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FEATURES

DEPARTMENTS

ABOUT THE COVER

The front cover relates to a feature article on recent legislation mandating live fire testing of weapon systems. The back cover is associated with a new management tool to assist PMs in their decision-making process. Cover designed by Joseph R. Day, AMC Graphics Section.

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Live Fire Testing: The Legislation and Its Impact

By James F. O'Bryon

Introduction

It's been more than a decade since U.S. forces withdrew from Vietnam. Since then, American forces have been called upon to serve in limited conflict situations (i.e. Grenada, Libyan retaliatory strikes). During this same period, U.S. military forces have fielded a host of new major weapons systems. However, few of these have seen actual combat in the real world of enemy threats.

Background

Legislation mandating live fire testing (LFT) is contained in the Military Authorization Bill of FY87. It was authored because of the conviction that our weapon systems need to be proven against real threats even when the United States is not involved in active combat. It was also recognized that the long lead times required for the development of our systems will not permit major design changes near or at the end of their design cycle without serious impact on fielding, schedule and budget. Additionally, the next major conflict may not permit sufficient time to gather the necessary vulnerability/lethality insights, and then allow design fixes to be retrofit as we have during past conflicts. It may be a short duration, high intensity "come-as-you are" war.

The live fire testing program had its genesis as a joint service program under the sponsorship of the Office of the Director, Defense Test and Evaluation, OSD, and was chartered in March 1984 under the title "Joint Live Fire (JLF)." This multi-service, multi-year effort was, and is, funded by DOD and has the following four objectives:

- assess the vulnerability of U.S.
- assess the lethality of U.S. conventional combat systems against foreign threats,
- gain insights into methods of re-
- provide a data base to improve the computer modeling of weapons system lethality and vulnerability.

ons platforms, and,

- provide a data base to improve the computer modeling of weapons system lethality and vulnerability.

Although the original inent was to have three thrusts—ground systems, air systems and sea systems, only two JLF plans were submitted: one for ground targets and the other for air targets.

To achieve a multi-service perspective, joint technical coordinating groups were called upon to assist in preparing the JLF test plans, and in carrying them out under DOD review and approval. The Joint Technical Coordinating Group for Munitions Effectiveness was charged with managing the ground targets phase and the Joint Technical Coordinating Group for Aircraft Survivability was charged with the management of the air targets phase.

Over the past three years, these JLF efforts have yielded numerous insights into the way our combat systems would actually respond in combat situations. Testing continues under this program at Wright Patterson AFB, Naval Weapons Center (China Lake), Edwards AFB, Aberdeen Proving Ground, Soccorro, NM, and at other test facilities.

U.S. and foreign munitions and weapons platforms (tanks, armored personnel carriers, fixed and rotary wing aircraft, antitank guided munitions, shoulder launched shaped charge munitions, mines, kinetic energy penetrators as well as a host of other systems) have been, and continue to be, tested within the JLF under DOD sponsorship, examining systems that have already arrived on the battlefield in significant numbers.

Live Fire Testing

In contrast to the joint live fire program which was designed to examine systems that have already been fielded, the live fire program is structured to examine the performance of systems prior to entering full-scale production. It was recognized that the types of benefits accrued from testing under the JLF should also be applied to developing systems providing early insights into the expected vulnerability and lethality of these systems before they are fielded. The FY87 Military Authorization Act calls for:

- Survivability, vulnerability, and lethality tests to be carried out sufficiently early in the development phase of the system or program to allow any design deficiency demonstrated by the testing to be corrected in the design of the system, munition, or missile before proceeding beyond low-rate initial production.
- A covered system or munition may not proceed beyond low-rate initial production until realistic survivability testing of the system is completed.

AV-8 Flight Controls test set-up at Naval Weapons Center, China Lake, CA. Target aircraft is shown on the right. Aircraft on the left provides bleed air to target aircraft pneumatic controls.

A complete copy of the live fire legislative language will be provided upon request to the Live Fire Test Office at the Pentagon. Call 202-697-5732 (Autovon 227-5732)

The Legislation

The law applies to major conventional weapons acquisition programs (those which exceed $1 billion in procurement costs or $200 million in RDT&E costs). It also applies to all conventional munitions programs which will exceed procurement of 1,000,000 rounds without regard to dollar costs, recognizing that many less costly, but widely proliferated, munitions programs must also be evaluated. The legislation permits the secretary of defense to request a waiver for major systems which would be prohibitively expensive or impractical. This waiver, however, must be requested during full-scale engineering development. The only other waiver would be during time of war.

Although most of the attention to date on live fire testing has been on U.S. vulnerability testing, the legislation requires both vulnerability testing (ascertaining the ability of our systems to withstand threats) and lethality testing (assessing the ability of our systems to defeat foreign targets). Hence, the LFT program embraces the testing of Army, Navy, Air Force and Marine weapons systems platforms and including land vehicles, aircraft, ships, artillery, guns, missiles, subsurface systems, small arms and others.

The LFT legislation requires that no defense program which qualifies under the above conditions may proceed beyond low-rate initial production until live fire testing is conducted. The services cannot afford to wait until they produce their entire buy of munitions or go to combat before they discover their lethality and vulnerability shortcomings. Rigorous tests without prejudice to assess the actual performance of these systems must be made during the development process.

Computer Models?

Some have asked why computer models can't be used in lieu of live fire testing to estimate target vulnerability and weapon lethality. Computer models are only as good as the physics built into them, no better, no worse. Today's weapon systems are very complex, and so are the defeat mechanisms which go after them. Computer simulations which are able to reliably predict target response to munitions including penetration, spall effects, ricochet within the vehicle, fire initiation, sustainment and extinguishment, shock response, damage to platform subsystems, crew casualties and the synergisms between them don't exist.

Admittedly, much work has gone into these models to date and they are very useful in providing insights into relative tradeoffs during the design process. Some of these models have represented some aspects of the target interaction process reasonably well while other important aspects have been handled very crudely if at all. Vulnerability models tend to treat some damage mechanisms with a micrometer and then cut other mechanisms with a chain saw.

The data from the live first tests are not intended primarily as a means of improving the computer modeling capability of the design community although that certainly is a spinoff. Rather, the primary purpose of these tests is to gather first-order insights into the total ability of a given system to withstand and/or inflict combat damage, including all of the synergisms. Live fire tests are necessary, and so are computer models. One cannot substitute for the other.

Crew Casualties

The LFT legislation stresses the importance of assessing crew casualties. If one looks at current computer models, the vast majority of the attention is devoted to non-crew types of defeat mechanisms. Crews are susceptible to a host of potential killing and/or mission-degrading mechanisms. These include injury from primary penetrators, spall wounds created by impacting munitions, blast overpressure, toxic fumes, acoustic damage, shock from impacting or proximity bursting munitions, flash blinding, burns from ignited fuel, hydraulic fluids, munitions, clothing soaked with combustible liquids and a number of other sources.

Clearly, estimating crew casualties is not a simple matter. However, it is essential that it be done now, and as well as possible. Combat data collected over the years provides one valuable source of data. Another excellent source of casualty data which also must be drawn upon is the shock trauma data base which grows daily across the nation. Injury and death resulting from traffic accidents and other classes of trauma are well documented and must be used to translate data being gathered during live fire testing into casualty estimates. It also should yield insights into which instrumentation should be used to gather the vital signs which are, in turn, the indicators of injury and recovery. Better that we use the data base that we have now than to wait for combat casualties to filter in from the next conflict and wish we'd done better earlier.

The Threat

One key to conducting a successful live fire testing program is the proper definition of the threat against which the system in question is to be pitted. Much of the controversy surrounding the Bradley Fighting Vehicle LFT, for example, relates to which threats it is actually expected to engage. Will it be exposed to threats which significantly exceed its protection level? Will it be able to engage threat targets successfully with its own weapons suite?

The LFT has subjected the Bradley to a spectrum of threats from small arms fire all the way up through major tank-fired munitions. The test data have yielded valuable information and many improvements have been proposed as a result. However, live fire testing is only one part of the picture.

Live fire testing only provides information on the lethality and vulnerability of weapons systems. Survivability is a larger issue. One must look at the probability of survivability (Ps) as a series of conditional probabilities as shown below.

$$PS = 1 - PD \times PA/D \times PH/A \times PK/H$$

where PD = probability of detection

PA/D = probability of being acquisted given a detection

PH/A = probability of being hit given an acquisition

PK/H = probability of being killed given a hit

Simply stated, survivability is a function of battlefield detectability, hitability, a weapon system's killability (vulnerability) and repairability. One must also mix into the above equation the weapon's ability to deliver effective firepower if it is to contribute to the battle. (Otherwise, the clear solution for maximizing platform survivability is to stay home.)

Detectability and hitability issues are addressed in operational tests. These are also critical to the solution of the survivability equation. Without these data, no complete assessment of a weapons system can be made. Both types of tests need to be iterative processes throughout the development process with the final iteration being full up combat-configured systems completely loaded with ammunition, fuel and all other combustibles.

Data Users

The data gathered from the tests are vital to a number of consumers. First, the test results provide insights to the system designer to enable early fixes to be made to specific vulnerability and lethality shortcomings. They are also useful to those users conducting subsequent operational tests to enable them to maximize their effectiveness though firsthand knowledge of their weapons' strengths and weaknesses.

Thirdly, the data are a necessary input to merge with the results of the operational tests to enable a complete survivability assessment to be made (since typically operational tests are non-destructive in nature). The data also provide, in the final analysis, a "report card" to Congress on the expected ability of the system to actually perform its designed mission. The live first tests are a Milestone Decision data point.

Funding

The Congressional language states that "the costs of all tests required shall be paid from funds available for the system being tested."

Implementing the early stages of the LFT program will be disruptive financially since the services submitted their budgets into the Program Objective Memorandum process prior to the current legislation. Live fire tests to date have been costly. This is to be expected. When one is required to test for combat effectiveness and damage, one must be prepared for combat-type costs and losses of materiel. It is incumbent upon the services to allocate resources (test items, funds and test facilities) to enable these tests to be conducted without undue delay.

Procuring threat munitions and platforms is and will continue to be a major need of the LFT program. Tests must be conducted with threat munitions and targets (or approved surrogates) which are representative of the spectrum of systems expected from the time of Initial Operational Capability through the reasonable lifespan of the system. Preliminary efforts are underway by the LFT Office to acquire these necessary assets.

The Live Fire Test Office has as its prime function the implementation of the live fire legislation. It will issue guidelines for test plan preparation, review and approve service-prepared test plans, perform independent assessments of the test results, provide liaison with Congress on the test results, and work with the services and DOD in improving live fire test methodology, instrumentation and, in general, assure that conduct of live fire testing is within the spirit of the Congressional intent.

Conclusion

Live fire testing is here. It's necessary. It's also costly and has gained much national attention. When one looks at the alternatives, it makes good sense to gather these data through a well planned and executed test program rather than to wait until hostilities force us to discover things too late. Live fire testing is the price of peace.

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Understanding the Proposal Process

By CPT R. Mark Brown

Introduction

Since the federal government is spending billions of dollars annually on the defense budget, it is not surprising that these expenditures have come under increasing scrutiny.

Media horror stories of $100 claw hammers, of defense systems that don't do the job or don't do it as well as expected, and of too many, too few, or the wrong types of spare parts, are rampant. Increased legislation, increased regulation from our acquisition leadership, and studies such as the Packard Commission report have failed to stop these stories.

What can be done to change this hostile environment? There are no easy answers. However, one step towards improvement would be to understand the proposal process that large defense contractors go through. By doing so, the government can save time, money, and aggravation by asking the correct questions in the correct form. Also, by understanding this process we can receive better proposals and hopefully avert wasted effort and expense by both the contractor and the government.

Understanding the Proposal

First, it is important to understand that proposal efforts by large defense contractors are large, complex, and expensive. Groups of talented people are assigned to these efforts for long periods of time and at great cost to the companies. The reason for this is clear. There are two key areas to any business; manufacturing and sales. You must have a product and you must sell it. In the defense contractor community, proposals are analogous to sales.

Secondly, the government is in the driver's seat. The solicitations state the desires, constraints, and expectations of those who want the product and the defense contractor must respond to those requirements or fail to obtain the contract. Therefore, it is crucial that the agency issuing the solicitation communicates clearly, directly, and precisely what is needed. In the long run, doing so reduces cost and increases efficiency for both government and contractor.

Communicating with those who are going to respond to solicitations involves many types of government procurements. These are summarized in Figure 1. It is important to communicate requirements clearly on all solicitations but particularly on the larger, more complex systems acquisitions.

So what is a proposal trying to do? Sell obviously; but more than that. The contractors are trying to communicate five things to you. Essentially, they are telling you what they are offering, how they are going to do it, why their way is better than the competition's, how much it will cost, and why their price is more realistic. In short, contractors are attempting to earn an invitation to negotiate and to establish a strong negotiating position.

In trying to do this, contractors have identified seven keys for success. Much like the principles of war for military commanders, these keys for success don't guarantee that a contractor will win every bid. But also like the principles of war, these keys establish a process that, if applied thoughtfully, will enhance the chances of success. Furthermore, they will ensure that the likelihood of wasting time, money, and effort by moving in the wrong direction is less likely to happen. The keys for proposal success are:

- start early
- address the real problem
- work the decision makers
- know the competition
- know your own strengths and weaknesses
- develop a WIN strategy
- implement it with proper tactics

It is important to note that the first two relate directly to those who issue solicitations. This is particularly true of addressing the real problem. This principle highlights the need for the government to communicate in simple, clear terms of what is desired in a solicitation in a timely fashion.

A proposal effort is divided into the pre-request for proposal (RFP) phase which includes all that goes on before the RFP is actually published in the *Commerce Business Daily*; the RFP phase which includes all actions between release of the RFP and proposal submittal; and the post-RFP phase which includes the actions that occur after the proposal is submitted.

Pre-RFP Phase

During this phase, the contractor attempts to gain as much information (intelligence) as possible about the impending solicitation. Information comes from a variety of sources, including rumor, contacts inside and outside the government, and publications. This is the time when contractor management starts to decide whether to commit assets to pursue this contract. Information gathering is an ongoing process.

Sometime before solicitation release, the contractor conducts an opportunity analysis. At this time, the contractor decides what is in this for me? Do we want to bid this? Usually a preliminary bid/no-bid decision is made and the contractor considers the following questions: Can we make this? Can we do it profitably? Can we beat the competition? Do we want to try? What will be required to do all of this? If the decision is to bid, the contractor then moves to formulate the WIN strategy.

In preparing this WIN strategy, the contractor concentrates on the theme or message it will send back to the government. These points are considered:

- Why select X corporation?
- What are the preferences of the evaluation/decision makers?
- What is the competition going to say?
- What is our past performance?
- What are our resources?
- What is our technical approach?
- Why we are better?

They address these questions reflecting the evaluation criteria outlined in Section M of the RFP. In a nutshell, the contractor considers its strengths and weaknesses and how to capitalize or downplay them.

Next, the contractor moves into the proposal planning stage. At this time the contractor: selects a proposal manager and proposal team; organizes the team; and maps the team's direction. This is usually in the form of a proposal directive. Ideally, the proposal manager and team are the project manager and team if the contractor wins the award. This is not always the case. In fact, the contractor may never intend that to be so. However, that is the preferred approach. Therefore, caution should be exercised if part of the bid evaluation is based on who (particular individuals) will perform the contract.

Additionally, many solicitations imply that the contractor should be staffed prior to contract award to gain a maximum evaluation for his bid. This causes unnecessary overhead costs for the contractor, and should be avoided. If the contractor is awarded the contract, performance is his problem. How he staffs should be his business.

TYPE	USED TO BUY	METHODOLOGY
GSA CATALOG	STANDARD COMMERCIAL ITEMS	ANNUAL PRICE COMPETITION
IFB	STD. GOV'T-DESIGNED ITEMS	AUTOMATIC AWARD TO LOW BIDDER
TWO-STEP (IFB)	STD. CONTRACTOR-DESIGNED ITEMS	AWARD TO LOWEST BIDDER QUALIFIED BY PH-I EVALUATION
NEGOTIATED BIDS	HIGH TECH GOODS & SERVICES	SOURCE SELECTION BOARD SCORES TECHNICAL, MGT, $ PROPOSALS
· CONVENTIONAL	SMALL & NON-CRITICAL ITEMS	NEGOTIATIONS WITH ALL IN COMPETITIVE RANGE
· FOUR-STEP	R&D (ABOVE $2M)	NEGOTIATIONS WITH WINNER
· A-109	MAJOR SYSTEMS OVER $ THRESHOLD	MULTI-PHASE COMPETITION WITH PARALLEL CONTRACTS & SUCCESSIVE ELIMINATIONS
UNSOLICITED & SOLE SOURCE	CONTRACTOR UNIQUE ITEMS & TIME CRITICAL UNIQUE ITEMS	AWARD AFTER REVIEW, JUSTIFICATION, & PRICE NEGOTIATION
SPECIAL DoE	NEW PROCESS DEVELOPMENT	COST-SHARING, LOAN GUARANTEES, COOPERATIVE AGREEMENTS, ETC.

Figure 1. Common Types of Government Procurement.

RFP Phase

When the RFP (or other solicitation) is released in the *Commerce Business Daily* it is picked up and the first intense period is spent analyzing exactly what is required by Sections C, L, and M of the RFP. All questions from the preliminary bid/no-bid decision are reviewed and a final bid/no-bid decision made. If the decision is made to bid, then a responsiveness matrix is made and an authorship matrix mirroring that is prepared. The responsiveness matrix assures all requirements of the solicitation are addressed and the authorship matrix assigns a responsibility for each requirement. In this effort, each RFP requirement is broken down and assigned to a responsible author to answer it. This ensures bid responsiveness and directs employee efforts.

Next, a kickoff meeting is held and each team member is briefed on his/her responsibilities and timetables. At this time, pen has yet to touch paper. Still, incredible amounts of time, money, and effort have already been spent.

After the kickoff meeting, the volume managers (technical, management, and cost) assemble their teams and outline and storyboard their responses. Then they begin to write, prepare artwork, assemble and edit before sending the proposal to internal review teams. Every proposal team member spends major resources in terms of time and effort during this phase. Fifteen, 16, and sometimes more than 20-hour workdays are not uncommon during this time. It is

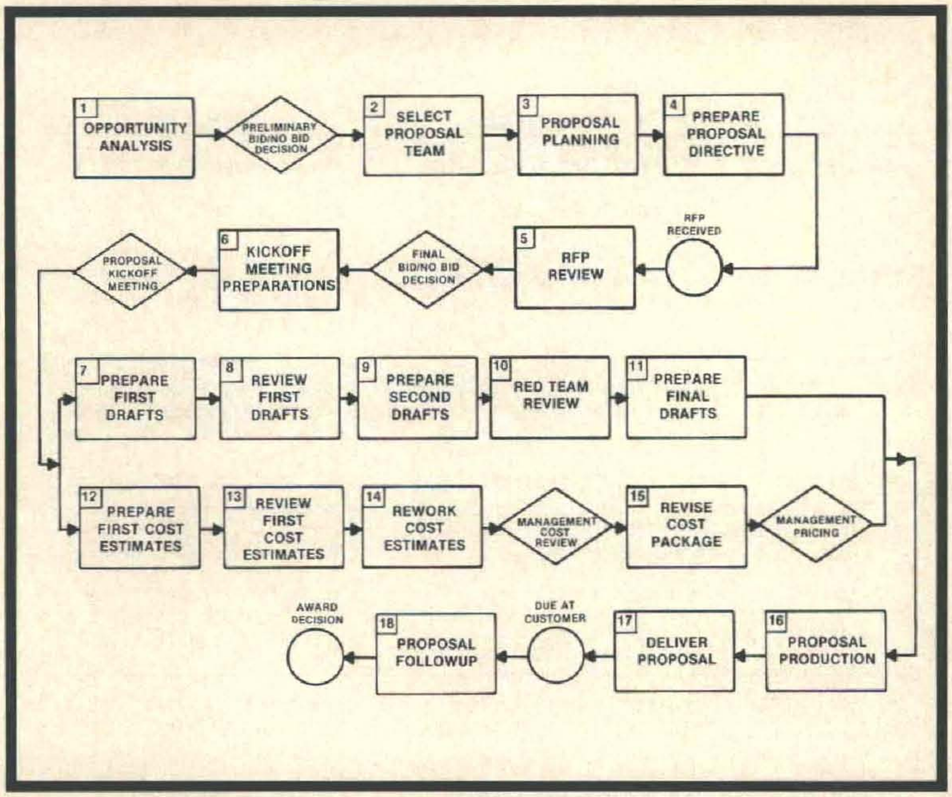

Figure 2. Generic Proposal Process Flow Diagram.

during this time that any ambiguity, non-clarity, or incorrectness in the RFP surfaces. These faults cause great concern, wasted time, effort, and can result in poorer responses to the government. For example, a recent RFP for systems support for a vehicle system stated that the proposal should be limited to 500-600 pages.

As a component of the RFP, the solicitor asked the contractor to demonstrate how it would accomplish a Class I engineering change proposal. Doing so required 500 pages in training manual changes alone! Clearly, the author of that portion of the RFP did not know what he/she was asking or did not understand the scope! Points like this cause the contractor to request clarification. This is done while "the clock is running." Barring an extension of the due date, this robs the contractor of time to prepare a good, accurate, responsive proposal. At any rate, the volumes are prepared for internal review based on an internal schedule.

The internal review, as the term implies, is done by company managers. These reviews fall into three categories: pink team, blue team, and red team. Any proposal effort may have one, or any combination of the three. A pink team checks the integrity of pre-RFP drafts, picks up gross errors, and brings specialized attention to certain problem areas to help flush out needed additional data. A blue team concentrates on a special technical area such as tooling, assembly, or subcontracting and reviews the text from a cost viewpoint. A red team examines all aspects of the proposal in detail as would an independent reviewer. It directs changes and improvements to the proposal. In general, red team reviews are very thorough and brutal.

The proposal team then takes the recommendations and directions of these teams and rewrites and refines the applicable portions of the proposal. The contractor then assembles the proposal. This is no small logistical effort as the proposal may be quite voluminous. This activity may require three days to a week. Most RFPs ask for multiple copies and this complicates this task.

Finally, there is a management review and delivery. This delivery may also be a logistical problem based on the size of the proposal, the distance to the procuring agency and the time available. To be late with the proposal would mean tens of thousands of wasted dollars and no contract for the contractor. These proposals are often hand-delivered by an employee to ensure on-time arrival.

Post-RFP Phase

After the proposal is delivered, the proposal team members attempt to catch up on lost sleep and reorient themselves to a normal work schedule. They do not however stop work. They begin to prepare for requests for clarification by the government, negotiation, and requests for Best and Final Offers to the contracting agencies. After contract award, they receive a debriefing on the contract award (if requested). If awarded the contract, the proposal team often changes hats to become the "project team" and enters into a phase of contract clarification and definition. This is especially true of the more complex "systems acquisitions" by the government. A generic proposal process is summarized in Figure 2.

Conclusion

In conclusion, it is easy to see that the proposal process is complex at best. The complexity increases with the requirements of the acquisition. For major systems, such as B-1B bomber or an M-1A1 tank, this complexity is almost beyond comprehension. In terms of doing the best we can with our limited budget dollars, it is paramount that we as government acquisition specialists ensure that our solicitations ask the correct questions and ask only those questions essential to making a wise judgment with respect to the purchase. To do otherwise causes us to receive solutions to the wrong problem, to not receive solutions at all, to receive solutions that are so costly as to be prohibitive, or to receive solutions that are too superficial and would lead both the government and the contractor down a disastrous path.

In terms of cost, it is essential that we receive enough valid proposals as practical so that we may choose the one that provides the most "bang for the buck." Competition will drive down the prices of government purchases only if the solicitations are correct and we receive as many qualified bids as possible.

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Department of The Army Reorganization

The Army has announced a number of organizational and functional changes consistent with the Goldwater-Nichols Department of Defense Reorganization Act of 1986.

The changes under Title V of the act are some of the most dramatic and far-reaching since 1947. In announcing these changes, Army Secretary John O. Marsh Jr. said that the changes will streamline the Army's management processes, reduce the size of management headquarters throughout the Army, and redistribute personnel to field commands.

The widely publicized act limits the combined strength of the Army secretariat and the military staff to 3,105, requiring the reduction of at least 548 spaces. This reduction does not constitute a cut in the Army's total end-strength.

This decrease in personnel specifically includes a 15 percent reduction in the number of general officers assigned and detailed to the Army headquarters. In addition to reductions at the Department of the Army headquarters, Title VI of the act requires a 10 percent reduction in the size of headquarters staffs of major field commands. Those 10 percent reductions must be accomplished by Oct. 1, 1988.

The legislation provides for five assistant secretary positions on the secretariat staff yet specifies two of them: the assistant secretaries for civil works, and for manpower and reserve affairs.

In addition to those two secretariat positions, Marsh will have three other assistant secretaries, those dealing with financial management, acquisition, and installations and logistics.

To oversee the Army's acquisition process, Marsh recently appointed Under Secretary of the Army James R. Ambrose as the Army's Acquisition Executive (AAE). As the AAE, Ambrose will be responsible for the supervision of all major acquisition programs through the implementation of a Program Executive Officer (PEO) system. All major program managers who handle the development and acquisition of material will report directly to a PEO, who will in turn report directly to the Army Acquisition Executive.

The Army will have an assistant secretary for research, development, and acquisition. The personnel in this newly focused office will consolidate the offices of the secretariat's assistant secretary of the Army for research, development, and acquisition, and the Army staff's deputy chief of staff for research, development, and acquisition (DCSRDA). The three-star general who serves as the DCSRDA will become the deputy to the assistant secretary for research, development, and acquisition.

The AAE and the assistant secretary for research, development, and acquisition together will form the acquisition organization in the Department of the Army headquarters.

In the financial management arena, Marsh directed that the Offices of the Assistant Secretary for Financial Management and the Army Staff Comptroller merge in the secretariat. The assistant secretary for financial management and his three-star military deputy in the single office will manage all Army financial functions in the headquarters. The assistant secretary for financial management will have the comptroller, a three-star general, as his deputy.

In the area of information management, a three-star general will become the director of information systems for command, control, communications, and computers. The new office in the secretariat will perform the functions previously managed by the Army staff's assistant chief of staff for information management and the information resources director in the Office of the Assistant Secretary for Financial Management.

Reorganization officials say that civilian control at the secretariat level has increased as a result of the Army reorganization. The personnel in the secretariat will be responsible for functions associated with acquisition, auditing, comptroller, information management, inspector general, legislative affairs, and public affairs.

Through the reorganization changes, the secretariat will increase from 11 percent of the current HQDA staff to about 30 percent of the new organization—an increase of approximately 535 spaces that come mainly from the Army staff. The Army staff, reduced from 89 percent of the current headquarters, will comprise 69 percent of the new HQDA.

On the Army staff, the office of the chief of staff will have a vice chief of staff and a director of the Army staff. The chief of staff will also have four primary deputies, the deputy chiefs of staff for personnel, for intelligence, for operations and plans, and for logistics.

The remainder of the Army staff will include the chief of engineers, the surgeon general, the chief of Army reserve, the chief of the National Guard Bureau, the judge advocate general, and the chief of chaplains.

Marsh believes that the Army reorganization efforts will streamline management and accountability processes, improve decision making, and redistribute critical manpower back to the field commanders.

As a result of the reorganization, the Army anticipates a new management structure with greater economies and efficiencies that at the same time improves the effectiveness of the Department of the Army.

The Program Manager's Support System

By Greg Caruth

Introduction

He could tell he was a full-fledged program manager. Not only was he beginning to recognize the regular employees in several airport terminals, but the guards at the Pentagon were beginning to look familiar, too. He knew it was likely to get more hectic.

Being away always guaranteed a rush of support staff to tell him all the latest problems and changes. The first few hours back at his desk were usually overwhelming. But things were getting better. He had his new computer and some of the intensity of the first morning back was already gone. He turned on the screen.

First things first, he ran his electronic mail, then checked his action items. He reviewed his calendar for changes and updates on flight schedules, hotel reservations, and briefing times. Next, he examined his program status. He called up the program overview function. Three areas, administration, contracting and program strategy management—were green. Two areas, logistics and technical—were yellow. Finances showed up in red. He asked himself what the problem is now.

The assistant PM had already worked some problems, made notes on the screen's "notepad" as to what caused the problems and how to correct them. The PM added his own notes for the assistant so there would be some record that the information had been duly noted and acknowledged. Every problem was met with the same response: "What is the impact on the program?" His "Program Impact Advisor"—a key function of the computer program—included a cost/schedule analyzer. The commander had "requested" the PM to do a "what if" analysis and determine the impact if a $2 million cut were made in the program. After careful scrutiny, the "expert system" gave him a "what if" scenario that recommended slipping some work schedules into the next fiscal year. That saved the $2 million this year, but would cause the initial operational capability to slip approximately eight months.

Another screen came up with a list of possible alternatives with rationale for accommodating the $2 million cut. The PM then called a staff meeting with the technical business and logistics people; they discussed it; the PM called his commanding general using his computer and the PM explained the impact. The PM also informed the action officer at the Pentagon and transmitted a copy of the solution to him. The decision was made and back-up data provided to all concerned. That was that!

To reassure himself, he looked at the overview status some more, studying the green, red, and yellow arrows to determine "hot areas." He reviewed data summary sheets for notes added by the staff. He studied the options again to reassure himself the best decision had been made. Finally, he made some printouts for filing, and updated his "brain book."

PMSS Fact or Fiction?

The computer program discussed above will be available in the near future. It will have a common data base used by all office members. In addition to the PM, the financial analyst, the technical personnel, contract, logistics, and administrative types all will share it.

The Program Managers Support System (PMSS) will be a management tool for attacking the unstructured "ad hoc" decision-making process. Different from a management information system, it will offer answers to the questions "What if . . . and Should I . . . ?" Certain functions automated by PMSS will eventually include generation of a work breakdown structure; development of an acquisition strategy plan; the formulation, execution and monitoring of a budget plan; parametric cost estimating; contract monitoring; and procurement document generation—and the list keeps growing. It's the difference between "hit and miss" management by a PM that may remember to do everything, and an all inclusive reminder system designed by experts with alternatives and suggestions built in.

How it Helps

Without PMSS, unintentional omissions may exclude important areas. The

PMSS will include (hopefully) all aspects of a functional area. Their significance will be addressed in such a way that the manager will review all factors. They can intelligently elect not to attend to an area. But that area will no longer be overlooked accidentally. There are indications from the Air Force that substantial savings, in the millions of dollars, have been realized even with limited application using one Defense Systems Management College (DSMC) module—Cost Analysis Strategy Assessment. The only comparable PM tool before PMSS was the spreadsheet.

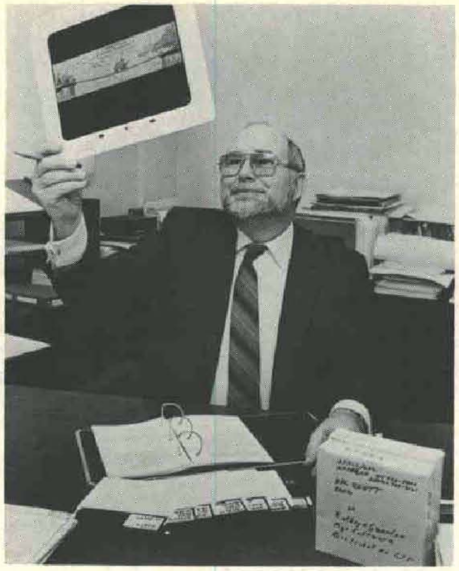
A Briefing Tool

Since much of the PM's time is spent briefing, PMSS is an excellent technique for retrieving current, consistent, traceable information. It gives pertinent data on the screen, as a printout, and even as a viewgraph. Although each service has its own needs and style of presenting data, the system will contain some generic displays useful to all services, as well as some service-particular displays.

A Well Received PMSS Module

One module in PMSS that has been well-received is CAPPS—the Contractor Appraisal System. Contractors traditionally deliver huge quantities of data to the PM. The problem is too much data. CAPPS offers control and measures how well a contractor is doing. Under DOD regulations, a contractor is required to submit specific data, but it takes a long time to wade through it. CAPPS takes the data, presents it in a meaningful way, and interprets it so that in minutes —not days or weeks—problem areas are identified, so that time isn't wasted on non-problem areas. And, CAPPS provides textual comments—in "English." The bottom line is spending time solving problems compared to spending time finding problems.

CAPPS is particularly usable because Contractor or Performance Measurement data are in graphic form, with trend analysis and outcome predictions. No more reading reams of paper! Already, 1,500 copies of the second version have been distributed. The Air Force has shown an interest in incorporating CAPPS into the Air Force standard system. CAPPS can currently be used on the IBM-PC/XT, and compatibles, Zenith Z-100 and Wyse PC. It has been reviewed by upper levels of the Navy, and its use is being encouraged.



PMSS Director Hal Schutt reviews a viewgraph as he prepares to make a presentation on a module.

Another PMSS Module

Another module in PMSS is SCRAM (Schedule Risk Assessment Module). This module is still under development. Network schedules can be built with it. Milestones can be selected from the network and status can be monitored with red, green and yellow indicators. Also, the PM can apply any of four probability distribution curves to each activity in the network and do Monte Carlo simulations to determine the probability of success in meeting scheduled dates. Monte Carlo uses a random number generator to give a statistical average of choices.

A Similar but Different Module

CASA, another module being offered by the DSMC, is not part of PMSS but was developed by another group at DSMC. Instead of being designed for the PM, it is for the life cycle cost analyst to analyze and estimate total life cycle costs of a system. It may be integrated into PMSS as it becomes more of a generalized tool. CASA is "on the street" now and over 300 copies are in use by financial analysts in the acquisition community.

A Brief History

PMSS began in 1981 as the twinkle in the eye of the now PMSS Director Hal Schutt and the dean of the Research and Information Department at the Defense Systems Management College, Fort Belvoir, VA. After visiting 21 PM offices to determine needs and requirements, Hal and his staff developed a statement of work for PMSS. In 1983, there followed a contractual package, and then a request for proposal for architectural concept development. Three parallel contracts were awarded competitively. DSMC began developing functional modules that could be used separately until a complete integrated system could be offered (this is called the "bottoms up" approach). Thus, the information age, and the information glut it caused, was attacked by a systematic attempt to use computers to simplify the PM's life.

The basic concept of PMSS had been briefed to the Policy Guidance Council of DSMC, which includes the commanders over the service acquisition communities. With enthusiastic prompting, Schutt and his staff continued development of the programs.

Designing PMSS

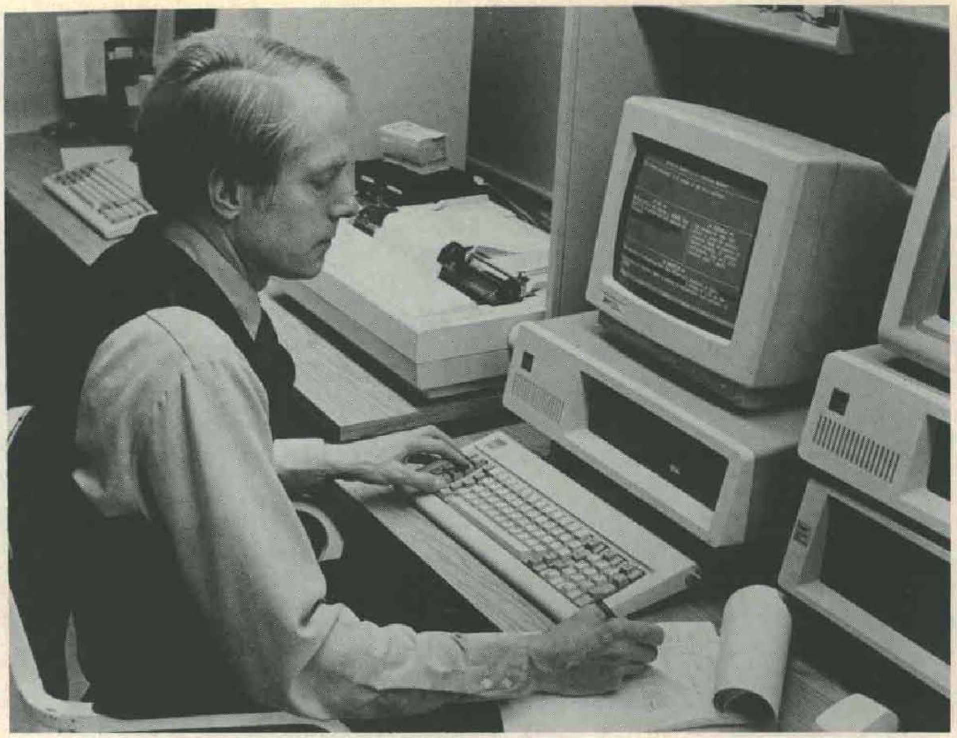
How long did it take to determine what was needed in PMSS? In some cases, information was readily available; other cases, not so. With CAPPS, the requirements were clear. Information being used in the Program Management Office was specified by DOD Instruction 7000.2, Contractor Performance Measurement of Selected Acquisition. This specifies the kind of information that must be reported by the contractor. For other modules the requirements had to be gathered from the DSMC faculty and the program management offices.

A Unique Project

The PMSS is a unique project at the college. Other places are independently working on similar areas of information management. Software Cost Estimating for example, was a module in use by a Navy PM, and was improved and adapted to be more user-friendly by DSMC. When the college starts a module, currently available software is examined. Commercial modules usually contain extraneous material the PM doesn't need.

What Computers Will be Used in PMSS?

Simulations by the contractor, Analytics Inc., are based on the IBM-AT with a color monitor, printer, and mouse. For demonstrations, a projector can be used for visuals. But the Z-248 is a likely candidate for the finished program in a year and a half. Information will be on hard disks. Easier to use than floppies, they increase the speed of operation. The difference of cost for a disk drive taking hard disks instead of floppies is several hundred dollars—money well spent.



Jesse Cox, PMSS software development manager, examines some information via the CAPPS software module.

Do You Need CAPPS?

- *Do you require your contractor to submit Cost Performance Reports (CPR) and/or Cost/Schedule Status Reports (C/SSR) in accordance with DoDI 7000.2 and DoDI 7000.10?*
- *Do these reports contain a large amount of monthly data?*
- *Do you have difficulty analyzing this data and determining what it means?*
- *Do you have access to an MS-DOS or PC-DOS based microcomputer such as an IBM-PC/XT or a Zenith Z-100?*

If you answered "Yes" to these questions, then you may benefit from the Contractor Appraisal (CAPPS) software module developed at DSMC. If you are in the government, send a letter request for the module to: PMSS Directorate (DRI-S), ATTN: Ms. Kathryn Scanlon, Defense Systems Management College, Fort Belvoir, VA 22060-5426.

Who Gets PMSS

All Program Management Course students at DSMC will receive copies "to take home." Also, any PM who requests a copy can get it. PMSS functions relate directly to the defense PM's point of view. The system can be tailored within each PM shop. For instance, the SAR (System Acquisition Report), typical for any PMO to do on a monthly basis, is a standard format, but can be varied.

Defense contractors can get the modules from the Federal Software Exchange Center at the National Technical Information Service. The cost will cover reproduction of disks and distribution.

Aggravation Saver

PMSS saves time and aggravation. The PM starts with concrete approaches. When the guys in the "E" Ring at the Pentagon give their "I don't believe it," the notebook in the computer shows the history of the problem, the "fix-its" along the way, and the notes on "why." PMSS provides an excellent audit trail.

Of course it's too early to predict savings, in time and dollars, but eventually hind sight by users will give a good estimate of the true value of PMSS. The one wish of Hal Schutt is that the program will be useful and effective in the PM office to the point PM's will feel they want to use it. Demand will be proof enough. The new standard micro-computer, the Z-248, is on order by the services for a minimum of 90,000 units. Computer availability is growing! Hal Schutt estimates that in the near future, every PM and functional office will be on-line. By then it will probably be a new model based on the 80386 chip—faster with multi-user capability.

GREG CARUTH is chief of the Graphics Division at DSMC, and is the art director of Program Manager magazine. His interest in PMSS stems from post graduate work in educational technology at the University of Maryland.

Life Cycle Software Engineering

By Jack Byers

Introduction

Life Cycle Software Engineering (LCSE) is finding its way into an increasing number of programs within the Army. However, there is little knowledge in the development arena as to what it is and how it can be put to maximum use for a program/project manager and the Army as a whole. This article will provide a background on LCSE within the Army Materiel Command (AMC), LCSE current posture and its future potential/direction.

What Is LCSE?

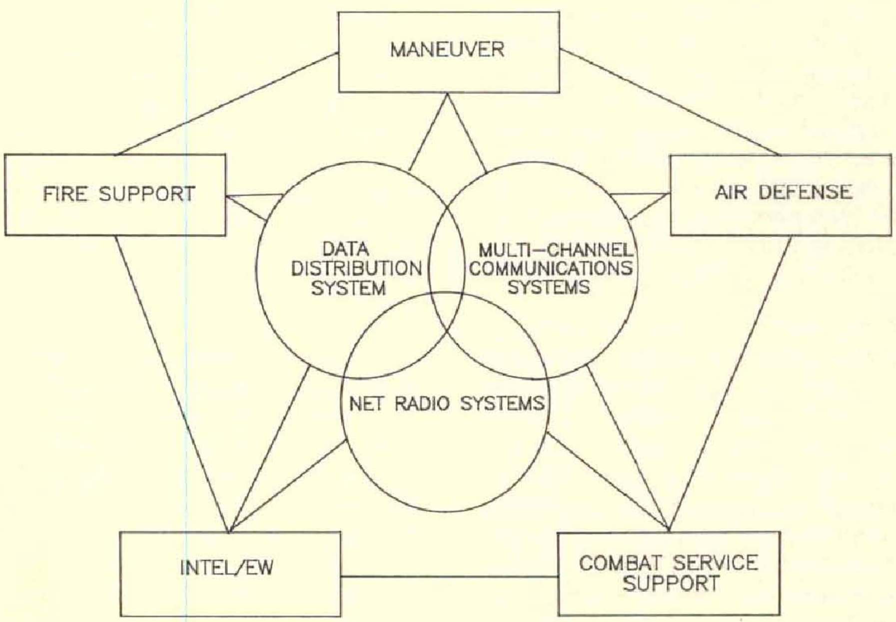
In order to understand the program, the reader needs to comprehend what software is. Software are basically the invisible instructions that command computer equipment to perform computational or control functions. This computer equipment can range in form from a main frame computer to a single "chip" with permanent instructions. LCSE can best be thought of as a subset of Life Cycle Software Support (LCSS). LCSS is defined as that part of overall system support necessary to plan, manage, develop, sustain, modify, and improve a system's computer software in a time frame necessary to meet the needs of the Army. This definition is applicable for all software throughout the Army.

The key distinction made between LCSS and LCSE is that Life Cycle Software Engineering applies to Battlefield Automated Systems (BAS). That is those systems employing computer resources operating within the boundaries of the battlefield, regardless of function, mission, or direct/indirect support systems. Within AMC, LCSE is further defined as support necessary for theater/tactical Battlefield Automated Systems. Examples include large communications systems such as Regency Net, missile systems such as Chaparral and small hand-held computers such as the Backup Computer System. The purpose of LCSE within AMC is to provide centralized, structured software support to weapons systems employing embedded computers. Simply stated, LCSE is the cradle to grave management of computer software used in Army weapons systems.

Background

The Army's Life Cycle Software Engineering Program officially started in 1983 with publication of the Life Cycle Support Implementation Plan in December. This plan established a framework for detailed implementation with AMC, the Army Training and Doctrine Command (TRADOC), Health Services Command, and the former Computer Systems Command for technical and operational execution of LCSS. AMC was specifically tasked to develop, maintain, and execute plans for operation of soft-

BATTLEFIELD FUNCTIONAL AREAS



ware support centers to provide responsive technical direction and support for Battlefield Automated Systems during development and deployment.

Scope of the Program

LCSE within AMC is administered through centers aligned functionally to support the Army Command and Control System (see accompanying figure). AMC is responsible for four of the "nodes" shown in the figure. The exception being the combat service support node which is administered by the Information Systems Command.

There are four major LCSE centers within AMC. They are the centers supporting the Army Communications-Electronics Command (CECOM), the Army Missile Command (MICOM), the Army Armament Munitions and Chemical Command (AMCCOM), and the Army Aviation Systems Command (AVSCOM). The AMCCOM center is located at the Armament Research Development and Engineering Center and the AVSCOM center is located at the Aviation Research and Development Activity. Besides the parent facility at Fort Monmouth, the CECOM center has divisions located at Fort Sill, OK and Fort Leavenworth, KS. There are plans to initiate a center at Fort Huachuca, AZ. MICOM also has a division located at Fort Bliss, TX.

The LCSE divisions established at Forts Bliss, Sill, and Leavenworth specifically support doctrinally sensitive weapons systems. All totaled, these centers provide software support for approximately 232 different weapons systems with embedded software. This equates to approximately 20 million lines of software. At the CECOM center alone, 89 different software languages are supported. These languages range from a variety of assembly languages to the more complex, but easier to read and understand high order languages such as FORTRAN, PASCAL, and JOVIAL.

Frequently the contractor will apply software language unique extensions that make it difficult for an individual fluent in the base language to comprehend. At present, in order to support many of these weapon system software languages, the government/military ratio is supported by outside contractor personnel. Currently, the ratio of support is approximately 70 percent contractor, 30 percent government. This ratio attempts to maintain a software restart capability by the government should the original contractor be unable to complete work on an existing program.

Program Benefits

The Life Cycle Software Engineering Program, as currently structured, offers a variety of benefits to the Army and individual project/program managers. For the Army, the program maximizes utilization of the scarce human resource. This is accomplished by pooling the available software talent so that work load can be leveled and particular skills can be matched to unique problems. Another benefit resulting from LCSE is avoidance of duplicative efforts among various programs to solve similar problems. This helps keep several programs on schedule or, when fielded, operating correctly as the problem for one is solved.

Program managers receive matrixed support from the responsible LCSE center. This centralization aids in keeping overall software costs down while allowing visibility of these costs. Program managers now have a single source of in house expertise for software problems.

Interfacing With Program/ Project Managers

In order to effectively operate as software maintainers, the AMC Life Cycle Software Engineering centers need to be involved in the early development stages of a weapon system life cycle. Acting as the PM surrogate for software, the LCSE centers provide advice on the proper documentation required, desirable processors to be used, the primary language that the software is to be written in by the contractor, and other functions necessary to ensure software supportability after the weapon system is fielded.

It should be emphasized that the program/project manager remains in control of program development and retains final authority over software. In performing these functions, the centers require reimbursable funding from the PM. To project resource requirements, the AMC LCSE centers are uniformly applying a cost model to individual weapon systems. This model is the Software Engineering Cost Model adopted from the Constructive Cost Model developed by Dr. Barry Boehm of TRW Corp. Input parameters to the model allow tailoring to specific system requirements and individual center capabilities.

Model output is in the form of man-years of effort required to support a program based on projected change rate of code and other factors. Output resource estimates are provided the PMs for inclusion in their budgetary estimates. At present these estimates do not include center overhead costs. Center overhead costs are directly funded so the costs provided the PM are true support costs.

Because software support estimates are projected for seven years in the future, the estimates include transition and maintenance costs once a program is transitioned away from the PM. Because of early interface with PMs, centers provide for an orderly transition of system software for fielding support.

Future Actions

One of the most immediate actions to be taken by the software engineering centers will include efforts to reduce the number of unique programming languages employed throughout the Army for Battlefield Automated Systems. The vehicle for this action will be implementation of Ada programming language wherever possible. Ada, as the DOD standard language for Battlefield Automated Systems, is gaining industry acceptance. Currently over 50 Ada Joint Program Office validated compilers are available for use on machines ranging from advanced personal computers through main frames. Expanded use of Ada is expected to reduce the DOD yearly bill for software support, however, results will probably not be seen for between 10-15 years.

Further on the horizon is use of artificial intelligence (AI). Although AI is still very much a laboratory tool, developments in this area are especially promising for reusable tool generation and the ability to generate an entire program given input parameters. In order to try to capitalize on these developments, a Software Technology Center is being established at CECOM. The center will act as a "capstone" LCSE Center with responsibility for ensuring commonality among the AMC LCSE centers, and insuring software reusability where possible.

Summary

With the ever increasing use of software in weapons systems, LCSE is playing a commensurately larger part in the Army. Software frequently allows for increasing weapon system capability at generally much lower costs than bending of new metal and may allow existing weapons systems to meet new battlefield threats without developing new hardware. By exploiting emerging technologies such as artificial intelligence and standardizing on programming languages such as Ada, Life Cycle Software Engineering will help keep DOD software costs under control.

JACK BYERS is a software engineer in the Battlefield Information/C4 Division, Office, Deputy Chief of Staff for Development, Engineering, and Acquisition, HQ AMC. He holds a bachelor's degree in mechanical engineering from Clarkson University and serves as manager for the AMC Life Cycle Software Engineering Program.

ARDEC Developing Adhesives Data Base

The most current information about adhesives is being brought "up-to-speed" for user retrieval through modern computer technology at the U.S. Army Armament Research, Development and Engineering Center (ARDEC).

The Adhesives Section within the Armament Engineering Directorate (AED) has the lead in bringing adhesives technology to bear on solving problems relating to adhesives. The staff of the Adhesives Section, which was formed in 1958, is located in the Organics Branch of the Armaments Technology Division in AED. It is the largest and most experienced group of scientists and engineers in the Department of the Army whose primary interests and work are devoted to the science of adhesion and engineering with the adhesives for bonding applications. These personnel are recognized authorities in the field of adhesive bonding and, as such, are often called upon as adhesive consultants by other Army agencies, Air Force, Navy, NASA and a host of defense industries.

Prompted by Army Materiel Command (AMC) CG GEN Richard H. Thompson's Adhesive Bonding Initiative, the Adhesives Section desired to update their previously developed computerized data bank of adhesives test data. The requirements for tough, lightweight, high-performance structures have increased greatly in the past couple of decades, and adhesive bonding is essential for the design, fabrication and functioning of many components of modern Army materiel. The technical literature and need for it has expanded accordingly.

The adhesives experts went to another organization located at ARDEC, the Plastics Technical Evaluation Center (PLASTEC), because that group had past experience in the development of computerized data bases using a data management system (DMS). PLASTEC, since 1960, has provided the defense community with a variety of technical information services applicable to adhesives, organic-matrix composites and plastics.

The Adhesives Section and PLASTEC are working together to expand and improve the existing prototype Adhesives Data Base so that appropriate organizations and individuals can access the most current research and methodology. This advance is helping to minimize duplications of effort, disseminate results of research, and expedite problem solving.

Presently, this data base is used in support of the ARDEC mission. In addition, other interested defense scientists and contractors will be able to dial into the computer program from any location in the United States by FY 1988. All they'll need is a conventional computer terminal and modem to access this extremely "user-friendly" system, which is stored in a VAX-11/780 computer.

The VAX was chosen because of excellent adaptability of the data management system. The DMS has two important features—a Screen Input Processor and Data Base Builder. The processor enables the user to query the data base and retrieve data by interactive screen formats. The Data Base Builder is a menu-driven, highly automated method of structuring and initializing a data base.

The Adhesives Data Base is structured into several blocks, or record types, each containing a specific type of information:

- Adhesives—data on generic adhesives in broad classifications such as epoxy, acrylic, etc.;
- Documents—titles, authors and other information specifying the source of test data;
- Trade Designation—a more detailed description of the material, its attributes and applications of the commercial or otherwise specific adhesive used in the test data;
- Test Method—a description of the type of test used to produce data;
- Surface Preparation—somewhat lengthy descriptions of the different techniques of specimen preparation used in the Test Data record; and
- Test Data—the actual numeric test data for each test run performed.

Also, other new features are "growing" into the system:

- "Lessons Learned"—historical data on problems; and
- Designing and Manufacturing with Adhesives to include:
- Design Information—basic information on joint geometry and design, materials selection, surface treatment, compatibility issues, the use of primers, cure conditions, environmental and durability requirements, validation of design and process requirements; and
- Planning for Production—information on producibility principles, scale-up, manufacturing equipment and facilities (controlled atmospheres where required), processing conditions, process controls, quality control and testing.

For questions relating to the data base, contact John Nardone on (201) 724-4222 or AUTOVON 880-4222. For questions relating to adhesives, contact Mike Bodnar on (201) 724-3183 or AUTOVON 880-3183.

The mailing address for both is: Commander, U.S. Army ARDEC, ATTN: SMCAR-AET-O, Picatinny Arsenal, NJ 07806-5000.

The Mathematical Sciences Institute

By Wilson V. Kone

Background

In January 1986, the U.S. Army's Center of Excellence in the Mathematical Sciences was established at Cornell University under the name of Mathematical Sciences Institute (MSI). The Mathematical Sciences Institute became fully operational in June of 1986. This institute is intended to be a national focal point for comprehensive, integrated, fundamental mathematical research programs. Emphasis is based on expanding mathematical research into new directions and encouraging increased graduate study in mathematics. This goal is being accomplished through ongoing graduate research programs and a vigorous program of postdoctoral junior and senior visitors.

The visitors consist of 10 postdoctoral researchers and a substantial number of more senior scientists (perhaps as many as 90 a year). The latter include about 25 Cornell faculty members. All outside visitors are sponsored by mathematical scientists at Cornell. In addition, the institute provides 20 graduate fellowships for students writing Ph.D. theses.

This center of excellence for mathematical research is funded primarily by a contract through the Army Research Office (ARO), Research Triangle Park, NC. Dr. Jagdish Chandra, director of ARO's Mathematical Sciences Division, is the Army point of contact for interface with the institute and also serves as the committee chairperson of the Army Mathematics Steering Committee under the direction of the director of Army research and technology. This committee assists in coordinating the activities of mathematics research groups and reviews their programs semiannually.

Additionally, the MSI program is guided by an advisory committee consisting of senior scientists from the Army and prominent universities. The current committee is comprised of representatives from the U.S. Army Ballistic Research Laboratory, U.S. Army Materials Technology Laboratory, Rensselaer Polytechnic Institute, University of California (Los Angeles), Cornell University, NYU-Courant Institute, and University of California, Berkeley.

Research Areas

The Mathematical Sciences Institute supports Cornell mathematical research in the following areas:

- Applied Analysis: emphasis on dynamical systems and non-linear partial differential and integral equations;
- Physical Mathematics: emphasis on non-linear and time-dependent phenomena in continuum theories of fluids and solids;
- Numerical Analysis and Computing: emphasis on algorithms, software and software support for numerical computations using supercomputers on complex non-linear and time-dependent phenomena in three dimensions, graphics, CAD/CAM, numerical optimization, symbolic manipulation, and data base systems; and
- Statistics and Applied Probability: emphasis on computational statistics, modern data analysis, reliability, quality control, and stochastic processes.

Each year a specific area of emphasis is selected during which special seminars and workshops are conducted. Prominent scientists in the field of emphasis are invited to Cornell for a full term or more to participate in the workshops and give seminars to faculty and students. The area of emphasis planned for academic year 1987–1988 is in Physical Mathematics "Group Theory in Mathematics." The academic year 1988–1989 area of emphasis will be in Applied Probability and Statistics, "Stochastic Analysis/Random Systems."

Workshops

Additionally, at least one workshop is held in each of the other research areas every year. These meetings are 2–3 days in length and address specific, timely topics. Presentations are normally limited to a small number of invited scientists, usually those leading the research in that area. Attendance is open to all interested mathematicians. A limited amount of travel funds have been set aside to attract graduate student attendance. The following workshops are scheduled for the remainder of 1987 and Spring 1988: Infinite Dimensional Dynamical Systems and Their Finite Dimensional Analogues (May 18–22, 1987); Computational Discrete Optimization (tentative) (June 1–5, 1987); Existence of Quantized Gauge Fields (May 1988); Gauge Theories of Continua (June 5–8, 1988); Symmetry and Group Invariance in Non-linear Continuum Mechanics (June 9–14, 1988); The Mathematical Analysis of Material Microstructures (June 15–18, 1988); and Analytical Methodologies in Queueing Theory (June 1988).

Army Assistance

An integral part of the MSI contract is to provide assistance to the Army. This mathematical assistance is provided in three ways. First, MSI provides tutorials organized under the auspices of the Army Mathematics Steering Committee at selected Army locations on topics of current concern to the Army scientific community. This is a continuing education program whose purpose is to ensure the currency of mathematical procedures used in government establishments. The two to four day classes are conducted by Cornell mathematical scientists and are also designed to provide informal interaction between Army scientists, engineers and the instructors so as to orient on mathematical problems and questions currently facing the Army community. A complete list of tutorials planned for 1987 is available from the U.S. Army Research Office, P.O. Box 12211, Research Triangle Park, NC 27709.

The second method of providing Army assistance is through direct technical assistance in all areas of the institute's expertise. Nearly 200 members of the Cornell faculty, visiting scientists, postdoctoral researchers and graduate students are resources for consultation on Army questions. A special unit within the institute has been set up to provide the Army direct access to the consulting services.

The Mathematical Consulting Liaison Unit's mission is to furnish the Army with expertise and advice over a broad spectrum of mathematical problems in which Army personnel are involved, including, but not restricted to, the design and analysis of experiments, statistical sampling, life testing, reliability, statistical software, modeling, and the analysis of discrete data.

Questions which cannot be handled by the staff of the consulting unit will be referred to the Cornell faculty, or to institute supported visiting scientsts. Initial access to the MSI Mathematical Consulting Liaison Unit is through the Director of ARO Mathematical Sciences Dr. Chandra (Autovon 935-3331, or Area Code 919-559-0641) or any member of the Army Mathematics Steering Committee. The head of the Mathematical Consulting Liaison Unit is Professor Walter Federer (Area Code 607-255-7763). This service is not restricted to the Army scientific community. Those in all areas of RD&A, training, and operations in need of mathematical assistance are encouraged to use this service.

Examples of consulting provided by MSI include assistance to the Materiel Readiness Support Activity on the collection and analysis of reliability and maintenance data on helicopters; and, to the Tank-Automotive Command on useful life determination of tactical wheeled vehicles. As is often the case, the assistance provided may be as simple as directing the Army researcher toward the current literature or procedure applicable to the problem.

The third method of Army assistance available is through the Theory Center at Cornell. Use of the Theory Center supercomputer facilities is available to MSI visitors and Army personnel. A Supercomputing Liaison Unit has been formed to facilitate Army access to the Theory Center. This unit is directed by Professor David A. Caughey (Area Code 607-255-3372).

Moreover, MSI visitors and interested Army scientists will be admitted without charge to Theory Center tutorials, conferences and annual meetings, and be entitled to receive its publications. They will have the same rights as Cornell faculty to submit proposals for using the production and experimental supercomputers.

Allowances have also been made to provide tutorial services at Army facilities to encourage the use of the Theory Center privileges. Assistance has been provided to Aberdeen Proving Ground and Watervliet Arsenal in establishing accounts and communication links to access the supercomputer for work in such areas as computational chemistry, defining bench marks, and finite element research.

Summary

The Mathematical Sciences Institute, although only one of several of the Army's Centers of Excellence, is becoming a national center for mathematical research. Cornell scientists are conducting mathematical research and finding applications for their mathematical research in many diverse areas. The basic research sponsored by the U.S. Army through MSI could well provide methods for solving the Army's design and operational problems of the future. Help in finding solutions to current problems is available through the Army assistance facilities of the Mathematical Sciences Institute at Cornell University.

WILSON V. KONE is the administrative associate for the Mathematical Sciences Institute at Cornell University. He holds a B.S. degree from the U.S. Military Academy and a master's degree in system management from the University of Southern California.

Systems Considerations in Generator Selection

By Jim Lucas

Introduction

When a tactical communication or weapon system is being developed, the initial estimates of power requirements are often based on sketchy knowledge of actual needs. Communication equipment, radar, and other power consuming items are usually rated on their maximum power output; while input power requirements may remain somewhat of a mystery.

Major power consuming items such as air conditioning are characterized by a relatively high appetite for power on start up which diminishes to a lower level during operation. Their power needs are further complicated by a sensitivity to ambient temperature and humidity, whether the communication shelter is parked in the sun or in the shade, and the circulation of air within the shelter, which can promote greater crew performance/effectiveness at higher interior temperature and humidity conditions than would be possible without circulation.

Oversizing

In some instances, the number of crew members required to operate the shelter may also be loosely defined. The usual approach to these multiple uncertainties is to allocate sufficient power to cover the worst case. Unfortunately, in many instances these highly conservative power estimates become embedded in the system before they can be trimmed down to an effective fighting weight. This results in underloaded generators which consume substantially more fuel than the ideal generator would require.

These oversized generators themselves, as well as their fuel supplies, add weight and volume to communications and weapons systems making them more difficult to transport, more costly to purchase and operate, and reducing mission duration for a given quantity of fuel. In some cases an additional burden of weight, volume and cost is imposed by system reliability/availability constraints.

It has been virtually habitual to provide redundant generator sets to increase the probability that power will be available when needed. Systems that operate in contaminated environments may also be equipped with redundant air conditioning equipment. As with the generators, the tendency has been to oversize air conditioners well beyond the needs of shelter-based tactical systems.

Evaluation of actual operating conditions, including temperatures and humidity levels at the sites where the equipment will be used, will allow appropriate air conditioners to be selected. Greater air circulation within the shelter will assure crew performance capability without the need to turn the shelter into a walk-in freezer.

In many cases it may be appropriate to vent equipment heat directly to the outside air without burdening the air conditioning system. These methods, along with the use of solar shades to reduce radiant heat input have a cascading beneficial effect. Lower heat loads in the shelter permit smaller air conditioners which permit smaller generators which permit smaller fuel supplies.

The use of redundant equipment for air conditioning also allows for smaller units since procedural options may be developed to reduce the usage of other power consuming equipment for short, peak temperature, periods during record setting heat waves in order to operate both the prime and the backup air conditioners. Other types of equipment such as antenna raising/lowering devices and antenna deicing heaters may be equipped with either/or switching to preclude overloading the generator. In the same way, air conditioners with built in heaters may be either/or switched since it is not appropriate to operate them simultaneously. Other equipment (radios, computers, etc.) provided for functional redundancy may also be equipped with either/or switching.

System Requirements

This Gordian knot of system requirements can best be cut by compiling actual power consumption data, recorded during equipment prototype development, and analyzed (or further tested) to take the required range of system operational environments into account. The project manager for mobile electric power has enlisted the Belvoir Research, Development and Engineering Center for this task of applications/systems engineering for tactical generators.

Within the center, the Directorate for Logistics Support has assigned the various aspects of the effort to the Environmental Control Division, the Power Generation Division and the Power Conversion and Distribution Division. The divisions have in turn designated the Environmental Equipment Support Team for air conditioner/heater concerns, the Electromachinery Team for generator research, the Power Conditioning and Control Team for underhood power and power conversion, the Support Equipment Team for power distribution and generator/trailer configuration, the Special Projects Team for generator development efforts, and the Systems Assessment Team for overall system analysis, evaluation and measurement.

The Systems Assessment Team serves as lead for tactical power applications/systems engineering support of both new developmental and existing fielded tactical power systems.

The functional requirements of each tactical power system should be critically reviewed. A communication system, for example, may broadcast to a given signal strength at a receiving station a specified distance away either by using a non-directional antenna with a power hungry high wattage radio (which also fights the air conditioner) or by using a directional (flashlight beam) antenna with a low wattage radio.

The reliability/availability needs of each generator supported tactical system are also being more closely reviewed. In many cases, the data used to estimate system reliability/availability are inconsistent. Some of the mission equipment data are point-estimate data resulting from factory testing while other (e.g. generator) data are derived from actual field experience and still other (e.g. developmental mission equipment) data are estimated by the supplier based on known life data on certain components (such as ball and roller bearings).

In general, the field data (properly interpreted) are the most valid, the point estimate data are less so, and the component estimated data are least valid. Mixing these values in reliability calculations can produce misleading results. Further, for a system view, the availability for mission operations is most severely effected by time lost awaiting replacement parts.

Maintenance

As a practical matter it is easily possible that a single generator set carefully maintained and accompanied by an appropriate collection of replacement parts could demonstrate a percentage of availability on a par with two generators not as meticulously maintained nor accompanied by replacement parts. In addition to analysis of high probability replacement parts, another technique being developed for improved tactical system availability/reliability is the provision of limp-home capability by means of under the hood power or by means of a second, smaller generator capable of powering the assigned mission at a reduced level.

Maintenance procedures, both for the primary generator and the reduced capability generator are under review. A deep maintenance methodology has been developed and applied as a means of assuring, before the start of a critical test or mission simulation exercise, that the hoses, fan belts, fuel supply, coolant, engine oil and filters are all in excellent condition. Other availability enhancement techniques are being pursued and analyzed for applicability to diesel engine driven generators.

Summary

System level techniques for generator and air conditioner selection to optimize tactical communications and weapons systems include the following:

- challenging system requirements; such as climate and altitude limitations, definitions of mission duration, system reliability/availability needs, omnidirectional broadcasting, on board fuel quantities, and other system characteristics;
- use of solar shades, rejection of waste heat outside the shelter, enhanced air circulation within the shelter, use of electronics gear which is insensitive to elevated temperatures, and which produces less waste heat;
- utilization of the full (above rating) capacity of the generator, for limited periods of time during summer operations at high altitude and much longer times during cold weather operations, and low altitude operations;
- use of availability enhancement, deep maintenance, high probability spares, starting battery status checks, trickle charging, etc;
- provision for limp-home capability for air conditioning, under the hood power, limited mission electronics, small standby generator, etc;
- compilation of actual power consumption data at the earliest feasible prototype stage, enhancing data if necessary to account for weather, altitude, etc; and
- design of power switching logic to avoid wasteful use of power, provide for motor startups (i.e. air conditioner compressor motor) allow graceful degradation by deletion of electrical loads, in priority determined order, to relieve overloading.

These procedures, diligently applied, will assure the most bang for the Kilowatt!!

JIM LUCAS is a senior member of the Systems Assessment Team at the Belvoir RDE Center. He has a bachelor's degree in mechanical engineering from Cleveland State University.

Water Well Kit Performs Successfully

A 1500-foot well completion kit developed by the Troop Support Command's Belvoir RDE Center was used successfully during exercise Gallant Eagle, which was held recently on the desert at Fort Irwin, CA. The kit consists of drilling fluid, chemicals, a well casing, screens, and a pump and its accessories.

During the exercise, drilling teams from the Air Force, assisted by personnel from the 425th Engineer Detachment at Dallas, TX, successfully completed wells at several locations. The kit was type classified in 1980, but this was only the second time it had been used in an exercise.

Even though the kit had been procured in limited quantity, and had remained in storage for contingency use, construction of the wells went smoothly and the soldiers were pleased with the kit's performance. Their wells produced as much as 250 gallons of water per minute.

Observers on the scene recommended that additional quantities of screen, fluids and chemicals be included in the kit in case a deeper well was required. They also recommended preparing manuals and releasing some of the kits from stock so that regular unit training with the kits could be conducted.

Measurement and Analysis of Subjective Data

By MAJ Richard S. Farr

Background

The measurement and analysis of data are fundamental to all testing activities. Although the most critical step in experimental inquiry is the structuring of an instrument which will accurately and reliably measure the variables of interest, the purpose of the measurement, the attainable precision of the measurement, and the plan of data analysis are all inextricably linked.

While most testing activities involve the measurement and analysis of "objective" data (in the sense of basic physical measurements), the measurement and analysis of "subjective" data (based on human perceptions) presents many perplexing problems to even experienced investigators.

Often the methods applied by researchers in their efforts to measure and analyze subjective data are tacitly based upon specious assumptions that may have intuitive appeal but are mathematically insupportable. Particularly bothersome are the problems associated with the measurement and analysis of such subjective intangibles as "comfort," "acceptance," "beauty," "ease of use," and so forth using rating scales. This article presents the logical basis for one approach to the use of rating scales for the measurement and analysis of subjective data.

Measurement

A fundamental requirement of any testing operation is the accurate and reliable measurement of the particular parameters of interest. Whether for ultimate purposes of characterization or comparison, such measurement is a necessary precondition to the collection of test data. In order to perform certain operations with numbers that have been assigned to data observations, the method used to assign those numbers to the observations must be compatible with (isomorphic to) the numerical structure which includes the operations one desires to perform. The following is a brief discussion of the principle levels (scales) of measurement and the operations appropriate to each.

- Nominal Scale: Here, numbers or symbols are assigned for purposes of classification only. Examples are numbers or symbols assigned to armed forces specialty codes, elementary school grade levels (1st-12th), telephone area code numbers, military unit designations, city street numbers, etc. The scaling operation involves partitioning a given class (high school grade levels, for example) into a set of mutually exclusive subclasses (9th, 10th, 11th and 12th grades). This involves only the relation of equivalence (=); all members of a subclass are equal in the property being measured or scaled (all senior students = 12th graders, all Atlanta residents = 404 area code, etc.)

While it is computationally possible, for example, to perform a variety of calculations (summations, means, variances, etc.) on the many telephone area codes throughout a given geographical region, the numbers resulting from these operations would have no real significance or logical meaning. This is because observations measured at the nominal level of scaling are not isomorphic to the operations of arithmetic. For example, in a six person grouping of three Georgia residents (telephone Area Code 404), two California residents (AC 805) and one Colorado resident (AC 303), the calculation of an arithmetic mean is computationally feasible but entirely inappropriate and logically inadmissible as a measure of central tendency. The mode, or most frequent occurrence (404), however, requires only simple enumeration rather than arithmetic for its determination and is, therefore, an appropriate measure of central tendency at this level of measurement.

- Ordinal Scale: The relations among observations here involve both equivalence (=) and ordering (>). Among the Army enlisted grades of master sergeant (MSG/E8), sergeant (SGT/E5), and private first class (PFC/E3) for example: MSG = E8 > SGT = E5 > PFC = E3. Redesignating the class titles would not affect relations involved as long as the ordering remains the same: MSG = E30 > SGT = E27 > PFC = E9.

As with the nominal scale, the ordinal scale is not isomorphic to the operations of arithmetic. For example, in a particular group of 20 enlisted soldiers (1 MSG/E8, 3 SGT/E5s, and 16 PFC/E3s), it is meaningless to say that the "average" enlisted grade is $[(1 \times 8) + (3 \times 5) + (16 \times 3)] / 20 = 3.55$. However, the mode and the median (the "middle" value in a set of ordered observations, both PFC = E3 here) are meaningful and appropriate measures of central tendency for ordinal measurements.

- Interval Scale: Here all the relations of nominal and ordinal scaling apply and, additionally, the distance between any two scale measures is known. On the Celsius temperature scale for example, the difference in temperature between an ice-water mixture (0 degrees C) and boiling water (100 degress C) is 100 equal intervals. On the Fahrenheit scale of measurement this same temperature difference spans (212 degrees F minus 32 degrees F = 180 degrees F) 180 equal intervals. On either temperature scale, however, the difference between 10 and 20 degrees is twice the difference between 5 and 10 degrees, half the difference between 0 and 20 degrees, and so forth.

Although the zero points on both scales are arbitrary, we can convert a measurement on one scale to a measurement on the other through a simple linear transformation (degrees $F = 9/5 \times$ degrees $C + 32$). The interval scale of measurement is isomorphic to arithmetic operations and, consequently, is the first truly quantitative scale of measurement encountered thus far. Here the arithmetic mean (average daily temperature in the month of June, or mean score on a Scholastic Aptitude Test, for example) is a meaningful and appropriate measure of central tendency.

- Ratio Scale: This scale of measurement has all of the properties of the above scales and additionally has a natural fixed zero point. In the ratio scale, the ratio of any two scale points is independent of the scale of measurement. Temperature scales based on measurements from absolute zero (Kelvin and Rankine), for example, have this property. Here temperatures of 200 degrees are twice as "hot" on either scale as measurements of 100 degrees (the same is not true for measurements on the Celsius or Fahrenheit temperature scales); a weight measurement of 50 is twice as "heavy" as a measurement of 25 regardless of whether the unit of measurement is in pounds, kilograms, stone, etc.

Measurement of Subjective Data

While we can axiomatically accept that such subjective parameters as comfort, trust, acceptance, taste, beauty, etc., have an underlying continuous distribution between opposite extremes within individuals, we face fundamental difficulties in the measurement of these parameters. This is true both within individuals and among groups; we cannot so much as locate the extreme points of these parameters within a single individual and, further, we have no absolute frame of reference common to all individuals. Nonetheless, an individual can, within reason, be expected to provide an ordering of his individual subjective perceptions of some parameter of interest.

Given these difficulties of measurement, it is obvious that no direct measurement of truly subjective parameters is possible on anything other than an ordinal scale of measurement and, consequently, that whatever measurements are made will not be isomorphic to the operations of arithmetic. Since the highest permissible level of measurement of such data is determined by the nature of the parameter to be measured, the measuring instrument, and any subsequent reduction and analysis of the measured data, MUST be adapted to that level of measurement. This fundamental requirement simply cannot be assumed away by creative manipulations of the measured data.

Which measuring instrument is appropriate in a given situation depends largely on the purpose of the measurement. If the purpose of the measurement is simply the characterization of human perceptions concerning a given parameter, an instrument which both provides a measure of those individual perceptions and, however, roughly, the strength of those perceptions, is both desirable and entirely appropriate. Problems arise, however, when the ultimate purpose of the measurement is to make comparisons among different groups' perceptions of a parameter of interest involving different variables. Although the same measuring instrument may be applied in all cases, all that we can safely assume is that each group's ordering of perceptions is internally consistent; we cannot assume any external consistency among groups.

In general, no meaningful comparisons can be reliably made about the ordering of different groups' perceptions (measured at the ordinal level) if there is no shared frame of reference common to all groups. As an illustrative example, consider . . . APPLES AND ORANGES. We might ask Group A to rate the taste of a new variety of apple on some monotonic scale such as VERY GOOD . . . GOOD . . . SO-SO . . . BAD . . . VERY BAD. If the purpose here is only to characterize the subjects' perceptions of the taste of the new type apple, this instrument will provide us with a basic measure of whether the new apple is liked or disliked as well as giving us some indication of the strength of that like or dislike.

If, however, our purpose is to find out whether the taste of the new apple, tasted only by Group A, would be perceived by the general population to be "better" than the taste of a new variety of orange, tasted only by Group B, then we must select our measuring instrument and interpret our measurements with much more caution. Should Group A predominantly rate the new apple as "VERY GOOD" while Group B rates the new orange as "BAD" or "VERY BAD," we might reasonably assume that the general population would prefer the apple to the orange. Should Group B rate their orange as "GOOD" or "VERY GOOD," however, the results would be inconclusive for purposes of comparison (since a common frame of reference does not exist) and all measurements might just as well have been taken on the three point scale of: GOOD . . . SO-SO . . . BAD.

Although such a situation would clearly indicate the need for further investigation, the original question of which fruit is preferred by the general population would remain unanswered. The point to be made is that the only valid method of comparing the taste of the new apple to that of the new orange is to have the group making the evaluation sample BOTH fruits and thereby establish the required common frame of reference. With such a common frame of reference, the group can provide truly comparative evaluations on almost any reasonable measuring instrument whether it be rating both fruits "independently," "upon their own merits," or merely asking each subject to state a preference.

In using rating scales to measure subjective data, great care must be taken to avoid the erroneous impression that the instrument itself can impart unwarranted precision to the measurement process. Appending numbers, for whatever reason, to any ordinal scaling does not change the nature of the underlying relations (= or $>$) nor will the procedure produce measurements that are anything other than ordinal in nature. In our apples and oranges example, we could just as easily have taken our measurements on a scale of: (VERY GOOD) 5 . . . 4 . . . 3 . . . 2 . . . 1 (VERY BAD).

Should we resort to such an artifice, however, we must warily guard against the spurious notion that any resultant "numerical" measures are amenable to arithmetic manipulation; computing such parameters as "means" and "variances" on nominal or ordinal scale data, and performing any statistical tests based upon such contrived parameters, are entirely inappropriate and completely meaningless exercises which could lead to very erroneous conclusions.

Although varied approaches have been taken in an attempt to structure subjective data measurements on an interval rather than an ordinal scale, none has proven entirely successful. Efforts have been made to either characterize the distribution of soldier responses in a range of very specific applications or to establish a relatively consistent ordering of verbal descriptors that have been associated with numerical scales. None has general applicability nor provides a suitable means for converting ordinal measurements into interval scale measurements. In any event, there are appropriate techniques of analysis available for use with subjective data which are compatible with ordinal measurements, which are analogous in function to the parametric statistical tests used with interval scale measurements, and which do not require perilous leaps of faith for their application.

Summary

The validity of any test based upon the measurement of subjective human judgment is dependent upon both the measuring instrument used and the ultimate purposes of the measurement. The discussion above demonstrates that you can compare apples and oranges . . . but if you want your comparison to be believable and to be accepted by a critical audience, your measuring instrument and your method of analysis must be adapted to the underlying nature of the data being measured. There is ample room in the test design process for common sense as well as for the application of sound professional judgment; it is imperative, however, that one closely scrutinize the basic assumptions being relied upon.

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Natick Works on New Airborne Assembly Aid

For paratroopers just landing on a drop zone in the middle of unfamiliar territory, in rough terrain at night, to assemble as a unit as quickly as possible is quite a feat considering the confusion and dispersion that may occur. The Natick Research, Development and Engineering Center's Aero-Mechanical Engineering Directorate, working on a U.S. Army Infantry School requirement, is developing a Drop Zone Assembly Aid System (DZAAS) to solve a problem which has existed for four decades.

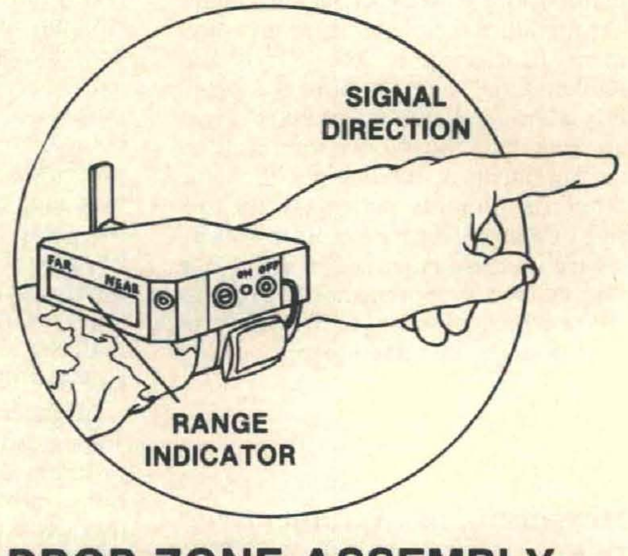
DZAAS is the assembly aid system that has been likened to the Dick Tracy wrist radio. It is comprised of a rugged, two-component system—a transmitter and a receiver. The transmitter is carried by an airborne group leader to the assembly point or is placed on a selected airdrop load and is set to turn on automatically.

The receivers are wrist-mounted with antennas that pick up the distinct signal from the transmitter. A LED light will turn on only when the receiver is pointed in the direction of the transmitter. Prototype testing was completed in June 1986; and, as a result, the transition to full-scale development is underway.

According to project officer George Laliberte, engineering tests at the Electronic Proving Ground, Fort Huachuca, AZ, and Yuma Proving Ground, AZ, confirmed that the system can "expeditiously locate the transmitter, even in rough terrain."

At Fort Benning, GA and Fort Bragg, NC, where the operational tests took place, test reports concluded that the "system appears to have high potential for improving paratrooper assembly and recovery of airdropped equipment loads on the drop zone in the required 1,500-meter range."

Among the test subjects were senior officers of the 82nd Airborne Division. Soldiers rated the DZAAS as "very easy to use in locating loads at night and simple to rig, operate and maintain." They preferred the DZAAS over assembly aids



DROP ZONE ASSEMBLY AID SYSTEM (DZAAS)

such as colored panels, helmet markings and strobe and chemical lights because the DZAAS eliminates visibility requirements.

While it used to take up to two to four hours to assemble an assault force, it now takes only 30 minutes on unfamiliar drop zones during day or night.

Full-scale development will be initiated in FY 87 to eliminate deficiencies noted during the prototype tests, to improve system reliability, durability, and to reduce component size, weight and cost.

Validation of Independent LSAR Software Systems

By John E. Peer

Introduction

Publication in July 1984 of MIL-STD-1388-2A, DOD requirements for a Logistic Support Analysis Record (LSAR), established, for the first time, standard Department of Defense (DOD) logistic data elements, definitions, field lengths, and standard logistic reports. This standardization within the Department of Defense and industry provided the right climate for the development of independent LSAR software systems. To foster these developments, the preparers of MIL-STD-1388-2A included in the standard a set of minimum design criteria for independently developed (i.e., defense contractors) LSAR software systems. The only provision was that any independently developed LSAR software had to be "validated" before it could be used on a DOD hardware development contract.

The term "validation" has been confusing and has been interpreted differently by many individuals. Quite simply, the intent of validation of independently developed LSAR software is to ensure that the software performs, as a minimum, the same functions as the Joint Service LSAR ADP System provided as government furnished material by the U.S. Army Materiel Readiness Support Activity (MRSA). To satisfy this intent, a joint service validation process was established and is detailed in this article.

Software Design Criteria

The general requirements section of MIL-STD-1388-2A defines the minimum design requirements that must be met in designing and validating independent LSAR software systems. These requirements are:

- The software must be capable of accepting input data in the formats displayed in Appendix A using the data element definitions in Appendix F of MIL-STD-1388-2A. As a minimum, it must be capable of processing all data elements that can be validated by the government.

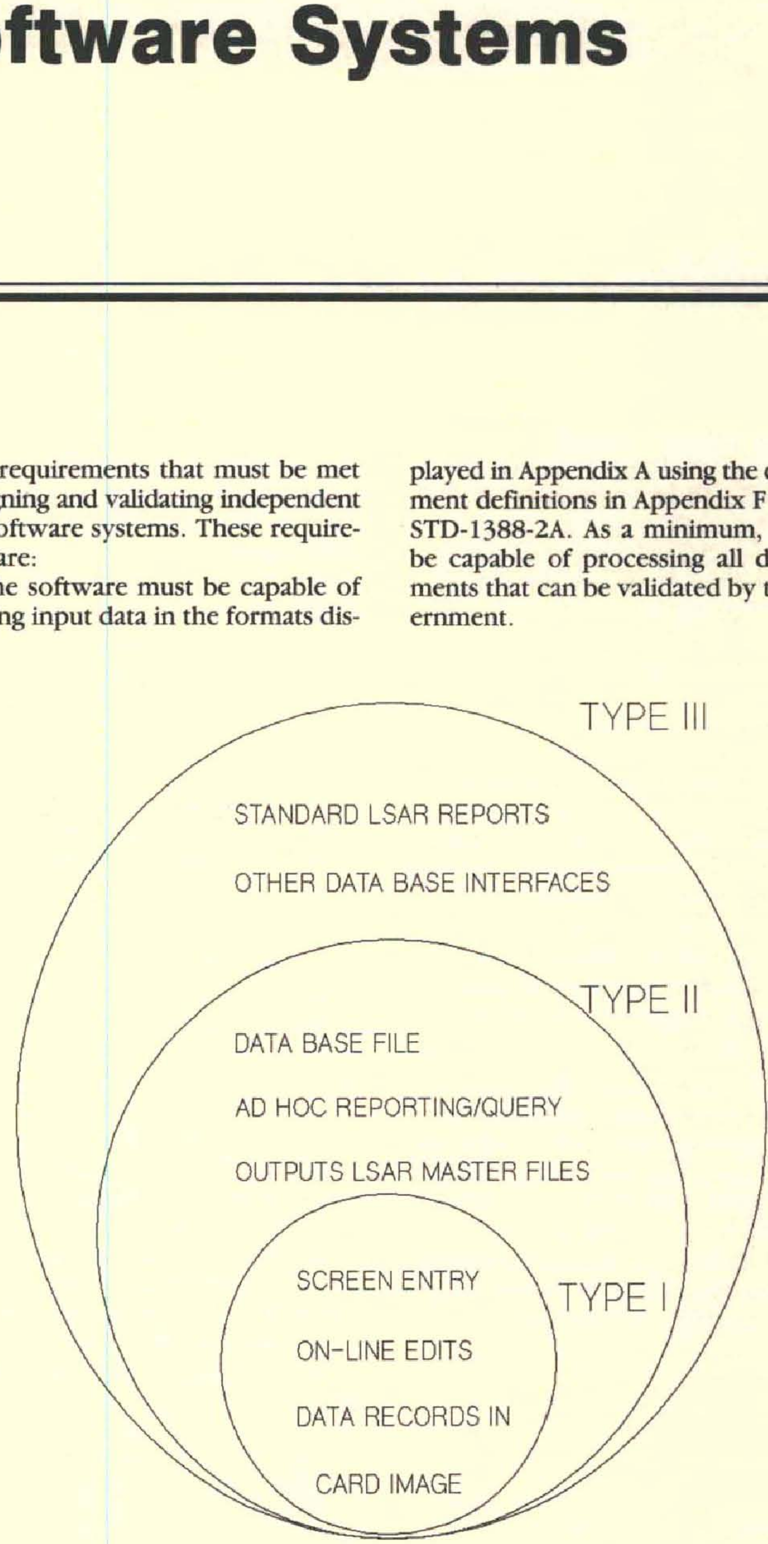


Figure 1. LSAR Software Capabilities by Type.

System Name	System Developer
DILSA	Logistics Engineering Associates
GOLDS	Garrett Turbine Engine Co.
ILSA	Automated Logistics Associates
LDGS	Raytheon Service Co.
LEADS	Evaluation Research Corp.
LLAD	Litton Data System Inc.
PALS	Page International Corp.
No Name	BDM Corp.
No Name	Martin Marietta Corp.
No Name	Pratt & Whitney Corp.
CALSTAR	Lockheed-Georgia Co.
SLIC	Integrated Micro Systems
MILES	Applied Management Sciences

Figure 2. Type I LSAR Software Systems.

System Name	System Developer	System Type	Status
ALSTAR	Boeing Computer Services	Type II	Validated
No name	Sikorsky Aircraft Co.	Type II	Validated
CLASS	Mc Donald Douglas Technical Services	Type II	Validated
SLIC	Integrated Micro Systems	Type II	Validated
SLIC	Integrated Micro Systems	Type III	In-process
MICRO-LSAR	Systems Design and Development Corp.	Type III	In-Process
ALSA	ISC Corp.	Type III	Validated
ALSS	COMARCO	Type III	In-process
UDB 2000	Air Force Human Resources Laboratory	Type II	-------

Figure 3. Type II and III LSAR Software Systems.

- The software must be capable of producing the LSAR software master files displayed in Appendix C of MIL-STD-1388-2A.
- The software must be capable of producing the LSAR reports in Appendix B of MIL-STD-1388-2A either independently or by using the Joint Service LSAR ADP System.

Broken down into simple terms, the above requirements meant that a validated LSAR software system would input the LSAR data, by whatever means, so long as data definitions, field lengths, and data edits were followed. The data could be stored in whatever efficient manner was deemed appropriate. But, it must be able to produce the LSAR master files and reports as products of the software or through use of the government software.

Figure 1 summarizes the basic software capabilities that have been used by independently developed LSAR software to meet the above requirements. The ultimate objective of the requirements has been to foster industry development and use of LSAR software that promotes efficient entry and easy access to the data for analysis and product generation.

Validation Process

Establishing a process to validate independently developed software became necessary for two reasons; first, government agencies needed some method that would tell them that independent software, as a minimum, would perform as well as the Joint Service LSAR ADP System. Secondly, it would provide industry a formal, documented process that stated their software was validated for use on any development effort. With this in mind, the validation process was subdivided into three formal steps:

- categorization of the independently developed LSAR software system;
- based on categorization, validation of the software via demonstration; and
- issuance of a categorization/validation letter.

Categorization of LSAR software resulted in defining three types of software. The basic capabilities of each type are shown in Figure 1. A Type I system is considered an adjunct to the Joint Service LSAR ADP System and does not supplant any of the Joint Service software. As such, it does not require validation. Examples of Type I systems currently available are listed at Figure 2. Type II and III systems do replace part or all of the Joint Service LSAR ADP software and therefore require validation. Examples of Type II and III software and their validation status are shown in Figure 3.

Validation of Type II and III systems by MRSA follows a straightforward procedure that is repeated for each software validation. The procedure involves standard test data, standard LSAR report selections, a validation guide, and the Joint Service LSAR ADP System. Contractors requesting validation are provided standard LSAR test data and the LSAR report selections, if Type III validation is requested.

For Type III validations, a contractor can request to be validated for the specific reports that can be produced by the independent software (i.e., it does not have to produce all the LSAR reports to be validated as a Type III system). It is then the contractor's responsibility to enter the standard test data, by whatever means, into their software system based on the prescribed sequence defined in the validation guide.

The results of data edit ejects (as a typed list or computer listing), along with the independently developed LSAR master files, are returned to MRSA for validation. For Type III systems, the generated LSAR reports based on the report selections would also be provided.

Upon receipt of the LSAR master files, edit results, and LSAR reports, MRSA compares the contractor's results with standard LSAR master files and reports that were generated from the standard test data using the Joint Service LSAR ADP System. If the contractor generated master files and reports "match" the standard master files and reports then the software has passed the validation process.

The "matching" process does allow for differences in the assignment values of secondary keys such as task identification code and failure mode sequence code, as well as, accommodating more stringent data element edits that an independently developed software system might employ.

The final step in the validation process is the issuance of a categorization/validation letter. Contractors that submit a system description for Type I categorization are issued a Type I categorization letter and report from MRSA. Systems that are validated as Type II or III are issued a validation letter and report from the Office of the Secretary of Defense, Weapon Support Improvement and Analysis Office. All categorization/validation letters are good for one year from the date of issuance and are applicable to the entire company. This eliminates the need for divisions of the same company from going through the validation process for the same software.

Naturally, should the contractor enhance the software during the one year period, revalidation of the software is required. Otherwise, the validation is effective for one year. At the end of the year, revalidation would be required. The extent of revalidation would be dependent on the enhancements made to the Joint Service LSAR ADP System and the degree to which the independent software continues to meet the minimum design criteria identified in the standard.

Summary

Publication of MIL-STD-1388-2A has established the interfacing software benchmarks necessary to promote the development and use of independently developed LSAR software. These benchmarks have served as the basis for the validation process that is in place and working to the benefit of government and industry. Continued use of the validation process will ensure the availability of efficient and accurate software capable of meeting the needs of the logistics community.

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Army Miniaturizes Television Displays

The smallest militarized "television" for use by sensors, radars and thermal sights in military aircraft and ground vehicles is only 1-inch square. It was developed at the Electronics Technology and Devices Laboratory (ETDL), Fort Monmouth, NJ. Recently however, ETDL announced what's considered a greater accomplishment—development of the world's largest operating Thin Film Electroluminescent (TFEL) display. It measures 10-inches-by-12½ inches.

Larger panels can be programmed with more information, according to Dr. Elliott Schlam, chief of the Integrated Device Processing and Display Division at ETDL. The larger displays are also much more difficult to develop because of the technology used, he explained.

The television most people have in their homes contains a cathode ray tube—a bulky glass picture tube, Schlam said. The tube narrows at the back into a long neck. The length and subsequent weight, are needed to direct the electrons that produce the image.

"With the thin film display panels, we don't need the cathode ray tube," Schlam said. "Instead of taking the electrons and deflecting them, we use two sets of electrodes that are scanned vertically and horizontally across columns and rows. They create dot patterns of light where they intersect, providing pictures or images."

The largest and smallest TFEL displays belong to a series of display panels developed at ETDL in the past few years in cooperation with researchers at industrial firms under contract to ETDL.

"Commercial developments in flat panel displays haven't, in general, addressed many of the Army's requirements for full temperature range operation, ability to withstand severe battlefield environments, provide light weight, low power consumption and fulfill a lifetime operation requirement all in the same device," said Schlam. "We saw the need for these displays (because of the Army's need to lighten the force), so we just started developing the concept on our own in the 70s."

In 1977, the Army accepted Schlam's thin film display panel concept for use in TACFIRE. Incorporated in the digital message device, the technology provides a better picture and greater power savings through increased battery life. It has also been demonstrated in the Firefinder control van. The van's console and display area had to be condensed. "We programmed a computer with electroluminescent displays, putting in a touch panel of switches for target tracking, radar, TACFIRE message control, and a digital terrain map," he explained.

TACFIRE is a surveillance and data link for the Army's Joint Surveillance Target Attack Radar System.

Today, the displays are used in a number of Army weapon systems, providing video and graphics through electroluminescent black-yellow images. Through the ETDL-developed technology, the compact TVs offer sharper images, and are smaller and weigh less—as little as three to four pounds, compared to 30 to 40 pounds. They can provide live commercial television, remote pictures from a field location, and displays of programmed information, providing push-button intelligence information to soldiers.

High Technology Training at Red River

By George Montgomery

Background

Nestled in the very northeast corner of the Lone Star State (Texas) is the Army's only remaining multi-mission depot, Red River Army Depot. It was named in honor of the Red River which marks the Texas-Oklahoma boundary a few miles to the north. It is, like most other depots, in a rural setting. Also, southern hospitality abounds. These things belie the urgent and dynamic nature of its rapidly changing mission.

The credo of the 5,000 plus Red River employees adopted over a decade ago is "Our Best–Nothing Less." This motto applies equally to performance of current missions and preparation for the future.

In mission performance, the workforce strives for quality, safety and improved productivity. Simultaneously, there is an enormous investment in preparing for the future. This investment has consisted of three primary things. First, Red River is in the midst of the largest real property (facility) modernization in the installation's history.

Simultaneously, the depot is engaged in improvements in equipment with more to come. Second, the Army's Force Modernization initiative (new weapons) has resulted in the installation becoming a center of technical excellence (CTX) for such state-of-the-art new systems as the Bradley and the Multiple Launch Rocket System (MLRS) to name only two. Third, the installation has started the process of modernizing its most important asset, human resources. As a matter of fact, the depot has launched a multi-faceted High Technology Training Program aimed at making sure employees know how to use, troubleshoot and fix state-of-the-art facilities, equipment and systems. This article is about that training effort.

Training

Between wars, the Army trains, trains . . . and trains some more. This makes sense these days because the strategic planners tell us we can't out man or out gun the ultimate enemy. Consequently, the force has the edge only to the degree that it has state-of-the-art technology housed in the best equipment money can buy and the soldier knows how to use it well.

The principle of hard training and regular retraining is more important than ever before because of the speed of technological change. This concept applies to the whole force . . . civilian as well as military. Things that used to be in science fiction movies are now an integral part of everyday life. Those issues, concerns and needs that yesterday belonged to the realm of scientists and engineers moved seemingly with the speed of light to the work benches of depot mechanics and electronic technicians.

The "future" began arriving at Red River (and at other depots) some years ago in the form of computers, robots, advanced electronic equipment and a host of other ultra-modern devices. There is today an avalanche of new technologies at the depots demanding that they be mastered. As scientists and the Army's laboratories wrestle with microelectronics, artificial intelligence and biotechnology, more new technologies will come pouring into the Army. Ultimately, one or more depots will be involved in fielding, maintenance or serving as test beds for this technology.

From all indications, the pace of technological change will continue to accelerate into the foreseeable future. It is anticipated that by the year 2000, every single job at Red River will involve some work with high technology equipment. The clear implication of this prediction is that every employee will need high technology training of some type. In addition, they will need to be retrained with regularity to prevent obsolescence.

High Technology Needs

In order to meet present and future technology related training needs, the depot is operating a special High Technology Training Program. The program is approximately a year and a half old. The pilot classes were given in September 1985. The concept for the program originated with then depot Commander COL Dennis L. Benchoff. COL Benchoff's motive in launching the unique training program was to prepare the depot's employees to meet future mission requirements. In an interview a few months after he took command he commented, "This depot needs to become a modern installation with a technically qualified workforce. The alternative is that this place will become a museum."

In order to insure the right subjects would be taught, a special Ad Hoc High Technology Training Committee was established to determine what Red River's current and future high technology training needs actually were. This committee performed an exhaustive needs analysis by means of a series of surveys and meetings. These surveys and meetings confirmed that a large amount of various high technology training was desperately needed now. Even larger amounts were predicted in the out years by the various modernization initiatives.

The ad hoc committee identified seven specific areas for which immediate training was needed. These areas are—literacy of new technology, computer software and languages, computer hardware and systems, electronic communications, electronic test equipment, office automation and technologically related fields. This committee also concluded that training was needed at three levels—operator/user (those engaged in running the equipment), maintenance technician (those responsible for fixing the equipment), and management level (those who oversee the use and maintenance of the equipment).

Based on the initial survey, 43 different specific courses were identified. After further analysis and review, the initial list was reduced to approximately 20 courses aimed at meeting current hi-tech needs.

Armed with this information, a variety of sources were examined to determine how to meet this unprecedented training need. While continuing to use, and even increase, all of our normal resources, e.g. in-house, commercial vendors, AMC schools, etc., a dialogue was expanded with Texarkana Community College, a local community college. Texarkana Community College, we discovered, was a ready and willing partner in striving to help Red River meet the gigantic task of providing state-of-the-art training to 5,000 people. This institution had met many of Red River's training needs over the past 20 years; e.g. mechanic training, basic skills, welder training, etc. The dialogue produced the framework from which the following high technology programs have sprung:

- a full scale electronics program with both duty and non-duty offerings,
- complete training in all aspects of computers including latest state-of-the-art software, and
- industrial electricity.

As you can see, we used a very simple approach. First, we determined what our needs were. Second, we made definite plans for meeting those needs over the long haul. Third, we told the college what our needs were and they met them. Today, we have a firm foothold on a dedicated high technology training program.

The genesis of our program is tied directly to the influx of new technology to the depot. The program has been implemented in phases (three or four courses at a time). Thus far, the cost has been extremely competitive averaging $4.00 per contact hour, less than any other source.

Since the summer of 1985 when the first courses were taught in which 80 employees participated, we have evolved into about 300 people per quarter participating in this program.

The Future

The future appears bright for this training program. By developing a local resource capable of providing Red River employees training in such diverse fields as electronics, computers and telecommunications, Red River has established a significant training base from which to launch itself into the 21st century. As the training implications of current research, development and acquisition efforts make their way to the depot, we plan to be ready.

Lest the reader misunderstand; we have not arrived but rather the journey has just gotten underway. While a high technology training program of which we are very proud does exist . . . it is still in its infancy. The long-range plan calls for the program to evolve into a stand alone, dedicated new Technology Training Center devoted to keeping the Army's depots abreast of technological change.

GEORGE MONTGOMERY is Red River Army Depot's training officer. He holds a master's degree in public administration from the University of Oklahoma.

Defense Secretary Issues Acquisition Charter

Secretary of Defense Caspar W. Weinberger has issued DOD Directive 5134.1, which assigns the responsibilities, functions, and authorities of the under secretary of defense (acquisition). The position is currently occupied by Richard P. Godwin.

This is the final step in fulfilling one of the key findings of the President's Commission on Defense Management, which recommended that all DOD acquisition management functions be consolidated under a single top-level DOD official reporting to the secretary of defense.

The charter provides that the under secretary of defense (acquisition) shall serve as the defense acquisition executive, the DOD procurement executive, and the principal assistant to the secretary of defense for acquisition management. As such, he will supervise all matters within the Department of Defense relating to the acquisition system, including: research and development; production; logistics; command, control, communications, and intelligence activities related to acquisition; military construction; and procurement.

Consideration initially was given to granting the under secretary direct line authority over the service acquisition executives and their subordinate structures. During the coordination of the charter in draft form, the general counsel of the Department of Defense advised that such an arrangement would be inconsistent with the statutes which establish the service secretaries as the heads of their military departments. Accordingly, the service acquisition executives will continue to report directly to the service secretaries.

Under the charter, the under secretary of defense (acquisition) has the authority to direct the service secretaries on all matters falling under his cognizance. This provides the under secretary with ample authority to carry out his responsibilities and to oversee the service acquisition executives and the acquisition programs of the military departments.

The under secretary of defense (acquisition) will supervise the following Office of the Secretary of Defense officials: director of defense research and engineering, assistant secretary of defense (research and technology), assistant secretary of defense (acquisition and logistics), assistant secretary of defense (command, control, communications, and intelligence), assistant to the secretary of defense (atomic energy), and director of small and disadvantaged business utilization.

In addition, the following Department of Defense organizations will report directly to the under secretary: Defense Advanced Research Projects Agency, Defense Communications Agency, Defense Logistics Agency, Defense Mapping Agency, Defense Nuclear Agency, and Defense Systems Management College.

Leaders in Customer Care . . .

The Army Waterways Experiment Station

Introduction

Since its creation in 1929, the U.S. Army Engineer Waterways Experiment Station (WES) in Vicksburg, MS, has tackled a variety of the nation's problems, both in the military realm and in the civilian sector. As the U.S. Army Corps of Engineers largest laboratory, WES is a shining example of the Corps slogan, "Leaders in Customer Care!"

WES operates on a reimbursable basis with customers paying the cost of research. Currently, over 150 organizations, including the Army, Navy Defense Nuclear Agency, Environmental Protection Agency, and other federal and state agencies, sponsor approximately 2,000 projects at WES. WES prides itself in the fact that its customers receive specialized care and attention.

Today, military research comprises 51 percent of the 1987 WES work program of $137 million. Civilian sponsors form the remaining 49 percent of the work program. The WES facility, with buildings and equipment valued at $86 million, employs over 1,500 civilians and 14 military officers.

The six WES laboratories, each able to work independently or together, conduct a broad range of military and civilian research. Because of space limitations, only one military project from each laboratory will be summarized in this article.

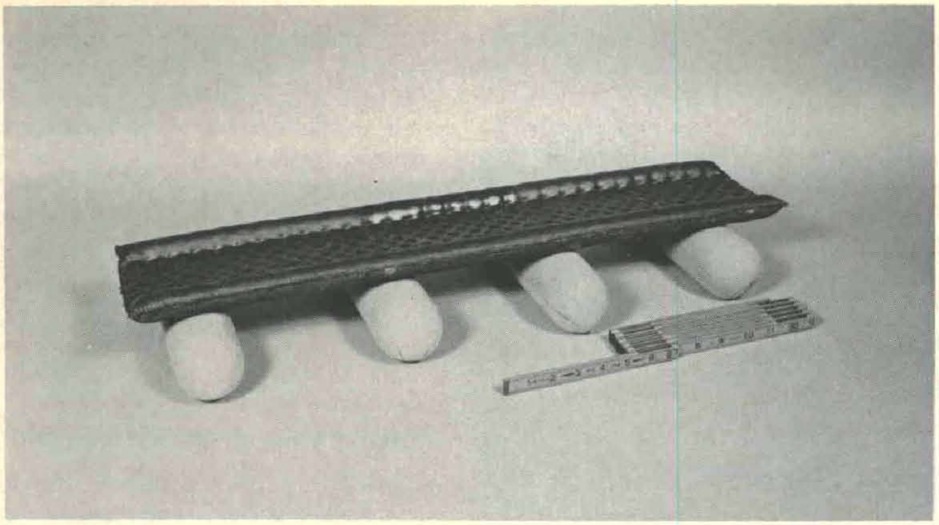
Hydraulics Laboratory

The Hydraulics Laboratory was the original "Waterways Experiment Station" from which WES derived its name. Research relating to locks, dams, flood control, navigation, sedimentation and dredging are conducted daily. One current Hydraulics Laboratory project involves a footbridge evaluation for the Army.

The footbridge was developed to be portable and to help keep soldiers and equipment dry while crossing streams. In this research, the WES Hydraulics Laboratory evaluated an existing footbridge design of a polyurethane foam/ fabric composite.

Engineers constructed a 1:9 scale model. After undergoing tests of several modifications to its original design, the floating sectional footbridge was altered to include the use of 8-foot-long by 2-foot-diameter pontoons underneath the footbridge that aligned with the water flow. The modification raised the load carrying capacity and increased the safety factor of the footbridge. At a stream velocity of 10 feet per second, the bottom of the walkway section was approximately one foot above the water surface. The footbridge is anchored to land on both ends.

The U.S. Army Engineer Waterways Experiment Station is located on 685 acres southeast of Vicksburg, MS.



Flotation Footbridge

Geotechnical Laboratory

The WES Geotechnical Laboratory conducts research in soils, pavements, mobility, trafficability, engineering geology, and earthquake engineering. A recent project involves a program that will help the Army evaluate railroad tracks on Army installations across the nation. This evaluation is necessary because military mobilization missions require the use of railroads for equipment and personnel transport.

The Army is responsible for maintaining 2,800 miles of railroad track at 106 installations scattered across the nation. Much of this track was built to meet the logistical demands of World War II. Today, the track is approaching 40 years old and in an undefined state of repair.

Research is developing a four-point evaluation program that includes visual inspections, track geometry testing, rail flaw testing, and track deflection tests. This program will assist the installation facilities engineers and planners in track evaluations by providing a sound engineering basis for decisions in track maintenance planning and track rehabilitation.

Structures Laboratory

The WES Structures Laboratory investigates phenomena in the fields of weapons effects, earth dynamics, structural design and behavior, and materials technology. A recent military project involved the study of rock-rubble/boulder overlays as components of a deflection shield for conventional kinetic energy weapons.

The concept involves the placement of several layers of hard boulders in a random pattern along the initial path of the incoming weapon. As the weapon tries to pass through the rock matrix, it will deflect from its initial path, ricochet or broach, or break up.

The investigation included subscale laboratory testing and full-scale experiments, as well as development of analytical tools for computer simulations of the penetration of projectiles into boulder overlays. The test results indicate that the protective potential and the effectiveness of rock-rubble overlays depend, to a great degree, on the characteristics of the weapon against which an installation is to be protected.

One of the problems with developing a "best" shielding device against air-launched weapons is that several types of threat weapons exist. WES research delves into methods to lower shield costs and provide shields subject to upgrade against more powerful future threats.

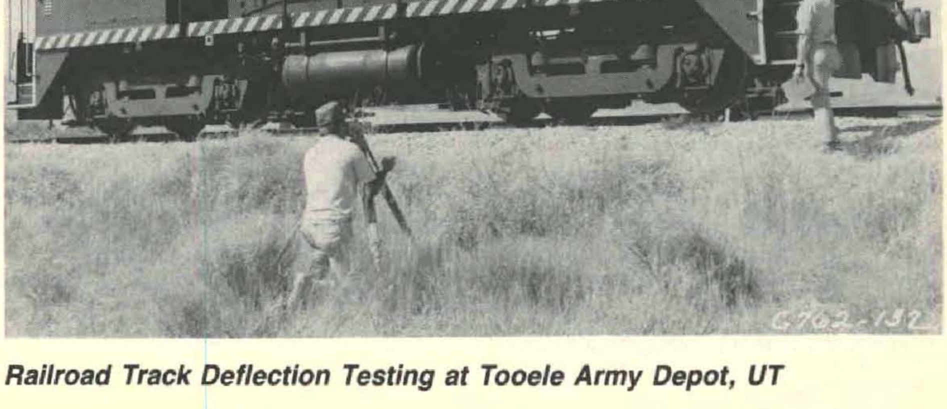
Environmental Laboratory

The WES Environmental Laboratory's mission is to investigate the effects of man's activities on the environment and to determine the environment's effects on military operations. A new five-year project involves assisting Army field commanders in the location of ground water in unfamiliar terrains.

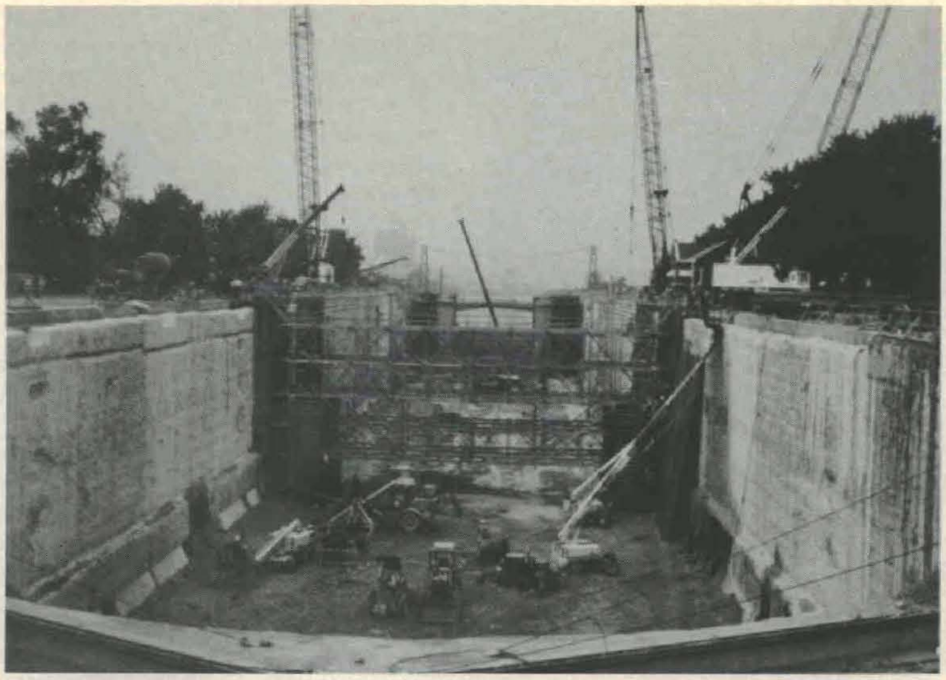
The "Water Resources Advisor" system must overcome the limited information available concerning subsurface water supply in many parts of the world. The end product of the study will be a computer program for use by field commanders in interpreting water resources data concerning potential water well drilling sites.

Coastal Engineering Research Center

The Coastal Engineering Research Center (CERC) researches the effects of waves, winds, water levels, tides and currents on shore and beach erosion, coastal protection, navigation, coastal dredging and harbor design. A current military project involves the use of a $1 million directional spectral wave gen-



Railroad Track Deflection Testing at Tooele Army Depot, UT



Truss system holds forms in place during lock repair, one area of the Research, Evaluation, Maintenance and Repair (REMR) program.

erating machine to study explosion-generated waves.

In a Navy sponsored project to define the vulnerability of moored submarines to explosion-generated waves, CERC is using both physical and numerical models to obtain data. An unclassified site, Sinclair Inlet on Puget Sound, has been selected for the physical model tests and for use during development of numerical models.

The tests are being conducted using the directional spectral wave generator to simulate the radial spreading of the wave train from the explosion source. This is one of the few wave generators in the world capable of producing such wave trains in a small-scale physical model. The physical model results will be used to calibrate and verify numerical wave and submarine displacement response models.

Information Technology Laboratory

The Information Technology Laboratory (ITL), created in 1986, forms the sixth WES laboratory. The ITL mission includes development of methods to advance the Corps knowledge and capability for the effective use of computers in engineering. ITL is heavily involved in the development of science-oriented computer hardware and software solutions for applications in research, applied engineering, management and business.

ITL personnel also serve as consultants in information technology areas. This provides engineers both at WES and at Corps installations world-wide with highly technical state-of-the-art expertise in a form easily converted to field applications. The Computer Aided Engineering and Architectural Design System (CAEADS) is a project designed to improve the design of military structures.

CAEADS is a research project designed to link selected building system programs developed or recommended by the Computer Aided Structural Engineering (CASE) project. This will allow Corps designers to use computer-aided design techniques from conceptual to final design of military building systems.

Another objective of this project is to develop the methodology for analysis of the structural response of rib mats to heavy loads and differential foundation movement. This capability will allow the development of design procedures that will lead to reduced design, construction, and maintenance costs for military building systems.

A CAEADS numerical study, using a CASE developed program, to determine critical parameters for analysis/design of rib mat slats has been completed. Results of this study were correlated into design procedures by the Corps' Southwest Division for use by its Districts and contracted architectural engineering firms.

Other Research Programs

Another WES program is the Research, Evaluation, Maintenance, and Rehabilitation (REMR) Program located in the WES Structures Laboratory. This $35 million, six-year program, has exceeded the halfway mark. It provides field personnel with affordable technology to maintain existing civil works projects and to extend the service life of projects where possible.

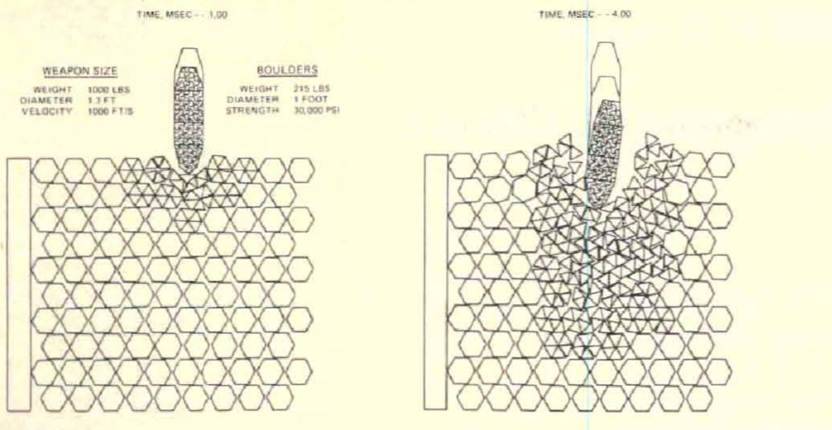
REMR develops guidance in seven problem areas: concrete and steel structures, geotechnical, hydraulics, coastal, electrical and mechanical, environmental impacts, and operations management. The program emphasizes technology transfer by using such media as reports, newsletters, field notebooks, video tapes, workshops, and briefings.

WES plays both a national and international role in performing basic and applied research. WES engineers develop research methods and techniques. They test materials and equipment and they provide consulting services in their specialized fields.

The WES manpower distribution includes 428 engineers, 256 scientists, 340 technicians, and other personnel totaling over 1,500 people. In addition, WES employs experts, consultants, personnel from academia and contract students. The professional/technical staff includes 14 types of engineers and 29 types of scientists, of whom, 117 hold doctorate degrees.

An important part of the WES role is technology transfer. The results from the WES research are published in technical reports that are available from the WES Reports Distribution Center. ON-TYME electronic mail users (ID: CORPS.WES/REPORTS, Key: I-WES CARES) have access to a complete listing of new reports as they are distributed.

Many WES employees are world-renowned leaders in their specialized fields. These specialists lead seminars, workshops, and professional meetings



Distinct element method for showing a projectile penetrating a rock-rubble screen

both at WES and around the world. Other employees are offered career-advancement opportunities through seminars, workshops, professional meetings, long-term training, and other educational opportunities.

Recently, the WES graduate institute was established to provide a center for graduate education and research in Vicksburg. The institute is an association of three universities and WES that provides graduate education in the technical areas of most interest at WES and to augment WES research efforts. This affords WES employees advanced educational opportunities in the Vicksburg area.

The multi-faceted WES mission is a complex story involving scientists and engineers in world-wide research. WES is and will continue to be a leader in "Customer Care" by providing the WES product of timely and cost efficient research results.

The preceding article was edited by Karen Magruder, a writer-editor in the Public Affairs Office at the U.S. Army Waterways Experiment Station.

Supercomputers Aid in Weapons Design

Thanks to its new supercomputers, the Army will be able to rely more on computer models that simulate real-world problems to gather research data for the analysis and design of advanced armor, guns, and munitions.

Installed earlier this year at the Ballistic Research Laboratory (BRL) at Aberdeen Proving Ground, MD, the supercomputers promise to significantly advance research in five BRL divisions—interior ballistics, launch and flight, terminal ballistics, vulnerability/lethality, and system engineering and concepts analysis.

Research chemists in BRL's Interior Ballistics Division study what happens inside a gun tube when a weapon is fired. They seek to learn about the properties of hypervelocity propellant charges that will provide more thrust or greater mechanical impulse from a given amount of materials. Thus, they aid developers of new munitions and assist armor developers to defeat the new munitions threats posed by potential adversaries.

During a recent study of energy-storing, metastable (fast-reacting) gases, a supercomputer showed that they possessed more energy than could safely be contained. As a result, they could not serve as an energy storage medium for propellant charges.

"These types of data are not generally known," said Dr. George Adams. "You can't look it up in tables, you can't measure it. Metastable materials and other classes of high-energy materials are just not susceptible to experimental study. Metastables are so reactive they change immediately upon touching anything else and make a different product. But they do lend themselves to computer modeling. The models needed to study the materials have been developed at BRL and are accessible via computers."

As a partial result of the study, chemists are looking at helium as a potential energy storage medium. While it produces less energy than reactive gases do, it is more easily controlled.

In the Launch and Flight Division, engineers are studying the aerodynamics of projectiles using sophisticated computer codes that allow them to determine the velocity, pressure, and temperature of the air flow around projectiles during various stages of flight. From these detailed descriptions of the flow field, engineers can determine, for instance, the heating on the projectile while traveling at supersonic and hypersonic speeds. At such speeds, components of kinetic-energy penetrators have been known to melt.

Supercomputers also are aiding division efforts to use solid fuel ramjets as tank training rounds for kinetic-energy penetrators. In Germany, penetrators have the potential to travel beyond test range boundaries and land in adjacent farm yards. Ramjets can simulate the trajectory of penetrators without flying as far and threatening the countryside.

Because fuel is burned inside the ramjet during flight, developers wanted to be able to see the intense flow field inside as well as outside the projector. Wind tunnel tests could only provide a limited understanding of the flow within the projectile. With the supercomputer, however, computational aerodynamic codes have been written that allow engineers to literally "see" inside the ramjet.

With supercomputer simulations and live experiments, the Terminal Ballistics Division studies the effects of advanced new munitions on armor. A single simulation can contain from 500 to 600 "time steps." Each step is less than a millionth of a second in duration. Live experiments can then be used to verify the effectiveness of the design concept.

BRL's supercomputer administrator, Howard Walter, expects the storage capacity of the Cray X-MP/48 to be tested in the not-too-distant future—even though its four central processing units share eight million words of memory. The second supercomputer, a Cray 2, will have 32 times as much storage capacity as the first supercomputer.

The Army plans to install a second supercomputer at BRL in June and a third one at the Tank-Automotive Command (TACOM) in Warren, MI, by the end of the year.

Career Development Update

From the FA 51 Proponent Office...

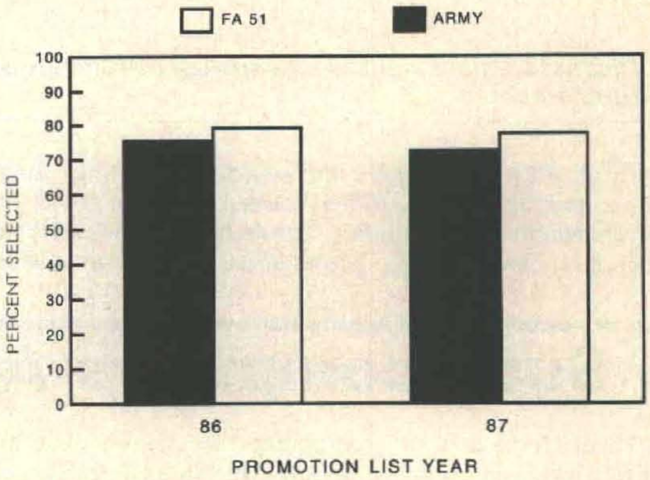
Educational Requirements Board Results

Results of the 1986 Army Educational Requirements Board (AERB) were recently released by the U.S. Army Military Personnel Center. There were 486 positions submitted for validation within Functional Area 51. Of those positions submitted, the AERB approved 436 for advanced civilian education utilization. There were 414 positions approved at the master's degree level and 22 positions approved at the doctorate level. Functional Area 51 has one of the most diverse AERB programs available. Within the engineering, physical science and business discipline sets, 51 distinct areas of study were identified.

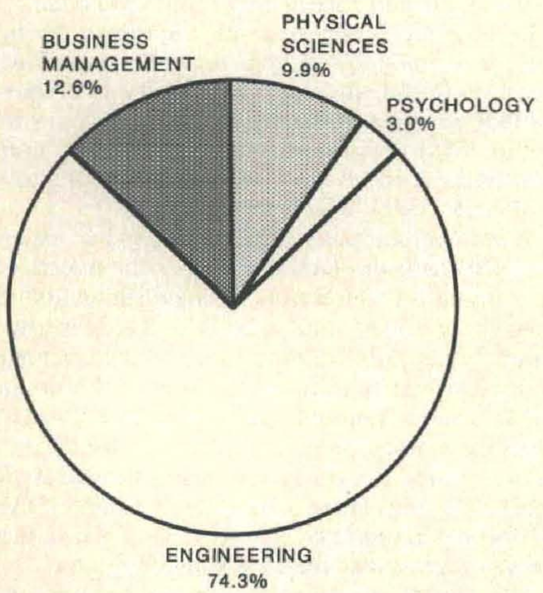
1987 Major Promotion List

The 1987 major promotion list was released in February 1987. A total of 204 Functional Area 51 officers were in the primary zone of consideration. Congratulations to the 156 officers selected for promotion. A review of the statistical summary provided as part of the promotion list, reveals that the FA 51 rate of selection was 76.4 percent, while the Army rate of selection was 72.3 percent.

MAJOR PROMOTIONS – FIRST TIME CONSIDERED



UTILIZATION POSITIONS (BY DISCIPLINE SETS)



Request for Research Topics

The FA 51 Personnel Proponent Office would like to initiate a listing of suggested research topics for use by FA 51 student officers pursuing advanced civilian education under the Army Educational Requirements Board program. Topics relating to research and development or test and evaluation will then be available to FA 51 officers for use in theses and dissertations. Proposed topics should include the following information:

- Thesis Topic
- Sponsor (organization and point of contact)
- Topic Description
- Enumerated Objectives
- Resource Requirements (e.g., TDY, other)

Information Request Line

The FA 51 Information Request Line is back in operation. Questions or comments on general professional development issues may be telephoned in by calling AUTOVON 284-8571 or commercial (202) 274-8571. During normal duty hours, you may reach the FA 51 Personnel Proponent Office by calling AUTOVON 284-8538 or commercial (202) 274-8538. Correspondence should be addressed to: Commander, U.S. Army Materiel Command, ATTN: AMCDE-O/CPT Forsyth or Miss Green, 5001 Eisenhower Avenue, Alexandria, Virginia 22333-0001.

From The Field...

First Robot Installed at Rock Island Arsenal

Rock Island Arsenal took a major leap forward in manufacturing technology recently when its first industrial robot became operational. The robot, dubbed "Samson," is expected to be the first of many that will be installed in coming years as the arsenal modernizes its manufacturing operations. In fact, a second robot, which inevitably was named "Delilah," is already in place and should begin running shortly.

Samson, a product of Cybotech Inc. of Indianapolis, IN, was purchased and installed for a total cost of about a half-million dollars. To make that investment pay off, the robot has been put to work welding. Samson's supervisor is Larry Becker, a welding foreman in the Fabrication Branch of the Arsenal Operations Directorate. So far, Becker is pleased with the performance of his new worker.

"Samson's met all our requirements," Becker said. "There hasn't been any problem with the quality of any of the welds."

Samson's first assignment has been to produce cradles for the cannon on the M1A1 Abrams tank. The robot can turn the cradles out at a rate of one every 45 minutes; in contrast, the manual welding of the cradles takes a little less than two hours. Each robot weld was a duplicate of the one that came before it, as opposed to manual welds which tend to vary.

Information like this, combined with the fact that robots don't take breaks or use leave, has led some to conclude that robots will someday replace people. But, Jerry McCartney, chief of the Fabrication Branch, noted that robots are only intended as a tool to make people more productive and to enable them to make better use of their uniquely human skills.

"Basically, robots are stupid," McCartney said. "They do the same thing over and over again without question. If you program them wrong they'll keep making the same mistake again and again until they're turned off."

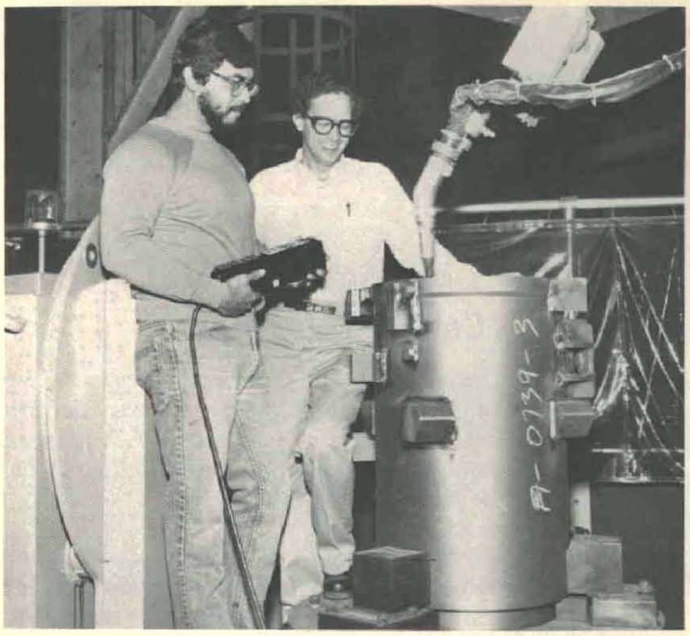
Because robots can replace human labor but not human judgement, people will always be needed to program, operate and monitor them. According to McCartney, this means that the introduction of robots will not cause the arsenal to displace anyone, but rather to retrain employees in order to move them into different jobs requiring different skills.

"Employees will work more with their minds and their eyes and less with their hands," McCartney said. "We'll be able to use robots to free people from performing tedious, dirty and dangerous tasks." McCartney pointed out that robots and other automated machines will give the arsenal the competitive edge it will need if it wants to remain as the free world's largest arsenal.

Basically, Samson is made up of two hands, an arm and a brain. The robot's "brain" is a high-capacity computer that stores and transmits the thousands of pieces of information needed to control its movements.

The computer is connected to the robot's arm, which can be moved into a variety of positions. The "hand" at the end of the arm is equally flexible and can be adapted for jobs other than welding, such as "pick-and-place" material handling operations.

The robot's other "hand" is a positioner, a moveable platform where the item the robot will work on is placed. By coordinating the movements of the arm and the positioner, the operator can take the robot through a full range of motions.



Welder Joe Lopez (left) and Cybotech representative Don Godfrey check out the performance of Rock Island Arsenal's first robot.

The idea to acquire a robot was hatched two years ago. A five-member team was then formed to work on the robot project. Along with McCartney, the team consisted of manufacturing and engineering technicians Bruce Buchholz, Harry Pulsifer, Don Rockwell, and Don Tice.

"We knew that people would be needed to make the robot work, so we wanted to get as much technical expertise and as many different views and ideas on the team as we could," McCartney said.

It took only two years for the robot to go from idea to operation, a fast turn-around that McCartney attributed to the hard work of team members and the high-level support the robot project received.

Initially, the team planned to purchase only one robot. Through a stroke of good luck, however, they were able to acquire Delilah. Delilah had been used in a test project by the Tank-Automotive Command. When the project ended, TACOM planned to dispose of the robot by selling it back to private industry.

The Rock Island team got word that the robot was available, and so inquired about it. Coincidentally, the TACOM robot was an earlier version of the model the arsenal was about to purchase.

"Since the robot was already a government asset, we picked it up for the cost of shipping and installation," McCartney said. "And, since Delilah and Samson both happen to be made by the same company, we can standardize training and the acquisition of spare parts."

Samson and Delilah have been temporarily set up in one of the arsenal's World War II era buildings, but will be moved into a new building, along with the rest of the welding shop, as part of a modernization effort known as Project REARM. The move is not scheduled to take place until sometime next year.

"We didn't want to move the robot twice, but we felt that the experience we would gain by using it and training on it would outweigh the disadvantages of moving it again," McCartney said. Samson and Delilah will be joined by other robots in the future as the arsenal continues to automate and modernize. More automation will serve to make the arsenal's people more productive.

MALOS Trains Combat Engineers

The U.S. Mechanized Infantry Task Force is dug in, awaiting the advance of the enemy. Suddenly, hundreds of enemy tanks appear on the horizon. The U.S. unit fires TOW missiles, killing some of the Red tanks outright. Other Red tanks encounter minefields and incur heavy casualties. Tracers from both units flash back and forth.

The "battle" is actually being run by a computer program called MALOS, that simulates a combat environment. Like war games at video arcades, MALOS, which was developed by the U.S. Army Construction Engineering Research Laboratory's (CERL) Facility Systems Division, is fun and interesting to play. However, MALOS is also accurate enough to be a valuable teaching aid.

The U.S. Army Engineer School, Fort Belvoir, VA, uses the program to train combat engineers to develop effective battlefield obstacle plans in support of a maneuver commander's defensive plan.

The task of creating a defensive obstacle plan is complicated and time-consuming—not suited to on-the-job training. Using a computer-simulated war game is a practical way to give combat engineers "field experience" in obstacle employment principles.

Prior to MALOS, combat engineers could spend as much as two days playing a board game to gain the same amount of experience that MALOS offers in 15 minutes of play. It can store and run an almost unlimited number of scenarios and up to seven different preplanned attack plans for each scenario.

MALOS has a library of game maps and attack plans that Army Engineer School instructors can quickly customize to emphasize a particular learning objective. Instructors do not have to be experts in computer programming to use MALOS. Designing a new scenario is an easy step-by-step process.

The instructor's first step in designing a scenario is to create a game map. Once the game map is prepared, the instructor develops a scenario data file that defines the "rules" of the battle: number of periods available, map scale, number and types of weapons and other assets, the order of battle, the Red attack plans, etc. The program is data based rather than hard coded to allow maximum ease and flexibility in scenario design.

Students begin playing the game by planning and implementing a defensive obstacle plan on the map. Because the number of work periods is limited, students learn the importance of setting priorities. When the students run out of work periods, MALOS executes the battle. The combat phase takes 15 minutes or less to run.

Students can implement many different obstacle plans in the same scenario to study the varying effects of the different plans. This strategy helps them identify their weaknesses and improve their performance.

Dr. Jim Snellen of the University of Illinois developed MALOS under contract with CERL. MALOS runs in a solitare mode using standard PLATO system hardware. Distribution of MALOS software is limited to U.S. Government agencies. Additional information is available from John Deponai, USA-CERL Facility Systems Division, commercial phone (217) 373-7271, FTS 958-7271, or toll free (outside IL) 800-USA-CERL, (in IL) 800-252-7122.

Innovative Bids May Save $800,000

The U.S. Army Laboratory Command (LABCOM) used a better idea to get IDEAS and save the Army an estimated $800,000 over the next five years.

IDEAS stands for Interactive Data Evaluation Analysis System—a computer system which will provide engineering support for the Army's fuze systems, and the technology base for the Anti-Radiation Missile. The original IDEAS was purchased 12 years ago, and needed an upgrade, which was purchased through LABCOM's FY 86 Productivity Investment Funding program for the Advanced Electronics System Laboratory of Harry Diamond Laboratories in Adelphi, MD.

The better idea to purchase the new system was an innovative bid evaluation process called "Life Cycle Cost Analysis." Clyde Warner, Contracts Branch, Installation Support Activity, explained that the traditional method of buying such equipment would be to award a contract to the lowest responsible bidder who meets all specifications based only on the initial cost of the hardware and software.

However, under life cycle cost analysis, the contract for the system's upgrade was awarded based on the lowest cost over the anticipated work life of the system—in the case of IDEAS, a five-year period.

Warner pointed out that although the successful contractor submitted the second highest bid for the initial hardware and software, it turned out to be the least expensive when factors such as operation and maintenance, options to be added later to the system, efficiency of operation, and customer support, were figured in. "Using this method, you aren't forced to buy the cheapest equipment and sacrifice quality," Warner said.

Dennis Cook, supervisory electronics engineer, who drafted the requirements document to procure IDEAS, said the idea behind life cycle cost analysis is to consider more than just initial cost. "Initial cost is only a fraction of what the government spends to use the system over its working life."

Rather, Cook explained, his proposal included both above line and below line costs. Above line costs included the basic system, five years of maintenance, and hardware and software options which can be purchased for up to three years off the existing contract without the need for a new proposal. Below line costs included factors such as execution speed, user friendliness, conversion difficulty, customer support and energy costs.

By devising a weighted scale to measure the importance of each of the below-line factors, Cook was able to come up with cost estimates for each. Thus, he was able to project costs over the five-year period in order to compare bids from potential contractors, who had also based their bids over a five-year period. Cook said it paid off.

Buying the better equipment up front rather than the equipment which was least expensive when based only on the initial cost for the system will yield an estimated savings of $800,000 over the five-year period, according to Cook.

Solar Energy Technology Protects Army Equipment

A scientist at the Troop Support Command's Belvoir RDE Center has found a way to use solar energy technology to protect Army equipment from detection by thermal sensors.

Richard Bulova of the center's Countersurveillance and Deception Division came up with the idea of using black oxides of nickel or chrome, substances used in solar panels, to reduce the amount of heat emitted by the exhaust systems of Army vehicles. "I started working on this about a year and a half ago while I was doing some infrared studies," Bulova recalled. "I noticed that the easiest thing to find on a vehicle was its exhaust system. Enemy sensors could pick it up and use it to target or identify the vehicle. Then, I came across an article about the composites used as solar energy collectors. They retained heat rather than radiating it into the atmosphere. I got the idea of using them to plate vehicle exhausts."

Bulova began to work with the composites as part of the center's In-House Laboratory Independent Research Program. Last year, as a first step the center awarded a contract to plate the exhausts of six 2½-ton trucks with black nickel. So far, tests have shown a significant reduction in the amount of heat given off by the trucks, and they retained this capacity even after a year of evaluation. Bulova estimates as much as a 200 percent improvement in reducing the possibility of detection may be possible. Similar results are expected with black chrome plating applied to three trucks under a contract awarded this year.

Vendors have estimated that the significant protection against detection could be provided for as little as $30 per vehicle.

Bulova has recommended that the Tank-Automotive Command begin a product improvement program to incorporate these coatings into their standards whenever possible, and that the center evaluate equipment currently under development for possible applications of these coatings as part of its responsibility as the Army's lead laboratory for camouflage technology.

Conferences & Symposia...

Upcoming Conferences

- 36th Defense Conference on Nondestructive Testing, Oct. 26–29, St. Louis, MO. POC: SFC Alan E. Kemmerling, or G.M. "Mike" Behnen, AV 693-1786 or (314) 263-1786.
- 9th Interservice/Industry Training Systems Conference, Nov. 30–Dec. 2, Washington, DC. Additional information: (305) 646-4500.

Operations Research Symposium Scheduled

The 26th Annual U.S. Army Operations Research Symposium (AORS XXVI) will be held Oct. 14–15, 1987 at Fort Lee, VA. Some 200 Army, academic, and industrial leaders are expected to participate.

The theme of this year's symposium is "Army Analysis Lighting the Way." The symposium will allow an exchange of information and experiences on significant Army analyses completed recently or on-going with a view to enhancing Army analysis and exposing the practitioners to constructive critique and, in general, broadening the perspective of the analysis community.

Attendance will be limited to invited observers and participants. Papers will be solicited which address the theme of the symposium. Selected papers and presentations will be published in the proceedings.

The U.S. Army Materiel Systems Analysis Activity (AMSAA), directed by Keith A. Myers, is responsible for the overall planning and conduct of AORS XXVI. For the 14th consecutive year, the U.S. Army Logistics Center, commanded by LTG William G.T. Tuttle Jr., the U.S. Army Quartermaster Center and Fort Lee, commanded by MG Eugene L. Stillions Jr., and the U.S. Army Logistics Management Center, commanded by COL Robert C. Barrett, Jr. will serve as co-hosts.

Inquiries pertaining to the symposium should be directed to: Director, U.S. Army Materiel Systems Analysis Activity, ATTN: AMXSY-DA, Aberdeen Proving Ground, MD 21005-5071. Phone inquiries should be made to Glenna Tingle, AUTOVON 298-6576, Commercial (301) 278-6576 or Kathy Brooks, AUTOVON 298-3051, Commercial (301) 278-3051.

Announcing Army RD&A Bulletin

During recent months numerous changes regarding DOD periodicals have been announced in various media. In case you may have missed one such announcement in the March-April 1987 issue (inside front cover) of *Army RD&A Magazine*, we would like to reiterate that *Army RD&A Magazine* will no longer be published under the Army's periodicals program. However, since a requirement still exists to keep the RD&A community knowledgeable of important developments, a new *Army RD&A Bulletin*—geared to the professional development needs of RD&A personnel—has been authorized.

Army RD&A Bulletin, which commences with this issue, will be published bimonthly and serve as a means of instructing members of the RD&A community relative to RD&A processes, procedures and techniques, and the acquisition management philosophy, and will disseminate technological and other information pertinent to RD&A professional development. The new bulletin may differ somewhat in format, content and, possibly, distribution methods from *Army RD&A Magazine*.

Information regarding paid subscriptions to the new *Army RD&A Bulletin* may be obtained by writing to the Superintendent of Documents, U.S. Government Printing Office, Washington, DC 20402 or by calling (202) 783-3238.

Army RD&A Bulletin

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