ARMY R,D&A

- RESEARCH
- DEVELOPMENT
- ACQUISITION

JULY - AUGUST 1985

SECTION H. SPECIAL CONTRACT REQUIREMENTS (Cont'd)

H.11 DATA (Cont'd)

(5) It is agreed that for the vendor items listed in Attach 8 of this contract entitled "List of Vendor Data Refusals," attached hereto and made a part hereof, Control Drawings in accordance with paragraph (3) above shall be the minimum data furnished to the Government under this contract.

(c) Previously Delivered Data. Data delivered under this contract may include data previously delivered under other contracts. Any such data shall be delivered in the same format as previously delivered. If any such data has not been changed since last delivery to the Government and comes within paragraph (b)(2)(ii) of the Contract Clause of this contract entitled "Rights In Technical Data and Computer Software (MAY 1981) Alternate I (MAY 1981)," it shall be delivered pursuant to the terms and conditions of such earlier contract.

(d) Additional Data. In the event the Government, during the life of this contract, requires additional data (over and above the Control Drawings specified in paragraph b. above) to be furnished with certain rights in usage thereof, and the Contractor can obtain/provide said data and such rights, the parties agree to negotiate an equitable adjustment to the contract price for the additional data prior to the Contractor's acquisition of such data.

H.12 BREAKOUT AND COMPETITIVE [illegible]

(a) Intent. The Government i[illegible] maximum practical breakout and competitive procurement of replaceme[illegible] systems and ground support equipment (all called "parts" hereafter in this [illegible] Helicopter for any requirement for such parts either domestic or [illegible] ense Acquisition Regulation (DAR) Supplement No. 6 (DAR SUPP 6). [illegible] the Government seeks to either: (1) provide for multiple qualification o[illegible] AW (b) below; or (2) acquire technical data packages with sufficient rights for [illegible] nt, by the US Government or a foreign government(s) in support of Rationali[illegible] n and Interoperability (RSI), for those parts which have overall high dollar savi[illegible] evaluated IAW the guidelines of DAR SUPP 6, IAW c. below. The parties hereby [illegible] CR shall be applicable in its entirety to this contract. Further, the parties agree th[illegible] favorable to the Government or the Contractor than this SCR shall be included in [illegible] contract that is subsequently awarded to the Contractor for, or related to the [illegible] Program.

(b) Qualification of Additional Sources. T[illegible] ent has [illegible] right and the option to require the Contractor to qualify at least one (1) additional competitive source for all parts to permit the competitive purchase of parts by the Government. This option may be exercised from time to time during the term of this contract. Upon written notice from the Contracting Officer, the Contractor shall, within a target thirty (30) days, provide the Government, on a SF 1411 with, as a minimum, the substantiating and supporting data required by the "Instructions applicable to the SF 1411) the estimated price for the qualification of an additional source. Upon the Contracting Officer's request, the Contractor shall negotiate a price for the effort associated with the qualification and thereafter at the Contracting Officer's request the Contractor shall proceed with and complete the qualification of said additional source and the contract price shall be adjusted for such effort. In qualifying sources, the Contractor shall use the same basis or standard or criteria, to the extent possible, in order that no competitive advantage or disadvantage is given to any source. The additional source shall be other than the Contractor unless the Contracting Officer specifically approves the Contractor as the additional source.

ARMY R,D&A

Vol. 26 No. 4 JULY-AUGUST 1985

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and Acquisition)
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ABOUT THE COVER

This issue of the magazine contains several articles describing some of the innovative approaches being used in the Army's materiel acquisition process. Featured are articles on the innovative approach to the LHX T800 Engine Request for Proposal, the solicitation for night vision devices, and a discussion of multiyear contracting. Cover designed by Patricia Warren, AMC Graphics Section.

FEATURES

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Applying Sound Business Sense to Systems Acquisition

By Kenneth S. Solinsky, John R. Gresham and Joseph M. Buccieri

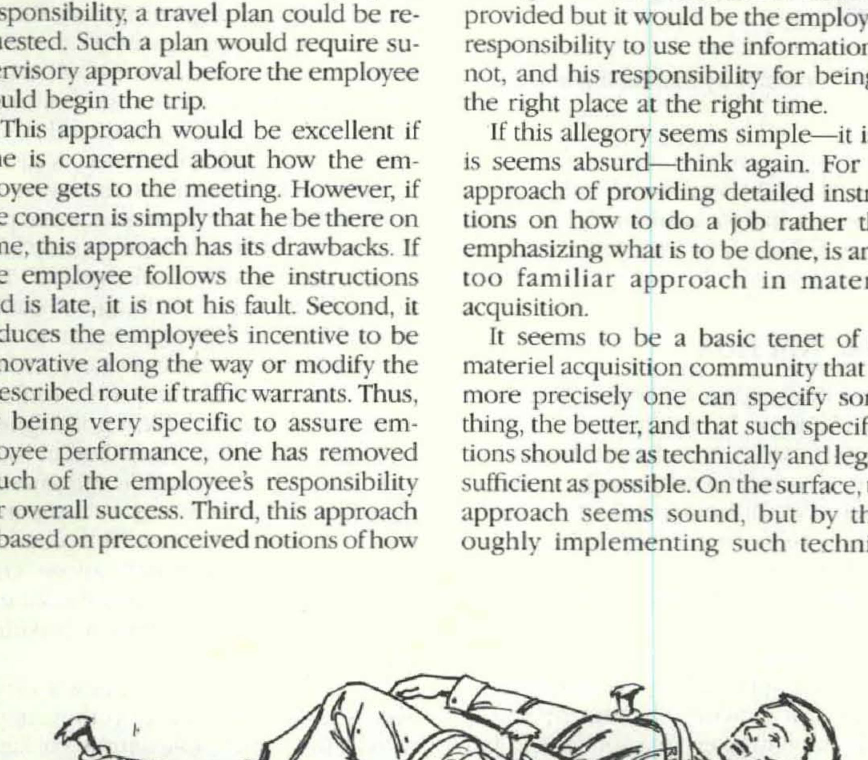
If one wants an employee to go from HQ, AMC in Alexandria, VA, to a meeting at the Pentagon, approximately 10 miles away, one can tell the employee to leave his office at 9 a.m., go down the elevator, get in his car, drive north on Interstate 395, exit at the Pentagon, park in the north parking lot, and walk to the mall entrance. Further information could describe how to get to I-395, or the speed to drive at various portions of the route. If one is concerned about the employee's responsibility, a travel plan could be requested. Such a plan would require supervisory approval before the employee could begin the trip.

This approach would be excellent if one is concerned about how the employee gets to the meeting. However, if the concern is simply that he be there on time, this approach has its drawbacks. If the employee follows the instructions and is late, it is not his fault. Second, it reduces the employee's incentive to be innovative along the way or modify the prescribed route if traffic warrants. Thus, by being very specific to assure employee performance, one has removed much of the employee's responsibility for overall success. Third, this approach is based on preconceived notions of how to get to the meeting and doesn't allow for alternate approaches such as taking a bus or catching a ride with someone else.

A better way of providing direction to the employee, if what one wants is his presence at the meeting on time, would be to simply say "be at the mall entrance at 9:40 a.m.," and then reward his performance appropriately. If the employee would like advice on how to get to the Pentagon, such information could be provided but it would be the employee's responsibility to use the information or not, and his responsibility for being at the right place at the right time.

If this allegory seems simple—it is. If is seems absurd—think again. For the approach of providing detailed instructions on how to do a job rather than emphasizing what is to be done, is an all too familiar approach in materiel acquisition.

It seems to be a basic tenet of the materiel acquisition community that the more precisely one can specify something, the better, and that such specifications should be as technically and legally sufficient as possible. On the surface, this approach seems sound, but by thoroughly implementing such technical specifications, one tends to focus attention on details which often distract from the basic intent of a system. Thus, we can develop systems which pass all required technical tests, but are less than optimal in operational testing or on the battlefield.



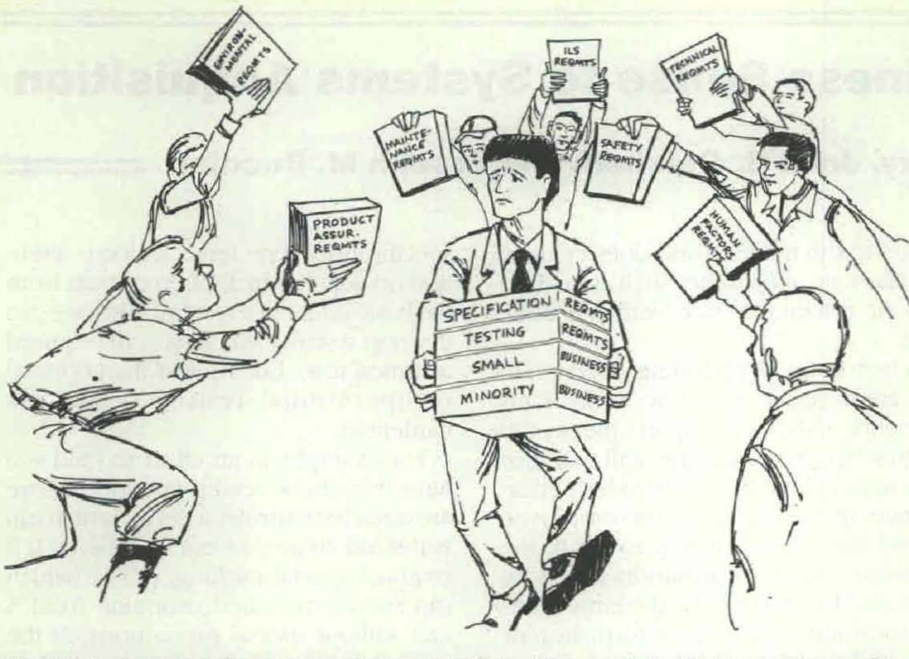
Just as mistrust led to the restraining of Gulliver in the Land of Lilliput, "how to" requirements and contract provisions imposed out of concern that a contractor will not do the right thing, can restrain the very initiative and creativity which has made United States industry the envy of the world.

For example, in an effort to field systems that can be readily transported, we are often led to prefer a device which can withstand 26 drops from 4 feet even if it requires special packing, to one which can survive repeated dropping from 3 feet without special precautions. At the same time, we are not interested in knowing what happens if the system is dropped once from 5 feet. This is done because we need to meet a specific standard. But the standard also impedes one's ability to make value judgements. The fact that the device, which does not need special packing, may survive better in the field, becomes lost in the fixation to meet a technical requirement.

Other examples of technology fixations detracting from a product's overall suitability are the extra cost or mechanical burdens often unnecessarily added to a system to meet requirements of environmental extremes. For example, a device might be designed so that controls and adjustments could be made with arctic mittens, when in fact, many such adjustments would likely be preset indoors before use.

The drive to be as specific as possible in stating requirements often leads to telling a contractor not only what one wants but how to do it. Specifications often address requirements on parts or subassemblies below a significant maintenance level, deliberately limiting a manufacturer's ability to make trade-offs. Further, the government often provides drawing packages containing details of all parts and assemblies from which the contractor is discouraged from deviating. At times the government even provides assembly procedures.

Build-to-print is certainly a viable means for procurement under certain circumstances, but it also has its limitations. One problem with a build-to-print approach is that it places considerable liability on the government. If a company faithfully builds-to-print, and the end item does not meet the specifica-



The typical acquisition manager is presented with consistently increasing and complex requirements from numerous sources.

tion, it is the government's problem, even if that company initially developed the technical data package. Contracting with a detailed "how to" type technical data package can also discourage evolutionary improvements in system performance or producibility, value engineering clauses not withstanding.

The approach of telling a contractor how to do a job extends beyond the actual technical data package to numerous other contractually binding requirements. Such requirements, initially contained in a solicitation, prescribe everything from how to manage configuration control, to the tests and test methods to be used, to requiring that the government be notified if the technical data provided is legible. Offerors are reluctant to take exception to such requirements for fear of being deemed nonresponsive, and so the requirements become contractually binding.

Undoubtedly there are outstanding reasons for the imposition of each "how to" requirement. In fact, for each requirement there is a constituency to describe its critical importance and the dire ramifications which can occur if the requirement is omitted. Often descriptions include case examples of problems which resulted on previous programs because of such omission. Consequently, today's contractors are being burdened with many requirements and contractual provisions in an effort to preclude the cumulative sins of the past.

Given the cumulative burdens which "how to" requirements impose on contractors, and the increased liabilities they impose on the government, it behooves one to ask if there is a better way of acquiring materiel.

What, Not How

One better approach is to tell industry what is wanted, but not how to do it, and award contracts based on best overall value to the government. In this approach, the solicitation contains overall system performance requirements based on user needs. It also allows the contractor considerable latitude in determining how best to meet the requirements.

Such an approach is not acquisition theory, but practice, having been recently implemented in a solicitation for night vision devices, with the full support and guidance of senior Department of the Army and Army Materiel Command managers.

In this approach, technical data contained in the solicitation are reduced to a system performance specification. If drawings or detailed "how to" specifications exist, they are provided for informational purposes only. Offerors may propose to meet the performance requirements by offering a broad spectrum of alternatives, ranging from a Non-Development Item (NDI), through a modified version of the device described in the informational drawings and technical specifications, to a pure build-to-print device. In all cases, the government does not warrant the drawing package nor technical specifications, does not require their use, and is not liable for the technical data package contents.

Offerors are also allowed to propose the logistics support concept, and configuration management approach, provided these plans are fully compatible with one another. Considerable flexibility is also provided regarding quality assurance and reliability. In this "business approach" to materiel acquisition, contractors are required to warrant their devices in accordance with standard warranty provisions or they may offer alternatives. Contractors are also required to pay liquidated damages in the event delinquent deliveries precipitate a financial loss to the government.

Contract awards are based on best overall value to the government which is defined as the aggregate worth of all award factors. In the night vision devices solicitation, these factors are technical performance/operational suitability, life cycle cost, product assurance, logistics support and program management.

In developing such a solicitation, one is faced with multiple challenges which must be addressed simultaneously. The first is the technical challenge of stating simply and completely what it is one needs without stating how it should be done. The second, and a more difficult challenge, is cultural. Most government employees have had it instilled in them to be as specific as possible and to avoid specifying requirements in a manner subject to interpretation. This new approach, which deliberately allows considerable latitude, requires rethinking of some fundamental system acquisition concepts.

Part of implementing the new acquisition concept is the need to thoroughly review the entire solicitation package, line by line. Such a review is an extremely eye opening experience. To a great extent, solicitation packages are a compilation of standard clauses, some of which have blank spaces filled in to "customize" them for the acquisition at hand. In carefully reading such clauses, one finds many that are several paragraphs or even pages in length that can be reduced to one or two sentences. Other clauses which are included as boiler plates can be eliminated entirely.

Conventional solicitations contain data requirements for the submission of test plans and management plans along with extensive material describing how these plans should be structured. Such plans detailing how a contractor will comply with contractual requirements are due several months after contract award and must be "negotiated." Such data items and attachments describing the format for plans and reports were eliminated from the night vision solicitation. Instead, the solicitation requires contractors to submit plans for how they intend to satisfy the government's stated needs as part of their proposal. Therefore, while the night vision solicitation provides industry considerable flexibility to propose a best value approach, there will be a clearer understanding of what is to be done prior to contract signing than is normally the case.

Businesslike Approaches

The night vision solicitation contains a substantial warranty provision which offerors must be responsive to. They may also offer an alternative warranty which would represent a better value to the government. The presence of the warranty enables consideration of reduced testing, thus offerors can propose a combination of warranty terms and pre-acceptance testing which assures the government that it is getting the equipment it wants in an efficient businesslike manner.

Another businesslike approach incorporated into the night vision devices solicitation is a liquidated damages clause. This clause applies to Night Vision Driver's Viewers which are installed in tanks and other combat vehicles. Under the terms of the liquidated damages provision, contractors are required to compensate the government for the financial impact caused by late delivery of driver's viewers. Such losses are significant if one has to park millions of dollars of combat vehicle assets while awaiting a needed device. Thus, the liquidated damages clause is an effective means of assuring on-time deliveries, and reduces the need for data requirements intended to provide such assurance.

As a result of the extensive review of the night vision devices solicitation, and the deliberate effort to write a comprehensive document rather than assembling standard clauses, the solicitation which had been over 2 inches thick, not including drawings and specifications, was reduced to a document which is three-fourths of an inch thick. It is also easily readable from cover to cover, and better expresses the agreement the government seeks to enter into.

While this acquisition approach provides a vehicle which enables industry to be innovative and offer a best value solution to the Army's materiel needs, it is the way in which the overall program is structured that is key to fostering the industry interest necessary for achieving a best value solution. Thus, in the case of the Night Vision Program, the Army's five-year requirement for image intensification devices is consolidated into a single solicitation representing an attractive business opportunity. This five-year multiyear approach provides the necessary production stability to enable meaningful industry investment and reduced system costs.

An additional feature of the night vision solicitation is that the total award quantity will be split between the two best overall offerors, based on their proposals while maintaining two competitive sources for future competitive procurements and in case of a national emergency.

Summary

The Army has often discussed streamlining the acquisition process and purchasing systems in a more businesslike manner. Now with the Mobile Subscriber Equipment, T-800 Engine, and Night Vision Programs, it is evident that the Army is taking action to:

- provide program stability and meaningful business opportunities,
- maximize overall competition,
- provide flexibility in order to obtain the best overall value, and
- utilize warranties and liquidated damage provisions.

Today's acquisition managers should identify candidate programs for streamlined businesslike acquisition, and if necessary, seek higher-level assistance in removing institutional impediments.

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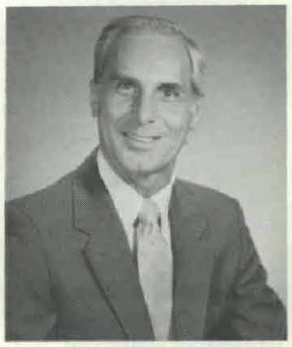

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The LHX T800 Engine RFP

By LTC Willie A. Lawson

Introduction

The time has come for the Army to move out front and set the standard for procurements now and well into the future.

In response to this challenge, Army aviation is pursuing a comprehensive fleet modernization program to replace the aging Vietnam-vintage light helicopter fleet. The task is to replace the existing light fleet (AH-1, UH-1, OH-58, and OH-6 helicopters) with an affordable heavy and light helicopter fleet mix superior to the threat and suitable for the Army 21 mission.

The AH-64 Apache will fill the heavy attack role, aided by its scout, the OH-58D, and the UH-60 Black Hawk will continue as the Army's first squad air assault helicopter. The Light Helicopter Family (LHX) will consist of an air vehicle for light armed reconnaissance/attack roles and one for light utility missions.

The LHX family will provide a modern, more capable, more survivable, less costly-to-operate fleet that augments and complements the existing operational capabilities of the AH-64, UH-60, and OH-58D. The current LHX program schedule calls for the award of the LHX T800 engine contract in July 1985, with the LHX air vehicle development and training systems contracts to be awarded in April 1987. The focus of this article will be on the innovative approach to the LHX T800 engine Request for Proposal (RFP).

Innovations and Strategy

The acquisition strategy for the T800-XX-800 engine program has been structured to develop, qualify, and competitively procure an advanced, highly reliable, low-life-cycle cost engine. The program goals, if they are to be achieved, must be incorporated early in development. Therefore, the RFP was structured to define what the Army wants, not to specify how to do it. The specific intent was to permit maximum flexibility and latitude in corporate initiatives. In keeping with that theme and the LHX motto, "Not Business as Usual," the T800 RFP was structured to allow the contractors the most flexibility. In addition, the format was changed to make this RFP very readable—including incorporation of an executive summary with a full table of contents.

The RFP contains a T800 system specification which is truly performance-oriented, at both the system and subsystem levels. It allows the contractors to go through the design process without being delayed because of the need for government approval of engineering change proposals. Plans and design proposals were made a part of the response to the RFP. This will allow the government to evaluate the contractor's management capability without telling the contractor how to do his job.

The design freedom needed by the contractor in coming to a final design solution will be accomplished by requiring only a final production specification upon completion of qualification testing, which will then become our build-to specification. The important thing about this RFP is that we did not blindly copy other specifications, but included only what was needed in the RFP. We made every attempt to spell out definitive requirements—not "how to's." Throughout the RFP process, we maintained contractor/government cooperation by providing drafts to industry for comment.

Usually, the government tends to over apply management controls to contracts too early in the design process and thereby constrains the iterative process required to reach a balanced weapon system design. We have structured the T800 RFP to allow maximum contractor control and minimum government intervention during his design process.

The RFP contains many techniques and approaches to limit government involvement in the contractor's day-to-day performance. The overall concept, which was the foundation for all of the techniques, is to establish what we want and then transfer the risk and responsibility for performance to the contractor. In other words, the government will not direct the contractor's method of meeting the requirements nor will the government continually monitor the detailed status of contractor performance. Examples of these techniques are:

- Establishment of banded performance requirements in lieu of directing "how to" perform or specifying configuration. This gives the contractor maximum latitude and flexibility in proposing and executing the development program that, optimally, will efficiently and effectively produce the desired results. The "banding" of requirements gives the contractor the opportunity to conduct trade-offs in an effort to provide an engine that best meets the government performance requirements.
- Contractors have management systems currently in place and are capable of meeting the government's program needs. It is therefore our objective to avoid intrusion into established business practices or involvement into control of the contractor's program activities. Instead, during proposal evaluation, emphasis will be placed on determining the offeror's understanding of his management responsibility and of the necessary coordination to implement the competition initiatives. In lieu of a validated Cost Schedule Control System, the contractor's financial management systems will be utilized to the maximum extent practicable, although all of the potential offerors for the full-scale development program have validated Cost Schedule Control Systems. The government is also giving contractors the maximum flexibility to establish a Work Breakdown Structure that best reflects the contractor's existing financial management system. In addition, only essential system, cost, and engineering management plans are required. By implementing these initiatives, the government was able to reduce the number of data items in the RFP from approximately 125 to 50.

The government will not facilitize for the T800-XX-800 program, which means we will not pay on a direct basis for brick and mortar, tooling, and test equipment required for development and production. Contractors will be required to assume the risk of investing the necessary corporate funds to facilitize for the program. This investment will be recouped on an indirect basis in accordance with approved accounting practices. We believe this approach—which calls on industry to bear the cost of facilitization—will cause the prime contractors, their subs, and their vendors to remain committed to the program as viable sources of parts supply.

The contractor will be responsible for configuration management during development. This requirement is another prime example of avoiding government involvement in the contractor's day-to-day performance. The Prime Item Development Specification, used in previous programs to state in detail the contractor's configuration, has been deleted. The contract will establish only the performance requirements. This approach provides program flexibility and transfers risk to the contractor. Changes to the system specification will be made only if the government's requirement changes. Previously, contract changes and additional costs were often incurred when the contractor's configuration changed (as reflected in the Prime Item Development Specifications), even though the government's requirement may not have changed. In the case of the LHX T800 contract, at the conclusion of qualification testing the contractor will submit a product specification which the government will utilize for production buys. It is at that point the government becomes the configuration manager.

A firm fixed price contract will be executed for this development effort. This type of contract limits government liability, shifts the cost risk to the contractor for successful completion of the contract, and allows the contractor the maximum flexibility to complete the program within the contract price.

We believe that if he is given enough flexibility, the contractor can go a long way in reducing today's trend of spiraling weapon system costs. The T800 RFP allows him that flexibility.

The second major focus of the T800-XX-800 program is competition. Competition will be maximized beginning with development and continuing through production. The objectives are to acquire parts at a low cost; provide better logistic supportability; expand the industrial base of small business, small disadvantaged business, and women owned business; and use fewer government in-house management resources.

Alternate production sources must be the keystone of our competitive provision. It is extremely important that industry establish a second production source for the successful engine configuration. Therefore, offerors have established agreements and procedures to achieve the necessary technical transfer and will be in a posture to produce a common engine design at each of their facilities. Design commonality will be maintained by an agreement to control Class I and Class II engineering changes.

By being prepared to enter into production with two viable engine sources, both of which are capable of manufacturing the same engine, we have provided for a broader base, ensuring a positive impact on Army readiness. The existence of two independent production sources will create an expanded lower-tier production base to support surge and mobilization parts requirements. The competition resulting from this effort between the two prime producers will ensure a more stable and earlier maturation of the final configuration. Using the competition to enhance productivity improvements will also, in turn, result in a much lower unit cost for the engine. Incorporating guarantees into the contract will ensure that primes, subs and vendors are committed as viable sources of supply.

Finally, the contractor must agree to grant the government additional rights (in limited rights technical data) delivered under the contract for the purpose of acquiring replenishment parts. This release is effective six years after award of the full-scale development contract.

Previous RFPs have typically placed emphasis on product performance with reliability, availability, and maintainability (RAM) and integrated logistics support (ILS) being of lesser importance and considered as trade-off issues. The RAM and ILS influence on operation and support costs have been recognized in the T800 program, and emphasis has been appropriately elevated in the RFP.

In many programs considerable effort often occurs after initial production to bring the system to acceptable RAM levels, with the Army bearing the burden of this expensive effort. The T800 program requires the contract to meet RAM requirements during full-scale development, decreasing the expensive additional testing and production changes and increasing user satisfaction.

Manpower and Personnel Integration (MANPRINT) efforts (which include human factors, manpower, personnel, and training) spelled out in the T800 RFP will require emphasis early enough to influence the design. In other words, the engine will be designed to fit the soldier in the field.

Continuous review of logistic support analysis recorded data will provide a more accurate data base which will lead to better source data. This should result in much better logistic support analysis design influences, provisioning, training, publications, and cost analysis.

Prime contractor responsibility for training device development as a part of the "system" will result in more effective training through more timely delivery (to support operational test training), fewer interface problems, and improved configuration fidelity with the end item.

Summary

The sum of these initiatives has resulted in a much shorter, simpler RFP than generally issued by the government for a major development program. This is a visible, but somewhat superficial, outcome. The more important, long-term benefits of this strategy will be a reduction in the life cycle cost of the engine and expansion of the industrial base to include continued development at the small and minority business level.

Issuance of the RFP is the first step in the innovative acquisition process of a major weapon system. The approach will be monitored through proposal evaluation and contract performance to capitalize on those areas which streamline the acquisition process, while providing the best materiel for the Army within the resources available..

LTC WILLIE A. LAWSON is assistant project manager for the T800 Engine, Light Helicopter Family, U.S. Army Aviation Systems Command. He has a B.S. degree in aerospace engineering from Embry-Riddle University and is a graduate of the Defense Systems Management College Program Management Course.

Driving Costs Down

Multiyear Contracting

By MAJ (P) Edwin P. Goosen

The following article is based on the author's personal observations and experiences gained during a recent Training With Industry assignment at the Sikorsky Aircraft Division, United Technologies Corp.

Multiyear procurement, one of the Defense Acquisition Improvement Program initiatives, is widely supported within DOD for its cost saving potential. One example of a multiyear success is the Army's Black Hawk helicopter, produced by Sikorsky Aircraft Division, United Technologies Corp. The first multiyear contract (MY I) covered three production lots during 1982, 1983, and 1984. Although actual savings attributable to the multiyear approach vary depending on which analysis is used, all agree they were substantial. Accordingly, support was gained for a second multiyear contract (MY II) for three more production lots in 1985, 1986, and 1987. My purpose is to examine one department within Sikorsky, the Materiel Department, and to focus on what it did in response to the multiyear environment to drive costs down.

Why the Materiel Department? Typically, most cost saving efforts have been directed at in-house manufacturing and producibility. However, 66 percent of the cost of the Black Hawk is represented by purchased and subcontracted material (subsystems, parts and raw materials). As such, the Materiel Department, having complete responsibility for managing the flow of material and its costs, represented an area with twice the cost saving potential of the in-house part. Sikorsky recognized this as an opportunity and committed itself to reduce the cost of purchased material for the MY II contract.

'Curve Busting': A Senior Management Commitment

Most of Sikorsky's efforts were integrated into a well planned, coordinated and executed program called "Curve Busting." The main theme was "affordability" and the basic concept was that traditional learning curve improvement was not good enough. If aggressive management attention was placed on producibility, greater than normal or incremental cost improvements could be achieved. The "curve" had to be "busted" and re-established at a lower mark.

Curve Busting was an aggressive effort by Sikorsky to communicate its commitment to affordability with each of its 3,000 suppliers and gain that same commitment back from them. The message was that business-as-usual could not continue. Political and economic realities were constraining defense resources and the government could not continue to buy weapon systems at ever increasing costs. It was absolutely essential as well as good business to reduce costs. Only then could the government continue to buy the weapon systems it needed and only then could the prime and its suppliers secure their business base for the future.

Prior to initiating the formal Curve Busting program, every member of the Materiel team, including each buyer, received an intensive Curve Busting education. It stressed the affordability issue, the company's business interest, the supplier's business interest and multiyear cost saving opportunities. Each buyer was also challenged with ambitious price targets which they were expected to achieve when negotiating contracts with suppliers for MY II.

This preliminary indoctrination provided the in-house base which would implement the program to those smaller suppliers not targeted for the formal program and provide the emphasis and critical follow-up during the supplier's planning and proposal effort. Each buyer had an understanding of the benefits of multiyear procurement and was responsible for insuring their suppliers understood and realized the cost saving opportunities available to them under multiyear. Buyers were to make it clear to their suppliers that the stability and increased production quantities, rates and period of performance would justify their focusing more attention on cost reductions through productivity, innovation and risk taking.

The formal implementation of Curve Busting was initiated in mid-June 1983 in preparation for the MY II proposal. This was about a year in advance of anticipated negotiations with suppliers and provided adequate time for them to hear the message, digest its impact and take the necessary actions to comply with the intent.

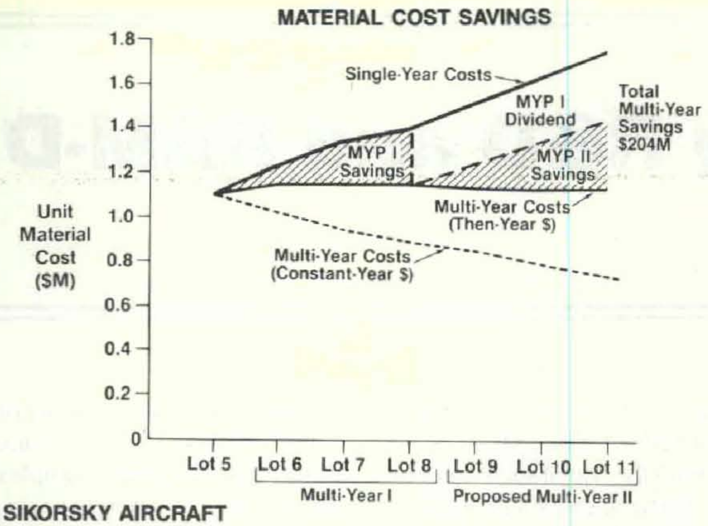
A total of 119 larger suppliers, representing approximately 80 percent of the cost of the Black Hawk purchased bill of materials, were targeted for the formal Curve Busting program. Basically, it worked like this: First, the Sikorsky Curve Busting team would formally present the concept to the supplier, stressing affordability, good business sense (future base), productivity and multiyear cost saving opportunities. The supplier was challenged to obtain greater-than-normal improvements in manufacturing yield and to commit, in writing, to an aggressive cost-reducing program.

Second, the supplier prepared its Curve Busting plan, detailing its goals, actions and method for providing periodic feedback of progress. Goals were set in three Curve Busting improvement areas: reduced unit man-hours, improved manufacturing (quality) yields and purchased-material cost reductions on a multiyear basis. During this process,

BLACK HAWK CONTRACT HISTORY

	YEAR	QTY	UNIT PRICE (THEN YEAR $)	UNIT PRICE (CONSTANT FY 80 $)
	77	15	3.236 M	4.034
	78	56	2.040 M	2.195
	79	92	2.376 M	2.237
	80	94	2.520 M	2.158
	81	80	2.932 M	2.379
	82	96	2.971 M	2.359
MY I	83	96	3.156 M	2.428
	84	96	3.090 M	2.266
	85	96	2.704 M	1.885
MY II	86	96	2.738 M	1.813
	87	96	2.771 M	1.757

SOURCE: BLACKHAWK PROJECT OFFICE



SOURCE: SIKORSKY AIRCRAFT

Sikorsky personnel were available to assist the supplier in preparation of the plan as appropriate. This interface was effective in generating a partnership approach to this effort. Finally, the plan was approved by Sikorsky and monitored during its implementation.

The real benefit of this program was that it forced the supplier's senior management to place special emphasis on producibility and establish cost targets well in advance of proposal submission. In effect, it negotiated much of the cost issue away long before actual negotiations would start. The supplier knew he would have to accept a price less than MY I and, therefore, had to reduce costs if he were to maintain a fair and reasonable profit.

'Should Cost': Operating Level Input

Whereas Curve Busting was a philosophical approach targeted at the senior management of selected suppliers, a "Should Cost" Program was developed by Sikorsky for application at the operating level. Again, the central theme was affordability and its objective was to work with suppliers directly in generating ideas for cost savings. The program combined some of the elements of the traditional DOD should cost analysis and classical value analysis. Unlike DOD's approach, however, it did not include cost auditing and was carefully structured in a positive manner to emphasize the element of partnership between the prime and subcontractor and the mutual benefits to both parties in finding ways to reduce costs.

The Sikorsky Should Cost team consists of full-time senior representatives from each of the fabrication related disciplines, i.e. design, manufacturing, materials, quality assurance, industrial engineering, etc. This team, augmented by specialists, implements the Should Cost Program by conducting visits with selected suppliers which are structured to encourage maximum cooperation between prime and supplier in exploring a wide range of cost saving ideas. Suppliers are selected on the basis of the dollar value of the material supplied. Visits are preceded by thorough advance preparations by both the Sikorsky Should Cost team and the supplier's counterpart team.

The visit emphasizes structured brainstorming in small groups or one on one, i.e. engineer with engineer and manufacturing with manufacturing. A typical visit will take from two to five days. At its conclusion, both teams reconvene and all cost saving ideas are put into writing and submitted to the senior management of both the supplier and Sikorsky.

The supplier must then incorporate the ideas into a proposal which defines the recurring and non-recurring cost reductions that can be achieved. The proposal is submitted to Sikorsky who conducts a final technical and financial review. Those ideas which truly represent cost savings, while maintaining or improving the required parts characteristics, are approved.

The results have been impressive. Sikorsky estimates an annual savings of about $9 million. The key to the program is tapping into the wealth of cost saving ideas which the supplier's personnel have. Most are relatively small in terms of DOD standards and, therefore, lack visibility and lie dormant within the supplier. However, an affirmative program such as Should Cost provides an opportunity to surface ideas and, although relatively small on an individual basis, their cumulative cost saving impact is significant.

Multiyear Opportunities

Multiyear contracting gives the prime contractor significant increases in buying opportunity and greater flexibility in developing and managing his supplier base. Should Cost and Curve Busting are examples which keyed on producibility. Other benefits are increased competition and greater potential for development of alternate sources.

Competition is much easier to get as increased quantities and longer-term programs attract new suppliers. Sikorsky achieved increases in competition of 87 percent in MY I and 177 percent in MY II based on a comparison of the number of dollars competed to single-year levels. Likewise, alternative sourcing becomes a viable option as non-recurring costs can be amortized over expanded quantities. This gives the prime leverage in dealing with single source suppliers who might otherwise have been reluctant or unwilling to cooperate in producibility efforts such as Curve Busting or Should Cost. The bottom line for Sikorsky was an 8.7 percent reduction in the cost of materials for MY II over MY I (then-year dollars) and a stable price for the Black Hawk to the government for a seven year period despite inflation.

In conclusion, I think multiyear procurement is one of the most effective initiatives for reducing acquisition costs. The Sikorsky example demonstrates its great potential. However, savings don't just happen automatically. It takes a strong commitment of both will and resources, and aggressive action on the part of the prime contractor to capitalize on every opportunity afforded by multiyear. When done, the results are impressive.

While DOD is highly supportive of multiyear, Congress has been reluctant. We in the acquisition field must seek new multiyear opportunities and insure their success. We can't afford to blow a chance because we or our contractors weren't ready for the opportunity. Continued success will build multiyear credibility with Congress. Then it will be up to Congress to show its commitment to cost reductions in weapon systems acquisition by allowing greater use of multiyear.

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Log R&D and RAM-D —

Introduction

In recent months, the research and development community has seen increased emphasis in two areas: Log R&D (logistics research and development) and RAM-D (reliability, availability, maintainability and durability). Although not normally part of the R&D lexicon, the Log R&D and RAM-D areas will remain prominent in the R&D world in the years ahead. The RAM-D area, in particular, is the subject of a major new effort launched by the vice chief of staff in October 1984. Its goals are to reduce the operating and support demands of present and future weapons systems.

Log R&D and RAM-D

From a standpoint of definition, RAM-D is considered part of Log R&D, although RAM-D has a specific set of goals within the Log R&D initiative. Logistics research and development addresses all R&D efforts that can contribute to the solution of logistic deficiencies, and/or improve our operational capabilities. In RAM-D, we're addressing different goals: the need to reduce the cost and manpower requirements related to the reliability, maintainability, and durability of systems. Improvements in these areas will undoubtedly contribute to many Log R&D problems as well. Yet another element is included within the RAM-D initiative: producibility. We've had many experiences where sophisticated systems have been developed with superior attributes, only to have substantial problems in terms of producibility.

Problems that can be solved through logistics R&D are not hard to find. Some of the more obvious examples are a lack of an adequate supply of water or ammunition that hinders combat effectiveness. If the water needs are for human consumption, we will be looking for potential solutions from R&D that would either reduce water needs or allow us to extend the use of such water as is available. Perhaps the sheer bulk or volume of ammunition is the limiting factor in the amount we can transport, and that severely affects our strategic deployability. If so, can we reduce the volume? As obvious as such questions are, they have not received enough attention in the past on the part of the R&D labs. Emphasis has been directed to such operational needs as improving communications, countersurveillance, target acquisition, firepower, or vehicle speed and range. Current Log R&D efforts are intended to bring the capabilities of AMC's scientists and engineers to bear on the logistic problems. They deserve attention, since all the firepower in the world is of little value if the ammunition supply is inadequate.

RAM-D Goals: Dollars and People Savings

As stated, the goals of the RAM-D initiative are to reduce the costs and manpower to operate and support current and future weapons systems. These operating and support (O&S) costs come in two categories, both of which are in short supply: dollars and manpower. In terms of money, the statistics on the M1 tank noted in AMC Commander GEN Richard Thompson's recent article (*Army RD&A Magazine*, February 1985) provide the perspective. Of the total system costs, less than 2 percent represented R&D. Acquisition amounted to 23 percent. The remainder, 75 percent, reflects operating and support costs. Given these figures, it is obvious that investments in R&D can yield substantial cost savings in terms of O&S costs.

The second driving force behind the RAM-D effort — the need to reduce the personnel required to operate and maintain systems — has become more critical in recent years because of two converging elements. Complex systems demand more maintenance and more highly skilled personnel. Behind the maintenance personnel are the support forces, and this maintenance "tail" is often underestimated. For each soldier directly engaged in maintenance on a system, there may be several more soldiers serving behind in support roles. This not only includes those directly supporting the system, but the personnel behind these, who are maintaining the parts, documenting the services, and performing all of the other necessary functions in the logistic chain. As our direct maintenance requirements grow, the support personnel requirements behind them multiply.

The other constraint is the fixed amount of manpower in the Army. The more people involved in maintenance and support, the less available for more critical needs. As a result, in the RAM-D thrust, we are looking for manpower reductions as well as cost. In either case, it presents some new challenges for the R&D community. Scientists and engineers who have concentrated their energies in the past on advancing the state of the art will have to balance this by addressing RAM-D problems, and this requires developing an understanding of the factors that lead to O&S costs and manpower demands.

RAM-D Challenges

On the surface, Log R&D problems may not seem to offer challenges as exciting as those associated with the advancement of technology that will improve the Army's combat effectiveness. With RAM-D, where the incentives are based on cost and manpower reductions, challenging technological issues may be even less obvious, but they do exist. One excellent example of this is

What Is This All About?

By John V.E. Hansen

the "expert systems" program that AVSCOM's Applied Technology Laboratory evolved to develop a system employing on-board diagnostic devices coupled with artificial intelligence to improve helicopter maintenance. Such developments would become a vital part of the technology base for other weapons systems as well.

One other new aspect associated with the RAM-D thrust is that we will be placing a lot more emphasis on developments that can demonstrate out-year cost savings. This means we will support efforts that in the past may have been hard to justify. In the past, we've worked hard to develop systems with emphasis on RAM-D to assure the needed operational capability. Anything beyond that may have been subject to cries of "gold plating." Today, developments that can yield a justifiable return on investment in terms of reduced outyear O&S costs will be supported.

RAM-D is not new, but in the past, reliability and availability (as seen by the emphasis on readiness) have received more attention than either maintainability or durability. Because of recent experiences, producibility is also being brought to the forefront. These issues deserve increased attention on the part of the R&D community, and some progress is being made. One step taken to develop an awareness of the maintenance and support world on the part of R&D personnel was the recent meeting to tighten the link between the Army Depot Systems Command (DESCOM) and the developers. Its intent was to make developers aware of DESCOM assets and capabilities that could be used during development, and to share some of the problems encountered in the support and maintenance of current systems. The dialog established was also aimed at permitting DESCOM to contribute to the development process by suggesting areas where downstream producibility problems could be avoided.

Producibility

Producibility problems are often underestimated in terms of their ultimate cost. When technology base efforts have yielded the first prototype of a new system, many of the ultimate producibility problems are already beginning to get set in place. A design review with DESCOM at this stage could yield suggestions that would head off such problems, thereby reducing costs and accelerating the acquisition process as well. DESCOM's involvement in early design reviews has also recently been been institutionalized in a revision to AMC regulation 700-15.

DESCOM has another important contribution to make: heading off the maintainability problems. Research and development teams often are not fully aware of the real world maintenance problems on systems they develop, and increased dialog with DESCOM (given their considerable maintenance experience) early in the development process should minimize such problems as well.

Closing the Loop — A New Dimension for R&D

There are real challenges for the AMC research and development teams to find opportunities where technology can be brought to bear on RAM-D problems, and that requires an understanding of real world maintenance problems. To some scientists and engineers who have been concentrating their energies on the development of the technology base, this will represent quite a change. However, from a standpoint of return on investment, it will pay handsomely for all concerned. The growing portion of Army expenses involved in O&S costs presents a sufficiently large target so that even small percentage reductions will more than justify additional R&D efforts. Technological advances that can permit more efficient use of the available soldier force are equally important.

In summary, Log R&D efforts are continuing in order to improve our operational capabilities and to reduce our operating and support costs. The RAM-D portion of these efforts focuses on dollars and manpower savings, and the criteria against which we judge our research and development efforts have been enlarged to reflect this. Because the incentive from the RAM-D effort is savings of dollars and manpower (rather than operational capability improvement) it commands a different perspective, and will present some new challenges to the R&D community. It also represents an area where the R&D community can make one of the greatest contributions to the Army.

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Quality Circles

A Bridge Between People and Productivity

During the past decade and a half there has been a marked growth in the United States of a management labor technique for enhancing productivity through cooperation, communication and coalition. The technique is known as quality circles and within the last five years it has found favor in the Army Materiel Command (AMC), growing from a few circles in our industrial base in 1980 to today's count of well over 400 circles, and 3,500 people in a variety of AMC organizations and functions.

Quality circles are groups of four to 12 employees who work together performing similar duties, generally under one first-line supervisor. They meet regularly for one hour per week on duty time to identify, analyze, and solve or recommend solutions to problems which they encounter in the process of carrying out their responsibilities.

Although many people think the Japanese created quality circles, the fact is that they are an American invention, created during and in response to the crisis of World War I. Since then, their ebb and flow has been directly related to the state of our economy, that is, whenever American management felt pressured to "do something" about its productivity or efficiency, it turned to those techniques that seemed to offer some sort of relief.

Quality circles also gained favor because the social values of the American populace changed from a security-based attitude (employees wanted or needed a job for the economic benefits employment would bring) to one which placed emphasis on the social aspects of employment and, significantly, the degree to which an employee could make a contribution to his or her work process. Employees of the 1980s want or perhaps need to feel they have some degree of control over their work environment and, more importantly, want to improve and want to contribute to real growth in their organization.

The basic philosophy of quality circles is that all workers deserve the opportunity to perform in an environment in which they are recognized as contributing members of their organization. Circle objectives, therefore, include utilizing worker creativity, promoting personal leadership development, boosting morale, increasing communications between workers and managers, and building an employee attitude of problem prevention. Overall goals are to increase employee awareness of costs and quality, enhance productivity, strengthen motivation, and improve management/employee relationships.

Quality circles operate differently from a typical organization. Instead of the manager or supervisor acting as the sole problem solver, the quality circle approach brings workers and management together to best solve problems involving their work. This approach is based on the premise that the resident experts are the people who do the work. Thus, circles create in the individual a sense of participation and contribution which results in improved worker productivity, better quality, and reduced costs.

Circle members assume responsibility to identify and analyze problems in their own work areas. The sense of participation employees gain from this involvement is a powerful and necessary motivating influence, and can lead to increased willingness to work toward goals set by the organization. This is especially true when personal goals are being achieved at the same time.

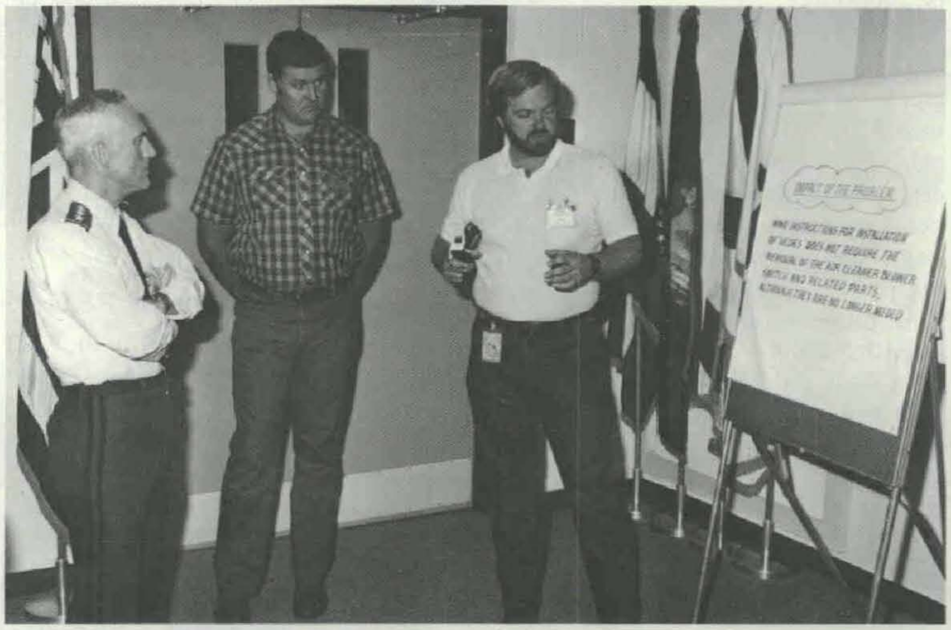
As an example, White Sands Missile Range (WSMR) has had considerable success with quality circles in a relatively short time. Currently, they have 24 quality circles involving over 160 employees ranging in occupations from engineering, administrative, and clerical support to skilled trades. WSMR circles have offered solutions to a wide variety of problems. Recommendations were approved in practically all cases.

The cost/benefit ratio for development of quality circles at WSMR has been almost 1-to-2.5. Expected annual benefits from implementation of quality circles, based on the first year and a half of operation, are almost half a million dollars. The U.S. Army Depot Systems Command, after more than three years of using quality circles, has achieved over a 1-to-3 ratio. More importantly, benefits are being realized in less measurable but highly desirable areas such as communication, job satisfaction, and worker pride in the end products and services.

In a Nov. 23, 1984 memorandum to GEN Richard H. Thompson, commander, AMC, GEN John A. Wickham, Army chief of staff stated, "I encourage every Army command to consider establishing Quality Circles. . ." He requested AMC to "offer assistance."

In summary, we are totally committed to achieving an Army of Excellence. The challenges of training, maintaining, leading, and caring for the Total Army Family dictate that we constantly seek more effective, efficient, productive ways of achieving excellence. Quality circles is one way of achieving this excellence.

The preceding article was authored by Thomas S. Siciliano, a senor management analyst in the Productivity Management Division, Office of the Deputy Chief of Staff for Resource Management, HQ, U.S. Army Materiel Command.



GEN John A. Wickham Jr., Army chief of staff, listens to a briefing by Joe Daniels (right) on a suggestion submitted by the "Track Adjusters" Quality Circle from the Directorate for Quality Assurance, Anniston Army Depot, AL. Fred Bass, another member of the Track Adjusters watches the briefing.

Robotic Vehicle Technology Research

By Cheri Abdelnour

Someday robots could save American soldiers' lives. They might take over dangerous missions, penetrating contaminated areas to fire weapons, conduct reconnaissance, NBC detection or carry supplies.

Although it will be years before this happens, the study of unmanned vehicles for military use is shifting into high gear. Last year, the Defense Advanced Research Projects Agency (DARPA) began investing $600 million in its Strategic Computing Program. The program will develop a technology base using recent advances in artificial intelligence, computer science and microelectronics. It focuses on three applications areas: autonomous vehicles, an aircraft carrier battle-management advisor and a pilot's advisor.

Scientists from government, industry and university research centers are participating in the program. The U.S. Army Engineer Topographic Laboratories (ETL) is managing portions of the long-term research that may one day help the military field robots. In addition, ETL is part of a team working on the Army robotic vehicle program for near-term teleoperated and semiautonomous vehicles. The DARPA and the Army programs are designed to complement each other.

Autonomous Land Vehicle

ETL recently awarded two autonomous land-vehicle contracts and nine image-understanding, or computer-vision, contracts for DARPA's Strategic Computing Program. The contracts are valued at about $25 million. DARPA is also providing ETL with $1 million for related in-house research and contracts associated with the autonomous land vehicle.

Martin Marietta is the integrating contractor for an autonomous land vehicle that will demonstrate the technology potential for the DARPA program. Hardware and software techniques developed by ETL, Martin Marietta and other contractors will be tested and approved before they're incorporated in the demonstrator.

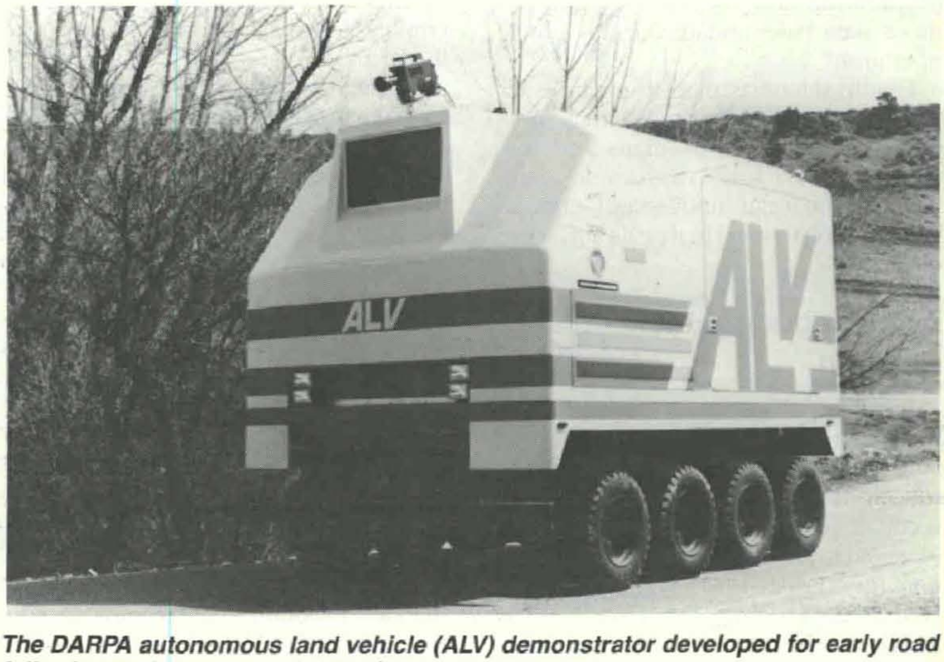
Since the vehicle won't have a driver, sensors such as stereo television cameras and a laser-ranging device will be its "eyes" for the initial part of the program. Other sensors will be employed later.

Eventually, researchers hope to develop a capability that will enable a vehicle to maneuver on a battlefield using its own "intelligence." During a mission, the vehicle must be able to go from point A to point B. Route planning will be accomplished with on-board terrain data bases. The vehicle will analyze sensor input then decide the best way to locally navigate along the planned route. If the vehicle encounters obstacles, it must go around them, replanning the route when necessary.

At first, the vehicle demonstrator won't be able to move fast or do complicated maneuvers. However, each year it will master increasingly difficult tasks. "The DARPA program involves high risk technology development," Dr. Robert Leighty, ETL's Research Institute director and technical agent for the project, said. "DARPA has very aggressive goals for the autonomous land vehicle program," he added. "The demonstration systems are designed to 'pull' new capabilities from the technology base, rather than 'push' available capabilities at the user," he explained, adding: "It's envisioned that one day the demonstrator will perform certain tasks as well as a similar manned vehicle."

Major technology demonstrations are scheduled at a test site in Colorado this year and will continue through 1990. The demonstrator will begin by travelling 10 kilometers per hour on paved roads. By 1990, it will plan a cross-country route using digital terrain data stored in its computer. The vehicle will navigate by recognizing landmarks and avoiding obstacles. It will update its computer data with information derived from its sensors, replanning the route if it comes to impassable obstacles such a demolished bridge. The demonstrator will reach speeds up to 50 kilometers per hour on paved and unpaved roads and travel up to 20 kilometers per hour in wooded areas.

Today's machine vision systems aren't sophisticated enough for an unmanned vehicle to successfully operate in a combat environment, so scientists are developing new methods and techniques for the demonstrator's vision system. The image understanding software they're developing will take information from sensor imagery and interpret it so the demonstrator can follow roads and road networks, recognize landmarks and avoid obstacles. Terrain navigation re-



The DARPA autonomous land vehicle (ALV) demonstrator developed for early road following and cross-country testing.

search will focus on a capability to determine vehicle position, heading and attitude. Obstacle recognition and evaluation work will include vision system parameters, vehicle parameters and obstacles found in particular geographic areas.

Other research is aimed at improving computer hardware so an unmanned vehicle can plan routes and someday move as quickly as a manned vehicle in battlefield situations. Researchers plan to speed up computer vision processing by designing programs that run simultaneously. To do this, they're modifying image understanding algorithms and studying parallel computer architectures. Once they determine how to design parallel computer programs, they'll combine very large-scale integrated circuits and micro-electronics to implement these designs.

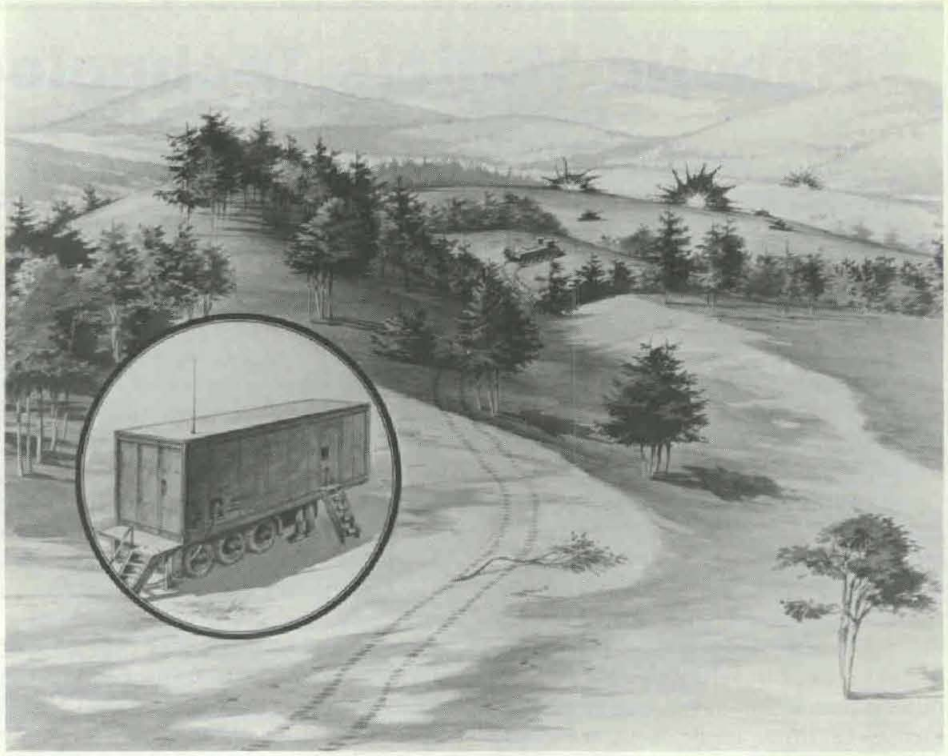
Additional image understanding research depends on knowledge-based vision techniques so the demonstrator computer can "understand" what it "sees" through sensors. Researchers will develop basic techniques for machine representation and reasoning. Then they'll use the processes to build models of objects the vehicle "senses."

Next, they'll concentrate on obstacle recognition and evaluation so the demonstrator can keep on course by comparing what it "sees" to models and digital map information stored in its computer data base. ETL scientists will conduct a detailed ground-truth survey of the demonstration area and build a high-resolution digital-terrain data base. Also investigated will be rapid data base preparation and concepts for autonomous data base update during vehicle operations.

Finally, scientists plan to create ways for the vehicle to detect and track moving objects such as humans and machines. This will lead to the development of systems that can "understand" enough of a situation to react to threats and avoid collisions.

Army Robotic Vehicle Program

ETL is handling the technology transfer between the DARPA autonomous land vehicle program and the Army robotic vehicle program since it is directly involved in both projects. As part of an Army robotic vehicle program management team that includes the Human Engineering Laboratory and is led by the Tank-Automotive Command, ETL is also responsible for digital terrain data, route planning, stereo vision and land navigation. ETL scientists have done robotics research since 1981 and began developing terrain navigation subsystems for the Army robotic program in 1982.



The Army robotic vehicle demonstrator will consist of an unmanned platform and a remotely located control station.

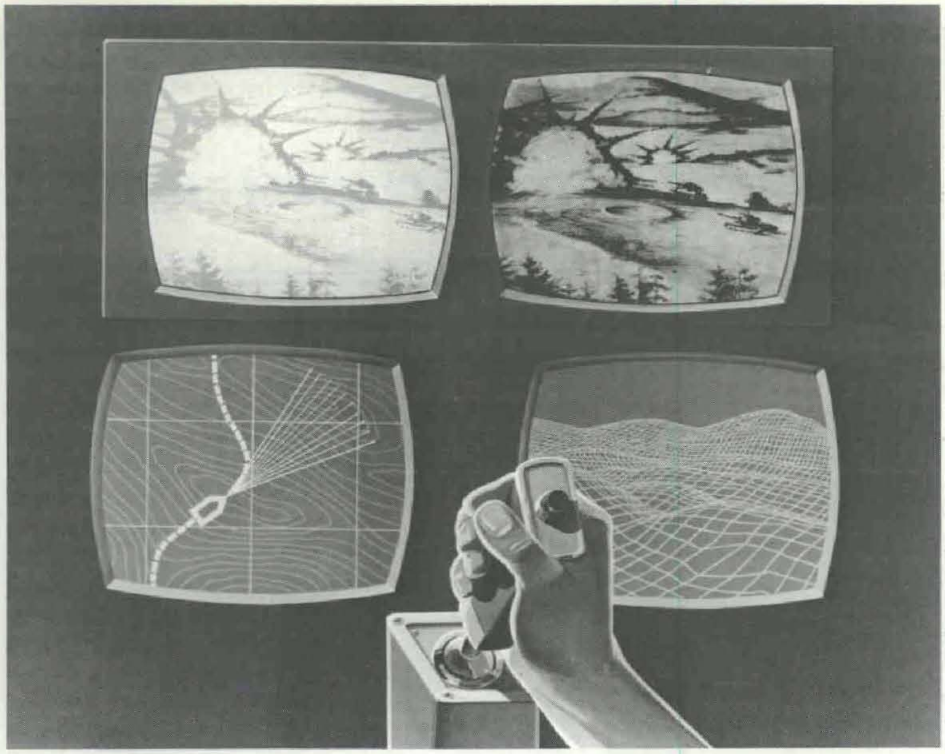
Bruce Zimmerman, manager of ETL's role in the Army program explained, "Since we realize it will be years before autonomous vehicles can operate in battlefield situations, we're focusing on getting enhanced teleoperated systems to do this in the near-term." Zimmerman emphasized that although he believes the Army can afford to to field a semi-autonomous vehicle that will do road following in the mid-term, it can't afford to independently support a research program to develop technologies for an autonomous vehicle. Therefore, he said, "Our program is being developed to take advantage of DARPA's research. We have the hooks built into it so we can implement DARPA technology with minor changes. We're using the same computers, navigation sensors and computer architectures." At the same time, Zimmerman added, the Army program helps give the DARPA project a military mission focus. "It's a two-way street," he said.

The Army robotic vehicle program goal is to develop technology for an unmanned program that can move across the battlefield. This platform or vehicle must be adaptable for a variety of missions. The demonstrator system will consist of an unmanned vehicle and a remotely located command and control station with a communications link to the vehicle.

A tracked vehicle such as an M113 will probably be the initial platform. It will be tested this fall on the same Colorado range as the DARPA project. The first platform demonstrations won't be very mission-oriented, Zimmerman said. The vehicle will be driven around the fairly rugged terrain so the control systems and computerized driving aids can be tested. However, it will eventually be fitted with sensors and equipment for NBC detection or reconnaissance missions. Demonstrations of such battlefield operations are anticipated for fiscal year 1987 at Fort Knox, KY.

The demonstrator, controlled by a driver remotely located in the control station, will maneuver as well as the same manned vehicle over comparable terrain. Since the driver won't be able to see the demonstrator, he'll depend on an inertial navigation unit on the vehicle that determines its position, attitude, direction and speed. This information will be transmitted back to the control station and will be continuously plotted on a digital map.

Vision sensors on the demonstrator will also give the driver maneuver information. The control station will feature a driver's control console with stereo vi-



Operators at the remote location will use navigation display screens and computers to plan the platform's route and pilot it across the terrain.

sion so the driver can see where the vehicle is going. ETL is developing photogrammetry, optics and a computer display for this system. In addition, two microcomputer controlled graphic and image displays will provide more information to the driver, or eventually to a separate mission controller monitoring NBC detection or reconnaissance sensors. One display will show single or composite sensor data while the other will let the driver or controller monitor the vehicle's progress across the digital map or select three-dimensional graphics decision aids.

The interactive route planning software will recommend routes based on information in its terrain data base such as slope, surface configuration, soils, hydrology and vegetation. Once the driver gives the system parameters, it can automatically plan a "best" route. It can also give the driver several choices and he can decide which route to take. Depending on his mission, he may choose a route that minimizes distance, fuel consumption and time or one that gives maximum concealment and survivability.

The driver will occasionally glance at the blinking cursor display which shows the vehicle's actual position and heading relative to the pre-planned route. Before the driver moves the vehicle along the route, he can call up computer-generated scenes of the area to help him determine critical points such as bridge crossings or choke points such as narrow gaps between hills. He can also call up a series of scenes to preview what the area along the route will look like.

Since the data base won't indicate changing information such as vehicle or troop movement, or highly detailed information such as individual trees, the driver will use the vehicle sensors to detect and avoid these obstacles. If necessary, he can have the system select another route. Someday scientists hope to update the data base automatically, perhaps in conjunction with satellite positioning systems.

The Army program will evolve from teleoperation to semiautonomy by incorporating new methods and techniques developed in the DARPA project. Eventually, researchers hope to use computer-aided driving so the driver will be free to operate another vehicle at the same time. He could preview portions of the route using stereo vision and computer-generated scenes, then mark out sections without obstacles that the vehicle could negotiate on its own.

Although scientists working on the Army and DARPA programs don't have a preselected path to follow in their search for autonomous military vehicle technology, they are confident they're on the right track.

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DARPA Autonomous Land Vehicle Demonstrator Goals

1985 Road following: The vehicle travels 20 kilometers over a preset route on a paved road at speeds up to 10 kilometers per hour.

1986 Obstacle avoidance: Moving around fixed obstacles in its path, the vehicle travels 20 kilometers on a paved road.

1987 Cross-country route planning: The vehicle plans and navigates a 10-kilometer route over the open desert at speeds up to five kilometers per hour.

1988 Road network route planning and obstacle avoidance: Using landmarks, the vehicle plans and makes a 20-kilometer point-to-point journey through a road network at speeds up to 20 kilometers per hour.

1989 Cross-country traverse with landmark recognition: The vehicle plans and travels a 20-kilometer route in desert terrain at speeds up to 10 kilometers per hour. It replans the route when it comes to impassable obstacles.

1990 Mixed road and open terrain: The vehicle plans a route and moves 20 kilometers over wooded terrain, paved and unpaved roads. It travels at speeds up to 50 kilometers per hour on paved roads.

Interview With

LTG E.R. Heiberg III

Chief of Engineers and Commander, U.S. Army Corps of Engineers

Q. ***Why does the Corps of Engineers have its own separate R&D program?***

A. The Corps of Engineers has an R&D program that is hardly separate from the Army. Where the missions assigned to the Corps are unique, and the effective accomplishment of these missions requires the use of modern Corps-specific technologies, then we direct the R&D programs assigned to the Corps. Some of these diverse missions include technology base development in environmental quality, environmental and terrestrial sciences, support to the Army in garrison, topographic engineering, military engineering, mobilization, and, of course, civil works. This last mission is a major part of our program, and embraces the huge water resources of the Corps that support nationwide water-related missions. The military engineer mission evolves from my role as the Army's engineer and advisor to the chief of staff on engineer-related combat engineering issues. The primary focus of our overall mission support effort requires providing specialized facilities that are affordable to acquire, operate, and maintain. As such, we must perform R&D to take full advantage of all available technologies in order to provide these facilities. I would like to emphasize that our research takes full advantage of proven technology in the private sector as a first course and undertakes R&D only if no solution exists in the private sector.

Q. ***How does the Corps ensure that its RDTE program is meeting the needs of the Army?***

A. Yearly, the Corps produces a Long Range Science and Technology Plan based on Mission Area Deficiency Statements produced by the members of the Corps family who work in the base support area and on battlefield deficiencies identified by the Army Training and Doctrine Command during Mission Area Analysis in the fire support, combat support, combat service support, and mapping areas. This plan is reviewed in the spring of each year by the various proponents to insure that the proposed research products will solve the stated deficiencies. The proponents also prioritize the research efforts. Based on the proponent's guidance and priorities, the labs are given guidance on the content of the next year's RDTE program and for the development of the next version of the Long Range Science and Technology program. Technical monitors, from the proponent organization, are assigned to all ongoing research programs to assist the labs in formulating the results of the research into usable products and to assist the labs in technology transfer.

The Corps R&D program also supports the water resource management activities of the civil works program. On an annual basis, the Corps' field offices, laboratories and headquarters identify civil works research needs. These are analyzed and prioritized at the headquarters by the technical monitors for the 32 civil works R&D programs. The Research and Development Directorate, through the laboratories, develops a research program to respond to these identified needs. Detailed program reviews for each of the 32 civil works R&D programs are held annually in the February to May time frame. These reviews include participation by field representatives, the headquarter's technical monitors and the research community. The outcome of these reviews form the basis for development of the proposed R&D budget and program for the upcoming fiscal year. A detailed five-year Research and Development Summary is prepared for the Corps' civil works R&D program based on the current year's program reviews.

"The primary focus of our overall mission support effort requires providing specialized facilities that are affordable to acquire, operate, and maintain."

Q. ***What are the missions, or special areas of research for the Corps laboratories?***

A. The Construction Engineering Research Laboratory performs research in support of real property maintenance activities, construction, construction materials and structural design, environmental quality in life cycle construction, and conducts systems research and studies for supporting life cycle facilities, design, construction, operation and management for the Army. Its mission includes theater of operation construction research.

The Cold Regions Research and Engineering Laboratory conducts research in support of cold regions construction, including the application of construction techniques and operations and maintenance of expedient and permanent facilities in cold environments. The Cold Regions Research and Engineering Lab also conducts research relative to the effects of cold environments on materials. The lab also does research to enhance Army mobility, survivability and operational readiness in cold environments, which also includes enhancement of the navigability of our inland waterways under severe weather conditions.

The Engineer Topographic Laboratories perform research in topographic sciences, to include terrain analysis, mapping, mapping intelligence, remote sensing and environmental climatology. The laboratories also provide an operational terrain analysis service, including terrain hydrology in support of Army planning. These laboratories not only support the Corps' mission, but also those of the Army Materiel Command and the Defense Mapping Agency.

The Waterways Experiment Station performs research and engineering studies in the fields of hydraulics, soil and rock mechanics, earthquake engineering, near-shore oceanography, coastal engineering, concrete, expedient construction, environmental effects, including camouflage and vehicle mobility, weapon effects, protective structures, pavements, water quality, mine/countermine technology, and dredging.

Q. ***Does the Corps develop equipment for the Army?***

A. Yes, we do, in a relatively limited way. For example, under AR 70-1, I have materiel development responsibility in the terrestrial and topographic sciences—which includes mapping, surveying, and military geographic information. Under a Memorandum of Understanding between the Corps and the Army Materiel Command (AMC), AMC funds us for 6.3 and 6.4 developments in these areas. The Engineer Topographic Laboratories (ETL) is my agent for conducting these developments. One recent example of this process is ETL's successful development and fielding of the Position and Azimuth Determining System (PADS), a self-contained, jeep-mounted, surveying system using inertial navigation technology. PADS has a high degree of acceptance by artillery surveyors.

Currently, we are working on two AMC direct-funded development programs. One, the Digital Topographic Support System (DTSS), is designed to provide the Engineer Terrain Teams with a capability to generate cross-country mobility and intervisibility products for the tactical commander and other field users in near real time. Using digital terrain data furnished by Defense Mapping Agency and augmenting this data in the field, the DTSS will bring us out of the "grease pencil" era and allow the integration of terrain, weather, and doctrine for the production of tactical aids that will constitute effective force multipliers.

The second developmental program we are working on for AMC is the Quick Response Multicolor Printer (QRMP). This exciting program will provide the capability to reproduce four color maps and terrain analysis products, overlaid with the most recent intelligence and situational information, in the field, in minutes. The QRMP will do away with almost all of the existing slow, bulky, hard-to-maintain field printing presses and be able to generate the required products with smaller, more portable, field equipment operated by fewer personnel.

Q. ***How do these developments get fielded?***

A. Responsibility for production and fielding of our topographical systems transitions to the appropriate Army Materiel Command major subordinate command after type classification. We continue to provide technical support during the production and fielding process.

Q. ***Can you cite an example of the Corps' laboratories transferring technology to the Army?***

A. Yes, I can. One example is the consolidated Washrack Facility. In the Fort Polk prototype of this technology, an M1 tank coming in from maneuvers can be cleaned within 10 minutes. This facility saves 500,000 training hours annually. Another consolidated vehicle Washrack Facility exists at Fort Lewis, and Army Forces Command has programmed approximately $100 million for consolidated Washrack Facilities within the next five years.

This example is but one of many which are in the pipeline. Currently, we have a Facilities Technology Application Test (FTAT) program wherein we are demonstrating 43 products at 28 installations. Our FTAT program will work with the directors of engineering and housing at our installations in demonstrating the viability of technology advancements which have tested well in our laboratories. The technologies which are being demonstrated are in energy conservation, buildings and grounds, pavements and environmental quality. We expect to have all of the 43 products transferred to the Army within five years.

Q. ***Would it not be more appropriate for private industry to perform the R&D work that the Corps' labs are now doing, particularly in the area of combat engineering?***

A. The Corps' labs do, in fact, contract out a major portion of their work, and we continue to stress the maximum use of private industry capabilities whenever possible. There are, however, at least three advantages that the Corps' labs have over the private sector. First, the civilian work force provides a continuing, long-term base of experience and expertise in specific technical areas of interest to the Army, as opposed to the relatively high turnover rate of private industry personnel on a project-by-project or contract-by-contract basis, especially in high technology areas. Secondly, the direct link between the labs and the "user" elements, all under the central Army organization, encourages more direct communication between the people that have the problems and the people that can develop solutions. And thirdly, there is no financial "profit" motive associated with the labs' missions. This greatly reduces the tendency to continue the development of concepts or systems that are not fully justified in terms of their actual value to the Army. What we seek, therefore, is an optimum balance between the in-house Corps' lab effort and out-of-house support from the private sector that is based on the advantages that each can contribute.

"A reduction in R&D would represent an unacceptable mortgage on the future health and vitality of the Corps' total program."

Q. ***Has the reduction of construction funds in the Corps' civil works program resulted in a reduction in the civil works oriented R&D program?***

A. No. However, there has been a significant shift in orientation of the R&D program from planning and design problems to operation and maintenance directed research. The Corps' new Repair, Evaluation, Maintenance and Rehabilitation Research Program ($35 million over six years) is a prime example of this reorientation that is consistent with the reorientation of the Corps' budget from new construction to maintenance activities. A reduction in R&D would represent an unacceptable mortgage on the future health and vitality of the Corps' total program.

Q. ***Does the Corps work cooperatively with other federal agencies on R&D efforts?***

A. Yes, as a matter of course. A good example of such a cooperative effort is our Interagency Field Verification of Dredge Disposal Alternatives Program which the Corps and EPA are working on together. The Field Verification Program will cooperatively develop predictive methodologies necessary for implementing the requirements of the Ocean Dumping Act and the Clean Water Act. We have other cooperative programs with the EPA in evaluating rotating biological contractor technology and in mitigating noise pollution. We also have cooperative programs with the Federal Aviation Administration, the Federal Highway Administration, the Department of Energy and the National Oceanography and Atmospheric Testing Administration. We work cooperatively to preclude duplication of effort.

Q. ***A good portion of the Corps' work, particularly construction projects, is dependent on contracts with industry. In view of recent reports of industry pricing improprieties, what actions have you taken to insure for fair and reasonable prices in contracts with industry?***

A. Procurement for construction contracts for the Corps is very well regulated by Federal Acquisition Regulations which require comparison with an independent government estimate. Furthermore, the large bulk of our work is done through direct price competition. The estimates are prepared as if the government were in competition for the job. The Corps can and does reject bids when improprieties occur, and supports legal actions against offending firms.

Q. ***Our How to Fight Field Manual 100-5 emphasizes that the United States Army must be capable of operating in any environment. As the "environmentalist" of the Army, what RDTE are you doing to ensure that the Army is capable of operating under realistic battlefield environmental conditions?***

A. Environmental conditions have a significant impact, not only on major weapon systems but also on tactics and logistics considerations. Military tacticians have long recognized the importance of the effects of the environment on both friendly and threat forces. In exercising my responsibility for the Army environmental sciences technology base, the Corps has developed a new thrust initiative called the AirLand Battlefield Environment (ALBE) to focus RDTE on the realistic battlefield environment. ALBE supports the AirLand Battle doctrine and the Army 21 concept. The ALBE thrust is intended to bring about increased recognition, understanding, and use of the environment in Army systems, training, doctrine development, and combat operations. It is structured to deliver the underlying technology to exploit the battlefield environment as a combat multiplier through integration of atmospheric, terrain, and engineering technology emerging from all of the participating organizations. We are planning a series of field demonstrations that will permit the Army's users to take an early look at the results of these efforts with the objective of translating of environmental effects into systems that will allow taking tactical advantage of the battlefield environment at an early date.

"What we seek . . . is an optimum balance between the in-house Corps' lab effort and out-of-house support from the private sector that is based on the advantages that each can contribute."

Q. ***What are some of the challenges facing Corps of Engineers research laboratories?***

A. A major challenge in today's environment of ever-expanding technology alternatives is to develop and expedite appropriate technology to reduce acquisition, operation and maintenance of military facilities in support of the Army in garrison, on the battlefield, and in support of the facility requirements for mobilization. And finally, we need to ensure that the "technologies" are effectively transferred throughout the Army and to other interested defense and government users. The ultimate challenge is to "deliver the research product" to the military or government user!

The Medical System Program Review

New Methods to Improve Medical Readiness

By CPT (P) John T. Robertson and CPT (P) Calvin J. Glazier Jr.

Army Vice Chief of Staff GEN Maxwell Thurman says the Medical System Program Review (MSPR) is "probably the most revolutionary look at the medical service enterprise that has gone on in my period of service."

The Medical System Program Review, conducted Dec. 17 and 18, 1984, at the Academy of Health Sciences, Fort Sam Houston, TX, was an opportunity for senior Army leadership to examine the entire medical system as it supports the U.S. Army at war. The design proposals presented during the MSPR were built around three major issues:

- The medical system is a continuum of care from the Forward Line of Troops (FLOT) through the continental U.S. (CONUS) base.
- The system should be optimized to return to duty the maximum number of trained combat soldiers at the lowest treatment level.
- The go-to-war medical system should be the basis of the U.S. peacetime health care delivery system.

An 11-month review process preceded the December presentation. More than 700 people from both inside and outside the Army Medical Department reviewed the battlefield functions of the Army Medical Department, that is, to prevent injury and illness, return soldiers to duty, clear the battlefield, and save lives. The goal was to develop and evaluate ideas on how the department can better support the Army doctrine of AirLand Battle.

Logic for Change

In future conflicts the Army Medical Department will not have the luxury of deploying an unlimited number of beds for soldiers who are not likely to return to duty. They must flow rapidly through the system (flow-through system) to a location where beds are available.

To move these patients rapidly through the system, surgery at each station must be limited to that necessary to make the patient transportable. To minimize morbidity and mortality while performing this limited surgery, the patient's physiology must be kept as close as possible to normal from the time of wounding until definitive care is given.

Immediate access to far-forward care is required to maintain the soldier's physiology. This care may be provided by the soldier himself, with assistance from a buddy, from a unit lifesaver, or from a highly-trained trauma team.

For those patients who will not return to duty, dedicated evacuation assets must be available to pass them through the system and provide continuous care en route. If evacuation is slowed or becomes unavailable, as in intense combat, the capability for life-saving surgery far-forward may be required.

While for patients who will not return to duty the emphasis is on rapid flow through the system, the soldier who can be returned to duty should be evacuated no farther than is medically necessary.

Maximizing return to duty is more than providing proper medical support to the soldier who is already injured or sick; it begins by avoiding illness and injury. Beginning at the FLOT, prevention is the most effective and least expensive way of providing the combat commander with healthy troops.

Out of these postulates evolved a new concept for an enhanced medical support system—a continuum of care which reaches from the individual soldier at the FLOT back through the CONUS base.

Continuum of Care

This new concept for an enhanced medical support system has six primary pillars: wellness/fitness, prevention, immediate far-forward care, restructured deployable and mobile hospitals, rapid evacuation, and CONUS base.

Wellness/Fitness

Any concept for improved medical support during wartime must begin in peacetime. It begins at the unit level with the individual soldier and his state of physical fitness. In DA Pam 350-21, physical fitness is defined as "the ability to perform physically demanding activities...for an extended period of time," but good health must go beyond strict emphasis on only physical fitness. A fit soldier is not necessarily a well soldier. Wellness incorporates a state of total physical, mental, and emotional well-being.

Prevention

Avoidance of injury and illness goes beyond the individual soldier to the commander. As Field Marshal Slim so aptly pointed out in his book, *Defeat into Victory,* "Doctors don't prevent disease, commanders do." Commanders must continually emphasize prevention in day-to-day training, in field training exercises, and in garrison. Prevention is maintenance of manpower, conceptually no different than pulling preventive maintenance on a vehicle.

Immediate Far-Forward Care

Immediate far-forward care is the key to the flow-through concept. Medical care must be readily accessible to the wounded, injured or ill soldier. In his study on the causes of death in conventional land warfare published in *Military Medicine* in February 1984, COL Ronald Bellamy said that "hemorrhage is the greatest threat to life on the battlefield." He suggests that the use of simple first aid techniques to stop the bleeding could significantly reduce death on the battlefield. Stopping bleeding requires immediate reaction by the soldier (self aid) or by his buddy (buddy aid). The MSPR proposed a revamping of first aid training during basic combat training to emphasize proficiency rather than simple familiarity with the life-saving tasks (Figure 1). These changes are already being implemented. Proposals have also been made to include these tasks in the Skills Qualifications Test.

Eight Tasks - Proficiency Level

- **Evaluate the casualty**
- **Clear the airway**
- **Perform rescue breathing**
- **Put on a pressure dressing**
- **Put on a tourniquet**
- **Prevent shock**
- **Splint a suspected fracture**
- **Protect self against heat and cold**

Figure 1.

Since one aidman in a platoon usually cannot take care of all the wounded during intense periods of combat, the MSPR suggested that another individual in each squad be given the role of medic extender or unit lifesaver. The training for these soldiers would extend beyond the basic eight life-saving tasks. They would be required to be proficient in 24 first aid tasks with special training to fit the specific mission of their unit. During the firefight, unit lifesavers would fulfill their normal roles in the squads.

Each wounded soldier should receive emergency trauma treatment by a physician or physician assistant-directed team within 30 minutes. Typically given at the battalion aid stations, initial treatment is limited to that necessary to save life and limb or to stablize the patient for evacuation.

Modular Medical System

A new modular medical support system is being developed which is composed of more flexible, responsive and interchangeable modules which are standard throughout most medical treatment organizations. These new design modules begin at the medical platoon maneuver battalion aid station level.

The division medical battalion includes a headquarters (which provides command and control) and support company (which operates a clearing station in the division area) and three forward support medical companies. The forward support medical companies are composed of ambulance squads, an area support section and a patient holding squad and operate clearing stations in brigade support areas. The ambulance squads provide ground evacuation from the maneuver battalion to the clearing station in the brigade support area.

The area support section is designed similarly to the forward treatment squads. However, it can also provide limited X-ray, laboratory and emergency dental treatment capabilities. The treatment squads feature a flexible organization which allows them to provide medical support in a variety of tactical scenarios.

The patient holding squad provides care for minimally sick or injured soldiers who are expected to return to duty within 72 hours. Soldiers needing minimal support for battle fatigue can also be held here. Because patients held at this level can defend and care for themselves, mobility is not jeopardized.

When situations arise in which casualties cannot be evacuated easily, the need for lifesaving surgery can be met by surgical squads from the Corps. These squads can move forward and be attached to the area support sections in the light and heavy divisions (surgical squads are organic to medical battalions of airborne and air assault divisions). This unit is staffed to provide sustained lifesaving surgical support and primary resuscitative care under austere conditions for up to 48 hours.

Also assigned to Corps are combat stress control and preventive medicine sections providing squads for far-forward treatment of stress casualties. These combat stress control squads are key elements in the treatment and control of battle fatigue and assist commanders in their prevention efforts and returning soldiers to duty.

Preventive medicine squads provide a complete spectrum of field preventive medicine services. The squads are modular, flexible and can divide into two-man sections to move forward into brigade areas.

Under the MSPR design, area support medical battalions provide unit level medical support to organizations without organic medical capability and division-level-equivalent support to all units in their areas of responsibility.

The area support medical company is identical to the division-level forward support medical company and is capable of reinforcement or reconstitution when required. Each is assigned a sector of responsibility and can provide medical and dental treatment, X-ray, and laboratory functions. They also have a limited patient holding capability. These area support medical companies also have the modularly-designed treatment squads which can be further employed as separate teams to best support the total population.

The patient holding company of the area support medical battalion augments combat support hospitals by caring for patients who do not require hospital care but are not ready to return to duty. Augmented by surgical squads or combat stress control squads, the unit's capability is expanded and it can perform many additional medical support missions.

Theater Hospital Support System

In their 1952 study of the World War II medical support system published in *Battle Casualties - Incidence, Mortality, and Logistical Consideration,* Gilbert Beebe and Michael De Bakey point out that, "from a standpoint of bed requirements, it would be highly desirable for a field army or an overseas theater not to be forced to use hospital beds for patients who cannot be returned to duty there, but this is manifestly impossible. All that can be done is to minimize...the bed cost of the evacuees to the echelon from which they are evacuated."

The MSPR features two new thrusts in the development of a theater hospital system. The first is the establishment of a two-stream evacuation system to replace the current single stream system and the second is the reduction of the number of types of hospitals in combat.

The current dual-function, single-stream evacuation system actually interferes with returning soldiers to duty, because the most serious patients are treated first. The resultant delay in treating return to duty candidates can lead to their conversion from likely returnees to probable evacuees out of the theater.

The first stream of evacuation is for those patients likely to return to duty within the theater evacuation policy. Emphasis here is to keep the patient as close as possible to the division. Patients are sent to the redesigned combat support hospital and from there either directly back to duty or to the patient holding company where they undergo further rehabilitative treatment before returning to duty.

The second stream is for those patients unlikely to return to duty in theater. It seeks to minimize the bed cost of evacuees by emphasizing rapid flow through the system, by limiting forward surgery to saving life and limb, preventing infection, and rendering the patient transportable. Above Corps level, only surgery required to be sure the patient can withstand air evacuation back to the U.S. is performed. Patients in this stream are routed through one or both redesigned evacuation hospitals where "initial effort" surgery is performed, then they are evacuated to a general hospital to obtain further surgery or to await evacuation out of the theater. The probable evacuee will spend on average no more than six days in theater (current and proposed systems are shown at Figure 2).

For this dual-stream system to work properly, air and ground evacuation assets must be readily available. The system also requires knowledgeable triaging at the clearing station level which is essential to limit transfer of patients between the two streams.

The second thrust of the MSPR was the total redesign of the theater hospital units from the current seven dual-func-

CURRENT AND PROPOSED THEATER HOSPITAL SUPPORT SYSTEMS

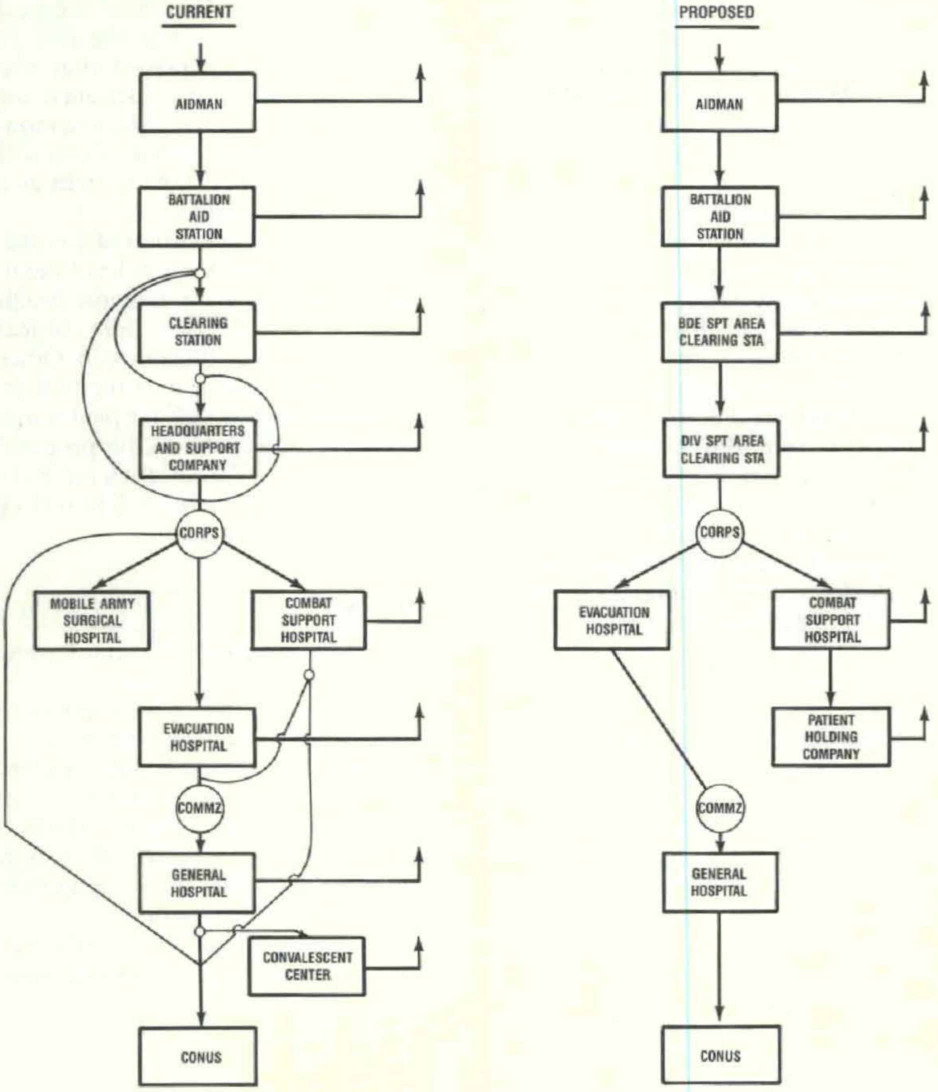

Figure 2.

tion hospital types to three single-function, smaller, more mobile, and modularly-designed hospitals (Figure 3).

Within the return to duty stream is found the first of these proposed hospitals, the redesigned 252-bed combat support hospital. This hospital provides treatment and convalescent care to soldiers who can return to duty and is designed to be at least 50 percent mobile. Patients requiring more care before returning to duty will be transferred no farther than the patient holding company. The evacuee stream contains the other two proposed hospitals. Within the Corps area is the redesigned 252-bed evacuation hospital which provides medical and surgical treatment necessary to stabilize patients for further evacuation. The evacuation hospital is also designed to be at least 50 percent mobile.

In echelons above corps (communications zone), a new 504-bed general hospital is found. This unit has assumed the functions of the current station, field, and general hospitals. Its primary mission is the continued treatment and stabilization of probable evacuees and preparation of these patients for evacuation to CONUS. This hospital has a secondary mission to provide area support to patients from above Corps level. This hospital is considered "relocatable" but not highly mobile.

Medical Support Services

In its total review of the medical system, the MSPR redesigned medical support systems to increase their flexibility and mobility in conjunction with Army doctrine. Dental, laboratory, veterinary and medical logistic organizations were redesigned to conform to the modular medical system.

Dental support services are divided into echelons based on where the treatment takes place and the requirements of that location. Only emergency treatment is provided far forward while more comprehensive and specialty care is provided in CONUS. The MSPR proposal limits far forward dental laboratory procedures to those supporting rapid return to duty or evacuation. Sophisticated laboratory support is provided by the theater-level area medical laboratory which has the capability to send forward specialty squads to reinforce corps or divisional units.

Current veterinary detachments will be reorganized into veterinary companies with veterinary platoons. These can be further divided into deployment teams. Veterinary services will continue to be performed at ports and forward to division supply points.

The MSPR reviewed proposals to redesign some elements and functions of medical logistics organizations. New concepts are under study to design a forward Medical Supply, Optical and

Theater Hospital Units

	CURRENT	**PROPOSED**
Corps	**Combat Support Hospital (200 beds)** **Mobile Army Surgical Hospital (60 beds)** **Evacuation Hospital (400 beds)**	**Combat Support Hospital (252 beds)** **Evacuation Hospital (252 beds)**
Echelons Above Corps	**Station Hospital (300 beds)** **Station Hospital (500 beds)** **Field Hospital (400 beds)** **General Hospital (1000 beds)**	**General Hospital (504 beds)**

Figure 3.

Maintenance (MEDSOM) to produce blood and oxygen on site. A second proposal is to have initial Class VIII requirements preconfigured into modules for the new organizations. Third, a base MEDSOM will support Corps and above units. The base MEDSOM will have an increased storage capability, a biomedical equipment maintenance section and intravenous/oxygen production capability.

Evacuation

Rapidly clearing the battlefield provides the soldier with confidence that care is quickly available if he becomes wounded, so MSPR proposals assume evacuation assets must be flexible, responsive, and be managed by an authority dedicated primarily to medical evacuation.

The new family of ambulances is probably sufficient for ground evacuation in the foreseeable future. However, a review of aeromedical requirements has identified a need for larger and faster aircraft. New designs for Army ground and air evacuation units as well as effective command and control for Corps and above units were recommended.

The Air Force is responsible for evacuation from the Corps rearward. The MSPR design calls for a flight duration of no more than six hours bed to bed intratheater.

At the strategic or intertheater level, the Air Force performs the evacuation function that links the theater to the final element in the continuum of care—the CONUS base. Under the new flow-through concept, it is quite likely that the Air Force will transport more seriously ill patients than under the current concept. In addition, medical evacuation is not the primary role for the strategic airlift fleet. Initial analysis indicates that alternative methods for strategic evacuation need to be evaluated. The Army and Air Force are studying the impact of the MSPR proposal upon equipment, supply and staffing requirements.

CONUS Base

CONUS is the final link in the continuum of medical care. CONUS hospitals provide the most definitive medical care within the health care system, and under the flow-through concept they will assume responsibility for most of the surgery now commonly done above Corps level.

The CONUS medical base has four primary wartime missions:

- Roundout deploying and deployed active component medical units with physicians, nurses, and other health care professionals on a unit level basis. To accomplish this, TOEs will be identified and reorganized from within existing TDA medical treatment facilities and scheduled for early deployment to the theater.
- Receive patients evacuated from the theater of operations. Under the flow-through concept, it is anticipated that patients evacuated to CONUS will be more seriously ill than under current doctrine. With a more seriously ill patient population anticipated, a more sophisticated Air Force treatment capability is required. Under the MSPR concept, the Army will place reserve component TOE hospitals at strategic sites to augment the Air Force capability. These reserve hospitals will be available for deployment if required. After treatment and stabilization, these patients will be transported by air, rail, or bus ambulance to a hospital facility within CONUS.
- Provide medical and dental support for mobilizing and deploying troops at the 54 CONUS mobilization installations, and to minimize the competition for fixed military beds. The MSPR recommends that Reserve Component TOE hospitals be used to augment medical care at these sites. These hospitals will also be available for deployment if required.
- Train medical soldiers in individual skills at the Academy of Health Sciences and selected other medical facilities and train all soldiers in the self-aid/buddy-aid tasks at the mobilization sites.

To improve medical readiness during peacetime and to increase the percentage of the active component medical force in the theater within the first 30 days, the MSPR proposed that the CONUS base should be "designed for war, modified for peace." The organization of TOEs within TDA facilities will give units the opportunity to train as a team during peacetime.

The second major portion of this proposal incorporates division level medical personnel into the peacetime health care system to improve their clinical skills and improve unit cohesion. Other squads within the division's medical assets will be used to staff hospital wards and the emergency room. This proposal will allow combat medical elements to work together as a team while they provide direct patient care.

Summary

The Medical System Program Review presented three major issues:

- The medical system is a continuum from the FLOT to the CONUS base.
- The system should be optimized to return to duty the maximum number of soldiers at the lowest treatment level.
- The go-to-war medical system should be the basis of our peacetime health care delivery system.

The proposed solutions to these major issues as outlined will improve medical readiness for war.

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Chemical Separations Using Chromatography

The following article was authored by Dr. Robert W. Shaw, chief of physical and analytical chemistry in the Chemical and Biological Sciences Division, Army Research Office, Research Triangle Park, NC. This is the first of a series of ARO technical notes which will appear in this magazine from time to time.

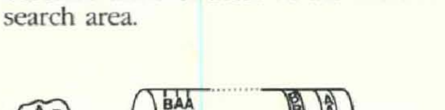
The Army faces some difficult problems in the chemical analysis of complicated samples. For example, on the battlefield we must determine whether chemical or biological agents are present, or during demilitarization of obsolete weapons we must determine whether an unwanted item has been completely destroyed. Also, around munitions plants we must sample the environment to determine whether leaks of hazardous materials have occurred. In each case, the sample taken for analysis will probably be composed of many different compounds and the analysis method will require detection of relatively small amounts of the target compounds. These factors present a heavy demand for any analytical technique, but there is a way to simplify the problem—first separate the sample into its various components and then analyze them one by one.

To illustrate the problem, consider what would happen if we tried to analyze the sample using infrared spectroscopy. Imagine, for instance, that you have an autopsy sample and you want to determine, for intelligence purposes, whether that person was exposed to a nerve agent. The infrared spectrum of an individual compound is complicated, but can be recognized and provides a clear identification of that individual compound. However, if many compounds are present, the measured spectrum consists of the overlap of all the individual spectra and detection of a trace component becomes difficult or impossible. Other analytical tools are subject to the same limitations.

The intent here is not to criticize infrared spectroscopy or any other chemical analysis method, but to indicate the need for the separation of complex samples. If a sample can be separated into its individual components, they can be analyzed and identified, one by one, using infrared spectroscopy or another technique. One separation technique is chromatography.

Chromatography is not new—it first appeared in a published work 80 years ago. Chromatographic methods are used extensively in basic research in chemistry and the life sciences and, on a large scale, in industrial process separations. There are, however, new variations and developments of the chromatographic process which increase the potential military applications of the process.

In using chromatography, a sample is dissolved in a carrier fluid, gas or liquid, which is then pumped across a surface. The surface contains an inert material which weakly adsorbs the sample components. Usually the carrier and sample are pumped through a tube and the adsorbing surface is on the inside tube wall. The different components adsorb and desorb at different rates and, as they pass across the surface, they separate. At the exit end of the tube the components emerge, one by one, for detection and analysis. If we put an infrared spectrometer or another detector at the tube exit, the spectra will be of individual compounds and identification can be straightforward. The diagram below shows the separation process. As mentioned earlier, there are many new developments of the chromatographic process. The remainder of this article will describe three of these in the basic research area.



Separation of a mixture of molecules of A and B into its components in a chromotographic column.

Supercritical Fluids

Trichothecenes are a group of biotoxins of complex molecular structure. They are the suspected toxic components of "yellow rain." We would like to separate them chromatographically and detect them individually using a mass spectrometer. The mass spectrometer works best with a gas phase sample, however, and the trichothecenes are not volatile—they won't dissolve into a gas under normal conditions. We can increase the dissolving power of the gas by increasing its density—by compressing it—but we want to avoid condensing the gas into a liquid. So we have a problem: a sample that will not dissolve into a normal gas, and a detector (the mass spectrometer) that works best with a gas. Supercritical fluids are a promising answer to this problem.

Gases have a characteristic critical temperature; above this temperature they are "supercritical" and they will not condense no matter how much they are compressed. One can heat the gas above its critical temperature (31 C for CO2, for example), and then compress it (say to 100 atmospheres) to increase its density and dissolving power.

Research workers at Battelle Northwest Laboratories have used supercritical CO2 to dissolve a sample of trichothecenes, passed the sample through a chromatographic column for separation, and detected the separated compounds using a mass spectrometer. Separations were fast—about one minute. This new method is much more powerful than the time and labor intensive chemical separations used previously.

Laser Fluorescence Detection

During an attack, nerve agents may be dispersed in a viscous liquid. This material and substances from other sources (e.g., diesel exhaust) will combine in the environment to form a complex sample for analysis. Liquid chromatography would be a powerful means for separation; but we need a sensitive detector to go at the end of the chromatographic column. The columns are very small in diameter (about 0.1mm), which means that the detector must have a very small effective volume—a severe design requirement. A recent proposal by research workers at Stanford University satisfies this requirement.

These workers focus a laser beam directly through the wall of the transparent chromatographic column onto the sample and its carrier as they pass through the column. The resulting fluorescence

(continued on Page 28.)

Army Level Program/Project Managers

(chartered under AR 70-17)

BMD
Ballistic Missile Defense

MG Eugene Fox

AOA
Airborne Optical Adjunct

COL Martin G. Olson

Shown are Army program/project managers chartered under AR 70-17, who are not assigned to the Army Materiel Command. A list of AMC PMs will be published in our September-October issue.

BMD RADAR

COL Gilbert J. Stieglitz

JTF
Joint Tactical Fusion

BG William E. Harmon

AWWMCCS
Army Worldwide Military Command & Control Information Systems (AWIS)

COL Benjamin R. Swedish

MEDICAL SYSTEMS
(Provisional)

COL Harry G. Dangerfield
Designee

APPLIED MEDICAL SYSTEMS
(Provisional)

COL Peter S. Loizeaux
Designee

BIOLOGICAL SYSTEMS
(Provisional)

COL David M. Robinson
Designee

PHARMACEUTICAL SYSTEMS
(Provisional)

LTC Gerald L. Wannarka
Designee

AMC Organizational Changes Announced

The Department of the Army has announced a number of organizational changes to improve the effectiveness of the U.S. Army Materiel Command's (AMC) research and development effort.

These actions, which are the result of a comprehensive assessment of AMC's laboratories, are designed specifically to improve the quality, productivity and effectiveness of the laboratory system and to improve support for the Army's readiness and force modernization program.

Implementation of the organizational changes, which will be accomplished simultaneously in two phases, began May 1, 1985 and will be completed on Oct. 1, 1985. The Army announcement stated that no organization relocations will result from these in-place changes and that all affected personnel will be offered a position of comparable responsibilities at the same grade level with assignments in place.

First Phase Actions

During the first phase of the restructuring effort, the following specific actions will occur:

- The U.S. Army Electronics R&D Command (ERADCOM) will be converted, in place, to form the nucleus of a new command—the U.S. Army Laboratory Command (LABCOM).
- Selected AMC functions and responsibilities will be consolidated with LABCOM.
- The following organizations will be transferred, in place, to LABCOM: Materials and Mechanics Research Center, Ballistic Research Laboratory, Human Engineering Laboratory, Harry Diamond Laboratories, Electronics Technology and Devices Laboratory, Atmospheric Sciences Laboratory, The Office of Missile Electronic Warfare (OMEW), and the Army Research Office.
- The following organizations will be transferred, in place, from ERADCOM to the U.S. Army Communications-Electronics Command, Fort Monmouth, NJ: Combat Surveillance and Target Acquisition Laboratory, Night Vision and Electro-Optics Laboratory, Electronic Warfare Laboratory (less OMEW), and the Signals Warfare Laboratory.

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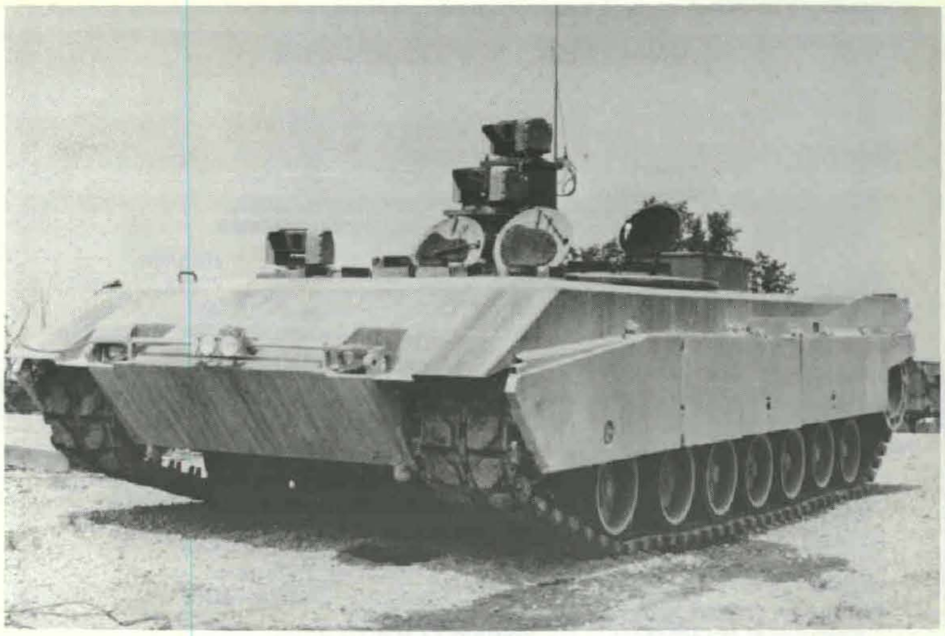
The Surrogate Research Vehicle



The SRV after successfully completing Phase I testing at Fort Knox, KY.

A versatile research vehicle developed by the U.S. Army Tank-Automotive Command (TACOM) is helping the user and R&D communities to evaluate proposed future combat vehicle concepts through actual operational field trials.

Known as the Surrogate Research Vehicle (SRV), it was designed and built two years ago by the Tank-Automotive Concepts Laboratory and Engineering Support Directorate of TACOM's R&D Center. Its purpose is to participate in mock battles to provide early evaluation and optimization of combat vehicle designs in a three-phase development and test program.

The overall objective of this research effort is to produce a series of system options upon which to base tank development decisions for production in the 1990s and beyond. The vehicle consists of an M1 tank whose hull has been modified to permit relocation of crew members. Also featured is a turret module with an externally mounted laser main gun simulator.

The Engineering Support Directorate's Design and Fabrication Divisions modified the hull, and the Pietzsch Co. of West Germany, a subcontractor to Litton Guidance and Control, built the original turret container and associated electronic hardware.

Unlike the standard M1 tank, which has a commander, gunner and loader in the turret and the driver in the hull, the original Surrogate Research Vehicle was designed to seat up to five crew members for Phase I testing. Besides the driver's station in the hull, there were duplicate commander's and gunner's stations in the hull and turret.

In Phase I, the five-crew-station arrangement allowed designers to find out which vehicle concept or crew configuration would be the most combat effective before building and testing expensive prototypes. For example, they could measure the effectiveness of crews ranging anywhere from two to five crew members, and operate the vehicle with up to three crew members in the hull and up to two in the turret. The vehicle can simulate automatic loading and thus needs no automatic loader.

For Phase II, currently under way, one of the turret stations has been removed to include advanced surveillance equipment.

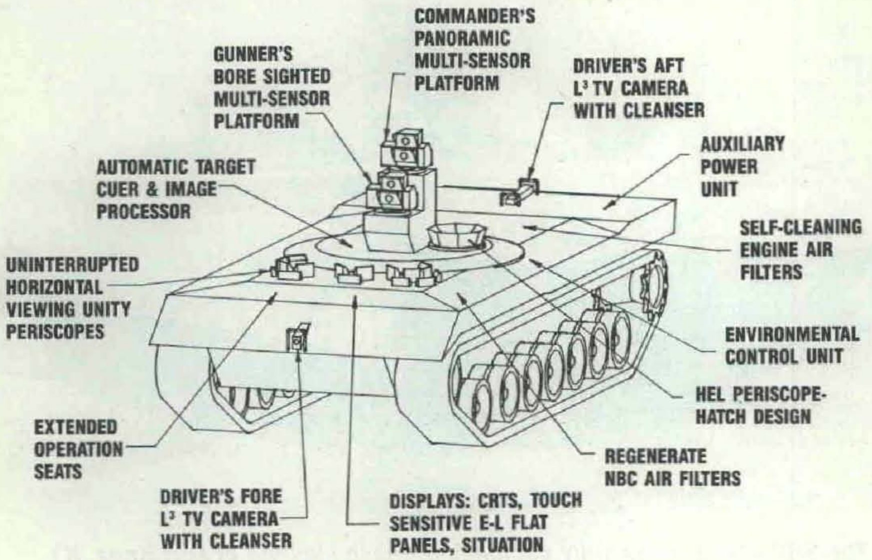
Also new in the vehicle is the way in which the crew sees the battlefield. In the M1, the commander obtains a direct view by either standing in the open hatch or by looking through a turret-mounted fire-control optical sight. The gunner also uses this sight, while the driver uses three simple periscopes. But in the vehicle, television monitors provide all crew members with an indirect battlefield view through a microprocessor-controlled surveillance system that employs externally-mounted electro-optical sights. These sights use cameras to convert optical images into television images.

The tank concept research program involves pitting the Surrogate Research Vehicle against "threat" vehicles in mock battles at Fort Knox, KY. Non-destructive, low-energy laser beams are used to simulate ammunition being fired. The program is a multiyear effort that addresses the issues of crew configuration, advanced surveillance, and command and control.

The first phase was completed in February 1984 and had two objectives. The first of these was to validate the design of a Tank Test Bed external gun concept now being developed jointly by the Concepts Laboratory and General Dynamics' Land Systems Division. The Tank Test Bed will consist of an M1 chassis, use automatic loading and advanced surveillance technology, and feature a 120mm externally-mounted main gun. Moreover, it will have a three-man crew, with all crew members stationed low in the front of the hull for better protection. When completed later this year, the test bed will demonstrate the potential of such a vehicle design as a future tank. The second objective of Phase I was to evaluate the operational feasibility of remote surveillance sighting concepts.

At issue throughout Phase I was whether or not the crew could adequately see the battlefield while buttoned up inside the hull. Engineers concluded that a three-man crew would be more combat effective from within the hull if a surveillance system could be developed that would provide a wider field of view than what was available in the Phase I system. However, they also concluded that such a surveillance scheme would improve closed-hatch vision regardless of the vehicle configuration.

SURROGATE RESEARCH VEHICLE DEMONSTRATES NEW TECHNOLOGIES



In Phase II, engineers are evaluating an advanced closed-hatch surveillance system which was installed at TACOM by R&D Center technicians. It was built for TACOM by the St. Louis-based Emerson Electric Co.'s Electronics and Space Division under terms of a seven-month hardware delivery contract awarded to the firm last August.

The new system provides a vastly improved surveillance capability. Unlike the Phase I system, which displays only black and white television images, the Emerson design incorporates two additional electro-optical sensors. One sensor can provide color images, while the other can detect invisible infrared ray emissions from nearby vehicles and other sources of heat, thereby making night vision possible. Moreover, all the Phase II sensors offer wider fields of view.

The commander and gunner can view the battlefield environment on two 9-inch television screens located at each crew station. Advanced image-processing techniques enable the commander to select any of several viewing options. For example, the system can produce a double-wide, near real-time display across both screens for an enhanced view. Or, for scrutiny of potential targets, it can present a real-time display on one screen and frozen images (still pictures) on the other screen. The system can also display one sensor image on one screen and another sensor image on the other screen concurrently. Additionally, it can have a narrow field of view on one screen and a wide field of view on the other to aid in locating targets. The crew can also see the surrounding battlefield through a unique periscope arrangement which provides an uninterrupted panoramic view.

The closed-hatch surveillance system also includes two 5-inch electroluminescent, touch-sensitive flat panel displays for each crew member. One of these provides a horizontal situation display with graphic symbology showing sight/weapon orientation and located targets in relation to the vehicle. The other panel has "user-friendly" menu selection for operating the surveillance system.

A major goal in the Phase II tests is to demonstrate for the first time the feasibility of image-based automatic target cuing in a ground combat vehicle. This will be done by programming the onboard computer with data representing characteristics of potential enemy targets. In operation, the computer will analyze and compare these data with the characteristics of potential targets detected in the real environment. Then, when a potential threat is detected, the surveillance system will alert the commander visually by displaying a rectangle around the target area appearing on the television monitors and produce an audible warning signal.

The initial demonstration will represent an infant stage of target cuing, where the cuing device will pick out only hot spots where potential targets may exist. But if all goes well in Phase II, TACOM engineers then plan in Phase III to pursue development of an advanced automatic cuing system. It would be designed to positively detect individual targets, classify them as being either trucks or tracked vehicles, and prioritize multiple targets. At issue is whether or not it is possible to successfully develop an adequate data base that would minimize false alarms and yet not miss any potential targets.

Although the Phase II tests are dealing mainly with vision and surveillance issues, the Surrogate Research Vehicle has also been outfitted with an advanced nuclear, biological and chemical protection system and other hardware for testing. The tests began earlier this summer at Fort Knox and will take about six months to complete.

The preceding article was authored by George Taylor III, a technical writer-editor for the Army Tank-Automotive Command, Warren, MI.

AMC Changes

(continued from Page 22.)

Second Phase Actions

The second phase will result in establishment of research, development and engineering centers at the Army Armament, Munitions, and Chemical Command, Army Aviation Systems Command, Army Missile Command, Army Tank-Automotive Command, and the Army Troop Support Command. This action will be strictly an internal realignment of functions, responsibilities and spaces.

From The Field. . .

NBS Fire Tests CERL's Foam Domes

The National Bureau of Standards has conducted full-scale fire tests on six polyurethane foam domes built by the U.S. Army Construction Engineering Research Laboratory (CERL). The foam domes are designed to provide temporary housing or storage during an Army or national mobilization.

The tests determined the behavior and performance of both uncoated and coated polyurethane foam domes in full-scale fires. Five of the 28-foot diameter domes had different commercially available fire-protective coatings applied to their interiors. The sixth dome was uncoated.

Researchers used ignition sources that simulated the typical initial size of a structural fire. The tests revealed that the coated structures met Department of Defense fire safety criteria and that protective coatings are necessary to prevent the rapid spread of fire.

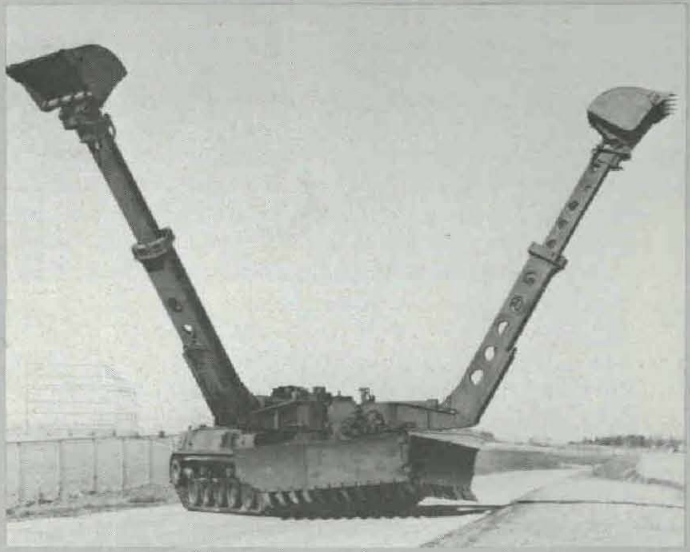
In addition, since the geometry of the protected domes had no effect on either ignitability or fire spread, CERL researchers have concluded that fire-resistant domes can be built for mobilization using a combination of polyurethane foam and thermal barrier coatings. CERL will publish a technical report describing its findings, *Full-scale Fire Tests of Polyurethane Foam Dome Structures*, in FY 85.

A 28-foot USA-CERL foam dome constructed during a mobilization exercise at Fort McPherson, GA, in 1982.

Work Continues on Counterobstacle Vehicle

Work is continuing on development of the counterobstacle vehicle (COV) at the Belvoir Research and Development Center as a potential replacement for the aging M728 combat engineer vehicle. The counterobstacle vehicle will provide combat engineers with a highly-mobile protected vehicle to conduct mobility, countermobility, and survivability tasks on the Air-Land battlefield.

The vehicle's functional subsystems include a combination mine plow/dozer blade and two telescopic arms with various attachments to allow rapid breaching of minefields, obstacle and rubble removal, obstacle construction, barrier emplacement, hardening of command and control elements and battle position preparation. Crew operations have been optimized in the COV's design which has resulted in a reduction in the number of crew members from four for the combat engineer vehicle to only three for the counterobstacle vehicle.



Counterobstacle vehicle experimental prototype with full-width mine plow/bulldozer and telescoping arms mounter with excavators.

The program's prime contractor, Bowen, McLaughlin, and York Co., has completed in-plant testing on the two experimental prototype COVs and is conducting functional tests at Fort Indiantown Gap, PA. The two COVs will be delivered to Fort Belvoir in September 1985 for engineering feasibility tests. Initial suitability testing during a concept evaluation program will then be completed at Fort Knox, KY. After an evaluation of all testing is completed, a milestone discussion is planned for late 1986.

Current COV fielding plans include 12 vehicles per combat battalion of the Heavy Division, Army Cavalry Regiment and separate brigades. Because of the current state of development and the urgency to field a counterobstacle vehicle as a replacement to the combat engineer vehicle, plans call for fielding of the COV in the early 1990s.

Competition Reduces Hellfire Costs

Introducing competition into the manufacture of Hellfire missiles has cut the cost of missiles and is expected to save millions of dollars over the next several years as the Army fields its new helicopter-borne, anti-tank weapon.

The Army Missile Command (MICOM) has bought Hellfire under a novel arrangement in which production will be divided between two competing contractors, Martin Marietta and Rockwell International, with the low bidder, Martin Marietta, receiving nearly three-fourths of the total award.

MICOM awarded the latest production contract earlier this year. Martin Marietta received $126,226,408. This sum included 4,104 missiles at $30,477 apiece and 100 training rounds at $11,488 each. The award to Rockwell amounted to $66,259,387, — 1,676 missiles at $38,760 each and 40 training rounds for $32,434 apiece.

Prices in the competitive buy were $15,386,360 or 7.5 percent below the Army's estimate of what the missiles would cost.

Seldom has the Army been able to compete a missile in early production as in this case because quantities may not be large enough to attract competitive bids and because a "sole-source" non-competitive arrangement may be necessary while a new missile's engineering specifications and production techniques are tested and proved over several years. But with

Hellfire, which had two prime development contractors and high-production potential, MICOM saw an opportunity to introduce competition early.

The command decided in 1982 that a way had to be found to bring down the cost of the missile when the price tag for the first production rounds seemed excessive. At that time, Martin Marietta supplied the missile's seeker under a sole-source contract and the rest of the round was being bought noncompetitively from Rockwell International. The cost of missiles being built this way was substantially more than Hellfire project studies showed it should be.

Realizing that each contractor alone possessed about 65 percent of the knowledge needed to build the complete missile, Bill Bailey, the Hellfire Project Office's financial officer, saw an opportunity to introduce limited competition into future purchases. Bailey proposed making the manufacturers share their knowledge with each other and then bid competitively to build the complete Hellfire missile round with the low bidder getting most of the annual order and the other a much smaller quantity.

Fred Segrest and Marie Lawrence of MICOM's Procurement and Production Directorate revised the techniques and executed the procurement strategy.

As a first step, MICOM set aside 50 percent of 1983 production for the individual contractors to build complete rounds in order to prove both were capable and qualified. Then in 1984, the contractors competed with the low bidder being awarded 57 percent of production and the other receiving 43 percent.

The competitive award for 1985 production, signed March 15, allots 71 percent of this year's Hellfire business to the low bidder. In succeeding years, the contractors will continue to compete on an annual basis, with the low bidder winning the larger portion and the other getting a much smaller share.

Another bright spot in the Hellfire dual-source acquisition strategy is the competitive breakout of shipping containers, dummy missiles and launchers. Breakout of these items from the main contract and competing them separately is achieving savings of nearly $85 million. The launcher, for example — which the Army had been buying non-competitively for $29,500 — now costs less than $10,000 as a result of being competitively purchased.

Introducing competition in the production of the missile also sets up two independent sources of Hellfire missiles that should be able to handle emergency surges better than a lone producer.

New Design May Reduce Bridge Weight

The Greeks have long been known for their ability to design beautiful, innovative structures like the Parthenon that were destined to last for thousands of years. That tradition continues today at the Troop Support Command's Belvoir R&D Center where Catherine Kominos, an engineer in the Engineer Support Laboratory, has developed a new design for bridge decks that could reduce the weight of the Army's future bridges by almost 20 percent.

Kominos, who works in the Concepts and Composites Branch of the lab's Bridge Division, began work on the design as an in-house laboratory independent research (ILIR) project when Branch Chief Richard W. Helmke suggested that she experiment with a membrane and shell structure as a design for a bridge deck. The branch's mission is to study the application of structural techniques to military bridging.

Catherine Kominos examines a completed model of her new bridge design. If tests are successful, this concept could reduce the weight of Army bridges by almost 20 percent.

Bridge mobility is directly related to the weight of the bridge components, and the heaviest part of the bridge is its deck. Traditionally, military bridges were designed as deck-floor beam systems which carried vehicle loads to truss girder support systems. Deck surfaces were flat and carried only local loads. Following World War II, engineers began to design deck surfaces which were part of the support structure, creating a composite deck structure.

"We knew that a membrane structure was the most efficient means of weight distribution, but there was no record of it being used in either civilian or military bridge structures," Kominos said. "We also needed some means of stiffening the membrane structure."

What she came up with was a concept that used a curved membrane stiffened by a series of opposing curved shells which formed the deck surface. This structure would reduce the weight of the bridge by eliminating the top cord of the bridge deck. When she went to test her design, though, she ran into a problem. "Our computers didn't have a finite element program with curved elements, so I went to George Washington University and verified my data on their computer. Their computer showed that a class 70 vehicle could theoretically be supported by my design."

After the initial workup, Kominos took her design to David N. Faunce of the Support and Facilities Directorate's R&D Model Fabrication Division to have a model made of her concept. "We used our new computerized milling machine to make the model," Faunce said. "The operator takes the engineer's design specifications and develops a program. This program is printed out on a strip of paper tape that is then fed into a milling machine. What we did in this case is feed in the coordinates for half of the structure and then tell the machine to repeat the pattern to produce the complete unit. It was a good experience for our operators, because, with our new equipment, they have to learn to be computer programmers as well as machinists. Once we finished preparing the program, it only took six hours to mill the finished design. It would have taken us 60 to 65 hours to do the same job by conventional methods. Not only that, if we need to make another model, we've got the program ready, all we have to do is set up the machine."

Now that the first samples of the new design have been produced, the concept will be tested. The center plans to let a contract for the extrusion of 10-foot sections for initial evaluation later this year.

Capsules. . .

DOD Announces Biennial Planning Cycle

Secretary of Defense Caspar W. Weinberger has announced the initiation of a biennial planning cycle for the Department of Defense (DOD) planning, programming and budgeting system (PPBS). The shift to a biennial planning cycle is expected to result in a more efficient and coherent process, saving unnecessarily frequent DOD-wide planning activities required for an annual cycle. This shift would also be supportive of a two-year Congressional defense budget cycle, a change currently being considered by some members of Congress.

Since its development and adoption by this administration in March of 1981, DOD's planning, programming and budgeting system has included the annual drafting of the Defense Guidance. The Defense Guidance, in turn, provides direction for preparation of the services' programs and budgets. After completing five such planning cycles, it became evident that the policy and strategy of this administration are firmly enough established that annual revisions are no longer necessary.

By reducing unneeded changes, the two-year cycle not only will improve coherence in the planning process, but will save time and manpower, thereby allowing for a more in-depth review during those years when the Defense Guidance is revised. The result will be greater stability and continuity in the programming phase of PPBS, through which policy and strategy are translated into fiscal programs.

By initiating a biennial planning cycle, the DOD has also added weight to its support of two-year Defense budget authorizations by Congress, a proposal which would save DOD and Congress a tremendous amount of time and resources. This proposal, and the more ambitious one of two-year appropriations, are now attracting significant Congressional support.

The first biennial publication of the Defense Guidance, covering the FY 1988-1992 planning period, is scheduled for January 1986. This new cycle does not foreclose interim changes that might be necessary due to new threats or other new factors that should lead modifications in the Defense Guidance. Such changes can be added by issuing appropriate memoranda.

Device Speeds Machined Parts Process

Manufacturing at Rock Island Arsenal is taking a giant step into the future. A numerically controlled machine tool has been fitted with a computerized sensing and control system that will improve the speed and accuracy of producing machined parts. The new method is called in-process controlled machining and the key component is an optical scanning device.

The new process is controlled by an auxiliary computer that relies on preprogrammed information and feedback provided by an optical scanner. The visual device is constantly checking the final cut being made and supplying information to the computer about the work it is performing.

"Twenty times each inch the optical scanner will report back to the machine's computer on the work it is doing," says arsenal mechanical engineer Ray Kirschbaum. "It is constantly checking itself and making decisions to nullify any deviation."

The prototype machine tool is being used to mill orifices on a bronze tube, which is a component on the M109 self-propelled howitzer's recoil system. This piece was selected because machining the close tolerances in the soft metal has been time consuming and difficult to control, says Kirschbaum.

Kirschbaum compares the bronze tube to working with a piece of "spaghetti." "It was difficult to achieve accurate duplicates with conventional numerical controlled machines because of the tools available and the soft metal," points out the engineer.

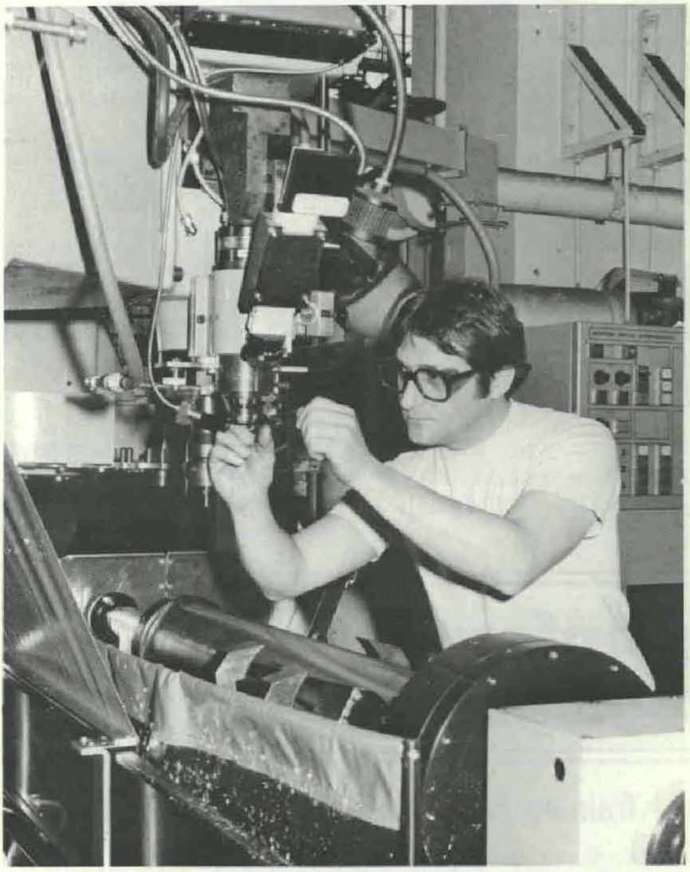
With in-process controls, the machine is capable of producing accurate duplicates and achieving tolerances that are much finer. Using a conventional numerical control machine tool, the allowable standard for the orifices was plus or minus .0003. But, with the in-process controls, machining standards have been reduced to plus or minus .0001.

The in-process controlled system was designed by Mechanical Technology, Inc. at their lab in Latham, NY. Based on Kirschbaum's instructions, the firm selected the visual components and incorporated them on the system.

"I told them we needed a system to cut with .0001 accuracy," recalls Kirschbaum, ". . .that would measure as it goes to guarantee the accuracy and could control the positioning of the tool as it cuts."

The system has proved its capability on a limited number of parts. Using conventional machining methods, the arsenal is able to complete only one of the finished bronze tubes per shift. With in-process controlled machining, anywhere from three to six times the work can be produced.

The new tool will also provide a complete quality inspection in eight minutes compared to approximately an hour that is



Machinist Wayne Richardson adjusts a light source on the Bostomatic milling machine equipped with a computerized sensing and control system.

required conventionally. "The machine will not produce bad parts. If something is wrong, such as dirt on the optical lens, the machine will shut off," notes the engineer.

Also contributing to the new machine's speed and accuracy is a high speed water cooled spindle that turns at 40,000 revolutions per minute, 10 times the speed of a conventional machine tool spindle. The new machine can also perform the work with just two cutting tools. Conventional machining requires six tools for the same job.

"The machine is about five years ahead of the current state-of-the-art," notes Kirschbaum. "At a recent Society of Manufacturing Engineers conference, leading engineers agreed that in-process controlled machining was about five years away."

AVSCOM Offers Spare Parts Shopping List

The Army Aviation Systems Command is now offering prospective suppliers an advance look at the type and the quantity of spare parts it anticipates buying. The AVSCOM Competition Advocate's Shopping List, which is updated quarterly, contains a microfiche listing of these items as well as the major end item they are used on.

"This is the first attempt by AVSCOM to produce an advanced procurement planning document for contractor's use," said BG Michael J. Pepe, AVSCOM deputy commanding general for procurement and readiness. "Contractors are cautioned that while this is the forecast at this point in our planning, the next 12 months' actual procurement of parts and the quantities may vary from the listing due to changes in the Army's requirements."

The Army hopes to use the lists to increase the opportunity for competition in the production of spare parts. Increasing competition will provide more and better sources of supply for Army aviation spare parts, while insuring that the Army pays the best possible price for them. It also gives more businesses the chance to land Army spare parts contracts.

The list is prepared in end article application sequence. That is, parts are listed under the major item of equipment, such as an engine or an aircraft, that they are used on.

Within each division, items are listed in part number order, using the part number of the original manufacturer. Other information on the lists includes the item's national stock numbers, the federal supply code for manufacturer's for the last source of supply, and the quantity that AVSCOM anticipates buying in the coming year.

To obtain a copy of the shopping list, along with instructions for its use, write to U.S. Army Aviation Systems Command, ATTN: Competition Advocacy and Spares Management Office (AMSAV-3), 4300 Goodfellow Boulevard, St. Louis, MO 63120-1798.

Conferences and Symposia. . .

Training Equipment Conference Planned

"Excellence through Simulation and Training Technology" will be the theme of the 7th Interservice/Industry Equipment Conference, Nov. 19-21, 1985, in Orlando, FL. Vice Admiral James B. Busey, commander, Naval Naval Air Systems Command, will deliver the keynote address.

Sponsored by the American Defense Preparedness Association, the conference is the premier event for the simulation and training communities of government and industry. The sponsor works with an interservice team in arranging the conference. The rotating chairmanship of the interservice team will be held this year by the Navy, represented by the Naval Training Equipment Center in Orlando. Approximately 1,500 persons are expected to attend the meeting.

Like previous conferences, the 1985 conference will provide the opportunity for an exchange of information and discussion of mutual problems. This is done primarily through the presentation of papers, panel discussions and guest speakers.

An exhibits area, featuring the latest state-of-the-art training systems and other items of interest, will be an adjunct of the conference. John Hammond, of AAI Corp., Baltimore, MD, is conference chairman.

The theme of this year's conference takes on added significance since it will be held in Orlando which has become a national center of excellence for simulation and training technology. In late April, the site of a new building, which will ultimately house the Naval Training Equipment Center and the Office of the Army Project Manager for Training Devices was dedicated. A tour of this site is planned in conjunction with this year's conference.

Registration information on the Training Equipment Conference may be obtained by calling (703) 522-1820.

Chromatography

(continued from Page 21.)

from the separated components passes back through the walls of the column and is focused into a detector. The good optical properties of the laser beam permit this direct means of creating a very small volume detector of very high sensitivity. The method has already shown unprecedented sensitivity for separation and detection of samples of chemical-agent type compounds.

Liquid Chromatographic Reactor

We may think of a typical reactor (the stirred tank reactor) as a pot into which we pour reactants. As the reaction proceeds, reactants disappear and products appear and everything remains mixed together in the pot. We may, however, use a chromatographic column as a reactor by injecting the reactants in one end and pumping them through. This reactor behaves very differently from the stirred tank: as the products appear, they separate from the reactants on the column.

Research workers at the University of Wisconsin are now developing the theory of the liquid chromatographic reactor. We believe that it will provide a means of studying the reactions of very hazardous substances in a high controlled manner and, eventually, of carrying out degradation reactions of those substances on a large scale. This technique, if successful, will offer a relatively safe and effective method for demilitarizing munitions.

These three areas of basic research in chromatography—supercritical fluids, laser fluorescence detection, and the liquid chromatographic reactor—continue the development and extension of a powerful, widely used separation method. Although the value of basic research is not often questioned, the links between that research and eventual practical application are sometimes not clear. In fact, we do not expect to be able to identify applications for basic research in all cases. In the three cases presented here, however, high quality basic research has provided direct solutions for important, practical problems. And, in these three cases, Army support has provided the initial push.

Executive's Corner...

AMC CG GEN Richard H. Thompson Discusses. . .

Pitfalls & Payoffs of Component Breakout

Introduction

Among the Army Materiel Command's key initiatives to improve the materiel acquisition process is greater use of component breakout. There are, to be sure, both positive and negative aspects involved in the breakout of system components and spare parts. I would like to use the Executive's Corner to discuss a few of them.

Government dependence on sole source prime contractors for major weapons can be significantly lessened through an effective component breakout program. Competing broken-out components can give rise to appreciable cost savings and also provide the government with additional leverage in dealing with a prime contractor.

Recent attention has focused on breakout and competition of spares requirements, which has been embodied in the Army's program for improving spare parts acquisition (the Spare Parts Review Initiatives). Breakout of spares requirements has also been recommended by the Grace Commission and endorsed by the General Accounting Office. With all the current interest in breakout, we might gain the impression that new ground is being broken. However, the fact is that we are only being asked to more effectively pursue the same fundamental policy of obtaining cost-effective procurements.

Is it more cost effective to break out a component for direct procurement by the government from the original manufacturer or do we derive greater technical and cost benefits through retention of procurement responsibility with the prime contractor? The answer can't be presupposed—it is entirely dependent on the particulars of a given program or item.

Ground Work and Accountability

A related question is whether the component can be competed, and if so, whether it makes sense for the government to conduct the competition in lieu of the prime contractor. A decision to break out and compete may have been effectively precluded if proper ground work has not been laid to ensure that the government has full data rights and a drawing package that is stable and at a level suitable for competitive reprocurement. Given the expense of a reprocurement package, the projected size of the program may not make purchasing it worthwhile. In addition, if the item involves state-of-the-art technology and/or the possibility of frequent engineering changes, a premature breakout may result in frequent design and quality disputes between the prime and the subsystem contractors. This, in turn, may jeopardize both system performance and the ability to meet delivery requirements.

When major components have been provided by the government (Government-Furnished Equipment), the government will be inevitably involved in these design and performance disputes. The task of determining responsibility for failures and enforcing warranties will be far more complicated.

If the government pays a prime contractor to accept overall accountability for the performance of a system, that accountability can be diluted significantly through breakout. Moreover, if accountability is transferred to the government we must be in a position to accept it. This is reflected in the cost of additional program, technical, logistics and procurement personnel needed to negotiate and manage contracts for breakout components as well as coordinating the interface between the prime and component contractors. The overall mission suffers while arguments are being settled over responsibility for integration problems, increased failure rates, and delayed deliveries.

Risks

Notwithstanding the drawbacks, a close comparison of the technical and cost risks must be made with the potential payoff of a successful breakout. From the viewpoint of a potential vendor, we must ask whether the size of a projected requirement is great enough to justify the capital outlays needed to develop and maintain the required technical and industrial capability. Included in this assessment is whether there are potential commercial applications for the item.

Assuming the component will be attractive to more than one offeror, the government can realize considerable savings by initiating competition. Care must be taken to ensure that the government does not split a total requirement through breakout and thereby lose a quantity discount. It makes no sense, for example, to break out and compete a spares requirement if the prime contractor is continuing to buy the same item separately to satisfy the production requirement. Assuming this will not happen, and that there is a mature design requiring only routine interface, the government's risk in breakout is probably acceptable. Conversely, if the component requires extensive design and integration interface between prime and component contractors, there is reduced justification for the government to interject itself beyond requiring the prime to establish an effective procurement system. Remember that an item need not be broken out to be competed, nor does breakout always entail competition.

Finally, not to be overlooked is the effect on the prime contractor of the very possibility of an extensive breakout. The prime may attempt to head off any long-term potential that a subsystem contractor may one day compete for the prime contract. The prime may conclude that the pressure to lower overall system cost through component breakout can be alleviated if he reduces his system price now. We must also be aware that a prime may be eager to shift the responsibility of managing a troublesome subcontract back to the government as primes are not otherwise likely to facilitate any breakout program that threatens their long term sole source position.

In summary, the cost reduction benefits of breakout and competition may be offset by the cost of obtaining a drawing package, the greater potential for quality and system integration problems, and the task of managing contracts, resolving disputes and assigning overall system responsibility. The benefits may outweigh the cost of breakout depending upon the complexity of the system, the size of the requirements, and perhaps most importantly the ability of the government to ensure that the quality and delivery requirements of the total weapon system will not be unduly threatened by breakout. Each system must be periodically examined for breakout potential and the costs and benefits weighed. Breakout and competition should not be pursued for their own sake but rather as means to an end.

I firmly believe that a well designed breakout program, with the proper incentives for the contractor and the proper safeguards for the government, will result in a more effective and technically superior product for the Army.

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SECTION H. SPECIAL CONTRACT REQUIREMENTS (Cont'd)

H.9 CONFIGURATION CHANGES (Cont'd)

(i) System Safety. The Contractor shall evaluate any proposed configuration change(s) for safety implications utilizing MIL-STD-882A, 28 Jun 77, titled "System Safety Program for Systems and Associated Subsystems and Equipments: Requirements for" as a guide and correct identified safety deficiencies of the proposed change(s) prior to submission of an ECP. Special emphasis shall be placed on nonapparent ultimate effects of such configuration changes. The impact on safety shall be addressed and the supporting rationale submitted with the ECP. If the proposed configuration change is found to have no impact on safety, the reason for that conclusion shall be submitted with the ECP.

(j) ECP Accomplishment/Incorporation. Accomplishment and/or incorporation by the Contractor of any Class I or Class II ECP into the hardware and/or software procured under this contract or by separate contract prior to Government approval of the Class I or Class II ECP, including Government approval of any and all released documentation and/or changes thereto, shall be at the Contractor's sole risk and shall, among other things, cause the items to be rejected. Any items rejected because of the accomplishment and/or incorporation thereof of a Government disapproved change or because of a change which the Government has NOT approved, shall NOT be an excusable cause of delay as that term is defined in the "Default (Fixed-Priced Supply and Service)" clause of this contract. This paragraph does not limit the Contractor's rights and remedies under the Contract Clauses of this contract entitled "Notification of Changes" and "Disputes-Alternate 1."

(k) **NO PERSONS, INCLUDING THE PCO AND ACO, ARE AUTHORIZED TO ORALLY REQUEST A CLASS I OR CLASS II ECP UNDER THIS CONTRACT.**

(l) **NO PERSON, OTHER THAN THE PCO, IS AUTHORIZED TO REQUEST ECPs UNDER THIS CONTRACT AND ALL PCO REQUESTS FOR ECPs SHALL BE IN WRITING.**

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H.10 CRITICAL PARTS PROGRAM

The Contractor shall continue its existing critical parts program as set forth in Document Number D210-11000-1, entitled "Requirements for Tests and Records of Process Sensitive Parts," 24 August 1979 (which document is incorporated herein by reference and made a part hereof) and shall apply that program to the applicable tasks under this contract.

H.11 DATA

(a) Predetermination of Rights in Technical Data. The Government acknowledges that an agreement exists between the Company and the Government as to rights in certain specified data. This agreement and the specified data are reflected in Document D8-0145, 4 March 1965, as amended by Revision (Rev) A, 27 May 1965, Rev B, 14 July 1965, and Rev C, dated 17 December 1965, which document and revisions were incorporated by Supplemental Agreement (S/A) No. 22 et al, effective 26 January 1966, into Contracts AF 33(657)-7004 (S/A No. 22 et al), AF 33(657)-9486 (S/A No. 40), AF 33(657-12258) (S/A No. 60),and AF 33-657-13529 (S/A No. 7).