is that if we consistently seek high quality and excellence, then people will perceive themselves as excellent and act in an excellent manner. This, in turn, will connote to the American public, including American youth, and to our adversaries that we have a very high quality Army. Therefore, seeking high quality people, irrespective of the high technology of equipment, is very important.

Q. **Do you believe that Army equipment is being designed with enough emphasis on the man-machine interface?**

A. We do not do well at expressing to industry the human dimension when they design a piece of equipment. We try to address this by letting soldiers work with the equipment as it is being put together in the R&D phase. From that, we determine the way in which that equipment should operate.

We have a long way to go in speaking to designers about the ability of our soldiers to perform certain tasks so that they can come up with the best design.

We've done some studies with the Army Research Institute—what we call reverse engineering studies—of some of our newly fielded systems. These studies look at the process of operating the system in the field. We then go back through the design process and see if we could have spoken to the designer in a different way so that he could make the equipment even easier for the soldier to operate.

We have found that there is a lot more that can be done in the early design phase of a system to avoid human factors problems. It is something the whole Army needs to work on.

Q. **Can you cite some specific areas where you believe the Army's materiel acquisition process could be streamlined?**

A. Yes. I would say that if we can get more into non-developmental item (NDI) approaches, we can streamline the process. Now, we need more concurrent staffing of many of the required operational documents. We have a process, for example, that says a ROC has to go all around the world for staffing—it has to go out to all the major commands for staffing. We have tried to shortcut that system by giving TRADOC more license to act as the official requirements generator and stop staffing the document worldwide if we already know that the need exists.

If we know it's a hard and fast requirement, then don't staff it worldwide in order to get everybody to have it pass through their in box. We simply have to speed up the processing of requirements documents and reduce the bulk of the document.

We're working a major NDI approach right now, Mobile Subscriber Equipment. It is a major test case of the Army's ability to buy tactical communication equipment off-the-shelf. What we're saying to industry is, "Bring in the system. Don't tell us how good it's going to be. Bring it in and we'll test it." That's quite revolutionary for us.

I had a truck manufacturer come in and talk to me about three months ago. He asked if the Army would like to put up some R&D money for a new truck. I said, absolutely not; if you've got a new truck to sell us, you put up the R&D money. You build the truck, get it out on the test track and check it out. Then when you complete the tests bring it in to us and we will look at it. That is what he did.

We need to talk to the entrepreneurs in American industry about what the real needs of the Army are. Then they can invest their IR&D funds in things that matter to the Army.

General Bill Richardson, TRADOC commander and General Dick Thompson, AMC commander, are trying to open up that dialogue. AMC has had that dialogue going for many years, but they're expanding it. I'm trying to do that as the Vice Chief of Staff. Under Secretary of the Army James Ambrose is trying to do that. All of us are trying to stimulate the dialogue with industry, tell industry what the true needs of the Army are so the government's R&D funds and industry's own funds are put to good use for things which are really required by the

"We have found that there is a lot more that can be done in the early design phase of a system to avoid human factors problems. It is something the whole Army needs to work on."

Army.

The difficulty is converting that IR&D product into a purchase for the Army. The bureaucratic tendency is to start the whole acquisition process from the beginning. That's not good. The solution is the NDI approach.

Another point I want to make concerns the dialogue that must ensue between industry and the Army if industry runs up against technological barriers. Industry has to have a dialogue with the Army so that they don't continue to work on something that clearly is not feasible to produce.

And finally, if we wait until a system is perfect, we may have to wait 10 years to get it, but if we're willing to accept a lesser capability up front and improve it later, then we can shorten the process. I call this the block concept. Fielding Block I as soon as possible, after reasonable testing, then pre-plan growth to Block II and Block III. The Army is behind in this concept. The Air Force and the Navy are ahead of us.

I'm not trying to sell this as the approach to everything, but I'm suggesting that if top management begins to look at what is possible we could very well take an evolutionary approach on a number of systems, as opposed to trying to go for the moon at the outset and then never quite reaching it.

Q. Critics of the Army's readiness rating system claim that it does not accurately reflect the Army's overall readiness posture. Does the system need to be revised?

A. Sure, the system needs to be revised. However, the inaccuracies are not necessarily the fault of the readiness rating system. The system is much more complex than that because it includes the TO&E, the MTO&E, the logistics system, and the personnel system. All of these are interrelated in the readiness system. A good case is the M1 tank battalion. Right now an M1 tank battalion should have 23 HEMMT trucks, but there aren't any HEMMT trucks in the Army inventory. The HEMMT truck hasn't passed its final test yet.

Meanwhile, the battalion or TO&E calls for 23 HEMMT trucks. Since we don't have any HEMMT trucks, we have to substitute five-ton trucks. So then the battalion commander has to measure what he has on hand against what he is supposed to have and he doesn't look very good. However, is he better off with the M1 than he was with an M60 tank? The answer is clearly yes, even though there's a problem with the right number of trucks. Unfortunately, we are caught up in the bureaucracy of documents and the bureaucracy of the way in which we account for things to the extent that it masks the true readiness of the unit.

So if you ask me if the Army's readiness system needs review and overhaul, the answer is yes, but it encompasses more than AR220-1. It encompasses the whole logistics chain, the whole personnel chain, and the whole documentation process. But if you ask me if the Army is in better shape than it was four years ago, the answer is a resounding yes. Five hundred Blackhawks, 2,000 M1 tanks, 1,000 Bradleys—all point out we're much better off and have substantially better readiness. From a personnel standpoint, four years ago we were taking 50 percent high school graduates in our units. Today it's 90 percent. This is a dramatic improvement.

Q. The process of establishing a requirement for a new system is sometimes said to be too lengthy. Are there any specific plans to expedite the system?

A. Yes. I think the whole process that we're using with the 9th Infantry Division gives the Army the capability to have industry present what they think is useful for us and demonstrate it. Then a requirements document can be written very rapidly.

If you can operate a system on exercises with troops, wring it out a little bit in the operational context, then you can write the requirement a lot faster.

Q. What are your immediate and long-term objectives for the Army?

A. One of my roles might be compared to what used to be known as the Army's Assistant Chief of Staff for Force Development. I am trying to address some of the problems you just asked about, such as the documentation system in the Army. If I can get the documentation system in the Army under control, and if I can get whole units fielded, like we do with PATRIOT and Pershing, then readiness will be under control. The air defense community has fielded whole units for years. PATRIOT is an example. We activate air defense units at Fort Bliss, TX, where we shoot bullets or missiles, and then the whole unit is moved overseas. We then have a whole block unit set of equipment and everybody falls in on it and you are ready to go to war.

However, during the fielding process for most systems, we buy too many "eaches." For example, we buy 5,000 SINCGARS Radios, we buy 3,000 five-ton trucks, we buy 30,000 rifles. We buy "eaches" instead of units. We should be buying units. We should say we want to field 10 M1 battalions this year, 10 Bradley units and 10 MLRS units, and we ought to buy all the infrastructure needed to field them. We don't do it that way. Instead, we have an objective thing called the AAO (Authorized Acquisition Objective). We say we need 100,000 trucks, so we buy 5,000 a year. If you do that then you can guarantee yourself that your readiness reporting system is going to tell you that you are short because you are not buying enough to fill all the units at once. The HEMMT truck is an example. Do you think we bought enough HEMMTs in one year to satisfy all demands? The answer is of course not. Then somebody has to prioritize who gets the HEMMTs. Now, we are back into the documentation problem.

We are changing that with the way in which we are about to purchase signal equipment. When we distribute SINCGARS and Mobile Subscriber Equipment we are going to do it by Corps sets. And further, when the Corps get their sets so will their associated Reserve and National Guard units.

Another goal that I have is to field JSTARS and an extended range MLRS. The JSTARS will be to the U.S. Army what the AWACS is to the Air Force. The JSTARS will begin to tell us the movements of the hostile forces in sufficient time to best position our own forces in order to take advantage of the speed, mobility, agility and firepower of our own forces. JSTARS will revolutionize the way in which our commanders have information on which to plan and execute their battle plans. It is a very high priority system and we are going full speed to get that particular system developed.

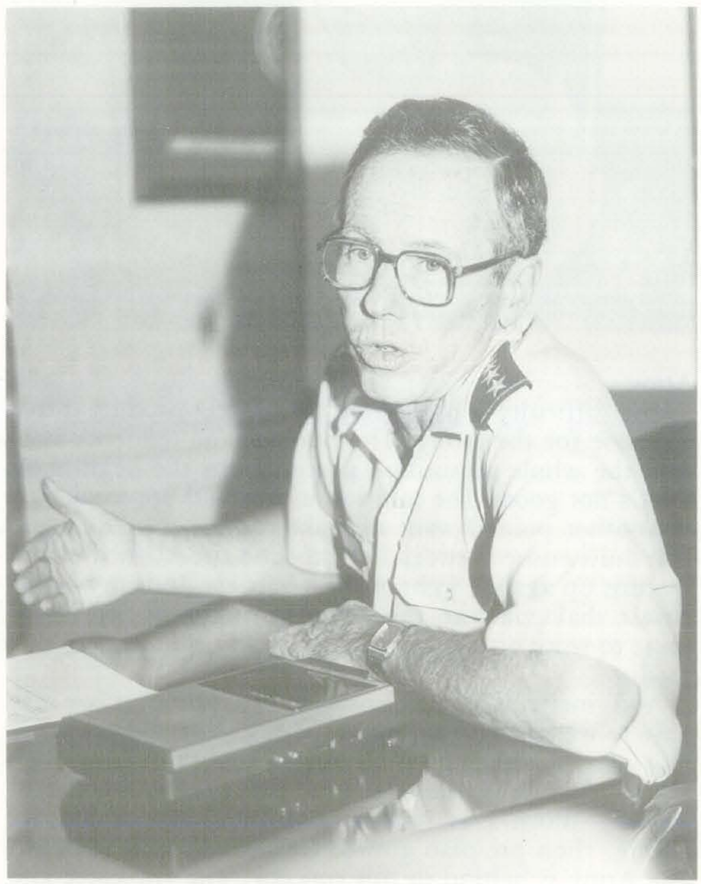
We now have very good intelligence, fire support and maneuver capability from zero to 30 kilometers deep into the battlefield. The the next thing is to extend that capability from the 30 kilometer line out to the next line which may be 80 kilometers or perhaps 150 kilometers. So, a high priority, on my part is to field the JSTARS to find the targets, and to field a longer-range MLRS system to attack them.

Finally, I want to open up a dialogue with industry to find the new technologies that will make a difference in an end-strength constrained Army. I am talking about the technologies that will make a difference in 1990, 1995 or in the year 2000. These are the technologies in which we must make investments today in order to gain the most benefit from them.

I will give you an example. The Army's approach to repairing things is to let them break and then fix them. Why can't we embed robotic sensing devices in places where it counts so that we don't wait for failure to occur, but predict it? We could know that the shaft of an engine is now beginning to vibrate just enough so that if we don't do something about it in the next five hours of flight we can count on it to be so far out of tolerance that we will have a major maintenance problem. You may ask why do we want to do that? The answer is that labor is very precious. Therefore, we are trying to get out of the labor game as much as possible and let the machines do the work.

Moreover, suppose I were going to launch a two day operation and my little handy-dandy predictive robotics device said that in another six hours of operation the engine in one of my tanks would fail. Wouldn't it be neat if I could pull the power pack out and replace it prior to jumping off, rather than having it fail half-way through the day? We don't think like that. Instead, we drive the tank out there and wait for it to break and then we sit around and try to figure out what made it break and then try to repair it.

If I can get the R&D community to begin that effort on my watch, it will pay off big in future operational readiness and in reducing the manpower intensive maintenance system we now employ. We can do it. We have the leadership and we have the technical ingenuity of Army civilians and American industry behind us.



"Why can't we embed robotic sensing devices in places where it counts so that we don't wait for failure to occur, but predict it?"

Modernization of Tactical IEW

1984 is a year of fulfillment for materiel developers in the intelligence/electronic warfare community. After many years of equipment deficiencies in tactical military intelligence units, new near state-of-the-art systems are now being fielded. Current efforts are the result of a conscious decision by the Department of the Army to field baseline systems with the intention of product improving them over time to achieve the full capabilities specified in the Required Operational Capability documentation. This article will cover some of these efforts.

One of the most critical gaps in the management of intelligence and electronic warfare resources, and reporting of intelligence data to the tactical commander, is the lack of an automated capability to process the vast amounts of information from modern collection systems. The long-term solution to this problem is the All Source Analysis System. It is expected to be fielded as a baseline system in the mid-1980s with full capabilities provided in the latter part of the decade.

To fill the temporary intelligence automation gap and, of equal importance, to introduce soldiers to the world of automation, a Forces Command initiative was undertaken. In 1983/84, this initiative led to the deployment of ruggedized Apple computers, called Microfix, to military intelligence units throughout the Army.

Additionally, the Army developed, as a quick reaction capability, a prototype semi-automated system for the control and analysis of signals intelligence information. Called the Technical Control and Analysis Center, it performs only a limited subset of All Source Analysis System functions. However, within the single discipline of signals intelligence which it supports, it vastly increases the speed and efficiency with which data can be processed and disseminated.

Technical Control and Analysis Center systems have been deployed to European divisions and corps and to the XVIII Airborne Corps. As a consequence of these automation efforts, the Army intelligence and electronic warfare manager and analyst is moving well beyond the traditional 3-by-5 cards and combat acetate.

The Technical Control and Analysis Center.

Trailblazer (AN/TSQ-114)

As noted above, the need to automate the processing of information has been, in large part, driven by the ever increasing flow of data into analysis centers, which in turn is due to the incorporation of automation into the collection systems themselves. These automated sensor systems are now being fielded in increasing numbers.

The Army's primary communications collection and location system for heavy divisions is the Trailblazer (AN/TSQ-114). This system was fielded in Europe as a quick reaction capability in wheeled vehicles in 1979. Follow-on procurement has led to mounting the system on tracked vehicles and providing increased capabilities. Several of these improved systems were fielded in Europe in the summer of 1984. Procurement planning includes purchase of enough systems to equip the heavy divisions in both the active and reserve components.

The wheeled counterpart for the Trailblazer is the AN/TRQ-32 (Teammate). This system, already owned by the Army, has undergone an extensive upgrading to permit better signal reception and more automated signal handling. The AN/TRQ-32 is being fielded in 1984 with corps, separate brigades, armored cavalry regiments and the non-heavy divisions.

The Teampack (AN/MSQ-103) is the Army's primary ground based collection and location system for non-communications signals. As with Trailblazer, the initial Teampacks were deployed to European divisions in a wheeled model. These have now been replaced by tracked models which were fielded in FY 84 to all active divisions and corps.

Funds are programmed to equip the new light infantry divisions and the reserve components with a wheeled version. Teampack systems are also undergoing product improvements which will improve their collection capability and allow individual modules to be developed into a network for greater locational accuracy and faster reporting.

The Army has joined with the Marine Corps in a limited off-the-shelf procurement of the Man Portable Radio Direction Finding System, or AN/PRD-10. These systems are scheduled for fielding toward the end of 1984 to airborne and air assault divisions and Special Forces units. Further procurement is planned to give all other divisions Man Portable Radio Direction Finding Systems in addition to their Trailblazer or Teammate systems.

For many years the Army has relied on airborne signals intelligence systems, employing them as Corps assets. These are the Guardrail communications intelligence system and the Quicklook electronic intelligence system. The latest iteration of the Guardrail system is the Improved Guardrail V which is mounted in the RC-12 aircraft. The first of these systems was delivered in October 1984.

Current research and development efforts are designed to place the Guardrail and Quicklook systems together in the RC-12 as well as to improve the capability of the communications intelligence packages.

Turning to electronic warfare systems, the AN/MLQ-34 TACJAM, a high-powered UHF communications jammer, was fielded to European divisions in 1984 and is still being procured to provide additional systems for Eighth Army and FORSCOM as well as to provide more systems for Europe. Because of its tracked mobility, TACJAM is ideally suited for deployment to the heavy divisions.

The AN/TLQ-17A, a medium-power VHF communications jammer, can be mounted either in a quarter-ton vehicle, where it is called Traffic Jam, or in a helicopter, where it is named Quickfix. These systems began deployment to the 82nd Airborne Division and Eighth Army units in 1983 and are presently being fielded to USAREUR and FORSCOM. The AN/TLQ-17A will be found in all Army divisions, armored cavalry regiments and separate brigades.

The Hand Emplaced Expendable Jammer, a lightweight, low-power jammer, is planned for deployment throughout the Army in large quantities. To provide the Army with an additional means of emplacing this expendable capability, engineering development is proceeding on an artillery delivered expendable jammer.

The Army has never been more active than it is today in the development and fielding of tactical intelligence and electronic warfare systems. The systems discussed, as they come into widespread use throughout the force structure in the next few years, will produce changes in the way IEW activities are conducted, which can best be described as revolutionary.

On the one hand, automation of the planning, collection, processing, and dissemination of intelligence information will provide the most accurate, comprehensive, and up-to-the-minute assessment of an enemy's status and intentions which has ever been possible. This will permit the tactical commander to employ his maneuver and firepower resources with unprecedented effectiveness.

On the other hand, advances in electronic countermeasures technology will allow friendly forces to seize and maintain control of the increasingly critical electromagnetic spectrum. This will deny the enemy commander the ability to maintain total control of his forces and weaponry.

The present modernization program for our IEW systems provides an excellent example of the advantages which can accrue from the application of advanced technology to the conduct of battle.

The preceding article was authored by members of Electronic Warfare Team in the Office of the Deputy Chief of Staff for Research, Development, and Acquisition, HQDA.

Teampack (AN/MSQ-103).

Applying U.S. Management Concepts to an Australian Acquisition Programme

By MAJ Gordon Jones
Royal Australian Armoured Corps

"The central objective of Defence industry policy is to ensure that the Defence Force can be supported and maintained in Australia, utilizing a combination of local industry, selective stockholding and reliable overseas sources of supply."—1976 Australian Defence White Paper.

Australia is keen to maintain and expand its industrial base for reasons of economic growth, technology enhancement, and to provide a capability for military expansion in times of threat. Australia recognizes however, that the relatively small size of its defence establishment makes it difficult to achieve economic order quantities or production rates to justify developing and producing all of its defence equipment needs.

Local developmental requirements therefore tend to be performed by government agencies, and some production requirements performed by government factories. What cannot economically be obtained by this method, or through local private industry, Australia buys off-the-shelf from overseas sources using competitive evaluation and selection.

The Australian Defence Force procurement system is structured to account for local development and production, but since few procurements are made through local development, regular validation of the system is seldom achieved.

Despite the difference in political and military systems, there is considerable application for lessons from the U.S. experience for the Australian situation. In particular, the political structure, a major system driver in the U.S., has similarities with the Australian system of a bicameral parliament comprised of representatives from separate states within a federal system.

Five year defence planning with annual funding is also a common characteristic. Many of the constraints and requirements imposed on the military, including the potential for programme instability, are therefore common to both countries.

A significant difference between the two systems is the concept of the programme office. The U.S. military concept of a Program Management Office incorporating all of the functions associated with an acquisition objective—not unlike the management structure of an industrial company—far transcends the scope of the Australian equivalent.

In contrast, the Australian Army Project Office relies on a heavily matrixed organization. This staff matrix uses a very small number of integrators. The project director (PD) must act, therefore, in the role of coordinator between each of the large functional organizations on which he relies for execution of his project. Whilst he has considerable control over the action of the project office, and provides a readily identifiable focal point for user communication, he has little control over the functional organizations. His project is therefore subject to changes in priority as the staffing of the functional organizations changes with normal posting turbulence. There is considerable scope, therefore, for the concept of "baselining" in the Australian project environment.

In the baselining concept, the functional commands and organizations, both military and governmental, agree to the extent of support to be provided by each function impacting on the programme, in return for assurances from the PD of his commitment to cost, schedule and performance objectives. In this way a considerable degree of stability can be achieved in an environment displaying considerable potential for instability.

Programme balance is particularly difficult to achieve where high reliance is placed on off-the-shelf buys. Systems developed for other nations are a reflection of the particular nation's perceived needs, including performance, schedule, cost, and supportability criteria. The first three parameters are well known and fairly visible. The latter, however, is analogous to an iceberg, with the ramifications of supportability design having many hidden implications for unwary buyers.

The Australian PD has diminished control over all elements of programme balance, particularly if the off-the-shelf purchase is being made early in system development. The project is then subject to the instabilities of both national acquisition systems.

The PD's ability to influence balance by element trade off is therefore limited. The concept of baselining again provides an opportunity to reduce many of these potential instabilities, at least those within his task environment and immediate general environment.

The off-the-shelf equipment supportability iceberg gives logistics management a magnified importance in the Australian context. In the U.S. system, supportability has been increasingly recognized as a major design constraint.

If achieved, the system design will reflect national support system characteristics, and the equipment will blend with that environment, resulting in the required levels of operational availability.

Since Australia buys off-the-shelf systems from many suppliers, but operates a logistics support system reflecting its own national characteristics and needs in a unique environment, early consideration of the integrated logistics support (ILS) requirements must be of primary concern to the PD. ILS elements deserving particular attention include:

Maintenance Planning. A system is usually developed to interface with the in-place maintenance and supply system. Decisions to repair forward, or replace only modules forward, will have a significant impact on the Australian maintenance plan, particularly on the maintenance organizational structure. The U.S. trend to contractor maintenance has not yet been followed in Australia, and adds another potential obstacle to support system interface, particularly in manpower and personnel considerations.

Manpower and Personnel. The allocation of manning, and the levels of skill for operation and maintenance, are conscious decisions reflecting demographic, cultural, economic and in-place support system considerations of the equipment developing country. Varying degrees of compromise will be required by the Australian service to integrate the system.

Technical Data. Data have a major impact on the maintenance plan for Australian use since it drives both the repair and maintenance levels, and the ability of Australia to maintain the system in country. An extension of this problem is the right to carry out system modification to suit Australian needs.

Supply Support. Australia is geographically remote from most of the northern hemisphere countries from which it obtains the majority of its off-the-shelf defence procurements. Continuity of supply in times of crisis is therefore a major concern. In addition, Australia's desire to be economically and technologically involved in defence equipment projects leads to careful consideration of the long-term benefits of manufacturing spare parts (and total systems) in Australia versus the short term cost benefits of overseas purchase.

Purchase of parts from the overseas equipment supplier invariably results in long lead time problems for equipment users and maintainers. Parts must be ordered overseas when delays become excessive, and impact adversely on operational availability. Whilst this situation offers opportunities for local industry, the potential is dimished by the need to identify economic order quantities and maintain a "warm base."

The scope for local industrial involvement is often limited (in time of peace) to repair, refurbishment or manufacture of fast-moving items. This in turn leads to interface problems in the production of an overseas design, including patterns, processes, technical data interpretation and quality assurance measures.

The project office must therefore identify very early in the acquisition cycle, those components displaying potential long lead problems, and the extent to which the problem can be alleviated by local industry involvement.

In common with the U.S. system, the Australian force development model is based on mission area analysis to determine need, and then proposing materiel or non-materiel solutions to needs. U.S. involvement, particularly in the case of off-the-shelf purchases, is therefore critical to identifying performance limitations and supportability implications. This involvement must commence early in the acquisition cycle, before identification of alternative equipments. It should continue right through the in-service life of the equipment.

At certain critical points though, user considerations should form the primary determinant. These occasions must include: determination of the initial requirement, trials of identified alternatives, testing of short list alternatives (particularly from a tactical application perspective), entry into service, and in-service modifications.

Despite the natural communication advantage of the lean matrix project office establishment, there is a need to provide an identified, formalized liaison link with the user community.

Once an equipment has entered service, the matter of configuration control becomes a major management consideration. Although the project office raised for the acquisition may have disbanded, the service organization responsible for the acquisition (Materiel Branch in the case of the Army) remains responsible for materiel standardization and pattern control. For an overseas off-the-shelf purchase with its patent, data and production rights implications, this is a major life cycle commitment.

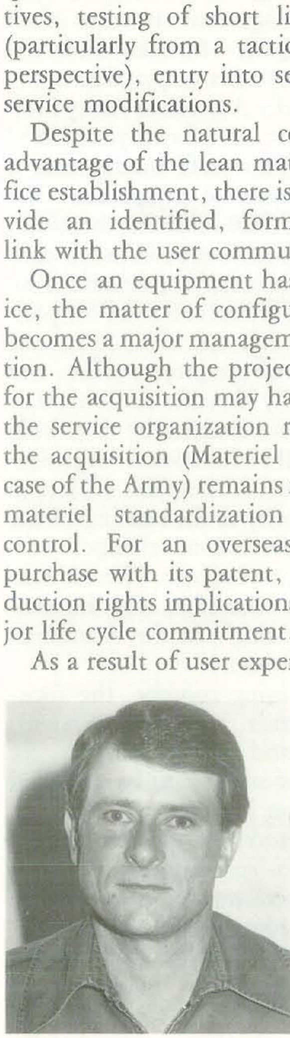
As a result of user experience with in-service equipment, the need for modification will undoubtedly arise. As the person initially responsible for the acquisition, the PD must address configuration control throughout the life cycle, not just to introduce the equipment into service. The plan for such control must address the translation of user requirements into hardware modification options, interfaces between configuration items, performance and supportability impacts of modifications, and management structure during equipment life cycle after disbanding the project office. Concurrent with these aspects, the plan must also address the interface with the overseas developer, producer and user.

Since most overseas off-the-shelf purchases involve some form of warranty, a warranty management plan must be developed to take advantage of such contract clauses. Development of such a plan offers opportunities to update and validate the configuration management plan, and provides considerable justification to maintain the project office as a management entity, at least until expiration of the warranty period.

Comparison of the Australian and U.S. systems provides opportunities to identify, by extension, those principle management areas which the PD must quickly control and constantly monitor including:

- Insuring a healthy interface between the overseas developer/producer and Australian procurer.
- Insuring early and constant user involvement in acquisition and in-service management.
- Establishing a firm baseline with the functional organization involved in the acquisition, and conducting regular project reviews with such organizations.
- Identifying the supportability issues and constraints of a foreign developed equipment in an Australian service environment.

In short, the primary focus of the Australian PD must be the same as that of his U.S. counterpart: the identification, reduction and management of risk.



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The DOD Very High Speed Integrated Circuits Program

By Tilden S. Tippit

What is a very high speed integrated circuit, or a VHSIC? VHSIC is the name of a DOD program which has the objective of putting military systems at the leading edge of integrated circuit applications. It is also a management approach for developing and fielding advanced integrated circuit technology. Additionally, VHSIC is a demonstration that the DOD can plan for the development of its own products as rapidly as the commercial market, and VHSIC is the insertion of the advanced integrated circuit technology into operational systems.

VHSIC is important because the silicon integrated circuit is barely 25 years old and has already become a technological keystone for all modern electronic systems. The silicon integrated circuit provides the advanced functionality, the low cost, and the high reliability needed to make such systems feasible.

These same electronic systems and the integrated circuits that make them possible are among the major technological advantages we have in the design and building of our nation's defenses. We have been able to counter an adversary with greater numbers and greater "brute force" by developing "smarter," more capable weapons.

This concept of maintaining military superiority through technological superiority has been a central doctrine in U.S. force structure policy and has been based to a large degree on our superior electronic capabilities. However, our "comfortable" lead in integrated circuit technology over potential adversaries has eroded. VHSIC will restore our lead in this technology.

The underlying problems which caused the erosion, and which eventually led to the formulation of the VHSIC program, resulted from the difficulties in getting the advanced integrated circuits from the industrial production line into operational systems—a process referred to as "technology insertion." These difficulties can be summarized as follows:

- Integrated circuits produced for the commercial market did not meet important military requirements, such as temperature, radiation hardening, and reliability assurance.
- Design cost for specialized military integrated circuits were increasing sharply with time.
- Rapidly changing production technologies were causing severe logistics problems in maintaining and repairing field equipments.
- System program managers who were charged with the development of new systems were faced with the dilemma between the technical advantages of using advanced integrated circuit products and the unacceptably high system risks associated with their development and use. Most program managers are reluctant to choose the high risk approach.

The result of these difficulties has been an increasing time delay between the availability of advanced circuits in the commercial market and their use in fielded military systems. That time delay was approaching eight to 10 years.

1984 is an important year for the VHSIC program. The principal goal of the program is to make available state-of-the-art very large scale integrated technology to military systems designers. As Phase 1 was conceived and initiated in 1980, the purpose was to look ahead four or five years and define the signal processing needs of military systems in the mid-1980s, design a chip set which would satisfy a maximum number of these requirements, fabricate prototype quantities with semiconductor fabrication design rules which would be possible in the mid-1980s, and provide brassboard demonstrations of new equipments based on the chip set. This is simply translating practices of the commercial market into the military arena so that DOD can have its own new products incorporating state-of-the-art very large scale integrated circuits in the same time frame as the commercial market.

In 1981, the DOD selected six contractors/teams which had designed a chip set according to these guidelines. Progress to date has been excellent. The DOD is now fabricating prototypes of military signal-processing chips just as the commercial market is producing its prototypes at similar levels of complexity. The following is a brief synopsis of some of the current efforts related to the fabrication of chips.

At TRW's Microelectronics Center, three fully functional VHSIC chips have been tested—the matrix switch, the content addressable memory, and the window addressable memory. All four of the remaining original chip types which this company will produce are in fabrication. The TRW VHSIC pilot line is under tight process control and there is sufficient line throughput and yield to produce the large number of chips needed for completion of Phase 1. The major yield detractors are being aggressively attacked.

At Motorola, which is teamed with TRW, the first functional four-port memories have been produced on their pilot line. This chip, designed for general purpose signal processing, has been operated up to 16 megahertz. The pilot line will be available for other custom VHSIC circuits. The Motorola process will be transferred to TRW, which is just completing a major new facility for VHSIC fabrication.

IBM's Federal Systems Division has successfully fabricated, packaged, and tested its fully functional VHSIC chip. This chip, designated a complex multiply and accumulate chip, can execute millions of multiplies per second and has inherent flexibility to perform a wide range of complex signal processing functions needed for many system applications. This chip is among the most advanced fully functional logic chips developed. Over 250,000 test patterns have been exercised on the chip in order to declare the chip fully functional at the design speed.

IBM has designed and fabricated this chip within an aggressive time schedule and has set up a pilot-production facility which is well characterized and under tight operating control. These facilities will be available for the design and fabrication of additional VHSIC chips for the technology insertion programs. IBM is the first and only VHSIC contractor to demonstrate its brassboard, an acoustic signal processor. This was achieved on May 1, 1984.

Hughes Aircraft Co. has produced and determined the functionality of the digital correlator chip. The correlator, which is only one of the three signal-processing chips this company will produce in VHSIC Phase 1, will be used in systems requiring high speed and low susceptibility to jamming.

Hughes has consolidated its VHSIC technology in a new pilot-line facility which is being used to process correlator lots. Further process enhancements are planned. The correlator chip has also been fabricated by RCA as the second source to Hughes. These chips are currently under test.

At Texas Instruments, the VHSIC basic process has been developed and transferred to pilot production, and process refinements are under way. Fully functional VHSIC 8K by 9 static random access memories have been produced and tested. These chips have over 400,000 transistors. Also, fully functional multipath switch chips have been implemented in a 4K gate array and have been demonstrated to be fully functional. A new front-end facility at Texas Instruments is being brought on line. Shortly thereafter, all VHSIC Phase 1 lots will be processed in this new facility.

The Westinghouse team is scheduled to produce a family of chips for a multiprocessing computer. Fully functional controller chips for the complex arithmetic vector processor (CAVP) have been fabricated at National Semiconductor as a specific application for the VHSIC 10K gate array. The CAVP controller application used over 4,000 of the gates. Also, National Semiconductor has fabricated 64K static random access memories with all but a few bits operating.

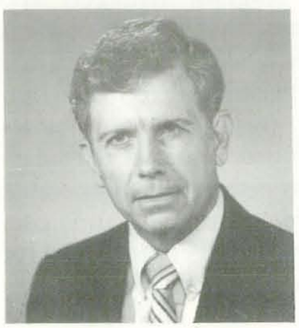
Solutions to the problems have been identified and fully functional chips are expected soon. Westinghouse has taken an aggressive but innovative design approach featuring a set of five common modules implemented in a set of six basic chip types.

Honeywell has produced and demonstrated two of its three VHSIC chips. Fully functional sequencer chips and arithmetic chips have now been produced. They have completed all 42 macrocells—the functional building blocks that are interconnected to form the semicustom integrated circuits which it is developing for the VHSIC program.

Several macrocells, including logic and memory, have been packaged and run at the full VHSIC clock rate and at extremes of power supply voltage and temperature. The successful demonstration of both the sequencer and arithmetic chips verifies the reliability of the fabrication process and the building blocks for future VHSIC chip designs which can be implemented on a fast turn-around basis.

In summary, the first VHSIC Phase 1 chips are being produced and the yield enhancement program is under way. The goal of the yield enhancement is to increase the chip yield to over 10 percent and reduce the price of the chips to around $500 each over the next three years.

The final goal is to make available to the DOD and its contractors the eight VHSIC Phase 1 pilot lines which will be capable of producing chips at an affordable price. These will be used for insertion into military systems, including those selected for support in the VHSIC Technology Insertion Program.



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Very High Speed Integrated Circuits for Army Systems

By Dr. H. Steven Kimmel

Introduction

This is a crucial year in the evolution of the DOD-sponsored, tri-service managed, very high speed integrated circuit (VHSIC) program. All six of the VHSIC contractors are expected to complete the development of electronic subsystems or devices utilizing 1.25-micron circuitry and introduce yield enhancement techniques to their pilot production lines. Thus, production quantities of VHSIC devices, accompanied by brassboard demonstrations of the VHSIC custom chips, are nearing reality.

Nonetheless, the success of the VHSIC program must be measured by the insertion of chips into those systems produced by the dozens of "non-VHSIC" military contractors. To this end, the Army embarked in early 1983 upon a course of action to seek the cooperation of Army and contractor program managers to achieve the early fielding of 1.25-micron VHSIC technology.

This article addresses the VHSIC technology insertion initiative taken by the Department of the Army to maximize the use of VHSIC chips and brassboards with Army systems.

Background

In 1977, the DOD began the process of resensitizing the microelectronics industry to military signal and data processing requirements. That effort was formalized by 1981 with the award of six three-year contracts to construct a new generation of integrated circuits. Each service monitored two of these VHSIC contracts, thereby ensuring that the anticipated major improvements brought about by VHSIC technology (in capability, size, weight, power consumption, and reliability of the next generation of militarized microelectronic circuitry) would be more responsive to individual requirements.

From the outset, the Army was interested in five of the six basic functional brassboards to be provided by the program. These were the anti-jam communication signal processor, multimode fire-and-forget missile processor, electro-optic signal processor, advanced tactical radar processor, and the electronic warfare signal processor.

By 1983, the first of the VHSIC chips emerged. Later, they were demonstrated to be fully functional.

These early demonstrations began to quantify a major VHSIC program objective—to establish a new technology base for high-throughput, high-density integrated circuits. The demonstrations also focused Army attention on the need to identify those systems which would require high-speed signal processor performance accompanied by built-in test and radiation-tolerant designs. That need, coupled with the progress of the VHSIC contracts and the interest generated by non-VHSIC military system and electronic component houses, are major ingredients in the Army technology insertion program.

Technology Insertion

Like any ambitious project, the Army VHSIC technology insertion program attempts to reach to the extremes of its grasp. Typically, program managers (industry and government) are reluctant to take risks.

While many project-managed systems were likely candidates for VHSIC, a 1982 survey of Army PMs revealed that only a couple PMs would commit to any firm interest in VHSIC other than perhaps a name association. Realizing that fieldable systems would require more than a mere program association, the Army initiated a VHSIC technology insertion initiative.

The VHSIC technology insertion initiative is under the direction of the director, Army research and technology, HQ, Department of the Army. In 1983, the military and industrial materiel development community was approached in order to achieve the following broad objectives:

• To acquaint Army and industry program managers with the progress of the VHSIC program.

• To prioritize high-return-on-investment candidates for VHSIC technology insertion.

• To maximize early insertion of the available VHSIC technology.

Early in the effort, it was apparent that to be successful, the technology insertion initiative would require substantial planning. It was also apparent that it would be necessary to educate program managers about the operational attributes and increased system reliability of VHSIC.

Thus, the first step of the technology insertion effort began in FY 1983. It began by examining likely candidates that could demonstrate performance enhancements accompanied by complementary life cycle cost embellishments.

By the end of FY 1983, a pre-insertion prioritization process had identified the following possible candidates: TOW 2 automated target recognizer (brassboard), ground vehicle fire control (brassboard), airborne signal processor (study), air defense threat signal processor (study), and fire-and-forget missile seeker (study).

The following selection criteria were used in the identification of these five candidate applications. They have become the cornerstone of the Army's VHSIC technology insertion initiative:

• Result in an early insertion.

• Have a strong system program office commitment.

• Demonstrate a large life cycle cost reduction.

• Maximize the use of available VHSIC devices.

• Maximize the payoff from VHSIC generic brassboards to many applications.

• Determine the versatility of chip-set architectures for many applications.

• Determine the participation of non-VHSIC contractors.

• Maximize the access to VHSIC technology by non-VHSIC contractors.

In addition, during the selection process, extra emphasis was placed upon life cycle cost reduction and further involvement of non- VHSIC contractors. Last year, $1.6M was awarded via contract modifications to give these five system managers a low-risk opportunity to pursue VHSIC technology in parallel with their conventional ongoing approach.

While the modification route was not deliberate from the outset, it fostered the following results: ground vehicle fire control (two competitive Statements of Work), airborne signal processor (three competitive Statements of Work), air defense signal processor (awarded to a non-VHSIC contractor), fire-and-forget seeker (three competitive Statements of Work including two non-VHSIC contractors).

Thus, in FY 1983, the Army had improved on what the other services had done by not "stovepiping" the VHSIC insertion effort among the "haves" at the expense of the "have-nots." Additionally, the Army was able to introduce the first test of the ability of non-VHSIC contractors to acquire system and component level design information necessary for the competitive sharing of this defense technology base.

Closing the Loop

The second step in the VHSIC technology insertion initiative was launched at the beginning of 1984 when more than a dozen military aerospace system and electronic component vendors were contacted. Each was offered the opportunity to separately provide the Army R&D, operations, and logistic headquarters staff with a proprietary assessment of where VHSIC technology is. They could also assess how it could or would be applied to their own product(s) line to achieve the Army technical objectives for VHSIC technology insertion.

By mid year, these briefings had succeeded in educating numerous Army and industry program managers on the attributes of this new 1.25-micron technology. Such awareness has helped accelerate the preplanned product improvements of many components/systems as called for in the 1986-90 POM.

Technical Objectives of the Army's VHSIC Technology Insertion Initiative

A. To demonstrate the capability of VHSIC through form, fit and function replacement packages to improve Army—

(1) Life cycle cost profiles,

(2) System performance levels, and

(3) Readiness posture via increased interoperability and reduced logistic support requirements.

B. To maximize the use of VHSIC devices that were designed, military qualified, and manufactured under the DOD contract.

C. To increase the versatility of the VHSIC available chip set architectures by involving non-VHSIC contractors.

An additional benefit from these briefings was the exposure of additional candidates for Army VHSIC insertion consideration. In the final stages of this identification process, nearly two dozen promising candidates, each championed by an Army system program manager, were evaluated against the same selection criteria used previously. What resulted was an $11 million investment for the following 10 FY 1984 technology insertion efforts:

• Position Locating System/Joint Tactical Identification System/Hybrid. A brassboard demonstration is scheduled for FY 1985 as a precursor to a production design decision. The demonstration will permit participation in future operational testing.

• Airborne Signal Processor for LHX. The processor development effort seeks to provide a qualified hardware/software design for the new LHX program by FY 1986.

• TOW Missile Wireless Command Link. The Army's workhorse anti-armor weapon, TOW, could achieve even greater operational flexibility with this form, fit, function development effort. Near-term efforts, under the auspices of the Army and contractor program manager offices, include design validation and dynamic flight testing.

• TOW—Automatic Target Tracker. Also sponsored by the program office, this effort will replace the existing missile guidance package with a new automatic, all-weather, day or night tracker capability. Now in its early stage, the effort is well timed for the preplanned product improvement (TOW 3) schedule.

• Hellfire Fire-and-Forget Missile. The Army program manager has sponsored this competitive effort that will combine an improved seeker with the VHSIC electronics thereby affording the Army's first fire-and-forget, air-to-ground anti-armor weapon system.

• Copperhead. Initiated in recent months, this project is scheduled for qualification firings of a new microprocessor design. The design holds promise to also be fully compatible with Hellfire as well as the Navy's 5-inch guided munition.

• Ground Vehicle Fire Control Processor, Abrams tank. Equipped with this processor, the M1 Abrams tank will possess a sixth dimension fire control computational capability. The effort is aimed at the preplanned product improvement program.

• Army Helicopter Improvement Program (AHIP). This insertion project will fully test an enhanced video tracking system for integration into the OH-58D by May 1986.

• Army Short-to-Medium-Range Air Defense System (SHOMADS). This effort seeks to develop a programmable signal processor employing non-cooperative target recognition algorithms, and a multitrack and missile guidance operational capability.

• Firefinder Radars. Sponsored by the Army project manager, this effort seeks an enhanced, modular, VHSIC-based digital processor which will be programmed in Ada to provide additional processing capability. Development and environmental tests are scheduled to meet the proposed FY 1986 product improvement program.

On the Horizon

With such a large number of VHSIC applications being explored, the Army is now in the enviable position of looking forward to the FY 1985 portion of this technology insertion effort that will focus on the technology's demonstration.

It is estimated that in FY 1985, more than $41 million will be available for VHSIC technology insertion. Candidate applications will be tested against numerous criteria to determine the best return on investment.

A key issue will be the extent to which logistic and operational planners recognize and support the claims of the proposed deliverable benefits. Similarily, the cost benefit analysis will receive even greater scrutiny to ensure these demonstration resource funds are well spent. Lastly, the entire VHSIC community will be, for the first time, at high visible risk to deliver production devices to meet critical system milestones.

While FY 1984 is a critical year in the planning of VHSIC technology, FY 1985 will surely be a year of opportunity. It will be a year to demonstrate a new high-technology that was envisioned nearly a decade ago.

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Scroll Air Cycle Air Conditioner

By Thomas J. Sgroi

In July 1984 the Belvoir R&D Center received the world's first scroll air cycle air conditioning unit. Arthur D. Little Inc., who developed scroll technology, was awarded the contract to build this unit in January 1983.

The Army requires special environmental control units (ECUs), better known as air conditioners, to cool critical systems which consist primarily of electronic equipment installed in shelters. One of the responsibilities of the Belvoir R&D Center's Tactical Energy Systems Lab is to develop ECUs for these systems.

You may ask "Why should Army air conditioners be different from commercial air conditioners?" The answer is simply that the military standard family of ECUs consists of the conventional vapor compression type that uses Freon as a refrigerant.

The greatest problem that military standard ECU's have in operating under military conditions, such as excessive shock and vibration, is the occurrence of vapor leaks. A small Freon vapor leak in the system soon renders the unit inoperable. Avoiding the problem of vapor leaks is the best way of solving the problem. This brings us to a significant function of the R&D process—new concepts.

Use of a readily accessible refrigerant such as air would result in leaks having a small effect on the efficiency of the unit. The air conditioning cycle that uses air as a refrigerant is known as the reverse-Brayton cycle or air cycle. The air cycle is inherently simpler and more reliable but less efficient than vapor compression units. However, new technology is closing the efficiency gap between these two cycles.

An air cycle machine typically consists of a compressor, expander and heat exchanger. Air is raised to a high pressure in a motor-driven compressor which also raises its temperature. The air then flows to a heat exchanger where it is cooled to near the outside temperature.

In an expander or turbine, the air expands and does work which greatly lowers its temperature. The work out of the expander is usually directed back into the motor shaft. The cool air from the expander cools the air conditioned space.

During the past 10 years, the Army has evaluated three air cycle concepts (one centrifugal concept and two rotary vane concepts), each having a higher efficiency than the previous one.

The Environmental Control Systems Branch of the Tactical Energy Systems Lab is now embarking on new and unique technology developed by Arthur D. Little Inc. that promises to be competitive with the Army's standard vapor cycle units.

This new technology is known as the scroll machine—a design based on the interaction of two interleaved spirals or so-called "scrolls," with one scroll fixed and the other orbiting within it. Its roots trace back to the liquid-moving idea of Archimedes and Leonardo da Vinci. These primitive conceptions were reduced to practice in a scroll design that was first patented in the United States in the early 1900s. The concept lay dormant until 1974 when the notion of a scroll compressor was brought to the attention of Arthur D. Little by an outside consultant-physicist, Neils Young, who saw the practical possibilities for a scroll machine.

The basic elements in a scroll machine are two identical spiral scrolls (Fig. 1), each fixed onto (or an integral part of) a circular cover plate. When the two scroll plate assemblies are mated, the two scrolls are interleaved in an eccentric fashion so that they form a seal and series of crescent-shaped pockets. The two circular cover plates complete these pockets, thus serving roughly the same

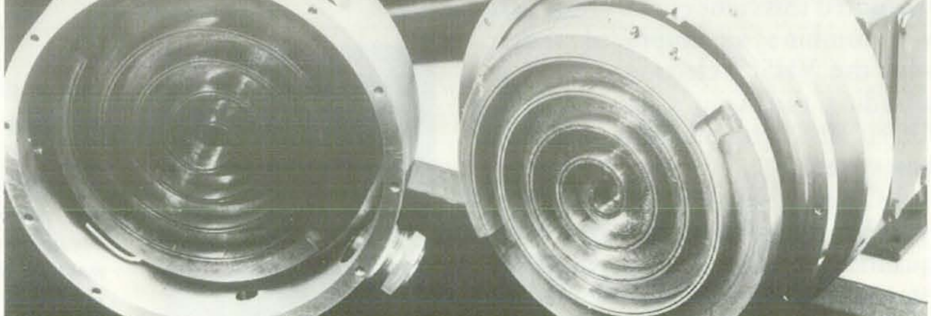


Figure 1.

FOUR OPERATING POSITIONS OF ADL SCROLL COMPRESSOR/EXPANDER

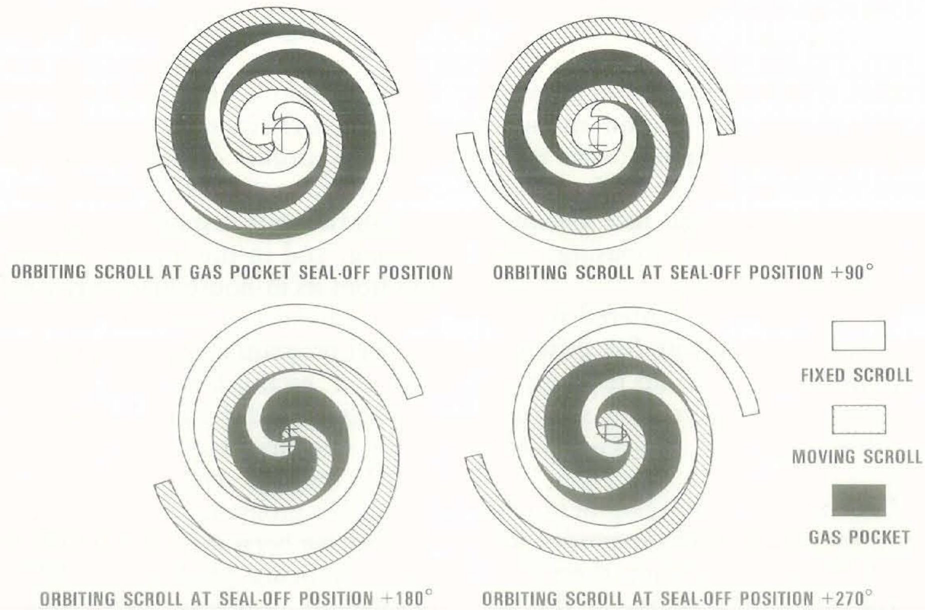


Figure 2.

function as cylinder walls in a reciprocating compressor.

One of the scroll plate assemblies is fixed. The other one orbits around the center point of the fixed scroll plate assembly and, as it moves, the pockets formed by the interleaved scrolls follow the spiral toward the center and diminish in size (Fig. 2). (If the device is used as an expander, the process is the reverse, i.e., the pockets move from the center to the periphery and enlarge.) The moving scroll plate assembly orbits with a fixed angular orientation; it does not rotate.

When used as a compressor, the inlet for the scrolls is at the periphery. The entering gas is trapped in a pocket and compressed as the pocket moves toward the center and diminishes in size. The compressed gas is exhausted through the outlet at the center of the fixed spiral.

Scroll machines offer many mechanical advantages over conventional reciprocating machinery. For instance, the absence of valves does away with a major item in compressor maintenance. Since scroll devices have lower starting torque and more uniform driving torques than do reciprocating devices, they can be driven by smaller motors.

Scroll devices can be constructed of self-lubricating materials to provide oil-free operation, and thus operate as an "open" cycle. That is, the air from the expander is supplied directly into the air conditioned space, as opposed to through a heat exchanger, which would be a "closed" cycle.

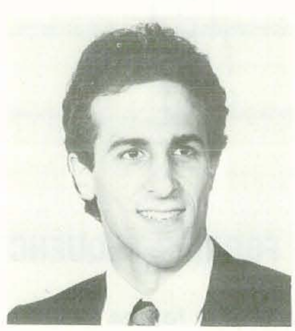
Under the 1983 contract to Arthur D. Little, the scroll air cycle unit being developed will be capable of producing 18,000 Btu per hour of cooling and will be an "open" cycle, requiring no lubrication. The compression ratio for the compressor and expander will be 2.75. The contract requires minimum isentropic efficiencies of 82 percent for the compressor and expander. With these efficiencies and operating under military conditions (120 degrees Fahrenheit outside temperature and 90 degrees Fahrenheit inside temperature), the temperature and pressure at the outlet to the compressor will be 300 degrees Fahrenheit, and 40 pounds per square inch absolute, respectively. The temperature at the outlet to the expander will be a frosty six degrees Fahrenheit.

The emergence of the scroll "open" air cycle machine coincides with the recent emphasis on integrating a chemical/biological filter with an environmental control unit. Fabrication of an integrated unit started in-house late in FY1984 and will be called the Integrated Chemical Filter /Environmental Control Unit (ICE).

Integration of the scroll air cycle machine with a chemical/biological filter will result in a decreased number of components, since the compressor will be used to pull the air through the filter. This will eliminate the need for the filter blower, motor and 60 hertz to 400 hertz frequency converter. This unit is designed to meet the requirements of the majority of electronic shelter systems, supply 18,000 Btu per hour of cooling and 100 cubic feet per minute of filtered air.

It is estimated that this unit will have twice the reliability of the military standard units and that its power consumption over a typical mission period will be much less than the military standard units.

The emphasis on integrating environmental control with chemical filtration is service-wide. The Air Force has helped fund the present contract and has, just recently, given the Belvoir R&D Center the developmental responsibility for filtered air. The Center's development of scroll air cycle techology is an example of our maintaining the best technical expertise concerning environmental control in the Department of Defense.



THOMAS J. SGROI is a design engineer for the Tactical Energy Systems Lab at the Belvoir Research and Development Center. He is responsible for the design, fabrication and test of the 18,000 Btu per hour/100 cfm ICE unit. He has a BS degree in mechanical engineering from George Washington University and is presently working on an MS degree in systems management from the University of Southern California.

Near Net Forging of Titanium Fuse Components

By Roger Gagne and Ernest Kinas

In response to an urgent request from Harry Diamond Laboratories (HDL) in Adelphi, MD, the Army Materials and Mechanics Research Center (AMMRC) in Watertown, MA, developed and established an in-house capability for warm die forging of titanium alloys.

The need for in-house capabilities became evident and urgent when material lead time for delivery of titanium exceeded one year, prices reached $23.00 per pound, and small quantity requirements failed to significantly interest forging suppliers.

AMMRC is currently using its established capabilities to produce symmetrical closed die titanium-6A1-6V-2Sn forgings to near-net shape for HDL. The objective of this program was to produce, over a period of between 36 to 40 months, several thousand precision titanium forgings. These forgings were to be used in the manufacture of a special purpose artillery shell fuse assembly that included ogive, housing, and collar.

The requirements centered around the need for producing five different forgings which make up the fuse assembly. The titanium alloy specified for this application was Ti-6A1-6V-2Sn.

The engineering development program for establishing the production capability and producing these prototype titanium forgings in the required quantities was carried out completely at AMMRC. Technical guidance for the fuse system and its components was the responsibility of HDL. Motorola, Inc.—Government Electronics Division in Scottsdale AZ, was the prime contractor for the manufacture of the fuse assembly.

AMMRC was responsible for purchasing, and in the interim, supplying from its in-house inventory a sufficient quantity of titanium bar stock to meet program schedules. Developing and establishing the required capabilities and designing and fabricating the necessary dies and associated tooling, was also part of AMMRC's program task. All requirements have been met and forings are currently being produced to HDL's mechanical property and dimensional tolerance specifications.

The initial decision was to use the close die forging process in order to produce forgings as close to finish

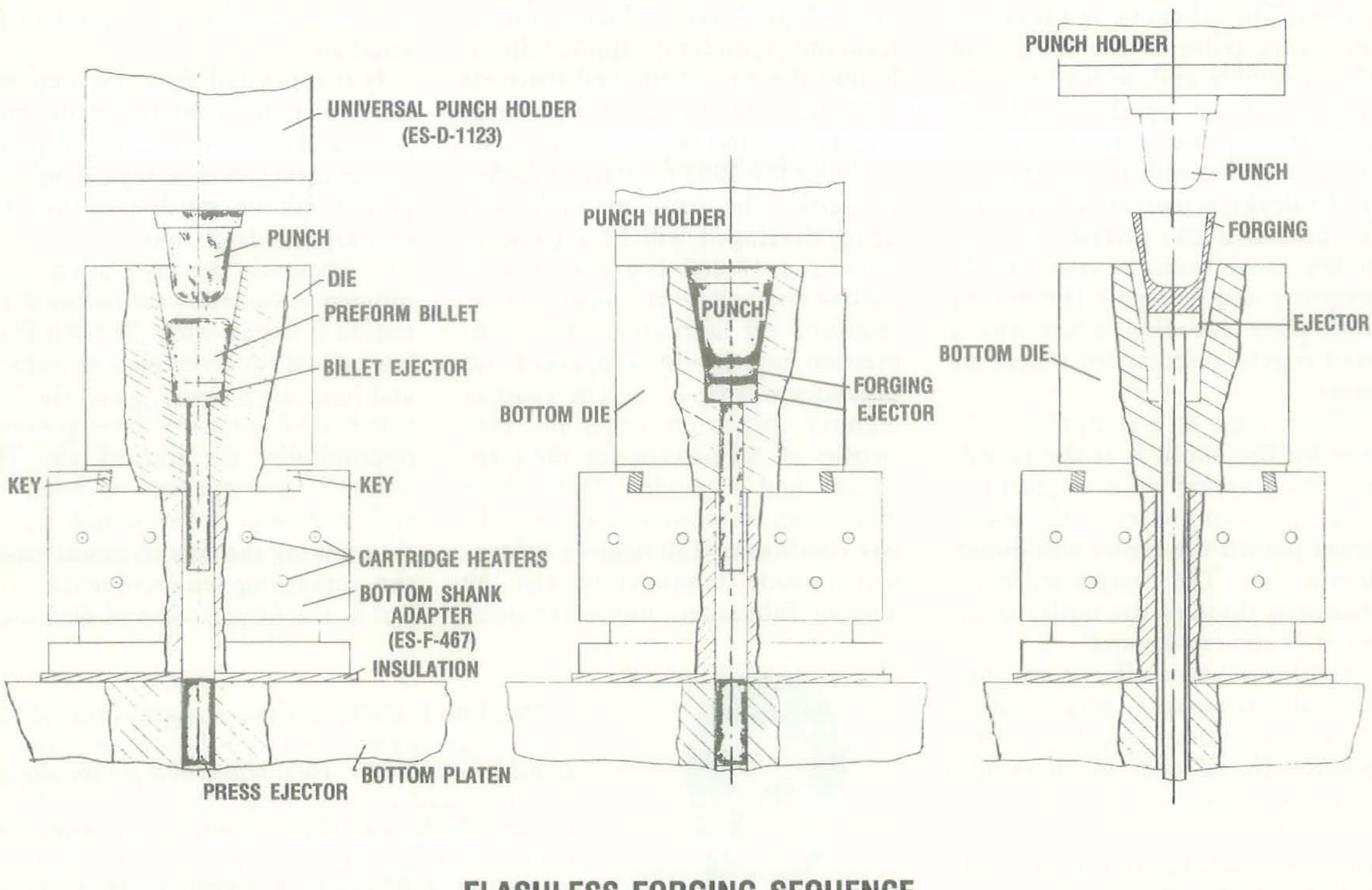


Figure 1 shows the forging operation for the center structure A fuze.

size as possible. This approach was necessitated by the rapid increases in the price of titanium alloys in the early stages of this program. Furthermore, titanium alloy shortages were developing and producers began quoting 12- to 18-month deliveries at prices established at time of delivery. These market conditions made materials conservation a major issue.

Procedures

With the exception of the power supply, (forged on an upsetter) all fuse forgings were produced on a 2,000-ton Bliss hydraulic forging press. Both the center and forward structures required preforming while the rear structure and retainer collar were produced in one operation.

Cartridge heaters were incorporated into the forging die tooling. This feature provided the capability of heating and maintaining both punch and die at 750 degrees Fahrenheit.

Forging billet weights were held to ± 0.5 percent. Billets were cut from bars using rotating bar cut-off equipment. All billets were sandblasted and glasscoated in order to minimize oxidation, gas absorption, and provide a lubricated billet surface. A commercially available graphite lubricant was applied to the punch and die surface.

Figure 1 describes the forging operation for one of the fuse parts, the center structure. The first view shows the preformed billet in the die prior to forging. The second view shows the forgings at the precise moment when the forging stroke is completed. The third view shows the ejector raising the finish forging in preparation for removal from the die.

It should be noted that the preform billet must be designed to fill the die cavity and help distribute the material so that there is no excess material remaining. Figure 2 illustrates the step-by-step preforms used in forging the forward structure. Note that the starting billet undergoes a substantial amount of deformation in preforming.

Results of AMMRC's forging program are as follows:

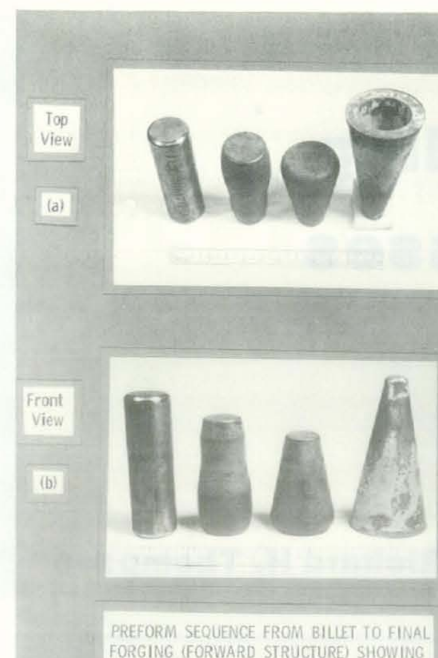


Figure 2 shows different views of the preforms used in forging the forward structure.

- Significant materials and cost savings
- Dimensional accuracy well within tolerance (± .032")
- Smooth forged surfaces with minimum oxidation
- Excellent die fill
- Increased equipment utilization (using interchangeable punches in a standardized punch holder)
- Process efficiency

The recently established warm forging facilities at AMMRC, coupled with the in-house research activities, now offer systems developers a valuable resource within the Army.

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AMC Commanding General Discusses Key Concerns

GEN Richard H. Thompson

The following is a condensed version of an address presented recently by Commanding General of the U.S. Army Materiel Command (AMC) GEN Richard H. Thompson at the second in a series of four AMC initiated "Contractors' Day" conferences. The purpose of these meetings was to establish an open dialogue with the Army's major materiel producers in order to share mutual concerns and to keep industry better informed of AMC's future materiel requirements and thrusts.

I would like to touch upon some of our concerns and initiatives which are of direct impact on our industry partners. I'll begin with the Army's modernization program.

As most of you know, our ongoing modernization program is the most ambitious and comprehensive in the Army's history. It will contribute more than 400 new weapons and equipment systems to the inventory. I believe that both the Army and industry can be proud of the successful development of much of the Army's badly needed new equipment. The challenge now, AMC's challenge, is to buy that equipment at economic rates and successfully deliver it—and the support system behind it—to our soldiers.

For our FY84 procurement program, we are talking big bucks. As with the FY85 budget, the 1984 dollars did not come easy. The defense budget is receiving ever increasing scrutiny and criticism from Congress—and with the debate on how to reduce the deficit, we can expect even closer congressional scrutiny in the future.

All of this adds up to one simple fact—we must spend our scarce funds wisely. We take very seriously our obligation to the American taxpayer to get the best deal possible for every tax dollar spent. In the future, the Army and industry must live by a mutual goal of fielding both quality and affordable military equipment—and I emphasize affordable.

In light of all the adverse publicity the services have received in the recent past over procurement practices, I will take this opportunity to tell you about some of the innovative programs we've instituted to improve the acquisition process.

To put our Army procurement practices in the proper perspective, I would like to set the stage. In FY83 we processed over 3,000 procurement actions, a 41 percent increase over FY80. This represents a procurement program of approximately $20 billion, an 11 percent increase over the same period. These contracts range from small, one-time purchases in the hundreds of dollars, to multi-year weapons systems contracts well over a billion dollars. Execution of these procurement actions entails the services of 7,968 people in seven major buying commands.

Our management challenges are staggering and center around three key concerns: providing the materiel *when needed*, procuring it at a *reasonable cost*, and insuring that our Army receives a *quality product*. I will address each of the key elements separately and discuss what we are doing to refine our process.

To provide materiel when needed, we have set a goal for all developmental programs not to exceed four years—that is, four years from a Milestone I program go-ahead decision (with funds in place) to the start of production. We are not so naive as to think that merely directing it will make it happen.

To achieve our goal we have embarked on a dynamic program to change our perspective of acquisition management, by focusing more on up-front planning and by developing a sound and comprehensive acquisition strategy.

We are also placing greater emphasis on the use of non-developmental items. We believe that the United States has the world's greatest marketplace and that we would be remiss if we did not tap those vast resources.

Another alternative involves greater use of pre-planned product improvements. The Army has never acquired a major system that was not improved during it's active service life. This alternative stresses "pro-active" development—that is to plan systems for appropriate technology insertion downstream.

Two more areas we are concentrating on are testing and military specifications. If we are to reduce the acquisition cycle we must not replicate testing. Our aim is to reduce testing quantitively, and increase it qualitatively by better planning and use of test data available from other sources.

The other area, application of military specifications, is also receiving closer attention by our development managers. We want them to avoid liberal application of military specifications by questioning and tailoring those that don't make good sense in meeting their product requirements.

Last, but not least, we are working to reduce the time required to award contracts through the application of automation to reduce procurement lead time.

To acquire materiel at a reasonable cost we are increasing competition by reducing sole source contracting and by revising our should cost analysis procedures. Increased competition is definitely paying dividends. The percentage of competitive dollars awarded for all types of hardware has increased steadily, from 28 percent in FY81 to 32 percent in FY83. Through June 1984, the AMC percentage was 42 percent versus a goal of 33 percent.

In spare parts purchases alone, we show an even higher competition percentage. We increased from 45 percent in FY81 to 48 percent in FY83, and through June 1984 our performance was 54 percent.

We are also focusing greater effort and are more selective on the contracts scheduled for Should Cost review. The new criteria calls for Should Cost reviews on the first production contract and, again, after the first production run is completed, which is normally the fourth production contract. Should Cost will concentrate on contracts of $50 million or more rather than the previous $25 million.

We have also realized cost savings by combining procurement initiatives in some procurements. For example, in the procurement of construction equipment, we bought three items—a road grader, a scoop loader and a scraper—competitively, using multiyear contracts. Our estimated savings are $378 million.

"We take very seriously our obligation to the American taxpayer to get the best deal possible for every tax dollar spent. In the future, the Army and industry must live by a mutual goal of fielding both quality and affordable military equipment—and I emphasize affordable."

Reasonable cost in the acquisition of spare parts has also received a lot of attention lately. I would like to cover several points concerning the management of the Army's $6.2 billion spare parts budget. With over 191,000 active items in the inventory, the job of insuring that each item is fair and reasonably priced is indeed challenging. The foundation of the Army's defense against overpricing is competition. With 48 percent of the Army's spare parts buys being purchased competitively, we feel that, while there is room for improvement, we are proud of our overall record.

To categorize the Army's efforts in the spare parts battle, I use four words—discipline, people, training, and common sense. We feel we are making great strides in all of them. Specifically, we are concentrating on five areas. First, we are aggressively pursuing refunds from all contractors supplying spares to the Army that we feel are overpriced. It has proven to be a real challenge which we intend to continue to meet head-on. The second area is the breakout program that centers on fostering competition in the spare parts program. An across the board application of breakout could realize as much as a 15–25 percent cost savings.

We have also developed a Digital Storage and Retrieval Engineering Data System which is a modern technological tool that we intend to use to improve the transmission of technical data, reduce administrative lead time, decrease drawing revision costs and enhance continuity of operations capabililty in the entire acquisition process.

Our fourth area of effort concerns data rights. I have recently directed that the warranty of data clause will be mandatory for use in all contracts where data procurement is involved. We have also initiated steps to review, on a sampling basis, the quality of data received and we are instituting procedures to challenge claims of proprietary rights in data.

Lastly, we established a minimum dollar value for procurement work directives for both stocked and nonstocked secondary items. This policy precludes procurement actions for less than the cost it takes to process those actions.

We have also instituted annual buys of items rather than buying the same item several times a year. This has had several positive results, such as reduction in frequency and volume of procurement work directives, shorter administrative lead times, and better unit prices.

To pull our efforts together in accommodating the *when needed* and *reasonable cost* challenges, we are attempting to stabilize programs by actively pushing multiyear procurement. It is estimated that this could result in a savings of five to 12 percent in unit procurement cost, through economies and efficiencies in the production process.

Another stabilizing effort is our Program Management Control System which provides a mechanism to enforce discipline in the acquisition process through tighter management controls. Program stability is improved since baseline requirements cannot be changed without formal approval from Department of the Army. The systems under development are tracked monthly to detect deviations from their baselines.

Our third challenge is to assure the fielding of quality equipment that our soldiers need and deserve. When coupled with our drive for a shorter acquisition cycle, this becomes a paramount challenge.

Poor equipment quality erodes the confidence of Congress, the public, our allies, and most importantly, our soldier in the field. The credibility of AMC, as well as our partners in industry, depends upon this quality and the performance reliability the systems impart. I'm not saying that anyone intentionally sets out to build shoddy materiel, but in the press of the acquisition process, priorities do get misplaced.

However, the lesson to be learned here is if we don't do our job right to begin with, it will be mandated to us. So let me assure you that the Army is elevating quality to the same level of importance as cost, schedule and performance. Also, we expect the same level of emphasis will be applied throughout industry.

Concern over acquisition of quality products is evidenced by the warranty provision in the 1984 DOD Appropriation Act. The Army has voluntarily imposed warranty requirements on selected equipments in the past, and I believe we've done a good job. However, the new warranty provision requires guarantees in all production contracts for weapon systems, whereas previously they were selectively applied. Both commercial and uniquely military items are included. Such a broad application of guarantees implies an upfront increase in acquisition and support costs as well as increased lead times. We are not in a position to quantify these at the present, but we're working the problem —and there are some problems we're very concerned about.

Most significant, perhaps, is our spare parts breakout program mentioned earlier. We feel it will be affected to the degree that prime contractors will want to retain control of spare parts and components, in order to maintain the integrity of the system for application of the system guarantee in the field—and rightfully so. Our concern here, however, is that less breakout will mean less opportunity for competition and small business participation.

My final topic deals with the logistics supportability and maintainability of our equipment.

Before I came to AMC, I was the Army's deputy chief of staff for logistics. Everyone expects me to stress logistics, and I won't disappoint them but I didn't invent the idea, and its importance is self-evident. What good is it to have equipment in the hands of the soldier quickly if we don't have the wherewithall to operate it, maintain it, or repair it?

Until someone comes up with the perpetual motion machine, all equipment, no matter how well designed, will need support. We're undertaking a major effort to ensure that logistic support is an inseparable component of system design and acquisition from day one. You don't think about a system without thinking about logistics. This poses an even greater problem with our push towards accelerated acquisitions. We not only have to do it better, but faster. To confront this challenge effectively, it is essential to recognize that the predominant cost of any system is the cost to support it. As an example, the anticipated cost breakdown on the M1 Abrams Tank is 1.2 percent for research and development, 23.8 percent for acquisition and 75 percent operation and support. Clearly, it is necessary to control the cost of that support, i.e., manpower, materiel, and time required to support the system if we are to control the actual life-cycle cost of that system.

". . . we, the Army must know what we want and state those requirements in specific terms. We must also have the courage to freeze design well before the production decision—and that design must be based on operational peacetime readiness and wartime effectiveness objectives."

The first step is the identification of logistical support requirements early in the life cycle. The logistician's truism is that it is never too early to consider Integrated Logistic Support in the materiel acquisition process. It must be done commensurate with concept development and continued throughout the life of the system. To accomplish this, two things must happen. First, we, the Army must know what we want and state those requirements in specific terms. We must also have the courage to freeze design well before the production decision—and that design must be based on operational peacetime readiness and wartime effectiveness objectives.

Secondly, industry must give us what we want and need, nothing less. This means that the first production contract cannot include the first of several change proposals designed to make the system work. These actions should have been accomplished before production.

Experience has demonstrated that decisions made early in the concept and development stages will determine production cost as well as the total operational and support costs of a system. It is, therefore, mandatory that we infuse "thinking logistics" as early as possible in the acquisition process.

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Deputy Director of Weapons Systems	BG August M. Cianciolo	695-3115	3E448
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Missiles & Air Defense Systems Division	COL Robert A. Drolet	694-8214	3B455
Ground Combat Systems Division	COL William O. Coomer	697-0046	3D455
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International Office	COL Howard P. Born	697-7879	3E413

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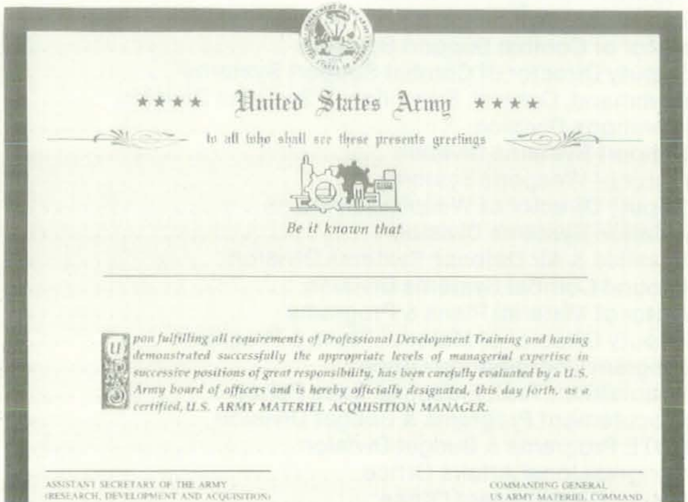
Acquition Assessment & Policy Division	COL John N. Tragesser	274-9811	8N22
Assistant Deputy CofS for Acquisition Management	A.H. Nordstrom (Acting)	274-8910	4S06
Deputy CofS for Technology Planning and Management	J. Bender	274-9561	10N24
Assistant Deputy CofS for Technology Planning & Mgt.	Robert A. Langworthy (Acting)	274-9561	10N24
Long-Range Planning	Brooks O. Bartholow	274-8372	10N33
IR&D Manager	Dr. Karl Bastress	274-8671	10N09
Tri-Service Industry Information Center	Dolores Mahon	274-8948	8S58
Deputy CofS for International Programs	Bryant R. Dunetz	274-8252	10N12
Chief, Office of Project Management	COL J.J. Vargo, Jr.	274-9571	10N18

Certificate for Materiel Acquisition Managers

A certificate has been designed and approved for officers certified as materiel acquisition managers (MAM). This applies to those officers in the grades of lieutenant colonel and colonel who are members of the MAM Program (additional skill identifier 6T).

Recently, a board of Army officers met to evaluate MAM officers for certification. Officers certified will be awarded the MAM certificate in the near future. Membership in the MAM Program is by selection board process and the competition is keen. Standards for becoming a certified manager are high. Officers who meet the standards and are awarded the MAM certificate can be proud of their achievement.



New System Improves Wastewater Treatment

In July 1984, the Belvoir R&D Center, Fort Belvoir, VA, published Technical Report No. 2408 entitled *Pilot Demonstration of a Sulfide Precipitation Process for Metal Finishing Wastewater Treatment.* With this publication, the Center successfully completed an important work unit in the DOD DO-48 Environmental Quality Technology Program.

The objective of the work unit was to demonstrate the effectiveness of a relatively new electroplating wastewater treatment process. The process is based on the use of a soluble sulfide chemical for the removal of toxic metals from wastewater generated in industrial metal finishing operations. The demonstration effort included the design, installation and operation of a 35 gallon-per-minute treatment system at the Tobyhanna Army Depot, Tobyhanna, PA, where extensive electroplating and other metal finishing operations are conducted by the Army.

The origin of this effort goes back a few years. In 1975, a study conducted by the Army Environmental Hygiene Agency indicated that the rinse waters from the Tobyhanna plating shop, containing highly toxic metals, were adversely affecting the efficiency of the depot sewage treatment plant as well as ". . . devastating the ecosystem of the receiving stream." The depot also received considerable adverse publicity in the local press as the result of a fish kill.

Effluent from the metal finishing operations was being inadequately treated before it was discharged to the sewage treatment plant. As a result of meetings between personnel from AMC, EPA, Tobyhanna, and the Belvoir R&D Center, the Center was directed to provide a solution to the problem. Funding was provided by the U.S. Army Toxic and Hazardous Materials Agency, lead agency for DOD Project DO-48.

Results of a laboratory treatability study of Tobyhanna plating shop rinsewaters conducted in 1979 were used to prepare and advertise a procurement package, specifying the unit processes and design criteria for the treatment system. A contract was awarded to JRB Associates, Inc., McLean, VA, in September 1980.

After extensive site preparations, a fully automated treatment system was installed and became fully operational in January 1983. The system was evaluated by the Army Environmental Hygiene Agency in March and April 1983 and by the Belvoir R&D Center from July through December 1983. The results of this monitoring indicates that the system is performing in a highly effective manner, producing an effluent meeting all state and federal pollution abatement standards.

The sludge produced by the process is minimal, amounting to only 0.4 gallon per 1,000 gallons of wastewater treated. This translates to only three 55-gallon drums of sludge per month with a disposal cost of $180 per month to the depot.

The total cost for chemicals and sludge disposal amounts to $1.38 per 1,000 gallons of wastewater. The system has provided Tobyhanna with a capability to comply with the newly promulgated federal pretreatment standards for the metal finishing industry.

The results demonstrated in this project are so favorable that the U.S. Army Toxic and Hazardous Materials Agency is now conducting a survey of several AMC installations engaged in metal finishing with a view toward incorporating the technology at other installations. The soluble sulfide treatment process has wide applicability and can be used to upgrade conventional metal finishing wastewater treatment systems based on metal removal by lime or caustic addition.

The preceding article was authored by Maurice Pressman, an employee in the Petroleum and Environmental Technology Division, Logistics Support Laboratory, U.S. Army Belvoir R&D Center.

Workers at the Tobyhanna plant begin the purification process by separating contaminants from waste water pumped into the facility from metal finishing operations.

When the treatment process is completed, sludge is drained off the disposal.

Improved Vehicle Diagnostic Equipment

By Joseph Steyaert and George Taylor III

The U.S. Army Tank-Automotive Command (TACOM) is developing an advanced automated diagnostic system for unit maintenance level mechanics that will simplify the job of detecting and correcting combat vehicle malfunctions. It is known as Simplified Test Equipment Expandable (STE-X) and it is a general-purpose tester that will provide a virtually limitless diagnostic capability.

The new system is planned for introduction in late 1987. In the automotive test area, it will supplement the current Simplified Test Equipment for Internal-Combustion Engines (STE/ICE), a microprocessor-based system that began replacing the older conventional test equipment in 1979. Additionally, it will replace the STE-M1/FVS, a modified version of STE/ICE now used to troubleshoot M1 tanks and M2/M3 Bradley Fighting Vehicles.

Besides being able to handle automotive tests like those handled by STE/ICE, STE-X fault-diagnoses all other hull and turret systems. It can also be programmed to troubleshoot other types of equipment, such as helicopters, missile and communications systems, general electronics and various specialized data and power bus structures. STE-X versatility will make it adaptable to any Army vehicle or weapon system envisioned up to the year 2010.

Although STE-X will meet all the tank-automotive unit level diagnostic requirements envisioned during the next 25 years, STE/ICE will continue to play an important role after STE-X arrives. The STE/ICE is a good, low-priced manual tester that addresses the automotive type systems within the Army fleet, and it will still be used to troubleshoot tactical vehicles. It will eventually be fielded with all units that support internal-combustion engine-powered materiel, including combat, tactical, engineer, construction, power generation and mechanical handling equipment.

The new expandable equipment is an automatic tester whose real forte is to test the electronic systems used in combat vehicle turrets, which are more sophisticated and harder to troubleshoot manually. STE-X consists of two main parts: the core and applications hardware box. The heart of the system is the core, which is one unit consisting of three distinct electronic modules. The largest of these, called the main frame, includes the STE-X central processing unit, or computer, as well as various cable connectors.

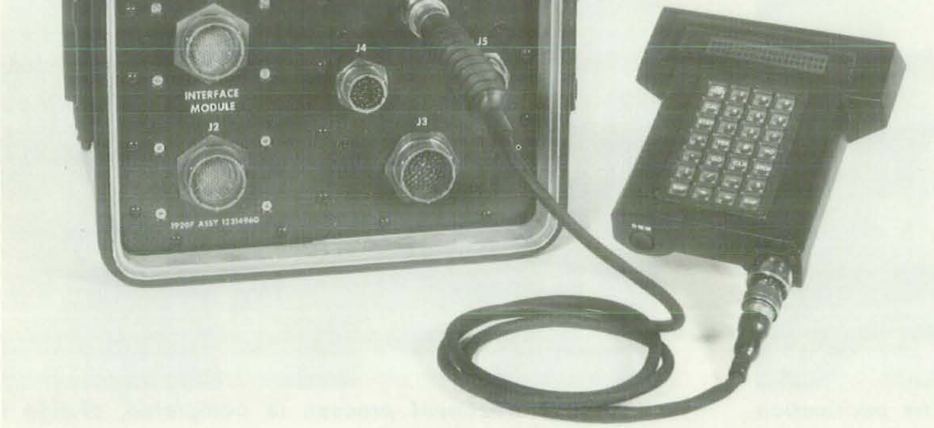
The computer features an electronic mass memory storage medium called bubble memory, which has an information storage capacity about 10 times greater than that of more conventional electronic memory designs. Bubble memory is a technology that involves placing thousands of tiny magnetic bubbles on small chips of artificial garnet about the size of a nickel. When low-voltage signals are applied to the garnet, these bubbles, magnetically oriented in different directions, rotate around the outside of the chips.

To the STE-X computer, each bubble, depending upon its orientation, represents a number in a code that the computer translates into meaningful diagnostic test program data. The size of each magnetic bubble is so miniscule that it is possible to pack many thousands of words on one garnet chip.

The memory is also non-volatile, which means that it will remember indefinitely—even with the system's power turned off. It is also possible to record a program and the bubbles will remain in the proper orientation for that program until some physical reprogramming action is taken to change it.

The second core module is a detachable unit containing additional memory circuits. Its purpose is to add new programs to the system for testing vehicles that are either new to the inventory or have been modified and would require an updated test program.

The advantage of the memory module is that a mechanic will be able to reprogram a STE-X set externally, without having to tear the equipment down. There will be a separate memory module for each new or product-improved vehicle. The mechanic will simply plug in the appropriate module for each and record the new program in the main frame.



The STE-X System.

STE-X ready to test the Bradley Fighting Vehicle.

The third part of the core is an interface module. This module receives the incoming signals from transducers or vehicle test points, separates them and feeds them into the main frame for analysis. Different interface modules would be used to test different commodities such as helicopters, missile systems or radars.

The other main STE-X component is the applications hardware box. This unit houses connecting cables that attach the tester to a diagnostic connector assembly that is built into the vehicle connected to the various key test points. For older vehicles not equipped with diagnostic connector assemblies, or special deep diagnostic applications, the box includes additional cables, adapters and transducers for attaching the set directly to the test points.

The system also contains a set communicator for the mechanic. Made up of an alphanumeric keyboard and a display screen with two 36-character lines, this device allows the mechanic to communicate with the STE-X set, select and initiate testing and obtain test results. The set communicator also functions on its own as a very durable digital multimeter.

To test a vehicle with STE-X, the mechanic first enters into the computer the type of vehicle to be tested. He then indicates which vehicle system he would like to test, and initiates an automated test sequence by pressing a button on the set communicator keyboard. When the testing is completed, the display either indicates that the system passed the test, or which part the mechanic must replace to correct a detected malfunction.

During some tests, such as those involving a tank gun stabilization system, a message may appear asking the mechanic to operate the system so that the STE-X computer can evaluate its performance. For instance, to measure the reaction time of the stabilization system, the mechanic might be asked to rotate the turret.

The power needed to operate the STE-X set is supplied either from the batteries of the vehicle being tested or an external battery source. Efforts to develop STE-X began in 1978, when TACOM intiated a feasibility study to determine if the technology existed for designing an automated general-purpose diagnostic system. That study, conducted in 1979-80, concluded that the electronics state-of-the-art had developed to the point that such a system was not only scientifically feasible, but was also economically practical.

In March 1981, TACOM awarded an advanced development contract calling for fabrication of two laboratory brassboard models. These were used to develop and establish the validity of the computer logic needed to operate the tester. In September 1982, TACOM awarded RCA a full-scale engineering development contract. Under terms of that agreement, the company will build and program six STE-X prototypes by June 1985. These will undergo field tests and troop evaluation at several Army test sites.

The vehicles to be used throughout the tests will be M1 tanks and Bradley Fighting Vehicles. Compatibility will also be demonstrated on the remainder of the tactical fleet. The tests should take four months to complete, at which time the results will be reviewed by officials at AMC, Logistics Evaluation Agency and TRADOC. If the results are favorable, the program will then move into the initial production phase.

JOSEPH W. STEYAERT is the diagnostic systems manager for the U.S. Army Tank-Automotive Command, Warren, MI. He has a BS degree in electronics engineering from the University of Detroit and is a registered professional engineer in Michigan.

GEORGE TAYLOR III is a technical writer and editor at the Tank-Automotive Command.

The CounterObstacle Vehicle Test-Bed Program

By Steve Martin

The Threat

U.S. Army maneuver forces on the modern battlefield will be confronted with all types of obstacles—both man-made and natural. The Soviet army and the Warsaw Pact make extensive use of minefields and other obstacles.

All armies, of course, use barriers and other obstacles in the defense, to slow down and canalize the enemy attack and to aid in sealing off any penetrations. The Soviets, however, plan to use them extensively in the offense as well—to protect an open flank during a breakthrough or meeting engagement, as an economy of force measure in an area where no attack is planned, or to blunt an enemy counterattack. Thus, U.S. forces will encounter extensive obstacles in both offensive and defensive operations.

Soviet engineers utilize all the standard types of obstacles—abatis, anti-tank ditches, cratering, bridge demolitions, barbed wire, etc.—but they rely primarily on anti-tank minefields. As a Soviet engineer text puts it, "Anti-tank minefields are accepted as the basic system of engineer obstacles."

Soviet doctrine calls for large numbers of anti-tank mines to be laid quickly across tank routes of attack and covered by fire. To accomplish this task, the Soviets have developed and fielded large numbers of mechanical minelayers. The engineer company of each motorized rifle regiment, for example, has three towed PMR-3 minelayers or three GMZ armored tracked minelayers and can lay some 600 anti-tank mines at four or 5.5 meter intervals in 15 to 20 minutes.

When Soviet engineers use other types of obstacles, their doctrine calls for them to be integrated with minefields and covered by fire. Similarly, they plan to integrate natural obstacles into their barrier plans whenever possible. Figure 1 shows the principal types of natural and artificial obstacles that U.S. and NATO forces can expect to encounter on the modern battlefield.

Principal Types of Obstacles

(All can be contaminated with toxic chemicals or nuclear radiation)

Minefields	Other Artificial Obstacles	Natural Obstacles
Hasty Deliberate Scatter Other	Bridge Demolitions Cratering and Culvert Demolitions Landslides and Road Destruction Antitank Ditches and Escarpments Abatis Tree Blowdown Posts Barricades and Log Cribs Urban Rubble	Ravines and Narrow Streams River Crossing Embankments and Walls Swamps and Marshy Areas

Figure 1.

Traditional Methods

The traditional method of dealing with these different types of obstacles has been to develop a number of different systems, each designed to defeat one or a narrow range of obstacles. To breach minefields, for example, rollers pushed by tanks, various types of line charges, or dismounted engineers with mine detectors and grapples or explosives can be used.

Various kinds of dozers can be used to cross anti-tank ditches and escarpments. Dismounted engineers with chain saws and vehicles with cables can clear an abatis or an area of tree blowdown. Dozers and front loaders are useful in clearing routes through urban rubble.

This method of dealing separately with each type of obstacle can be effective, but it presents two major difficulties. First, since Soviet engineers frequently integrate various types of obstacles, coordinating the different equipment and teams needed to breach a complex obstacle can be quite difficult and time consuming. In addition, several of these systems utilize unarmored vehicles or engineers working in the open. These methods will be dangerous and may be unsuccessful when the obstacles are covered by fire as Soviet doctrine requires.

An Integrated Approach

To provide a rapid and effective means of breaching obstacles, the Engineer Support Laboratory at the Belvoir Research and Development Center is developing a counterobstacle vehicle (COV). To defeat all kinds of obstacles, the COV will be able to breach minefields and will have a combination of excavating, dozing, lifting and hauling capabilities to defeat other obstacles. It will be able to work in a hostile combat environment.

In addition to its primary mission of breaching and clearing obstacles, the COV can also be used to construct combat roads and trails and

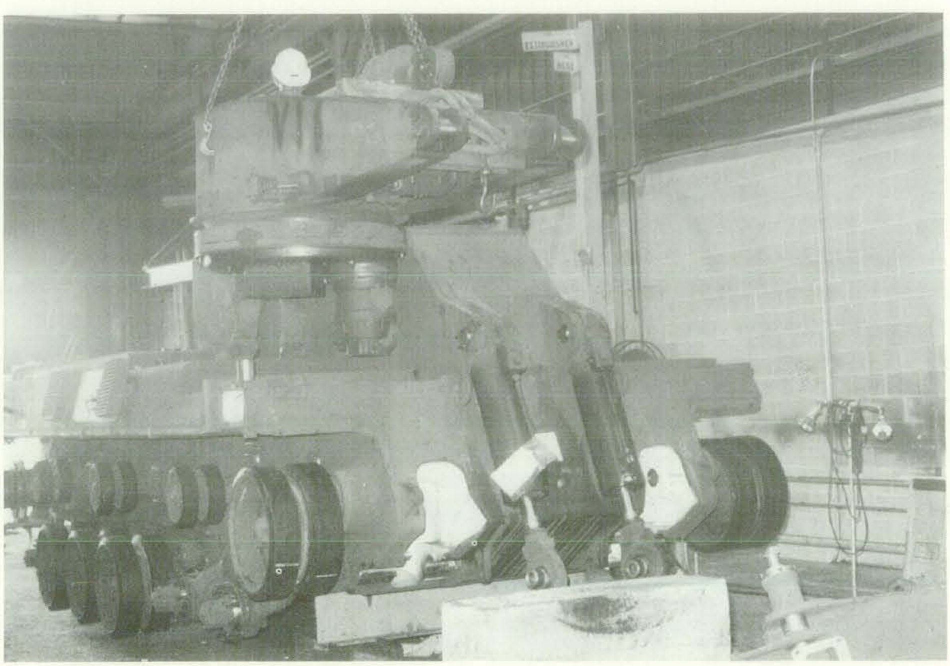
A weapons system staff manager looks into the crew compartment of a test bed. The circular area to the bottom right is the mount for one of its two telescopic arms. Behind the test bed to the upper left are various arm attachments.

perform countermobility and survivability tasks.

Since a composite COV has no commercial counterpart, many unknowns in developing and using such a vehicle are expected. The approach selected by the Belvoir R&D Center, therefore, is to use a test bed vehicle to evaluate the feasibility and utility of the COV concept and to develop data on which to base future decisions. A development contract for the detailed design and fabrication of two test-bed vehicles was awarded to BMY, of York, PA. The vehicles are now being fabricated and will be delivered for Army testing in FY85.

General Description

The chassis of the COV will be full tracked, to provide good cross-country mobility. The COV will be fitted with a full width mine clearing plow which is convertible to a dozer blade. The COV can also push mine rollers, such as the set developed for the M-60 tank, and tow trailer with the rocket propelled Mine Clearing Line Charge. A Cleared Lane Marking System will mark passages in hostile minefields cleared by any of these methods.



The telescopic arm's main frame is lowered onto its right-hand mount.

The COV test-bed vehicle will have two telescopic working arms with a variety of attachments available, including excavating buckets, grapples, lifting hooks hammer/pavement breaker, and an earth auger.

Methods of Operation

This panoply of subsystems and attachments will give the COV vehicle a formidable capability against all types of natural and artificial obstacles. Depending on the situation and the type of minefield, the COV can use the mine rollers, the full width mine plow, or the Mine Clearing Line Charge to breach a hostile minefield. For example, the COV can use the full width mine plow to "proof" a lane cleared by the Mine Clearing Line Charge. The dozer blade and the telescopic arms with their attachments can also defeat other types of obstacles.

To cross an anti-tank ditch, for example, the COV might use the dozer blade to push dirt from the near side and the telescopic arms with excavating buckets to create an exit on the far side. The dozer blade can also be used to prepare a bypass around a destroyed bridge, to clear landslides, and to fill road craters.

To defeat an abatis or clear a route through an area of tree blowdown, the COV would use the grapple attachment and the telescopic arm with excavating bucket and a tree cutter.

In clearing a route through urban rubble, the COV might use the hammer/pavement breaker to break up large pieces of rubble and the dozer blade to push the rubble aside or ramp over it. The grapple attachment could be used to move large beams.

The dozer blade and the telescopic arms also give the COV a varied capability of preparing obstacles, constructing roads and trails, and digging field fortifications in addition to its primary counterobstacle role.

Test-Bed Design Vehicle

The COV test bed design is based on the hull and chassis of the M88A1 recovery vehicle. Modifications include a number of changes to accommodate the combination plow/dozer blade system and the telescopic arms. The upper part of the hull has been modified, placing the three crew members in line, to make room for the telescopic arms on either side. An escape hatch is located in the bottom of the vehicle beneath the operator's station and is accesible to all three crew members.

The test-bed vehicle uses a 908 horsepower, Teledyne Continental Motors turbocharged, air cooled engine. A 400 horsepower Power Take Off at the front of the engine drives a hydraulic system which powers the telescopic arms and the mine plow/dozer blade. The standard M88A1 Detroit Diesel Allison transmission is modified slightly to compensate for the high torque at low speed required for mine clearing and dozing.

The M88A1 suspension system is modified to handle the weight of the COV (approximately 68 tons). Higher strength materiels are used for the torsion bars, anchors, and spindles. The diameter of the torsion bars is also increased to maintain the same ground clearance on the COV as on the M88A1.

A remote suspension lockout system provides chassis stability during plowing, dozing, and digging operations. The selected design concept consists of steel blocks that pivot into place to restrict the movement of those road wheel stations subjected to dynamic loading. Lockout blocks are positional by hydraulic cylinders controlled from within the crew compartment.

Combination Mine Plow/Dozer Blade

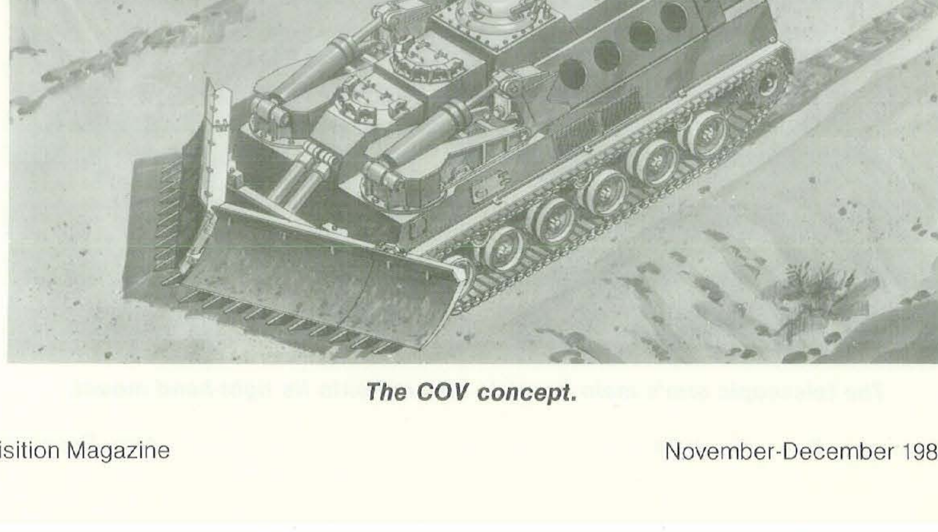
The combination full width mine plow/dozer blade, being developed by the Israeli Military Industries, is hinged at the center of the blade to allow the two sections to be rotated into either a "V" configuration for mine clearing or a straight configuration for earthmoving.

Removable extensions or "wings" are used in the mine plow mode to obtain the desired cleared path width of 180 inches. In the dozer mode the "wings" are removed, reducing the blade width to 162 inches, and covers are placed over the teeth to provide a continuous cutting edge.

Weapons System Manager Richard R. Rogowski inside grapple attachment for telescopic arms. The grapple is one of two special arm attachments for the test bed, and has a capacity of 2½ tons.

The full width mine plow is designed to provide a "quiet flow" of soil along the face of the plow or moldboard and minimize turbulence and drawbar pull required and hence maximize clearing efficiency. The key issue in achieving these design objectives is ensuring that an optimum depth of cut is maintained along the moldboard, since this dimension directly affects speed, soil flow, turbulence, and efficiency.

To facilitate maintaining this optimum depth, an automatic depth control system will be used. This system employs sensors to track the ground surface in front of the COV and a microprocessor to interpret the data and make adjustments to maintain the desired depth. Of course, the mine plow and the dozer blade can also be operated by manual controls. In the dozer mode the COV is expected to have an earthmoving capability roughly equivalent to that of a caterpillar D8 dozer.



The COV concept.

Telescopic Arms

The design of the telescopic arms is based on the Gradall 660 excavator, but the COV test-bed arms are more powerful, both structurally and hydraulically, and made of higher strength materials. Electric 'joy stick' controls will provide flexibility in operating the arms and their attachments.

Either the driver or the operator can operate one or both arms, or the arms can be operated simultaneously—one by the driver and the other by the operator. Each arm can extend to a length of 32 feet and operate minus 60 degrees to plus 60 degrees from the horizontal. Each has a horizontal operating arc of 135 degrees; thus both arms will give the COV test-bed vehicle a total excavating arc of 270 degrees.

When equipped with the 1.3 cubic yard bucket, each arm will have an estimated earthmoving capability of 200 cubic yards per hour. A lifting eye is included on the underside of each lifting arm to take advantage of the lifting forces available—12,000 pounds at 21 feet. In addition to the excavating bucket, three other attachments—the grapple, the earth auger, and the hydraulic hammer—will also be evaluated during the COV test-bed program.

Testing Schedule

The prime contractor, BMY, is scheduled to complete fabrication of two COV test-bed vehicles in late November 1984 and January 1985. Initially, BMY will conduct some six months of preliminary testing to ensure that all systems and subsystems are operational.

The Belvoir R&D Center will evaluate the COV test-bed July 1985 through January 1986.

The primary objective of this test will be to collect performance data on the COV test-bed vehicle and the various items and combinations of countermine and counterobstacle equipment. Testing will concentrate on the operation of the full-width plow and telescopic arms in breaching complex obstacles.

The clearing effectiveness of the full-width plow will be evaluated to assess its advantages over track-width systems. The dozer blade will be used for earthmoving tasks to determine its capability in this mode. The two telescopic arms will be evaluated in terms of earthmoving productivity with the excavating buckets and in a number of mission profiles with the other attachments.

The use of the telescopic arms for self-recovery will be addressed by evaluating the COV's performance in climbing steep embankments and walls. Figure 2 summarizes some of the testing scheduled for the COV. At the completion of the test-bed phase, the data will be analyzed and recommendations developed for improvements. Information obtained from this phase will be used to define the most important capabilities and to design a prototype COV.

Planned COV Tests

Telescopic Arms with Buckets
- Vehicle Stability
- Productivity
- Heat Tests (Hydraulic System)
- Controls

Telescopic Arm Attachments
- Installation/Removal
- Interfaces
- Operational Function
- Controls

Mine Roller/Track-Width Plow/Clams
- Installation/Removal
- Operational Function
- Controls

Vehicie Tests
- Speed
- Gradability
- Human Factors
- Load Analysis
- Controls

Full-Width Mine Plow
- Speed
- Efficiency
- Conversion Time
- Controls (Automatic and Manual)

Bulldozer
- Speed/Depth
- Slot Preparation
- Back Blading
- Controls

Figure 2.

Conclusion

The COV test-bed program will yield valuable information and insights regarding the feasibility of the COV concept. The program should give the Army the requisite background to build COV prototypes incorporating the best features of all previously explored concepts and designs. The development of such a vehicle with an integrated, advanced counterobstacle capability will fill an urgent need in increasing the mobility of U.S. forces on the modern battlefield and hence improve their effectiveness.

Additional information about the Counterobstacle Vehicle program can be obtained from the COV Project Office of the Engineer Support Laboratory, Belvoir R&D Center, AUTOVON 354-4272, commercial (703) 664-4272.

STEVE MARTIN is a project engineer, Construction Equipment Division, Engine Support Laboratory, Belvoir R&D Center. Recently assigned to the newly formed COV Office, he holds a BS degree in engineering from the University of Maryland and an MS in systems management from the University of Southern California.

From The Field ...

Microprocessor Controls Vehicle Attachments

Researchers at the Belvoir R&D Center's Combined Arms Support Laboratory Fort Belvoir, VA, have mounted a microprocessor-controlled backhoe and manipulator arm on a cross-country vehicle to evaluate their potential in a combat situation. By minimizing the manual operations required to handle these two attachments, the microprocessor system would reduce the danger to the driver from every weapon or chemical, biological or nuclear agent.

Once developed, the processor's computer program could record and evaluate data on the exact position of the attachments and calculate the exact voltages needed to perform a specific task. Engineers visualize a driver being able to call upon a previously entered program to dig a standard hole with the backhoe, to enter his own data for a special excavation, or to control the backhoe using a joystick.

The manipulator, meanwhile, would have the capacity to lift and stack a pallet of ammunition at angles up to 90 degrees when fully extended. This could be increased to as many as four pallets—all while the driver remains in the safety of the cab.

Data from intial tests currently underway will also form the basis for using artificial intelligence in other types of construction and materials handling equipment.

The specially adapted cross-country vehicle equipped with microprocessor-controlled backhoe and manipulator arm will enable an operator to load and unload ammunition from inside the cab of his vehicle.

CAD-E System Expands Natick Capabilities

The Aero-Mechanical Engineering Laboratory (AMEL) at the U.S. Army Natick Research and Development Center, Natick, MA, is increasing its capabilities with the recently acquired Computer Aided Design and Engineering System (CAD-E).

This technology is providing improved engineering design and analysis in the development of a wide variety of airdrop, shelter, and combat service support systems.

Interactive color graphic CAD-E work stations are located within each division in the laboratory and they are connected

Gary Thibault, a mechanical engineer with AMEL, Natick, MA, uses the CAD-E sytem to review a design.

to a central data base via a coaxial cable-based communication network. Engineers can create designs and models and perform structural analysis on the models and share data with other divisions, without leaving their office area.

The engineer can create and view prototype items in two dimensions, or interact with three-dimensional, solid-model drawings by zooming in on details not visible to the naked eye, mirroring objects about an axis, scaling the size of screen objects to real world requirements, moving designs across the screen, or duplicating designs multiple times, all with the stroke of a pen-like device to a flat menu tablet overlaid with English type commands.

Once the model is created, it can be further analyzed by a program called "NASTRAN" which evaluates the strengths and weaknesses of a particular design. The results of the analysis are then processed through a post processor application which permits materiel deformations and stress contours to be viewed in graphical colors.

Physical attributes of the design, such as the density of the item, the center of gravity, the moments of inertia and other mass properties, are automatically defined. These and other analytical capabilities greatly reduce the requirement for repeatedly designing prototypes because design flaws can be detected early in the CAD-E design phase. Hard copies of the design in an 8½-inch by 11-inch black and white format, or a full color production size drawing (44 inch by 22 inch) are subsequently available. These can be produced on a large pen plotter.

Although the system has been in place for only six months, it is producing results. Most importantly, the potential for high quality designs the first time around is increased. This results in better management of engineering programs and resources and reduces fielding time for end items.

New Program Focuses on Nutrition Problems

The U.S. Army Medical Research and Development Command officially re-established its military nutrition research program at the U.S. Army Research Institue of Environmental Medicine in Natick, MA.

The mission of the new research group is to study nutrition related problems of the feeding of soliders on the battlefield of the future. The critical end point of this research is effective soldier performance of cognitive, psychomotor and physical tasks during sustained periods under all environmental extremes.

The requirement for nutritional wholesomeness of rations will become increasingly challenging as the Army reduces numbers of battlefield cooks and kitchens, replacing them with prepackaged, low weight and volume rations and food packets needing only heating or rehydration.

The coming change in feeding methods is necessary because today's field kitchens are too labor intensive and logistically burdensome for the highly mobile and widely dispersed forces on the battlefield of the 1990s. The possibility of contamination on the battlefield and the need for protective clothing systems also requires simplicity in feeding systems.

The new military nutrition research program will respond to the needs of all four armed services, and will be conducted in collaboration with the food technology and food acceptance research programs at the U.S. Army Natick Research and Development Center, which is responsible for all DOD R&D concerning food. Close collaboration will also be established with the human nutrition research centers of the U.S. Department of Agriculture, and other federal nutrition laboratories.

In planning the scope and focus of the new research program, the Army obtained advisory assistance from the National Academy of Sciences Committee on Military Nutrition. The Army is also participating with the Interagency Committee on Human Nutrition Research in development of a Federal Human Nutrition Research Plan.

The new program will be directed by LTC David Schnakenberg, MSC, who holds a doctorate in nutritional physiology. He has been associated with the Army nutrition research program since 1965.

The U.S. Army Medical Research and Development Command, headquartered at Fort Detrick, MD, is responsible for the Army's medical research, development, test and evaluation program. Nine laboratories of the Command, including the Army Research Institute of Environmental Medicine, conduct R&D to protect soldiers from hazards of the environment, of their own equipment and systems, the threat of biological and chemical weapons, and to improve medical equipment and care on the battlefield. MG Garrison Rapmund, the assistant surgeon general for R&D is commander of the Medical Research and Development Command.

Water Jet Cuts Benite Igniter Strands

A new and more efficient high pressure water jet process for cutting of Benite igniter strands will be introduced shortly into production at the Radford Ammunition Plant at Radford, VA.

The process is based on use of a 60,000 psi water jet of extremely fine diameter, approximately seven thousandths of an inch, to replace the current labor intensive and high product loss process which uses ganged circular saw blades.

The new cutting system was developed at the Radford plant with funding by the Munitions Production Base Modernization Agency. The effort was technically directed by a project team headed by Robert P. Baumann of the U.S. Army Armament Research and Development Center's Large Caliber Weapon Systems Laboratory, Dover, NJ.

Jet cutters are used to improve cutting efficiency for a wide variety of commercial products, such as wood panelling, textiles, plastics, foodstuffs and automotive and aircraft components. The jet cutter is also quite powerful. It is capable of easily piercing metal coins with fine diameter holes.

The project was conducted to adapt the jet cutter to the unique requirements for energetic material manufacture and to install and evaluate self-implementing prototype jet cutting equipment for the production of Benite.

The jet cutter has many advantages over the mechanical sawing method. The present sawing process requires that the solvent-wet Benite strands be of approximately the final length needed; that they be manually trayed and then dried for several days. The dried strands are then manually bundled and placed onto a saw table.

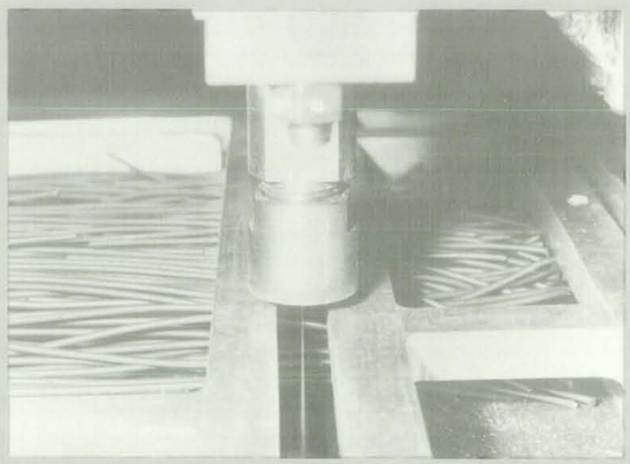
Ganged circular saw blades are remotely moved through the bundles giving several bundles of the desired finished length. During cutting, water-alcohol is deluged onto the bundles to minimize ignition. The Benite is then redried for several days at elevated temperatures.

About 30 percent of the Benite is lost due to breakage, warpage and in-process losses. Potassium nitrate, a water soluble Benite ingredient, is partially leached out because of the deluge. Extensive manual handling is needed in the traying, bundling and transportation operations, exposing operators to contact with hazardous materials.

With the jet cutter, solvent wet strands of approximately the final length are partially dried on specially designed trays. The trays are conveyed remotely through a bank of stationary jets yielding Benite cut to a final length. A deluge is not required due to elimination of the saw blades. The jets use so little water that the ends of strands are only slightly dampened. The cut material is then dried for a final time at elevated temperatures.

Tests show that the jet cut material is equivalent to saw cut Benite. There is less product loss with 30 percent reduction in scrap. The Benite also shows less evidence of potassium nitrate leaching. Significant reductions in drying and product handling were achieved, reducing energy, transportation and labor costs and exposure of operators to hazardous material. Minimum total overall savings is estimated at $1.45 per pound of Benite. A trend was also indicated toward reduced ignition delay and greater functioning precision.

In addition to cutting Benite, jet cutting has potential application to the cutting of other energetic materials, such as stick propellants, rocket grains, sheet propellant, combustible cases, cellulose, nitration sheet feed stocks and explosives. The jet can be designed for programmed maneuvers in intricate patterns which could offer geometric shapes either not previously possible or only available at high cost.



Shown is one of three high pressure jets of water being used to cut a tray of Benite igniter strands being moved along by a conveyor belt.

Army Type Classifies M252 Mortar System

The Improved 81mm Mortar System has been type classified following nearly three years of co-development by the United States and the United Kingdom. This means the system is ready for production, with fielding to the troops scheduled for 1987.

The United States had examined the British UKL 16A2 Mortar System as a possible candidate to replace the M29A1 81mm Mortar as part of NATO-member countries efforts at rationalization, standardization and interoperability (RSI).

According to Sam Pinkard, Improved 81mm Mortar System development project officer in the U.S. Army Armament Research and Development Center's Armament Systems Directorate, tests and evaluations showed the British mortar met the criteria needed for a future U.S. mortar weapon system, including greater range, which is more than 5,600 meters. Under the contract, the British modified the system to satisfy U.S. requirements. The modifications included waterproofing and blast attenuation.

The new mortar system, designated by the Army as the M252, is a reflection of NATO RSI efforts. The mortar itself is British, as are new high explosive M821 rounds. The mortar system included a NATO base plate and a U.S. system. In addition, the mortar will use new U.S. smoke (XM819), illumination (XM853) and pratice (XM879) rounds under development in the Armament R&D Center's Large Caliber Weapon Systems Laboratory.

COL Nicholas Barron, former director of the Armament Systems Directorate, says, "It's been a long and difficult struggle to reach type classification. All the long hours were well worth it. The Army needs the capability, and we're going to provide it."

New Complex Will Replace GS Shop Sets

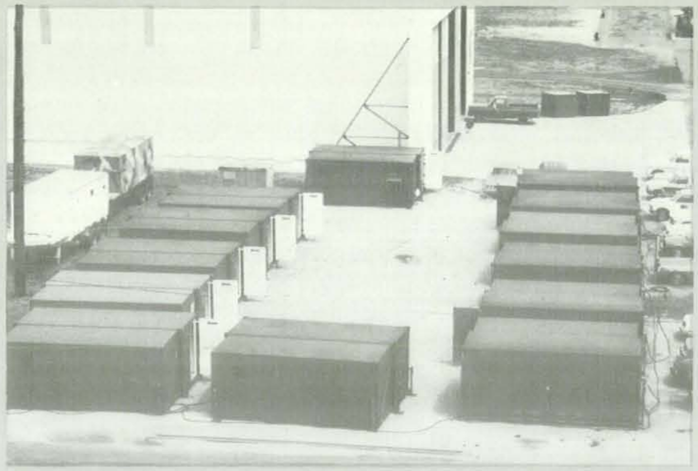
The Army will soon field the Non-Divisional Aviation Intermediate Maintenance (AVIM) Shop and Tool Set Complex designed to replace the obsolete Aircraft Maintenance, Semitrailer Mounted, C-1 through C-11 General Support (GS) Shop Sets. The GS Shop Sets, housed in outmoded vans, are not easily transported and do not support the unit, intermediate, and depot level maintenance concept needed to meet the current and future AVIM mission requirements.

In 1980, the Applied Technology Laboratory (ATL), Fort Eustis, VA, was tasked as material developer of the new shop complex. ATL is one of four laboratories of the U.S. Army Research and Technology Laboratories (AVSCOM).

The complex is composed of a tool crib, and electrical/instrument, pneudraulic, machine/welding, powertrain, propeller/rotor, sheetmetal/paint, engine, production/quality control, armament, fire control and battery servicing shops.

"Existing tools and components from the GS Shop Sets will be used for the new shop complex where possible," said Paul Pantelis, ATL project engineer. "Some items have been eliminated for repairs that are no longer authorized. Others have been added or replaced by state-of-the-art tools and equipment," he said.

Of the 12 AVIM shop prototypes, nine have been designed and constructed by ATL personnel, and two by the Armament, Munitions and Chemical Command, Rock Island, IL. The battery shop was developed and type classified by the Communications-Electronics Command, Fort Monmouth, NJ, and is housed in a S-280 shelter.



The Non-Divisional AVIM Shop and Tool Set Complex is designed to replace the obsolete Aircraft Maintenance, Semitrailer Mounted, C-1 through C-11 GS Shop Sets.

Each of the shops is equipped with its own electrical, heating and air conditioning systems, and was modified for compressed air and water inputs where required. The shops each have their own blackout lighting provisions.

The new shops, with the exception of the battery shop, are housed in highly mobile, one-side-expandable, rigid wall tactical shelters. These shelters, which are 20 feet long, 8 feet wide, and 8 feet high, can be expanded to 15 feet wide, and conform to American National Standards Institute and International Standards Organization (ANSI/ISO) standards for multimode transportability.

The shelters were developed by the Army Natick Research and Development Center, Natick, MA. Engineering and actual construction of the individual AVIM shops began in September 1982 at ATL.

The shops can be transported by highway (semitrailer or dolly set); rail; marine (containership); USAF C-130, C-141, and C-5 aircraft; and Army CH-47 or CH-54 rotary-wing aircraft. Sling lifting does not require unique lift adapters other than those normally used for ANSI/ISO containers. The lift and tiedown points meet the requirements of the MIL-STD-209 and MIL-A-8421. The fully-equipped weight of any one shop does not exceed 15,000 pounds and requires less than one hour to erect in the field.

The complex will normally be assigned to a transportation aircraft maintenance company which directly supports corps and other non-divisional aviation assets and provides backup support to division and separate brigades located in the corps area. It is equipped to provide mobile responsive maintenance support for aircraft, aircraft armament, and aircraft-peculiar items of ground support equipment. They are deployed on an area basis in any geographical area and under any climatological conditions where Army aviation units will be utilized.

Non-divisional AVIM units are assigned to support the mix of rotary and fixed wing aircraft systems in their area of operation. This complex of 12 individual shops will be used and supported by 150 to 250 personnel. A total of 25 of the non-divisional AVIM complexes is planned worldwide for the Army.

NOTE: Shortly before going to press, the Army RD&A Magazine *was notified that AVSCOM would turn over the AVIM Complex to the 507th Transportation (AVIM) Company, Fort Campbell, KY, on November 8, 1984.*

ACAP Helicopter Completes First Flight

A U.S. Army/Sikorsky Advanced Composite Airframe Program (ACAP) helicopter made its first public flight late this summer in a ceremony at the Sikorsky Development Flight Test Center, West Palm Beach, FL.

The ACAP contracting agency is the Applied Technology Laboratory (ATL), Fort Eustis, VA, one of four laboratories of the U.S. Army Research and Technology Laboratories (AVSCOM). The aircraft flew 20 minutes with Sikorsky pilots at the controls.

"The ACAP program is the result of many years of devoted effort on the part of the Army and the helicopter industry," said COL Patty E. Brown, director of ATL. He notes that in the mid-1970s ATL pushed for the development of an advanced structures technology demonstrator. However it wasn't until the late 1970s that enough industry and government support could be mustered to get ACAP under way.

"The objectives of ACAP were straightforward: demonstrate enhanced military characteristics, such as damage tolerance, crashworthiness, reliability, and maintainability, and at the same time reduce the airframe weight by 22 percent and the production cost by 17 percent," said Brown.

In 1979, the Applied Technology Laboratory awarded five Advanced Composite Airframe Program contracts to conduct trade-off analyses considering the myraid of design requirements and to develop an optimum preliminary airframe design that would satisfy these requirements. The results of these efforts indicated these objectives were indeed achievable through the application of advanced composite materials and innova—

The U.S. Army/Sikorsky ACAP helicopter is the world's first composite-fuselage helicopter to fly.

tive design concepts. Subsequently, two contracts were awarded, in March of 1981, for the detail design, fabrication, and test of a helicopter with an advanced composite airframe.

The mechanical properties of composite materials, such as stiffness and strength, are tailored to the requirements of specific locations on the airframe by varying the number of plies, their orientation to each other, and the type of composite material used.

Composite airframe sections are made larger than sections in conventional aluminum, and contain far fewer detail parts. The sections are "laid up" from pre-cut plies in their molds (tooling), together with their integral stiffeners, and cured in an autoclave.

Composite parts can also be made by filament winding on a specially shaped form before curing, as the ACAP's one-piece tailcone was formed.

The ACAP weight, cost, and producibility goals have been demonstrated through the fabrication of three airframes. The first airframe was a tool proof article used to demonstrate the tool design concept and manufacturing approach. The second airframe, which is being used as a static test article, has undergone extensive static and shake testing in the Sikorsky laboratory.

The third airframe will be flight tested for approximately 40 hours to verify the handling qualities, the steady state and vibratory loads, and the performance of Sikorsky's advanced composite airframe design.

"The testing and evaluation of the ACAP must not stop with the completion of the static and flight test programs, but must continue with the varied military test and evaluation efforts which will further establish the technological data base and reduce the risk associated with the introduction of this technology to future aircraft programs such as JVX and LHX," Brown said.

Single Release Developed for ALICE Pack

One of the more stressful moments in the life of an airborne soldier is being in the midst of an airborne operation, and being unable to get the All Purpose Lightweight Individual Carrying Equipment (ALICE) Pack to release. It is guaranteed to put sweat on your brow and fear in your eyes since landing with the Pack almost guarantees the paratrooper a leg injury or worse. In low altitude operations, there simply is not enough time to get to the leg pulls and release the load before landing.

To relieve a bit of worry from the already overburdened mind of the paratrooper, the engineers and riggers from the Aero-Mechanical Engineering Laboratory of the Natick R&D Center have developed a solution. It is a new single point release to jump the ALICE medium or large combat packs, with or without the frame. When completely rigged to the ALICE Pack, the release strap is positioned at the top center of the pack where it is readily accessible to the jumper.

The new release of "H" type design is made of nylon webbing with quick fit adapters to secure around the load and quick fit snaps for front mounted attachment to the parachute. To stabilize the pack to the trooper during aircraft movement and exit, two leg straps are provided to secure the pack to the parachutist's legs.

To release the pack, the parachutist simply pulls one easy-to-reach strap, requiring nine pounds of pressure, and the ALICE Pack falls away. Gone is the worry of not being able to find the leg pulls and the additional worry that the load may cause the straps to bind.

A prototype of the new improved H-Harness has already been jump tested by senior personnel of the 82nd Airborne Division, Fort Bragg, NC. Natick has refined the original prototype and is now preparing to provide sufficient prototypes for limited testing. The Harness, Single Point Release development effort has been marked by an exceptionally rapid turnaround from concept inception to live full-scale testing—an accomplishment made possible by the close cooperation and combined efforts of the developers at the Natick R&D Center and the testers at Fort Bragg.

Awards...

King Award Cites 'Best' Research Paper

The R.W.P. King award has been presented to Dr. Pinchas D. Einziger of the Polytechnic Institute of New York, for research sponsored by the Army Research Office on radome analysis. This prestigious award is given by the Institute of Electrical and Electronic Engineers (IEEE) Antenna and Propagation Society for principle authorship of the best paper by a young scientist under the age of 35.

Results of this research are considered critically important to modern, high performance radars and autonomous weapon systems and are contained in two sequential papers published in the November 1983 issue of the *Transactions on Antennas and Propagation*. The papers are "Rigorous Asymptotic Analysis of Transmission Through A Curved Dielectric Slab," and "Ray Analysis of Two-Dimensional Radomes."

Professor Leopold B. Felsen, Department of Electrical Engineering and Computer Science, Polytechnic Institute of New York, who was Dr. Einziger's advisor, was the co-author of the papers.

The two papers deal with a new method for tracking high frequency fields from a line source through a dielectric radome in two dimensions, either as a cylindrical shell or a tapered wedge. The method is based on optical ray tracing which furnishes the amplitude and phase of the field at a near zone or far zone observer by adding up contributions traversing the radome along direct and multiple internally reflected paths.

The ray tracing formulas account for proper spreading of ray tubes due to curvature or tapering. The novel feature has been the formulation of a curvature or taper corrected slab transmission coefficient which accounts collectively, in compact form, for higher order internal reflections. This allows the transmitted fields to be expressed either in terms of a single "collective" ray field, weighted by the collective transmission coefficient, or in terms of a hybrid combination of ordinary and collective rays.

The first paper provides the rigorous foundation for the new theory for the cylindrical shell prototypes. The second paper demonstrates that the same results can be developed directly by ray theory, and applies the method to the tapered layer, which has no exact solution.

Since ray theory applies also in two and three-dimensional more generally curved and tapered radome environments, including multilayered structures, the new theory provides a tool for radome analysis and design which was not previously available.

Conferences & Symposia...

NJSHS Winners Receive London Trips

Navigational locks on the Mississippi River and genetic engineering of cattle were only two of the many examples of high technology and science which were discussed at the 22nd National Junior Science and Humanities Symposium (NJSHS).

Sponsored by the Army Research Office, Research Triangle Park, NC, the symposium was held at the University of Wisconsin, LaCrosse, WI. More than 200 high school students from throughout the United States, Puerto Rico and the dependent schools of the Pacific and Europe had the opportunity to expand their scientific horizons.

Attendees at the 1984 national symposium represented the very best of the gifted and talented students from among the more than 7,500 individuals who participated in this year's Junior Science and Humanities Program.

Each student in attendance had done original research and had it presented at one of the 43 regional symposia for evaluation prior to being selected to attend the national symposium. One student from each of the 43 regionals presented their paper at the national symposium. Seven of these students were selected to represent the United States at the London International Youth Science Fortnight which was held this past summer at the University of London.

Trip winners, their schools, and the titles of their papers are: Amy Betts, Eastern Carteret High School, NC, "Inhibition of Barnacle Settlement by Natural Products From a Sponge"; Marni Reeves, Oxford High School, MS, "A 3-year Study of Peripheral Vision"; Karl Saxman, Los Alamos High School, NM, "Computer Simulation of the Earth's Future Climate Based on the Radioactive Energy Transfer, the Biogeochemical Carbon Cycle, and Atmospheric Thermodynamics"; David Zielke, Merritt Island High School, FL, "An Automated Laser Alignment and Operational System"; May Chen, Madison Memorial High School, WI, "Chromosome Breakage in Human Lymphocytes"; Robert Zeller, Abraham Lincoln High School, OR, "A Life History and Behavioral Study of Octupus by Biomaculoides"; and Glen Gaddy, McLean High School, VA, "A Total Protein-Amylase Determination and Whole Glandular Saliva."

Assistant Secretary of the Army for Research, Development and Acquisition Dr. Jay R. Sculley, who recognizes the importance of encouraging talented youth to pursue careers in science and engineering, spoke at the NJSHS banquet. He discussed the nation's need for continued scientific and technical pre-eminence and he presented the symposium winners with certificates.

London International Youth Science Fortnight winners (front row, left to right) Amy Betts, May Chen, Marni Reeves, (back row, left to right) Karl Saxman, Robert Zeller, David Zielke, and Glen Gaddy. The winners are flanked by (left) ASA(RDA) Dr. Jay R. Sculley and (right) ARO director Robert E. Weigle.

Smoke/Obscurants Call for Papers

The ninth annual Smoke/Obscurants Symposium, sponsored by the Army PM for Smoke/Obscurants COL Morton S. Brisker, will be held April 23-25, 1985 at Harry Diamond Laboratories, Adelphi, MD.

A call for papers proposed for presentation at the symposium has been issued. The deadline for receipt of abstracts is Jan. 15, 1985. Unclassified abstracts are preferred, although papers up to and including the confidential level are acceptable. Notices of acceptance or non-acceptance will be mailed by Feb. 8, 1985.

Subject areas for papers may include: field and laboratory testing, modeling, smoke/obscurants and electromagnetic systems, doctrine and training, and environmental and health effects studies and regulations.

Abstracts should include paper title, names and addresses of authors, telephone number of point of contact, presentation length (20 minutes maximum), security classification, and audio visual requirements. Additionally, please underline the name of the anticipated presenter of the paper.

Abstracts should be mailed to: Science and Technology Corp., ATTN: SOS IX, 101 Research Drive, Hampton, VA 23666. Additional information may be obtained from Carolyn A. Keen (804) 865-1894.

Call for Frequency Control Papers

A call for papers proposed for presentation at the 39th Annual Frequency Control Symposium, May 29-31, 1985 in Philadelphia, PA, has been issued.

Co-sponsored by the U.S. Army Electronics R&D Command and the Institute of Electrical and Electronic Engineers, Inc., the symposium is the leading technical conference addressing all aspects of frequency control and precision timekeeping. The meeting is unclassified, but classified papers may be submitted. If a sufficient number of classified papers are received, arrangements will be made for a classified session.

Authors are invited to submit papers dealing with, but not restricted to, the following subjects: fundamental properties of piezoelectric crystals, theory and design of piezoelectric resonators, resonator processing techniques, filters, surface acoustic wave devices and frequency control circuitry, atomic and molecular frequency standards, frequency and time coordination/distribution, and applications of frequency control devices.

The deadline for submission of summaries is Jan. 21, 1985. Authors will be notified of acceptance of papers by March 5, 1985. Two copies of a summary in sufficient detail for evaluation of the proposed paper (at least 500 words), together with the author's name, address and telephone number should be sent to: Dr. Samuel Stein, Ball EFRATOM Division, P.O. Box 589, Broomfield, CO 80020.

CRDC Hosts Annual Obscuration Conference

The Chemical Research and Development Center (CRDC), Aberdeen Proving Ground (APG), MD, hosted more than 170 scientists during the seventh annual CRDC Scientific Conference on Obscuration and Aerosol Research.

Held in the Edgewood Area of APG, the week-long conference enables aerosol scientists to discuss state-of-the-art advances such as formation, growth, characterization and optical properties of obscurants and other aerosols.

Dr. Ed Stuebing, a research physical scientist, assigned to CRDC's Research Directorate, originated these conferences in 1978 and has served as the coordinator and host each year. Stuebing said the annual conference was successful in stimulating advances in the state-of-the-art aerosol sciences, which is a field of interest to scientists from all over the world.

More than 81 technical presentations were made by aerosol scientists during the conference. Attendees represented not only CRDC and other defense organizations, but research activities from universities and high technology companies throughout the United States and from Canada, England, France, Italy and Israel.

Capsules...

TECOM Gets Approval for New Insignia

The U.S. Army Test and Evaluation Command (TECOM) has received official approval of the design of a new Distinctive Unit Insignia, or crest. It will be worn by all assigned military personnel.

The design was created to detail the background, accomplishments and heritage of the organization and to aid in developing unit pride and enhancement of morale.

Specific details of the TECOM crest focus on the Army's performance of test and evaluation functions. The basic design reflects the unity of the concepts originally devised for test and evaluation performance. Ultramarine and scarlett colors represent the military and industrial participants.

On the bisected field of red and blue, a futuristic gold star shape represents the headquarters. The modified "star burst" of gold streamers suggest the flow of information and guidance and the spatial relationships of the subordinate installations and field operating activities.

The modified diamond-shaped figure at the top center is provided a superior position to indicate the importance of command and control of the diverse mission elements. The spearhead's thrust also suggests the strength and commitment of the command to the performance of the multifaceted mission.

The alternating red and blue, separated by the white areas' piercing thrust, represents the essential sources of the command's mission, that is, civilian industry and the military clientele. The stark white projection also suggests a military fortification or bastion and is a feature shared with the Army Materiel Command crest.

The motto, "Test for the Best," in gold, is superimposed on the sable belt surrounding the devise. The motto highlights the command's essential performance of test action in direct support to the acquisition of materials for the Army. The sable belt continues the theme of unity and strength and also emphasizes the important interaction of the many performers in the mission who must, by working together, perform to meet the motto's objectives.

Executive's Corner . . .

AMC Deputy CG for RDA LTG Robert L. Moore Discusses . . .

Project Management Initiatives

One of the many initiatives the Army Materiel Command is currently undertaking is an increased emphasis on project management as a means to improved acquisition of materiel systems. Last year at this time AMC had 56 chartered program, project, or product managers. Today we have 68 and are likely to have more in the future. This increase is not an example of a growing uncontrolled bureaucracy but, instead, is a direct measure of the Army's determination to use intensive management to provide the soldier with cost effective, high quality materiel when he needs it. In this article I would like to briefly highlight some of the changes taking place as a result of this increased emphasis on project management.

New Thrusts in Project Management

Our new project offices are typically managing groups of generic systems as compared to the traditional concept of single system management. The intent is to maximize personnel utilization to the benefit of several programs. An example is the new Program Manager for Tactical Vehicles at the Tank-Automotive Command (TACOM), Warren, MI.

TACOM consolidated management of all tactical wheeled vehicle programs within a single office to manage the fleet of vehicles and present one face to the user. Within this program office, there are three chartered project managers—Heavy, Medium and Light Tactical Vehicles. Each relies on the program manager to provide overall staff support. The program manager is therefore controlling the development, production, fielding, and support of the fleet, while his project managers are managing individual systems. TACOM also has similar "super PM" arrangements for Tank Systems and Light Combat Vehicles.

Perhaps the most innovative of the new PMs is the PM for Ammunition Logistics (AMMOLOG) at the Armament Research and Development Center, Dover, NJ. This PM is charged with overseeing the entire spectrum of materiel support systems and technologies needed to get ammunition from the ammunition plant to the gun tube.

In addition to his own materiel development responsibilities, the PM, AMMOLOG also interfaces with the combat developer and users to ascertain materiel requirements and advises the combat developer when technological advances can offer significant improvements to ammunition materiel. He also works with other PMs and materiel developers to assure compatibility of the total ammunition logistics system and influences ammunition and materiel support systems design where improvements will benefit the "total" system.

Ammunition is one of the key logistical challenges on the battlefield. Therefore, improvements in this area can have far reaching effects. Other logistics systems are also being managed by project management. Another challenge on the battlefield is to provide sufficient fuel for combat vehicles and to provide water to the troops. The Troop Support Command, St. Louis, MO, has recently established a Product Manager, Petroleum and Water Systems to intensively manage these critical battlefield commodities from a "total" system perspective.

PM Selection and Training

We select 0-6 project managers by the central selection board process, similar to selection of officers for promotion, command assignments, and senior service college. Recently, HQDA decided that project management should be considered the equivalent to 0-6 level command. Guidance to future promotion boards is expected to reflect this thinking. Also, pre-assignment training for PMs, comparable to pre-command training, is now mandatory. The Defense Systems Management College (DSMC) at Fort Belvoir, VA, has designed a Program Managers' Workshop specifically for the new PM.

A key to the selection of qualified PMs is the pool from which they are selected. Ultimately, this pool of officers will be comprised of Materiel Acquisition Management (MAM) certified officers. Among other requirements, an officer must have completed the Program Management Course at the DSMC and at least two MAM related assignments to be certified.

Until MAM is fully implemented, the selection pool will continue to be made of up those officers in the 6T (MAM) program and officers in selected OPMS specialties, such as 51 (research and development). Importantly, we are looking for top-notch acquisition managers, not just engineers. The bottom line is that MAM officers comprise only 6% of the officer corps but manage 37% of the Army budget and deal in very complex and sensitive areas. We need the best there is.

PM Tenure and Utilization

Congress is proposing a bill to require major program managers to serve a tenure of four years. The secretary of the Army will have waiver authority. For the past 10 years, the average tenure for PMs has been appoximately 2.6 years. Experience indicates that the majority of PMs leave their job because of retirement or promotion. Very few move on to other 0-6 jobs. HQ, AMC is planning to utilize the considerable experience of our PMs by offering active PMs reassignment to other PM positions and other challenging acquisition related positions when their tours are completed. The Army and the taxpayers will benefit from the continued use of the talents of our PMs.

Matrix Management

In line with the consolidation of several PMs under a "super PM," AMC is refining its use of the functional matrix. PMs are developing strategies to define the specific support they plan to receive from in-house organizations and that support they plan to receive from contract. The idea is to do that work in-house for which we have the capability and capacity to perform and to limit PM office people to management.

Program Management Advisory Group

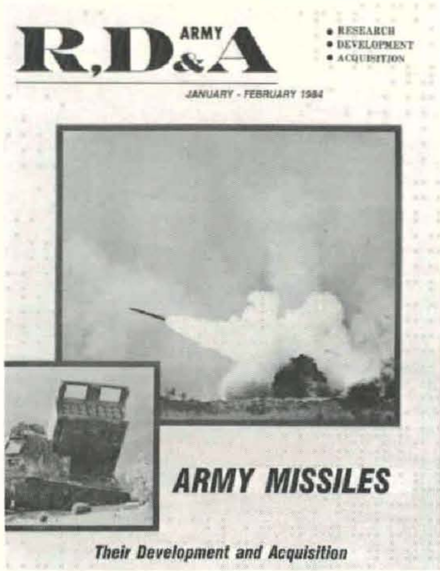
The Air Force Systems Command has successfully operated a Program Management Advisory Group (PMAG) for many years. On request, the Air Force PMAG analyzes PM offices to identify various problems and possible solutions. Importantly, the PMAG operates on a solution oriented basis as opposed to compliance orientation. Distribution of the completed report is limited to the PM Office and the PMAG, therefore assuring the confidentiality of the process. The Army Materiel Command is planning implementation of the PMAG concept.

Project management is a dynamic business. Each PM daily confronts challenges from multiple directions. As the single focal point for multimillion dollar materiel acquisitions, he must be knowledgeble about everything concerned with his program—from the budget drills and contract management to the way the soldier will use his weapon system on the battlefield. The challenge is there—we must deliver quality, supportable equipment to the troops on time and at reasonable cost. The initiatives discussed in this article are refining our processes to make the Army a "Smart Buyer."

1984 Index of Army RD&A Magazine Articles

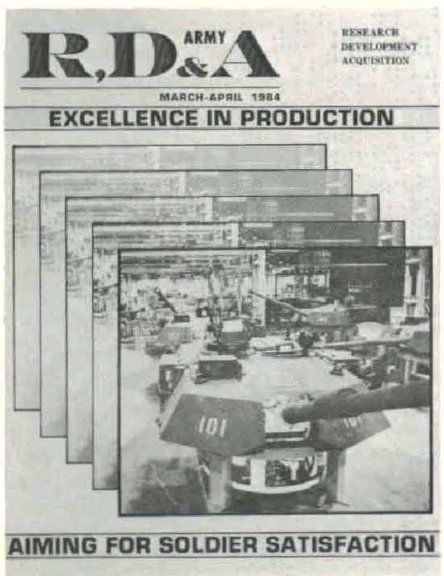
The following is a headline list of feature articles published in the Army RD&A Magazine *during calendar year 1984.*

JANUARY-FEBRUARY



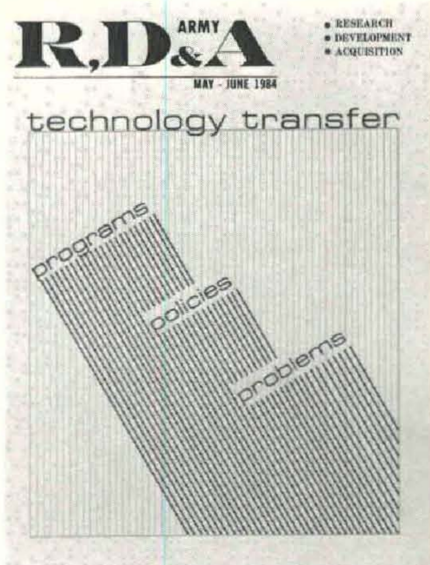
- How Development of a New System Begins
- The Multiple Launch Rocket System and the TOW 2 Missile
- The Role of White Sands Missile Range in Fielding Missile Systems
- A Brief History of the Army Missile Program
- What Do WSSMs Do?
- The Role of ODCSRDA's Missiles and Air Defense Division
- Interview with DARCOM Deputy CG for RD&A
- PM Conferees Cite Importance of Basics
- DARCOM's Key Role in Target Signatures Programs and Requirements
- Army Approves Materiel Acquisition Management Program
- AR 70-1 Revision Includes Major Policy Changes

MARCH-APRIL



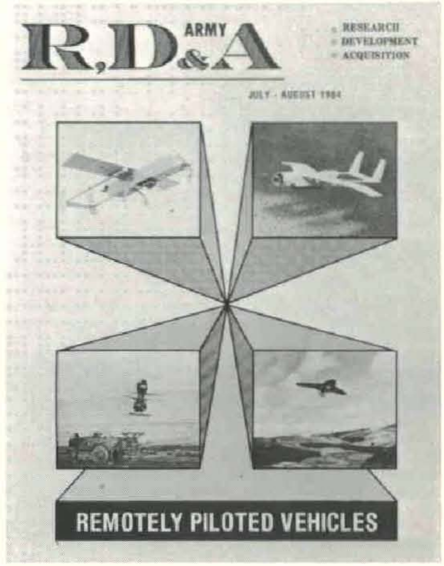
- Problems of Productivity
- Small Arms Weapons Manufacturing Modernization
- Recent Issues and Policies Concerning Quality Assurance
- Producibility Engineering and Planning Training
- Budgeting to Most Likely Costs—the PM's Dilemma
- Future Trends and Their Implications
- Training with Industry for Research and Development
- Interview with Dr. Bill Richardson
- DARCOM Hosts Briefings for New Army Brigadier Generals
- Unit Cost Reporting
- Assistant Secretary of the Army (RDA) Office Key Personnel
- Battelle Forecasts $94 Billion for U.S. R&D

MAY-JUNE



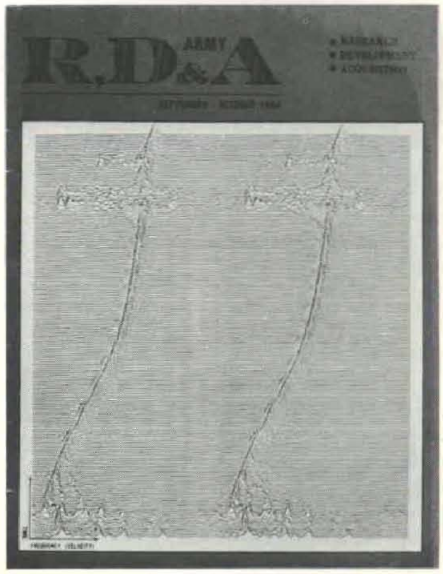
- Controlling Critical Technology
- A Perspective on Technology Transfer Dichotomies
- The Role of International R&D in Technology Transfer
- Multiyear Procurement: How Can It Help the Acquisition Process?
- Competitive Skunkworks During Full Scale Development
- The Light Infantry Division: A New Direction in Force Design
- Corp of Engineers AirLand Batlefield Environment Thrust
- Trends and Their Implications for DARCOM During the Next 2 Decades
- The Light Cavalry Helicopter: A Management Approach
- Auxiliary Power Unit for the M1 Tank
- The Single Manager for Conventional Ammunition
- New Tire Tester May Help Find Hidden Defects

JULY-AUGUST



- Interview with GEN William R. Richardson
- Remotely Piloted Vehicles
- Improving the DOD Spare Parts Acquisition Process
- Improved Weapon System Reliability
- Biotechnology and Its Applications to Military Medical R&D
- Release of U.S. Technology to Allied and Friendly Nations
- New TACOM Dynamometer May Improve Engine Test Procedures
- Army RD&A Readership Survey Results

SEPTEMBER-OCTOBER



- R&D Achievement Awards Recognize 65 In-House Personnel
- ASA(RDA) Cites M915A1 Quality Standards
- Benefits of Using Commercial Equipment
- Using the NDI Approach
- AMC PMs Directory
- An Industry Perspective on Spare Parts
- Industrial Preparedness Planning
- The Army's New Thrust Initiative
- Domestic Technology Transfer

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