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CHANGING CAREER DEVELOPMENT PATHS

ARMY
Research
Development
Acquisition

RD&A

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MAY-JUNE 1989

PROFESSIONAL BULLETIN OF THE RDA COMMUNITY

This medium is approved for the official dissemination of material designed to keep individuals within the Army knowledgeable of current and emerging developments within their areas of expertise for the purpose of enhancing their professional development.

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FEATURES

DEPARTMENTS

ABOUT THE COVER

The front cover design is associated with the two articles related to the professional development of both civilian and military materiel acquisition management personnel. The back cover relates to an article on the DOD's major initiative on total quality management.

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CIVILIAN ACQUISITION WORKFORCE

By LTG Jerry Max Bunyard and Robert O. Black

Overview

The professionalism and quality of the people in the acquisition community is vital to the Army's continuing modernization efforts. The Center for Strategic and International Studies' recent report, Making Defense Reform Work, said ". . . In the end, the quality of the personnel who staff the acquisition process, along with the system that trains, assigns, and rewards these individuals, will determine how efficiently the Department of Defense develops and procures new weapons."

The Packard Commission report and the DOD Reorganization Act of 1986 are replete with guidance and direction on what is required to enhance the quality of the acquisition workforce. Public Law (P.L.) 99-145 stipulates mandatory requirements to become project managers or a flag/general officer assigned to a procurement command within the services. All indications are that we are at that point in time so aptly described by the famous Oklahoma philosopher, Will Rogers, when he said ". . . Everyone says something must be done — but this time it looks like it might be us." Therefore, it is incumbent upon the Army to attract qualified new personnel and to improve the training and motivation of current acquisition personnel.

The purpose of this article is to explain what action the Army is taking to carry out the direction in P.L. 99-145 and the Packard Commission. While the acquisition process involves both military and civilian personnel, this article focuses on the civilian workforce. The article, "Restructuring of the MAM Program," on page 4 of this issue of *Army RD&A Bulletin* focuses on the military program for the professional development of acquisition personnel.

To ensure the reader is properly oriented when the term "acquisition" is being used, a definition of terms is in order. The life cycle management of weapon systems can be divided into three major processes: requirements, acquisition, and sustainment. The broad definition of each process is as follows:

- ***Requirements:*** Defining the users' clearly stated military need to satisfy a known deficiency or a projected deficiency based on the evolving threat or change in tactics or doctrine.
- ***Acquisition:*** Performing the required planning, integration and execution of research, development, test, evaluation, integrated logistics support, procurement and fielding functions in order to supply materiel systems and the associated items of equipment that conform to the users' requirements.
- ***Sustainment:*** Execution of the processes and procedures developed during the acquisition phase. This process ensures that the planned support of any given item is fulfilled.

Figure 1 identifies in general terms the type skills utilized in the three categories described above.

Based on the above definitions, the focus of this article will concentrate on the acquisition process of the materiel life cycle. The ultimate goal is to have true professionals and the highest quality people in the acquisition workforce. This will allow us to empower them with the authority and responsibility to do their job and feel confident they will do the job right the first time while continuing to improve the process within their area of responsibility.

Acquisition Management Mission Cluster Group (MCG) Career Program

To help assure that the Army trains their highest quality people to be true professionals, the Department of Army (DA) has formed an Acquisition Management MCG Career Program. An Executive Board, chaired by the Army acquisition executive, sets DA policy and provides oversight of this career program which will provide the personnel who will eventually become project managers and program executive officers. A Competitive Development Group Office will oversee the training, development, and referral of civilian acquisition personnel from the following career programs: Engineers and Scientists (Non-Construction), Engineers and Scientists (Resources and Construction), Quality and Reliability Assurance, Supply Management, Materiel Maintenance Management, Transportation Management, Communications, Automated Data Processing, Contracting and Acquisition, and Comptroller. Relative populations of personnel in these career programs are shown in Figure 2.

Taking advantage of the accomplishments of the Logistics and Acquisition Management Program (LOGAMP) and the Materiel Acquisition Management (MAM) Program, participants in the Acquisition Management MCG Career Program will, in part, come from these two programs.

Logistics and Acquisition Management Program (LOGAMP)

The primary focus of LOGAMP is to provide essential developmental assignments, along with technical and

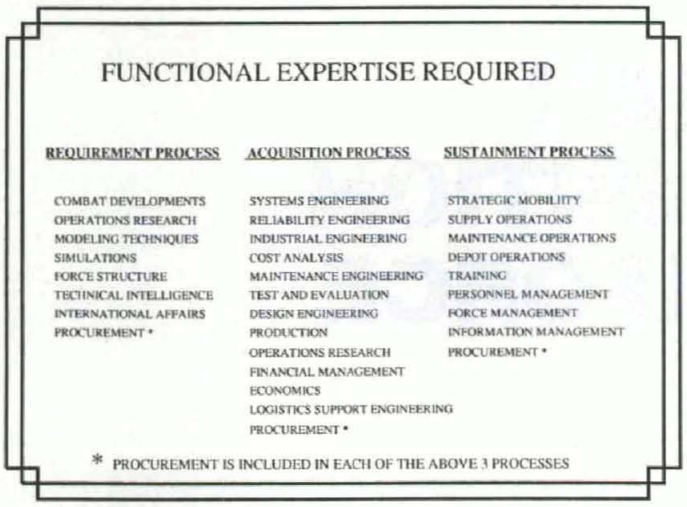

Figure 1.

ACQUISITION MANAGEMENT

MISSION CLUSTER GROUP (MCG) CAREER PROGRAM

CAREER PROGRAM	PERCENTAGE OF MCG POPULATION
COMPTROLLER	17 %
SUPPLY MANAGEMENT	9
CONTRACTING AND ACQUISITION	8
QUALITY & RELIABILITY ASSURANCE	3
ENGINEERS & SCIENTISTS (NC)	26
MATERIEL MAINTENANCE MANAGEMENT	8
ENGINEERS & SCIENTISTS (RC)	16
AUTOMATIC DATA PROCESSING	10
TRANSPORTATION MANAGEMENT	1
COMMUNICATIONS	2
TOTAL	100 %

Figure 2.

managerial training, to high potential civilians to produce multi-functional managers.

LOGAMP provides training and developmental experience in two major areas: Logistics Track and the Acquisition Track.

LOGAMP has appropriately modified the Acquisition Track within the program to assure that LOGAMP participants whose career goal is to become a project manager, deputy project manager or program executive officer will receive the proper training. Consistent with P.L. 99-145, and DODD 5000.52, required fundamental education, training, and experience levels were developed. Attendance at senior and intermediate service schools, as well as attendance at the required Defense Systems Management College Program Manager's Course, are a part of the Acquisition Management Core Curriculum.

In order to develop a multi-disciplined professional, a careful mix of training and developmental assignments is designed for individuals in the acquisition area. Appropriate developmental assignments and mandatory technical and managerial training will be provided to high potential civilians to meet the Army's requirement for effective acquisition managers. With carefully planned training assignments, individuals will meet the required years of experience in the acquisition, support and maintenance of weapon systems.

Engineers and Scientists (Non-Construction) (E&S (NC)) Career Program

As mentioned earlier in the article, the Acquisition Management MCG Career Program draws it's civilian participants from the 10 career fields involved in acquisition management. The E&S (NC) career field is the largest of these. In order to assure that engineers and scientists involved in acquisition assignments get proper training, the Army Civilian Training, Education and Development System (ACTEDS) training plan for the Army-wide E&S (NC) Career Program has been modified. This plan is the framework for effectively blending the management, scientific, and functional training needed by high potential civilians targeted for E&S (NC) Career Program key positions and PEO/PM positions for weapon system acquisition programs. A four-year college degree in engineering or science is required for entry into this program.

Career Ladder

Career ladders depicting progression paths to key positions are shown in Figure 3. Lateral assignments which provide necessary cross-training are depicted along with various paths which may be followed for staff versus operating positions and technical versus supervisory/managerial positions. The PEO/PM career ladder follows Track A, which is the technical management track. Track B allows engineers and scientists who wish to remain in research and development to advance in their careers from entry level to senior scientists/engineers in a parallel fashion to the technical managers of Track A.

Subcareer Programs

The functional diversity of the E&S (NC) Career Program necessitated the establishment of eight subcareer programs: Research, Systems Development Engineering, Production Engineering, Quality/Product Assurance Engineering, Test and Evaluation Engineering, Logistics Engineering, Operations Research Systems Analysis, and Software Engineering.

Special Track for Civilian PMs

A special track within the Systems Engineering Subcareer Program of the Army-wide E&S (NC) Career Program has been delineated for project managers (PM) and deputy PMs of major and

non-major programs. Training and experience requirements consistent with the law and Department of Defense directives are included.

Summary

The Acquisition Management MCG Career Program is a disciplined Army management approach for total training, development and referral of acquisition personnel.

The program will provide the Army with trained acquisition managers for program executive offices, program management, and select matrix support command organizations.

The civilian Logistics and Acquisition Management Program will provide candidates for the Acquisition Management MCG Career Program.

Since weapons systems acquisition is high technology business, engineers and scientists are also candidates for the Program Executive Office/Program Management Acquisition Management Career Track.

Both LOGAMP and the Engineers and Scientists (Non-Construction) career field have modified their training requirements to be fully compliant with Public Law 99-145. The other affected career fields will, no doubt, do so very soon.

To hark back to Will Rogers' statement, ". . .this time it might be us," we believe that we have taken the actions required for training and developing of acquisition managers. This new approach should provide us with the qualified personnel needed for this vital field of acquisition management.

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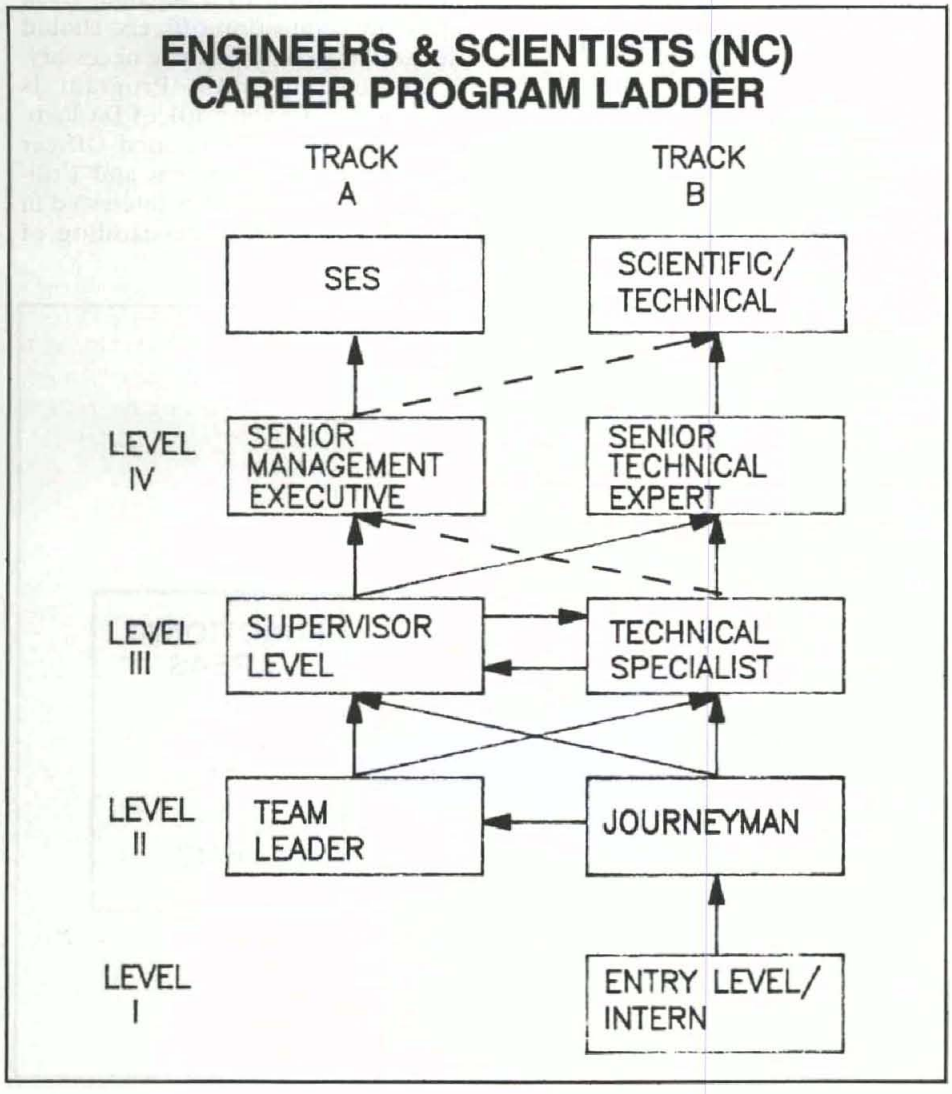

Figure 3.

RESTRUCTURING OF THE MAM PROGRAM

By LTC Daniel D. Ziomek

In response to recent changes in public law and direction from the Department of Defense, the Army plans a major restructuring of the Materiel Acquisition Management (MAM) Program. Since 1983, the MAM Program has provided for the professional development of Army acquisition management officers. While the program has grown in size and importance, recent studies have identified significant limitations in the ability of a skill based personnel management system, like MAM (skill 6T), to adequately meet Army requirements for properly trained and highly experienced acquisition leaders.

The Army Leader Development Study (LDS) Final Report, published in April 1988, recognized the need for the Army to look at a possible new career management field (CMF) for materiel acquisition management officers in order to ensure proper professional development. The LDS went as far as proposing consideration of a separate Army acquisition track. While the restructured MAM Program does not implement an acquisition track, it is viewed as a logical step in correcting current MAM professional development problems; and, it facilitates possible future transition to a separate track for Army acquisition officers, should further CMF changes prove necessary.

The current MAM Program is described in Chapter 101 of DA Pamphlet 600-3, Commissioned Officer Professional Development and Utilization. For those readers interested in a more thorough understanding of

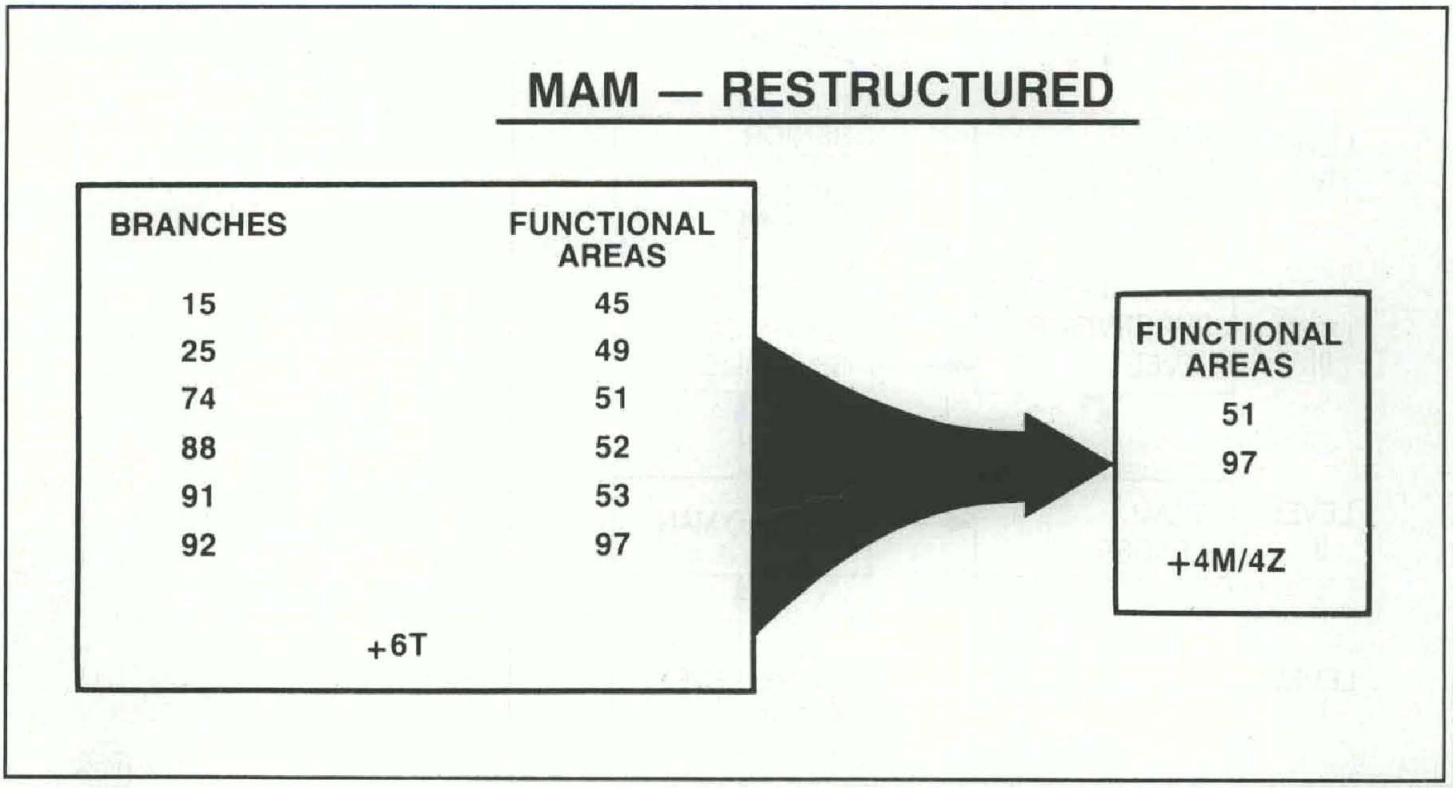

Figure 1.

the changes included in the restructuring effort, a review of the DA pamphlet is recommended. The following paragraphs summarize the most significant changes in the restructured MAM Program.

Revised Objective

The primary MAM Program objective is to "develop a pool of *qualified officers* to fill *designated critical acquisition management positions* responsible for the full range of functions in the materiel acquisition life cycle." This revised objective significantly narrows the focus of the MAM Program on the development of officers to fill product/project manager (PM), program executive officer (PEO), general officer (GO) and other designated critical materiel acquisition management positions at the grade of 05 and above. It is anticipated that requirements will be reduced from the current 3,000 plus skill 6T positions (CPT-COL) to approximately 250-400 skill 4Z (LTC-GO) positions. Skill "4Z" has been designated as the new code for Certified MAM officers and critical MAM positions. Skill "4M" has been designated as the new code for MAM Candidate Officers; however, it will not be used with positions.

Focus on FA 51 and FA 97

Functional Areas 51 (Research, Development and Acquisition) and 97 (Contracting and Industrial Management) will form the acquisition career development base which will provide qualifying experience, training and education for award of skill 4M and 4Z. Public Law 99-145 (the Department of Defense Authorization Act for 1986) and DODD 5000.52 (Defense Acquisition Education and Training Program) establish minimum criteria for the selection, training and career development of DOD personnel involved in designated critical acquisition management positions. The new MAM Program implements the law for selected positions through the use of skill management (4M and 4Z). There are many other positions within the Army acquisition management structure which are not tied to the law or DOD directive. These positions are best defined through the use of FA 51 and FA 97. Officers will begin their acquisition careers by being designated in either FA 51 or FA 97. Some, who pursue the MAM Program objective, will be awarded skills 4M and 4Z. Viable career development in FA 51 and FA 97 will remain independent of, yet support participation in the MAM Program. As depicted in Figure 1, FA 51 and FA 97 together with skill 4M and 4Z define a restructured Army materiel acquisition management career field.

Combined FA/ Skill Management

The establishment of an Army materiel acquisition management career field, incorporating FA 51 and FA 97 with skills 4M and 4Z, provides the capability to fully implement personnel life cycle functions, a capability which does not exist with the current skill based MAM Program. Through the use of FA 51 and FA 97, the MAM Program gains the inherent functional area capability of performing all personnel life cycle management functions: structure management, officer acquisition (accession), individual training and education, distribution management, sustainment, professional development, and officer separation. Skill codes 4M and 4Z provide a further capability to identify and intensively manage a designated population of officers within FA 51 and FA 97.

Candidates Awarded 4M

Entry into the MAM Program will be by designation or application. Selection and award of skill code 4M (MAM Candidate Officer) is to be made by a Total Army Personnel Command (TAPC) selection board based on the criteria shown in Figure 2. Skill code 4M applies to "candidate" MAM officers — those desiring to work toward qualification for PM selection and assignment. Skill code 4M is not used to code positions! Positions for MAM candidates to gain experience are designated by FA 51 or FA 97. The need for 4M is dictated by the overall size of the FA 51 and FA 97 population. It is not possible or necessary to develop 100 percent of those officers awarded FA 51 and FA 97 against the demanding criteria in PL 99-145 and DODD 5000.52. Because of the limited need (caused primarily by the small number of PM and other designated critical position requirements), a smaller career development population from within FA 51 and FA 97 can adequately support the MAM (4Z) position structure.

MAM CANDIDATE = 4M

FA 51 OR FA 97
...BY DESIGNATION (MOST)
...OR APPLICATION (SOME)
...BASED ON FOLLOWING CRITERIA:

(1) CPT THROUGH COL
(2) CPT/MAJ-APPLICANTS MUST BE SERVING OR RECENTLY COMPLETED DUTY IN AN FA 51 OR FA 97 POSITION
(3) MAJ(P)/LTC/COL-MUST MEET MAM CERTIFICATION STANDARDS FOR AWARD OF SKILL 4Z
(4) AT LEAST 4 YEAR AFCS REMAINING
(5) APPROPRIATE MEL
(6) BACCALAUREATE DEGREE OR HIGHER IN TECHNICAL, SCIENTIFIC, OR MANAGERIAL FIELD
(7) DEMONSTRATED OUTSTANDING PERFORMANCE AND POTENTIAL
(8) APPLICANT APPROVAL FROM CONTROL BRANCH OR FUNCTIONAL AREA (SINGLE TRACK OFFICERS)
(9) APPLICANTS MUST EXPRESS A DESIRE TO SERVE IN PM AND OTHER DESIGNATED CRITICAL MAM POSITIONS

Figure 2.

CERTIFICATION = 4Z

MAJ(P)/LTC	LTC(P)/COL
MEL 4	MEL 4
PMC GRADUATE*	PMC GRADUATE*
DEGREE IN TECHNICAL, SCIENTIFIC OR MANAGERIAL FIELD	DEGREE IN TECHNICAL, SCIENTIFIC OR MANAGERIAL FIELD
3 YEARS EXPERIENCE IN THE ACQUISITION, MAINTENANCE AND SUPPORT OF WEAPONS SYSTEMS.	8 YEARS EXPERIENCE IN THE ACQUISITION, MAINTENCE AND SUPPORT OF WEAPONS SYSTEMS WITH 2 YEARS IN A PROCUREMENT COMMAND (AMC)
PERFORMANCE	PERFORMANCE

* OFFICERS MAY BE GRANTED CONDITIONAL CERTIFICATION PENDING COMPLETION OF PMC

Figure 3.

CRITICAL (4Z) POSITIONS

(1) ALL POSITIONS MANDATED BY PL 99-145 AS IMPLEMENTED IN DODD 5000.52
(2) ALL CENTRALLY SELECTED AND GO PM POSITIONS
(3) ALL PEO POSITIONS
(4) ALL COL POSITIONS AUTHORIZED IN LIEU OF GO REQUIREMENTS IN AMC
(5) ALL LTC/COL POSITIONS REPORTING TO A PM OR PEO
(6) THE MILITARY DEPUTY TO THE ASSISTANT SECRETARY OF THE ARMY (RESEARCH, DEVELOPMENT AND ACQUISITION), ASA(RDA), AND SELECTED ASA (RDA) STAFF POSITIONS
(7) SELECTED ARMY LTC/COL ACQUISITION INSTRUCTOR POSITIONS AT DSMC, ALMC AND MEL 1 LEVEL SCHOOLS
(8) OTHER HQDA OR MACOM POSITIONS, BY WRITTEN APPROVAL OF THE MAM PROGRAM PERSONNEL PROPONENT OFFICE

Figure 4.

Specific Military Education

Training for officers in the new MAM Program will not change significantly from the current program. All FA 51 and FA 97 (4M) officers should attend the nine week MAM Course at the Army Logistics Management College (ALMC) prior to their first FA assignment. All officers awarded skill code 4M will attend the Program Management Course (PMC) at the Defense Systems Management College (DSMC) prior to their second MAM assignment. One new feature will be the use of mandatory assignment utilization tours following attendance at the MAM Course and PMC. TAPC will initiate "inhibit" coding procedures to ensure utilization.

Dual and Single Tracking

The MAM Program requires extensive acquisition experience to qualify for certification at the rank of COL. Most officers, however, should be able to retain branch affiliation, with alternating branch and functional area assignments, through the rank of LTC. A few officers will continue to dual track after promotion to COL. These officers will generally be both eligible for certification and highly competitive for command selection.

At the rank of LTC, officers will be required to assess their career status and goals in the MAM Program. The increased experience requirement for certification at COL versus LTC (eight years for COL, three years for LTC) may require individual officers to choose to single track early in order to achieve qualifying experience.

Some officers, because of special education, training, and experience, may choose to single track as early as the rank of MAJ. The new MAM Program will have a mix of both single and dual track officers, with the goal of retaining a viable dual track career development pattern through LTC.

A preliminary analysis of MAM Program position requirements at the grade of 06 has been completed. In order to reduce total officer inventory in the MAM Program (CPT-COL), and the corresponding drain on other branches and functional areas, single tracking for most FA 51 4Z and FA 97 4Z officers at promotion to COL will be a program objective. Because of the stringent qualifications imposed by

PL 99-145, a large MAM officer inventory is not supportable given limited school quotas and procurement command (AMC) FA 51 and FA 97 authorizations. Allowing officers in the program to freely dual track at the rank of COL could greatly inflate the required inventory.

Certified Officers Awarded 4Z

Officers who enter the MAM Program will automatically be considered for certification by a HQDA Certification Board upon selection to the rank of LTC. Those found qualified will be awarded skill code 4Z. MAM Program certification supports Army implementation of the requirements contained in PL 99-145 and DODD 5000.52. It is a two level process (LTC/COL) with up to three consecutive annual reviews or opportunities for certification at each level. Officers who clearly meet all qualifying standards may apply for early certification. Figure 3 outlines certification criteria. Officers failing to achieve certification after three successive annual reviews will be administratively removed from the program without prejudice. Officers removed from the program will continue to receive assignments in FA 51 or FA 97 but will not be eligible to fill skill code 4Z positions.

Critical Positions Coded 4Z

Unlike skill code 4M, skill code 4Z will be used to identify both officers and positions. The assignment of all certified officers will be intensively managed by TAPC to ensure maximum utilization of these officers in designated critical positions. Critical positions, identified by skill code 4Z, must meet one of the criteria listed at Figure 4.

The criteria for selection and designation of critical positions, like the officer certification process, supports Army implementation of PL 99-145 and DODD 5000.52. Strict compliance with the coding criteria should greatly reduce the number of MAM Program positions requiring intensive management (estimated reduction is from 3,000 plus to approximately 250-400 positions).

Provisions in the Law Apply to General Officers

Public law 99-145 amended 10 USC and established specific education, training, and experience requirements for general officers (GOs) assigned to duty in a procurement command (defined by the law as AMC). DODD 5000.52 implements the public law as it affects GO positions. The MAM Program certification standards have been revised to comply with the public law and DOD directive and will provide a mechanism, skill code 4Z, for identifying officers eligible for assignment to GO positions. Affected GO positions will also be identified with skill code 4Z. The specific GO requirements in the law are:

- The secretary of each military department shall prescribe regulations establishing requirements for the education, training, and experience of general or flag officers assigned to duty in a procurement command (AMC). Such regulations shall be subject to the approval of the secretary of defense.
- Regulations prescribed shall require that in order for an officer of a military department to serve in a flag or general officer grade while assigned to duty in a procurement command (AMC), the officer must meet the education and experience requirements for program managers: attendance at DSMC PMC and eight years experience in the acquisition, support, and maintenance of weapon systems, at least two of which were performed while assigned to a procurement command (AMC).
- The secretary of the Army may waive the requirements for assignment. The authority to waive such requirements may not be delegated.

The effective date of GO assignment provisions in the law is July 1, 1990. The use of the MAM Program to implement the law will provide at least three benefits:

- A virtual career development track from CPT to GO will be identified. This should help to attract and retain quality officers.
- A pool of officers will be identified and intensively managed to ensure compliance with the law. MAM certification (at the rank of COL) will become a validation of each officers' qualification under the terms of the law.
- Use of skill code 4Z with each GO position in AMC will identify that position as one requiring compliance or secretary of the Army waiver.

PROMOTION/SELECTION FLOORS

FLOOR	SUBFLOOR	SUBFLOOR	SUBFLOOR
FA 51/FA 97	SKILL 4M	SKILL 4Z	SINGLE TRACK FA 51/FA 97
MAJ	MAJ	COL	LTC
LTC	LTC	SSC	COL
COL			SSC
SSC			

Figure 5.

Promotion/Selection Floors

A general officer panel met in June 1988 to approve the proposed changes to the MAM Program. That panel clearly identified the issue of fair and equal promotion and selection opportunity as critical to the success of the restructured MAM Program. Short of establishing a separate acquisition career development track, with separate promotion and selection boards, a comprehensive set of floors and subfloors must be established. The planned floors are summarized at Figure 5. The intent of the floors is equity and insurance that a sufficient number of quality officers are available at the rank of LTC and COL who comply with the public law and are fully qualified for assignment to designated critical acquisition positions.

Officer Reclassification

All officers in the current MAM Program, who have achieved certification, will be grandfathered — skill code 4Z awarded in place of skill code 6T. All officers on the certification standing list, maintained by TAPC, will be grandfathered — skill code 4M awarded in place of skill code 6T. The files of all remaining 6T officers, who are not grandfathered, will be reviewed individually for retention and possible reclassification into FA 51 or FA 97. Officers presently holding or reclassified into FA 51 or FA 97 will be awarded skill code 4M. A primary goal of the reclassification effort will be to retain an adequate pool of experienced officers for future selection and assignment in critical acquisition positions.

Excepted Programs

Not all critical Army acquisition management positions can be identified through the use of FA 51 and FA 97. There is a recognized need for a small number of uniquely qualified PMs and PEOs in such fields as FA 52 (Nuclear Weapons Research, AOC 52B), FA 53 (Systems Automation Officer) and Branch 15C35 (Aviation/Intelligence). On an exception basis, with the approval of the MAM Program personnel proponent office, officers outside of FA 51 and FA 97 will be identified by proponents and TAPC for entry and certification in the MAM Program. Program exceptions will be based on the identification of *firm requirements* and will be *tightly controlled*.

Related Actions

Because this proposal affects the current FA 51 and FA 97 career fields, some minor changes to those functional areas are required and have been incorporated in the MAM Program restructuring. Following are the most significant changes:

(1) The title for FA 51 is being changed to "Research, Development and Acquisition" to better reflect the purpose of the FA and subordinate AOCs.

(2) AOC 51C (Combat Developments) is being fully integrated into FA 51 professional development.

(3) Assignment progression for FA 51, culminating in the award of AOC 51D (Acquisition), is clearly defined.

(4) The FA 97 structure is being reduced to a single AOC (97A).

Summary

The planned changes to the MAM Program will have significant impact on how the Army manages personnel assets as we move to develop a pool of professional materiel acquisition managers. This comprehensive restructuring effort is driven by public law and DOD directive. We must begin early to directly influence the career decisions of our acquisition personnel and get them on the appropriate career glidepaths. The acquisition of our current and future weapon systems is vitally important, highly visible, and will continue to draw close scrutiny from all venues, especially Congress. The message is clear, systems acquisition management in our TDA Army is as important as troop leadership in our TOE Army.

LTC DANIEL D. ZIOMEK is the Army proponent manager for the MAM Program and editor-in-chief of the Army RD&A Bulletin.

By Jack Strickland

TOTAL QUALITY MANAGEMENT

Linking Together People and Processes for Mission Excellence

In the March-April 1988 issue of the *Army RD&A Bulletin*, I portrayed the Department of Defense aspirations for total quality management (TQM) and revealed for the first time the secretary of defense DOD posture on quality.

TQM is on the move and spreading rapidly throughout DOD and industry. Your editor has kindly invited me back to give you a TQM update. Let me share some of our views and experiences, bring aboard any who remain unconvinced and apprise you of specific TQM activities that will affect the way DOD does its internal and contractual business. TQM is rapidly becoming institutionalized and is gaining enormous support because it is being recognized as a fundamentally sound way to manage an organization.

As a long-time former Army employee, it is particularly gratifying to see the Army taking a leadership role in making TQM happen. During November 1988, the secretary of the Army and chief of staff, Army issued a joint message that offered powerful support for TQM, stating "TQM is a tool which must become an integral part of every functional activity — at all levels, in every organization; Government and Industry."

Under Secretary of the Army Michael P. Stone has aggressively taken charge of TQM implementation in the Army. His personal commitment exemplifies the posture required of senior leadership in order to muster the grass roots support for TQM. Early activities have focused on organizational and other high-leverage issues. Under Secretary Stone personally chairs the newly established Army Total Quality Management Committee (ATQMC).

The ATQMC is the top-level executive steering committee chartered to provide guidance on the scope, implementation and institutionalization of TQM; approve policies and methodologies to support TQM implementation; and provide a forum for the exchange of ideas, lessons learned, and TQM coordination activities. Committee members will each chair an executive steering committee within this organization.

Under Secretary Stone has focused Army management of TQM implementation under the TQM focal point, Stephen R. Burdt, deputy for program evaluation, Office of the Assistant Secretary of the Army for Research, Development and Acquisition, and has dedicated a number of personnel spaces to the effort.

This centralized TQM activity has sponsored initial training for program executive officers and program managers; chartered a subpanel of the Army Science Board to guide TQM implementation activities and to identify and recommend methods to eliminate barriers to efficient TQM implementation; developed an approach for utilizing contract decisions as an incentive to encourage TQM implementation within industries competing for Army contracts; routinely ensured that TQM has been included in acquisition plans; and is investigating the feasibility of establishing an Army Acquisition Center to encourage the transfer of design, engineering and manufacturing process technologies throughout government and industry and to do research in and demonstrate advances in manufacturing technology.

The Army Materiel Command (AMC) is implementing TQM in a dedicated, well-planned effort. In his letter of Nov. 28, 1988, AMC Commanding General Louis C. Wagner, Jr., asked the AMC community to make a personal commitment to get involved and stay involved in TQM. GEN Wagner also showed fine insight when he stated "TQM implementation must be geared to the individual mission, management style, business practices, user relationship and personnel ability of each

1. TQM is a management system, a way of doing business, a never ending process.
2. TQM involves process orientation; product excellence flows from process excellence.
3. TQM requires the implementation of process management basics, to include:
   a. process definition and understanding
   b. process performance measures
   c. collection of data and analysis
   d. corrective action
4. TQM demands top management long-term commitment, participation and leadership so that continuous process improvement may flourish
5. TQM involves organizational goal setting and review
6. TQM is customer focused.
7. TQM employs a disciplined process improvement methodology using a wide variety of statistical based tools and group dynamics technique
8. TQM provides for top management motivation of managers and workers to not only do the work but to improve processes within their area of responsibility.
9. TQM employs teaming structures, including extensive use of cross-functional teams.
10. TQM involves celebration of success and rewards for performance.
11. TQM begins and ends with training.

Figure 1.

AMC activity. TQM is not a how-to exercise laid out in minute detail in an Army directive.

That is what TQM is about — each organization owns its own processes and must develop and deploy its own methodologies for continuously improving those processes. However, TQM and its operative concept of continuous process improvement is based on a firm set of precepts that are founded on the pioneering efforts of Dr. W. E. Deming, Dr. Joseph Juran, Dr. Armand Feigenbaum and so many others.

Figure 1 provides a succinct run down of some of the more critical elements deployed in a viable TQM effort. For more details the reader is encouraged to review the DOD total quality management brochure which outlines the concept and provides a list of reading materials.

Figure 2 provides the operative definition of TQM. You will note that TQM centers on process orientation. TQM seeks to raise our collective vision of quality and change our focus from the product to all of the processes that in their totality determine the quality of the product in the hands of the customer.

Figure 3 broadly depicts this process orientation idea. It attempts to depict, far from exhaustively, the wide range of processes that essentially encompass DOD and contractor acquisition operations. As shown, TQM is a management process that is aimed at the never-ending improvement of every one of these processes. It means every design process, every development process, every manufacturing process, every quality assurance process and yes, every contracting and administrative process.

Through my contacts with Stan Alster, the AMC special assistant for TQM, I learned that within HQ, AMC, the General Counsel's Office had offered its processes up as a pilot for TQM implementation. It is clear that AMC understands that every process stands in need of continuous process improvement. It also highlights the point that TQM is applied in all departments, be they comptroller and personnel departments, or the research laboratory — it is not reserved for the manufacturing operation.

In our early examination of the TQM methodologies and tools, we quickly realized that the DOD had, in fact, been way out front in implementing many of the TQM tools and techniques. For example, the Army in its thrust for variability reduction was calling for Statistical Process Control (SPC) in appropriate contracts. Likewise, the more advanced Army Contractor Performance Certification Program (CP2) was directly in the TQM mainstream. In addition, it was apparent that many on-going DOD initiatives were directly supportive of the TQM concept.

We decided we could buttress the TQM concept by linking it with those DOD initiatives that were geared to eliminate non-value or marginal value from the acquisition process. These process-improving initiatives include acquisition streamlining (DoDD 5000.43), transition from development to production (DoDD 4245.7M, NAVSO-P-6071), could cost, producibility engineering and planning, value engineering and concurrent engineering. By intensifying these efforts we can leverage the use of the commonly used tools and techniques of continuous process improvement.

Since the Army is an ardent advocate of acquisition streamlining, I think it is useful to illustrate the direct connection between acquisition streamlining and

Definition of Total Quality Management (TQM)

TQM is both a philosophy and a set of guiding principles that represent the foundation of a continuously improving organization. TQM is the application of quantitative methods and human resources to improve the material and services supplied to an organization, all the processes within an organization, and the degree to which the needs of the customer are met, now, and in the future.

Figure 2.

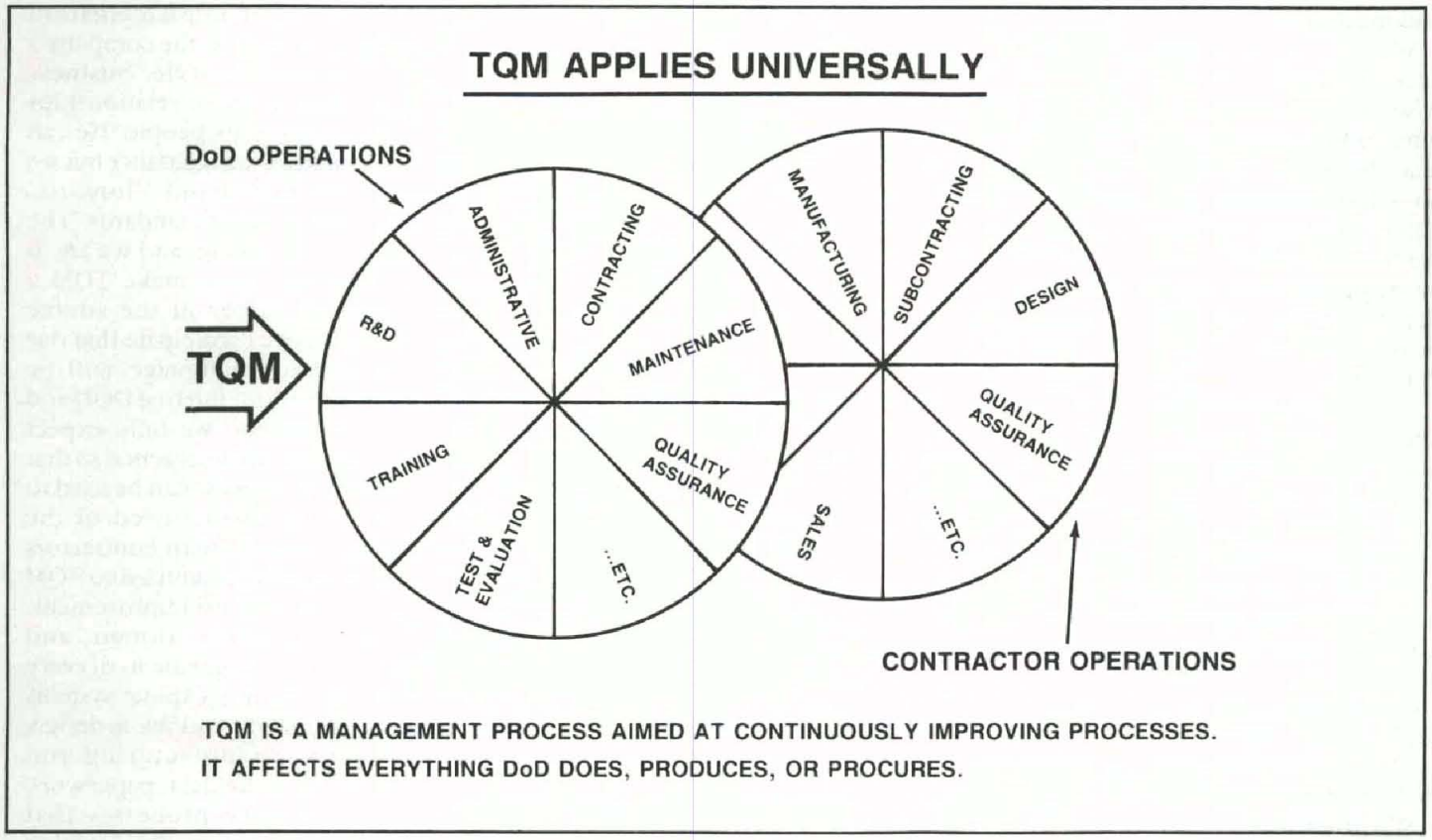

Figure 3.

its role in continuously improving the acquisition process. Think of the mechanics of the DOD procurement process. To communicate our weapon system needs, we rely on a mountain of detailed documentation; the voluminous statement of work (SOW), the countless tiers of specifications and standards, the endless list of drawings, the numerous data item descriptions and the contract data requirements lists (CDRLs). Then, add the tremendous number of contract clauses and you have a formidable job in executing and administering contracts.

Even at a superficial level it is obvious that a knowledgeable tailoring effort would greatly improve the process for communicating the DOD needs to its contractors. By improving this communication, there is a much greater chance that the product will reflect real user needs. More importantly, the lack of tailoring means the retention of unnecessary, non-contributing requirements and inspections with the additional cost burden and the negative impact on product quality.

One of our more interesting observations about TQM is that you don't necessarily have to have a total infrastructure in place to achieve significant benefits. One of our earliest actions was to ask the Logistics Management Institute (LMI) to study the "best of the best" industry and government continuous process improvement applications to get some quick "lessons learned." We found that TQM is not "instant pudding," a wise observation of Bill Scherkenback, the General Motors continuous process improvement guru. Even in the best of applications and after several years of implementation only 20-25 of the personnel were trained and actively involved in continuous process improvement. Nonetheless, the results were impressive.

We also found that the tools of TQM are in themselves so powerful that substantive improvements can be achieved by deploying the tools while the overall TQM support structure is being put in place. In fact, the early successes were found to provide the impetus for the company to fully implement TQM. I believe the Army experience with Harley-Davidson illustrates this point very effectively. In achieving the highly sought certified supply status under the Army's CP2 effort, Harley-Davidson employed such recognized TQM tools as statistical process control, process analysis and just-in-time inventory. I understand that the company is implementing a more extensive TQM effort because of the excellent results already evident in partial implementation.

We also found, not surprisingly, that many field activities had the insight to foresee the great promise of TQM. We found that a good number of individual activities had acquired their own training and were well on the way to TQM. The AMC Depot System Command represents a fine example

of how self — initiative can bring excellent results when top management becomes personally committed and when they provide leadership, training and motivation.

While I have been using Army examples here, I assure you that the other services and agencies are showing outstanding progress. If you want to hear about why TQM is the only way to go — just listen to the commander, Air Force Systems Command. If you want to see a well-structured effort, manned by people who believe in TQM, visit the Pearly Harbor Naval Shipyard, or the Naval Aviation Depot in Cherry Point, NC.

I urge each reader to begin to become knowledgeable of the TQM methodology, examine the processes under your responsibility and begin the process. You will be pleasantly surprised at the short-term payoff.

Industry acceptance of TQM is becoming increasingly evident. It is not growing because of altruism but because CEOs are turning to management through TQM as a way of reducing high scrap rates, rework costs, inefficiencies and customer complaints that threaten profits and market shares.

Within the DOD, acceptance is growing because of many of the same inefficiencies and problems encountered by industry. Many activities see TQM as a mechanism for optimizing the DOD weapons system requirements process, acquisition strategies and the business and administrative processes of the organization.

Think of how easier acquisition life would be if continuous process improvement was consistently applied to such key Army processes as mission area analysis (MAA), concept formulation process (CFP), basis of issue plan/qualitative and quantitave personnel requirements information, integrated logistics support (ILS), materiel release, test and evaluation, production management, etc.

I will now chronicle the series of actions taken within the DOD to institutionalize TQM.

- At the end of March 1988, the secretary of defense issued his initial pronouncement on TQM including the DOD posture on quality. The correspondence established TQM as a top DOD priority and asked that the under secretary of defense for acquisition spearhead the TQM thrust by integrating it into the acquisition process.
- The DOD infrastructure for implementing TQM has been put into place at the top level with the establishment of the Defense Council on Integrity and Management Improvement (DCIMI) chaired by the deputy secretary of defense as the TQM executive steering committee. A draft DOD directive is being coordinated within the DOD staff to institutionalize TQM.
- A DOD master plan for TQM was developed and provided to the DCIMI for comment. We have set some serious long-range goals, fully intending that TQM become a routine way of life with all personnel involved in DOD activities.
- Based on an August 1988 request by the USD(A), the services' TQM implementation plans for acquisition were received by the under secretary.
- TQM begins and ends with training, and first comes awareness training. As Dr. Derek Bok of Harvard noted, "If you think training is expensive, try ignorance." Early on, we brought in Dr. Deming to provide the rudiments of TQM to 420 DOD managers. Then, we conducted senior management awareness training for over 40 senior DOD executives. We have briefed over 10,000 people within DOD and industry to spur widespread TQM activity. On a broader scale, we established a TQM training working group to put together a TQM training strategy. They are well on their way to defining a TQM training policy, identifying target training populations, defining skills to be acquired, subject matter and training locations. To get the ball rolling, the Defense Systems Management College (DSMC) has structured several TQM seminars and courses and has begun their training effort. The Army Logistics Management College (ALMC), Army Management Engineering College (AMEC) and the Air Force Institute of Technology (AFIT) are regrouping to reassess their curricula, modify existing courses, and add new ones as necessary. Each service and the the Defense Logistics Agency are planning appropriate TQM training in their implementation plans.
- A DOD guide for TQM implementation is nearing completion.
- Obviously, TQM success depends on application of TQM by DOD contractors and their principal subcontractors. The entire DOD acquisition leadership has been motivating industry to implant company-wide TQM efforts. The results are beginning to show. Each contractor's TQM implementation scheme will depend on the company's goals, management style, business practices, subcontractor relationships and the abilities of its people. We can provide incentives and guidance but we must assiduously avoid "how-to" TQM specifications or standards. The approach we are taking, and we are in the draft stages, is to make TQM a consequential factor in the source selection process. I anticipate that our draft contractual language will be submitted shortly for internal DOD and industry comments. We fully expect that a consensus will be reached so that the contracting process can be used to foster the fundamental need of the DOD to do business with contractors who are viscerally committed to TQM and continuous process improvement.

The soldier, sailor, airman, and Marine are essential ingredients of every DOD process from weapons systems requirements determinations, to design, development, manufacturing and support, to all of the data, paperwork and administrative processes that attend these activities. Dr. Deming once said, "Who can put a price on a satisfied customer and who can figure the cost of a dissatisfied customer?" The price of a dissatisfied soldier, is measured in terms that dwarf cost; it may be measured in lower morale and decreased performance in a warfighting situation.

TQM offers each of us a practical, realizable way to improve the way we in the DOD and our industry partners conduct the business of defense. Continuous process improvement pays off for each individual worker, for management, for the organization and for the country. To quote Dr. Deming one more time, "It doesn't matter when you start — as long as you begin now!"

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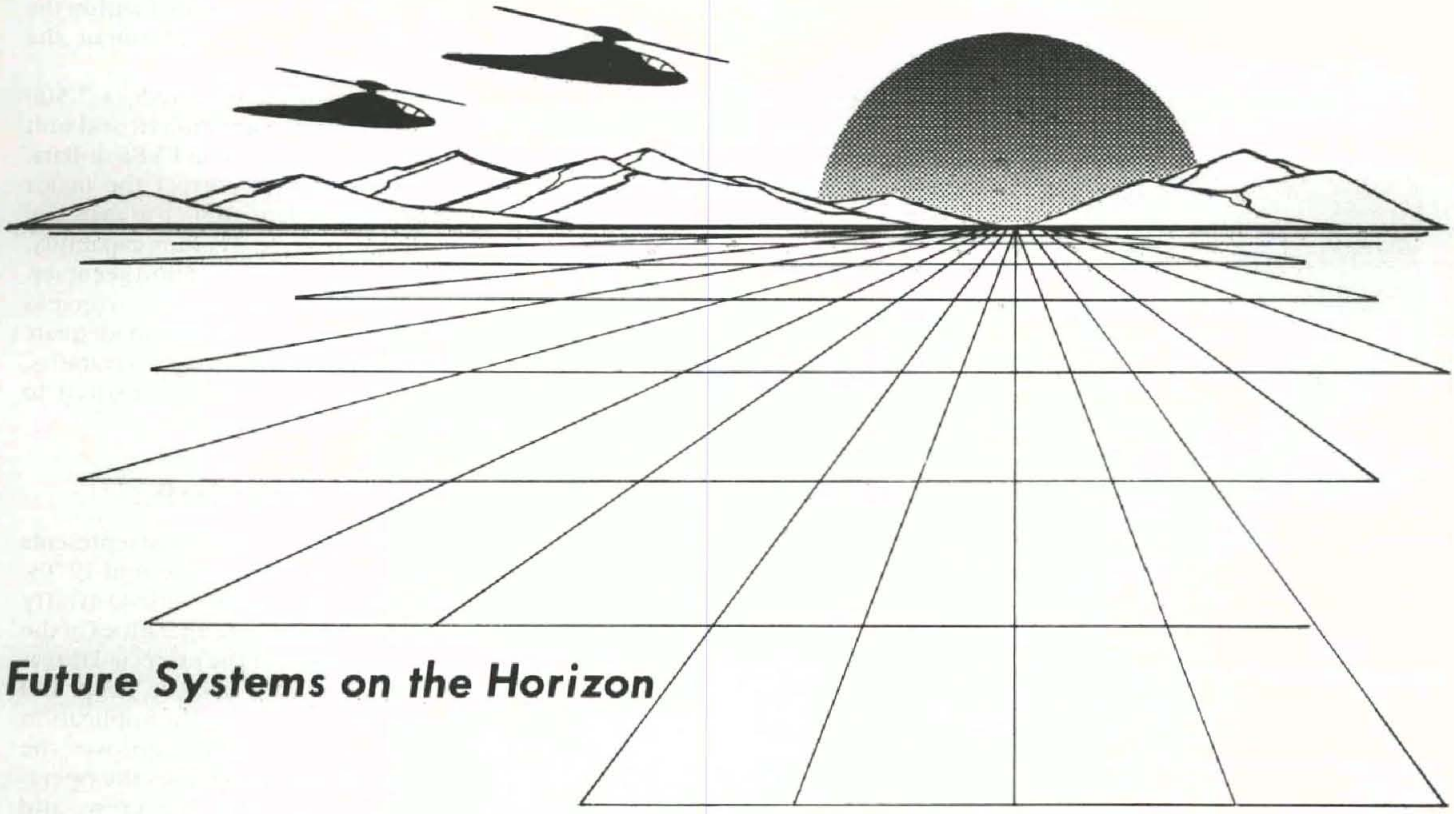


Future Systems on the Horizon

Army Aviation: PLANNING FOR THE FUTURE . . .TODAY

By Anthony M. Corgiat and MAJ W. Leonard Snitch

Introduction

Army Aviation will ultimately be measured on the battlefield of the future by its ability to operate as an "equal partner" in combat, combat support, and combat service support operations. As an integral part of the combined arms team, Army aviation has focused a major effort on enhancing our warfighting capabilities through advanced systems.

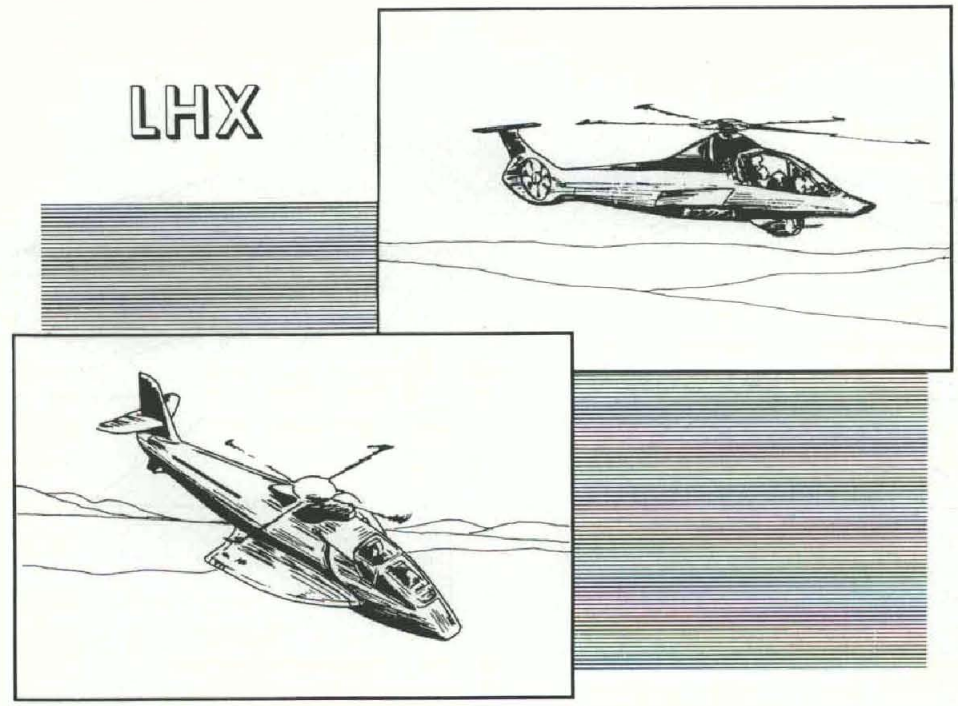
To meet the challenges of the future threat, Army aviation is placing greater emphasis on technologies and advanced system concepts which offer the potential for innovative, revolutionary change in military aircraft systems warfighting capabilities. These technologies and advanced systems promise opportunities that can directly affect combat power on the battlefield. To provide a means of targeting and pacing investments in these technological areas, an Aviation Tech Base Investment Strategy (TBIS) has been developed.

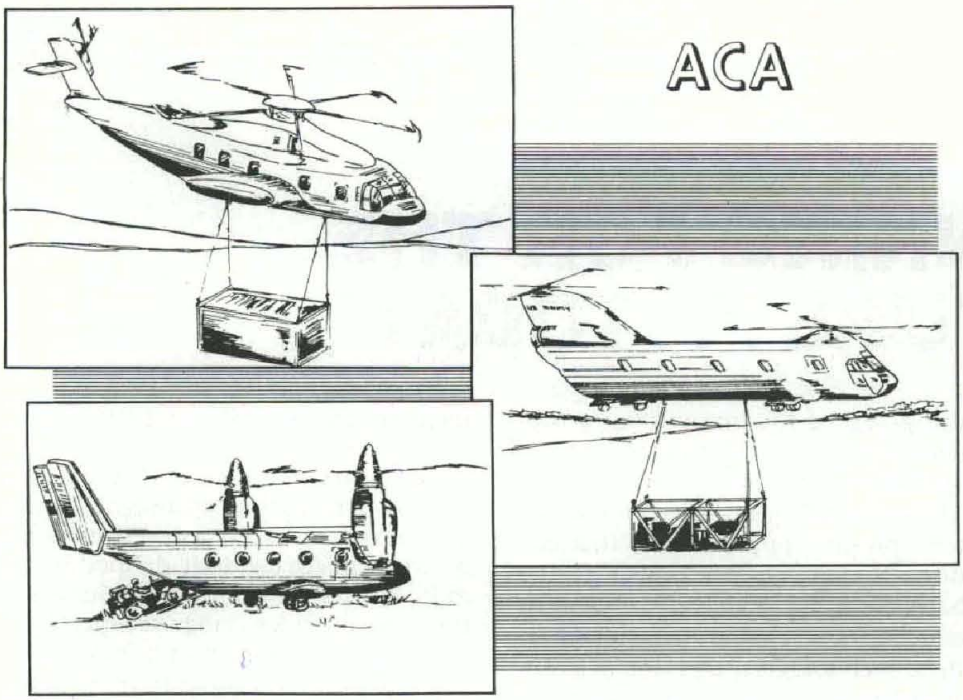
Within the TBIS, Next General/Future Systems (NG/FS) comprise a major part of our total investment (50 percent) and promise to satisfy an identified aviation requirement or provide a new military capability. Next generation systems are generally defined as those beyond the system currently in engineering development which include multi-stage improvement programs (MSIP), while future systems are those a generation beyond.

The difference between next generation and future systems is less critical than the fact that differentiating between relatively well defined and more conceptual solutions to combat problems provides a range of targets for tech base efforts from mid (next five years) to long term (10 to 15 years) and "beyond" (15 years and out).

At the present, Army aviation's Next Generation/Future Systems are: the Light Helicopter Program, Apache MSIP, Advanced Cargo Aircraft, Future Attack Rotorcraft, Army Aviation Command/Control/Intelligence, and the Advanced Special Electronic Mission Aircraft.

Beyond the NG/FSs, the following systems are being studied: Attack Air Mobility System, Special Electronic





Air Mobility Systems, Unmanned Air Vehicle Family and the Logistics Air Mobility Systems.

Light Helicopter Program (LHX)

The LHX will be a two-crew member, highly survivable (airframe and aircrew) lightweight helicopter capable of conducting combat operations in accordance with Air Land Battle doctrine and Army 21 concepts.

LHX will replace and retire the current light fleet of aging helicopters (AH-1, OH-6, and OH-58). The project will provide substantial improvement in combat lethality and battlefield survivability to defeat the threat of the mid-1990s and to modernize 100 percent of the Army's light attack/scout fleet. LHX will be integrated within the force structure to complement the AH-64 attack aircraft.

LHX design goals include a 7,500 pound empty weight aircraft and unit flyaway cost of $7.5M in FY88 dollars. The program will correct the major light fleet deficiencies such as marginal night and adverse weather capability, position location/navigation accuracy, inability to self-deploy to overseas theaters or operations, and inadequate reliability, performance, survivability, and cost of ownership compared to existing light rotorcraft.

AH-64 Apache MSIP

The baseline AH-64 design represents the state-of-the art of the mid-1970s. The Apache MSIP substantially improves the current capabilities of the AH-64A to counter the projected threat from 1995 to 2005 in close, deep, and rear battle operations. The application of Stage I of the MSIP improves the killing capability, increases the operational capability of the crew, and improves reliability.

Stage I MSIP will include multiple system and architecture improvements consistent with the increased lethality/survivability, improved fire control, application of air-to-air capabilities, reduced pilot workload, better hover control, and increased reliability, availability, and maintainability.

The Stage I MSIP is being designed to facilitate integration of the Airborne Adverse Weather Weapons System (AAWWS) that will further increase the warfighting abilities of the Apache.

The AH-64 Stage I Streamlined Acquisition Program will lead to production incorporation in FY 93 and fielding in FY 95 with AAWWS equipped aircraft. The program is also designed to allow retrofit of the Stage I improvements as AAWWS is retrofited to a limited number of fielded AH-64As.

Advanced Cargo Aircraft (ACA)

ACA will be a multi-engine, medium vertical lift aircraft which incorporates the latest technology in both flight controls and cargo handling systems. It will utilize a lightweight, quiet transmission and drive system, composite structures and composite, high efficiency rotor(s).

The ACA will incorporate adaptive fuel control, integrated propulsion and flight controls and precision automatic hover. It will replace the aging CH-47D medium lift aircraft fleet. The ACA will have the capability to vertically lift internal or external (outsized) payloads in excess of 35,000 pounds at 4000 feet/95 degrees Fahrenheit for a projected mission radius of 350-500 kilometers.

Currently, it is envisioned that the ACA will operate both near and beyond the Forward Line of Troops where it must be survivable through a combination of both vehicle performance and an active/passive aircraft survivability equipment suite.

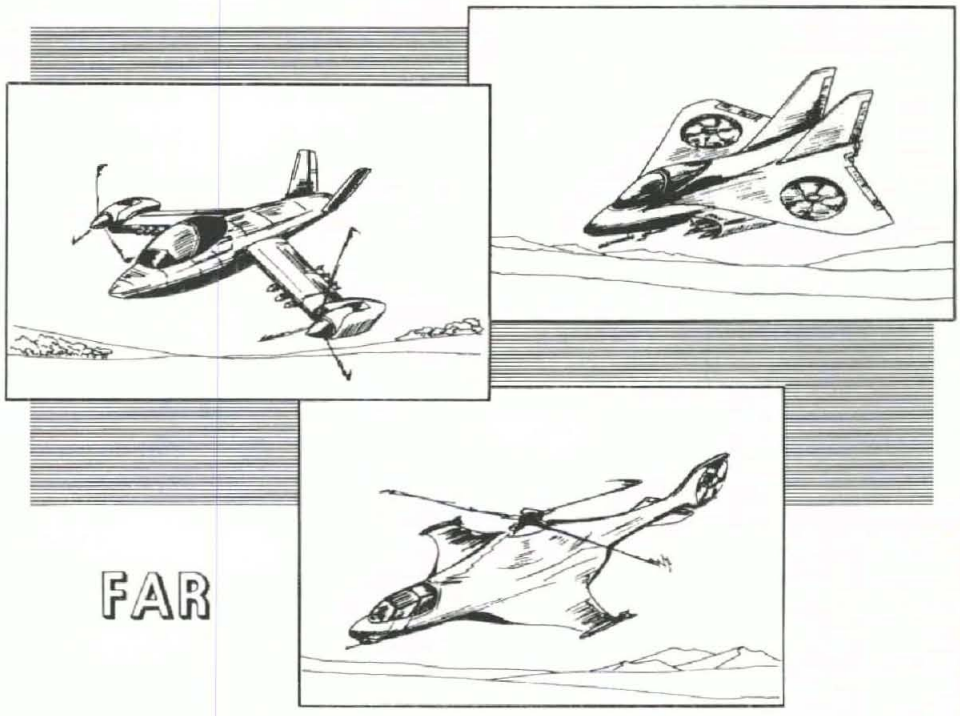
The ACA will have the capability of world-wide self deployment with all-weather, around-the-clock, reduced visibility operations, in-flight refueling, terrain flight with external payloads, and an advanced internal cargo handling system. It will have reduced vulnerability to ballistic and flechette-type weapons (including troop/cargo/compartment), directed energy, and nuclear/chemical weapons.

Future Attack Rotorcraft (FAR)

The FAR will be a multi-mission future aircraft. It will be designed to have high effectiveness and survivability enhanced by appropriate airframe and aircrew design techniques for protection against ballistic/flechette/small missile/high explosive incendiary threats as well as against threats beyond the turn of the country, in both air-to-air (helicopter primary threat) and anti-armor/area fire air-to-ground missions.

The FAR is expected to be operable night or day in all weather conditions. It is anticipated that an advanced configuration could facilitate a top speed of 325 knots and radius of action of 200 nautical miles, with a tilt rotor, folding tilt rotor or VTOL having the greatest potential. This highly maneuverable 15,000-20,000 pound class vehicle will utilize two engines of the 2,500 HP class. It will incorporate composite structures, low drag and weapons-airframe integration design technique, and be capable of worldwide self-deployment.

The FAR will make a maximum use of Phase II Very High Speed Integrated Circuit electronics and knowledge base systems technology to optimize and partition the man-machine functions.



Requirements will dictate automatic target recognition, an effective air-to-air missile, advanced fire/recoil/blast control, real-time mission replanning and combat recongfiguration, automated and integrated pilot aids, communication/navigation integrated into the battlefield command and control, and non-line-of-sight communications.

Army Aviation Command/ Control/Intelligence (A2C2I)

The A2C2I component of aviation is the network of aerial platforms, displays, processors, and communications links which integrate aviation forces into an efficient and effective force. A2C2I hardware and software resides within the fleet aircraft and in the various command posts and centers on the battlefield.

The A2C2I system differs from the other aviation NG/FS in that it is not a single, flyable system. It represents the direct analog to, and is fully integrated in (near) real time with the Forward Area Air Defense C2I system.

The A2C2I system will provide attack helicopter units with the information needed to fight as an active member of the combined arms team. The A2C2I system will exchange information among: scout/attack teams, battle captain, aviation battalion commander, and Army C2 systems. It will provide target position and identification data, command and control messages, and passive ranging via triangulation.

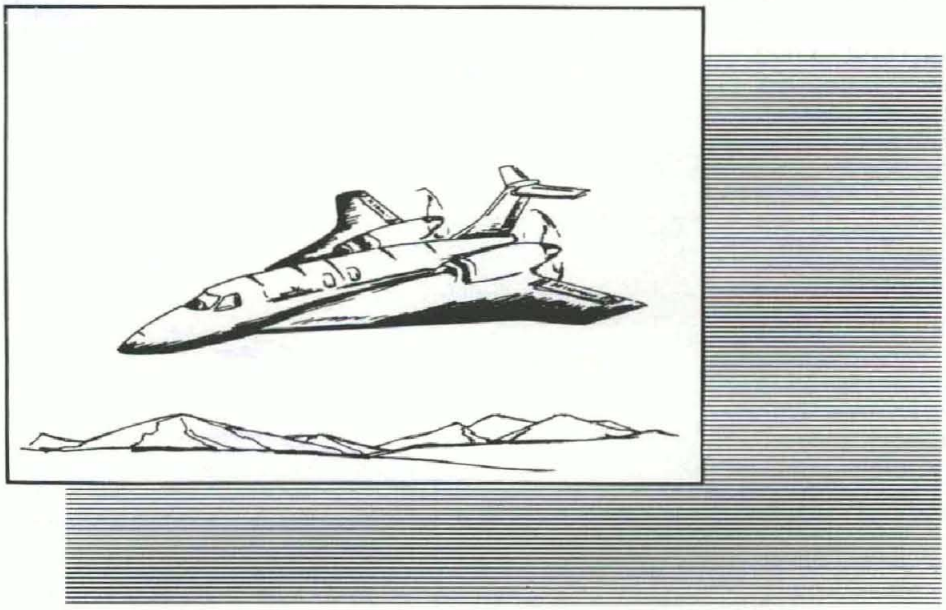
A2C2I will consist of tactical situation displays and associated processors to provide real time capability to acquire, process, and display targeting and intelligence information required for battlefield decision making.

Advanced Special Electronic Mission Aircraft (ASEMA)

The ASEMA will be an advanced, manned, fixed wing platform capable of carrying a mix of reconnaissance, surveillance, and target acquisition sensors. ASEMA requirements include: single pilot operable, ejection seats, air-to-air missiles, and rates of climb/descent, power margin, maneuverability, and structural capability consistent with evasive maneuvers. Mission duration is anticipated to be in excess of seven hours with a 3,000 pound mission equipment payload.

Beyond NG/FS

As technology and warfighting capabilities advance at an accelerated pace, Army aviation must plan for the future well beyond our Next Generation and Future Systems. In addition



to the Next Generation/and Future Systems already addressed, the following systems are being considered for development well beyond the year 2000. The primary technological thrusts that are applicable to all these systems will be in the areas of robotics and artificial intelligence.

Attack Air Mobility System (AAMS)

AAMS is a highly automated single pilot attack air mobility system with superior speed, agility, anti-armor and air to air capability. It will be part of an integrated attack capability which utilizes a ground or airborne command and control vehicle to control unmanned attack vehicles for high risk air to air and air to ground operations.

Special Electronic Air Mobility System (SEAMS)

The unmanned air vehicle will perform integrated reconnaissance, surveillance, target acquisition, and communication relays at high altitudes for extended periods. With a 30-day duration capability it provides a bird's-eye view of the battlefield to the battlefield commander.

Unmanned Air Mobility Systems (UAMS)

UAMS is the unmanned air vehicle extension to the AAMS. These recoverable vehicles will be small, lethal, stealthy, highly maneuverable at all speeds with a day/night, all weather capability.

Logistics Air Mobility Systems (LAMS)

LAMS is a family of highly automated manned/unmanned utility and logistics vehicles with a day/night, all weather multi-lift capability for loads greater than 50,000 pounds. Selective levels of automation will allow for a single operator to control a convoy of unmanned vehicles in a multi-mission role under adverse conditions.

Summary

In today's austere environment, affordability is likely to drive decisions on most defense programs over the next decade. Aviation assets are expensive and must compliment other Army programs which are also critical to a successful combined arms effort. With this continuing strain on resourcing, the idea of multi-stage improvement programs, nondevelopmental items, and industry teaming continue to be appealing.

Competition continues as a means of procuring cost effective, quality products for our soldiers in the field. These techniques as well as new and innovative methods in acquisition streamlining, must be used to ensure the affordability of needed future aviation systems.

The Army Aviation Systems Command is committed to capitalize on the benefits of technology and advanced systems concepts to maintain an affordable force structure and enhance the warfighting capabilities of the future.

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MAJ W. LEONARD SNITCH is an R&D staff officer in the Advanced Concepts Division, Directorate for Advanced Systems, U.S. Army Aviation Systems Command.

ARMY'S 'TECHNET' LINKS R&D OFFICERS

By CPT John N. Lesko, Jr.

Introduction

Army Officers at the U.S. Army Laboratory Command (LABCOM) have a new way to "talk" to each other. Called TECHNET, it is a computer based teleconferencing network which presently links all the military officers in LABCOM. Its purpose: "To enhance informal communications within LABCOM and between LABCOM, AMC's Research, Development and Engineering (RD&E) Centers, and the Army at large so as to assist in achieving and maintaining technology superiority over potential adversaries."

TECHNET provides BG Malcolm O'Neill, the LABCOM commander, and his officers with the means to asynchronously discuss research and development projects and technological advances. Now it is time to extend this informal means of talking throughout the other agencies and commands working on the Army's technology base.

The remainder of this article will, therefore, give a short history on the Army's use of teleconferencing, attempt to explain computer-based teleconferencing technology, outline a plan or model for TECHNET's future use, and supply potential participants with the information they'll need to join.

History

During the last several years, a small group of officers, NCOs, and civilians (some retired servicemen and women, others still working within the federal service), a few computer hacks, and a couple of behavioral scientists have been studying computer-based teleconferencing and how this new "staff technology" may be changing the way the Army goes about its business. They formed DELTANET and have made a difference in how the Army prepares for war.

Other networks followed. The Center for Army leadership at Fort Leavenworth's Command and General Staff College (CGSC) started discussing the benefits and shortcomings of this technology on its EXCELNET. A spin off group got together to develop a Living Expert System (LEXSYS) to assist system leaders (those senior executives at the three and four star or SES levels) with a computer-mediated decision support system or adjunct staff. The Army War College has sponsored this research during its last two academic years with group study projects sponsored by the vice chief of staff of the Army.

Networks with a materiel development or research interest are AMMONET (discussing class V logistics issues), AMMSNET (for the Acquisition Management Milestone System), AINET (discussing Artificial Intelligence matters), FINET (discussing force integration), LOGNET (focusing on logistics), ORSA (for Operations Research and Systems Analysis), SPACENET (discussing Army space concerns), and the Forumnet (covering topics across the DOD). The activity levels of these teleconferences varies. Subnets grow and expand or are organized in an ad hoc way to solve short-term problems.

When GEN Louis Wagner, commander of the Army Materiel Command, was briefed on the LEXSYS project, he asked, "what could be done to link those working in the tech base?" A briefing was given to BG O'Neill and TECHNET was born. LABCOM's TECHNET is a spin off network conceived by the collective efforts of those early ideas and discussions held by others within the Army's Forumnet system. LABCOM officers received personal invitations from the commanding general and have been active since May 1988.

What's so special about using computer-based teleconferences when we already have other communications means to help us conduct our business? To grasp the unique importance of this technology, let's look at what a user of teleconferencing technology can do.

Computer Based Teleconferencing Technology

TECHNET is one of 37 subnets under the Army Forumnet system. Each subnet links geographically dispersed participants via computer teleconferencing. Participants can use either a "dumb" terminal or a personal computer to link up to the system if they have a modem and a dial-up capability. Access is gained through either a commercial public data network or the Defense Data Network (DDN). Now think of all those personnel who own and use PCs at work or at home. The popularity and benefits of personal computing naturally have lead the Army toward capturing and harnessing this know-how via a network.

Each subnet consists of a group of users accessing a sophisticated electronic bulletin board. Users may post items on the bulletin board and

each participant can respond to any given item at their leisure. CONFER II software allows participants to send private messages to each other and to leave notes for themselves. However, the strength of a teleconference is found in the quick and effective means of communicating a message across organizational boundaries. This technology facilitates group discussions and the exchange of information among participants who are not physically at the same location or within the same laboratory or center.

Asynchronous communications overcome such problems as "telephone tag," caller non-availability due to travel or meetings, and different time zones. Personnel who use such teleconferences do not have to meet at the local televideo station. Nor do they have to cluster around the boss' office telephone at a convenient time to join a telephone-based conference call connecting those in Washington, DC with those in the state of Washington with those at the Army Research Office (Far East).

If a conference participant should temporarily leave this "electronic meeting," then the software allows for the participant to join back in where they had last left the discussion. A record of the discussion is kept to serve as proceedings of the conference. Note taking is therefore unnecessary. Item discussions are managed by an item facilitator. These facilitators keep the discussions on track, summarize, and may prepare concept papers which then can be staffed within the formal organization.

A Look to the Future

TECHNET can be used as a forum for a discussion of officer professional development topics. Junior officers can use the net to gain valuable insights on career enhancement from senior military mentors. Informal discussions include all who wish to comment.

Anonymous participation is possible but this feature is rarely used. By examining the roles our uniformed scientists and engineers play in the RD&A process and sharing our thoughts informally, we learn more about the nuts and bolts of technology transfer.

Informal communications allow for all within the command to hear and understand the intent of the message. The meaning of a new policy can be transmitted and discussed on TECHNET. Quick turn-around surveys can be conducted on-line through CONFER's polling, voting, and multiple choice features. These features allow those at the top to check on the possible impacts of their policy decisions. Problems can be quickly and efficiently tackled by using computer-based teleconferencing.

These capabilities will multiply as more and more users join TECHNET. Trends show an increase in computer-based communications and analysis. A critical mass of future tech base staff members will be more inclined to choose this technology as we move toward an organization based on information and run by knowledgeable workers skilled in the use of computer-based research methods. See Figures 1 through 3.

Some of the topics now on TECHNET are:

- R&D Project Management and Coordination
- The Formal and Informal Organization
- From Atop Mt. Everest — Potential RSTA Technology
- Space Junk — A Potential "Mine Field"
- The Need for MAM Trained Officers
- Staff Work Within the R&D Community
- Science Education Trends in the U.S. — A LABCOM Challenge
- Why Can't the Army Keep the R&D Talent It Has?
- The Federal Technology Transfer Act There are 45 items presently posted in the teleconference. Future topics will build on those already being worked. Four such future items are:
- Career Progression Concerns of R&D and MAM Officers
- How Can We Best Identify and Assign Officers Leaving AERB Sponsored Graduate Schooling?
- A Model for Technology Transfer — Moving Technology from LABCOM to Your Favorite RD&E Center to the Field

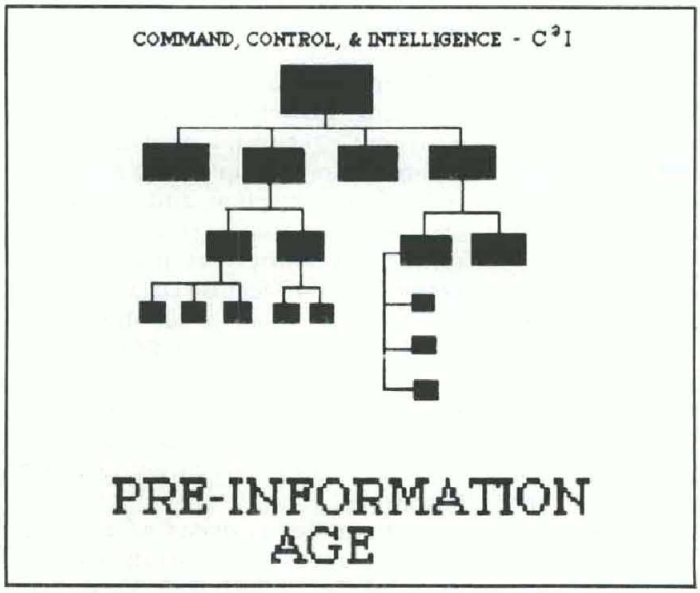


Figure 1.

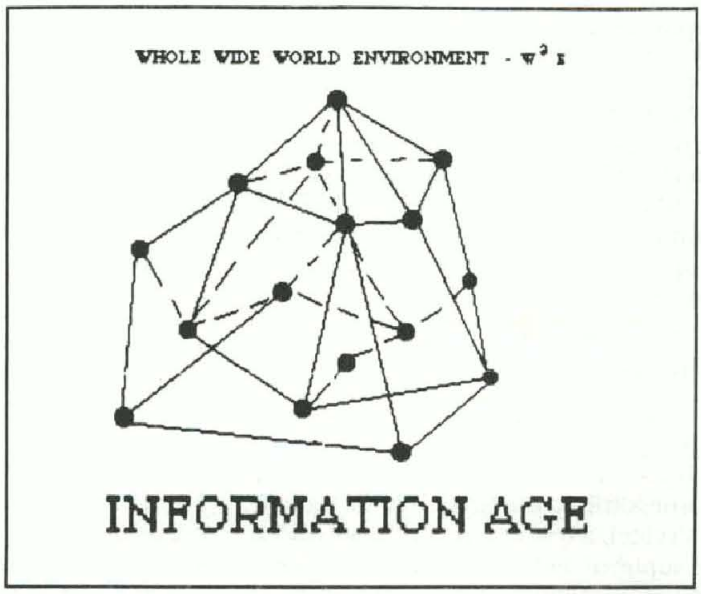


Figure 2.

• A Model for Technology Transfer — Moving Technology from the Army to the Field via a Defense Contractor. Through informal communications, TECHNET enhances a participant's abilities to effectively contribute to the organization's mission.

Now that TECHNET has been tested within LABCOM, its time to expand this computer-based teleconference. Military officers within LABCOM have done the proof of principle work. These officers now represent a cadre of users who can assist others in joining TECHNET.

The potential exists to expand the net to incorporate other LABCOM employees (e.g. senior civilians and non-commissioned officers) and those officers and key personnel working within the research development and engineering centers. We need to have an efficient interaction within TECHNET, not enlist an infinite number of subscribers. As TECHNET grows, there may be a need to subdivide the teleconference. CONFER software allows for groups of users to do this if needed. The entire technology base effort requires both a formal system of communications and an informal means to share ideas.

How to Join

If you are a graduate student, are training with industry (TWI), assigned to another MACOM, or preparing for an assignment in the Army Materiel Command, then contact a TECHNET co-organizer. CPT Karen Bagg at LABCOM headquarters, AV 290-4650 or (202) 394-4650, or the author, CPT John Lesko, at the Materials Technology Laboratory, AV 955-5746 or (617) 923-5746. If you are assigned to one of the RD&E centers, you probably deal with a LABCOM point of contact already. Contact one of the co-organizers, then ask the officer, with whom you normally work, about TECHNET. LABCOM personnel can help you with your first on-line session and provide helpful hints.

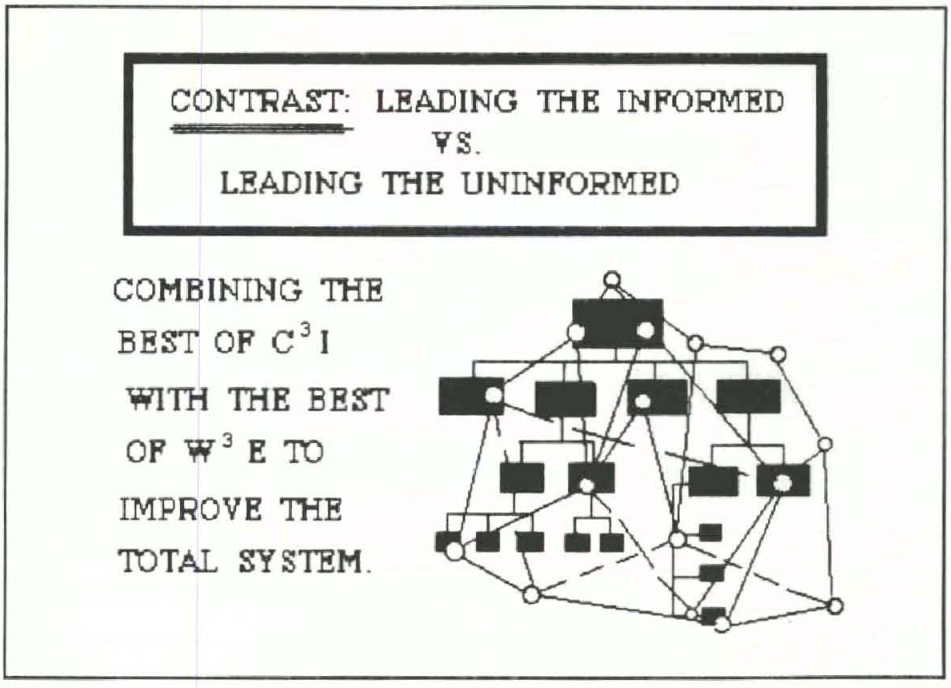


Figure 3.

Conclusion

As money for research, development and administration grows more scarce, new and innovative techniques in acquisition management must be employed. The Army TECHNET is one such staff innovation. TECHNET doesn't replace the chain-of-command, it enhances the span of control of those in authority by informing all of their intent. Compare and contrast leading the informed versus leading the uninformed. Through the effective use of formal and informal communications, our ability to accomplish the AMC/LABCOM technology base mission improves. Join the information age — join LABCOM's TECHNET.

CPT JOHN LESKO is the R&D coordinator for Materials Reliability at LABCOM's Materials Technology Laboratory and an Army TECHNET co-organizer. He holds a B.S. degree from the Military Academy and is completing an M.S. program in technology at Boston University.

QUALITY WEAPONS: A TEST AND EVALUATION CHALLENGE

By Dr. H. Steven Kimmel

With the recent orderly change of administration, it may be the appropriate time to examine, from a test and evaluation (T&E) perspective, the defense acquisition process in its quest for quality military products, materiel, and systems.

But before we can address any specific aviation, armor, munition or naval issue, it's best that we have a mutual understanding of the acquisition process as we know it today, particularly since changes, e.g., Congressional actions and Packard Commission recommendations, have occurred over the past few years.

To be sure, the Office of the Secretary of Defense (OSD) is attentive to and has established policy to improve the quality — of product, industrial base, as well as the military and civilian force structure. Nevertheless, to accomplish this goal, policy must be implemented by others. Certainly, the private and public sector research, development, test and evaluation communities will play a significant role in the acquisition of quality defense weapons.

If the reader seeks a bottom line early, here it is: test and evaluation is and has been last in line for defense investment considerations, often being overlooked or even ignored. This observation is not meant to be cynical, merely a testament to the well documented facts found (if sought for) by examining the budget of Defense Science Board, Government Accounting Office (GAO) findings, etc. Money alone, i.e., an increased budget allocation, will not cure the problem. The problem lies embedded within the sphere of influence fostered by our competitive sectors to bring to fruition new military technology. For more often than not, the impetus to achieve a technical superiority over our numerically superior adversaries results in weapons being produced without the completion of testing let alone readiness of the technology for production.

In addition, the following two postulates are further adding to the complexity of the problem; first, software is continuing to become increasingly important in the U.S. arsenal of defense products and second, realistic test and evaluation is receiving an increasing amount of emphasis and attention from several factions. Hence, software and testing of military systems remains as two intertwined topics of utmost concern and importance.

In addition, recent Congressional actions, combined with the Packard Commission recommendations, continuing GAO findings, and the new under secretary of defense for acquisition's total quality management goal, form sufficient reason for us to seek a better understanding, in an academic sense, and a clearer picture, in a businesslike sense, of why and how aviation or munition or even strategic defense testing must result in higher quality military products.

Defense system test and evaluation is not an end onto itself. Rather, it is a crucial, synergistic and pivotal element that must remain in balance with the military doctrinal expectations and, most important, provide credible, trustworthy results that support acquisition decisions.

Hence, members of the defense development community will be challenged to ensure that quality test and evaluation becomes synonymous with quality systems. As such, the following five facets are believed to be the key challenges inhibiting the use of effective, efficient T&E to obtain quality military products.

Focus on the Facts

The first to be reckoned with is a focus upon the facts surrounding quality system T&E from both policy and execution perspectives. Testing is serious business. This is particularly true since it is difficult to find threads of operational realism in the results derived from the myriad of laboratory, subsystem or component research driven test environments. By itself, improving the quality of testing is a challenge, but along with credible evaluation results it can become nearly unattainable. This same challenge is also experienced in having and promulgating the appropriate policies that will encourage effective, efficient software test planning and execution.

No matter what the fidelity or extent of testing might be envisioned, poor planning and execution coupled with incomplete or useless test data will certainly diminish the perceived contribution of T&E to the acquisition process. Make no mistake about it, the quality of the test program is an intrinsic issue that has serious resource implications. A test program that exhibits high quality is more likely to possess credible results useful to the evaluation community and senior decision makers along the Potomac.

Throughout the T&E period of performance, the modus operandi ought to be checking the hypothetical against the actual. Emphasis ought to be placed on checking the realism of the test not just its plausibility. Likewise, the Packard Commission's recommendation to increase the emphasis and use of prototyping in the acquisition process has evolved with mixed success. Certainly, the private sector pursuit for light helicopter (LHX) prototyping was restrained by the OSD decision to focus attention upon the LHX mission equipment package. Such OSD direction was deemed necessary in light of the risks and uncertainty associated with the technology and schedules being promulgated by the Army.

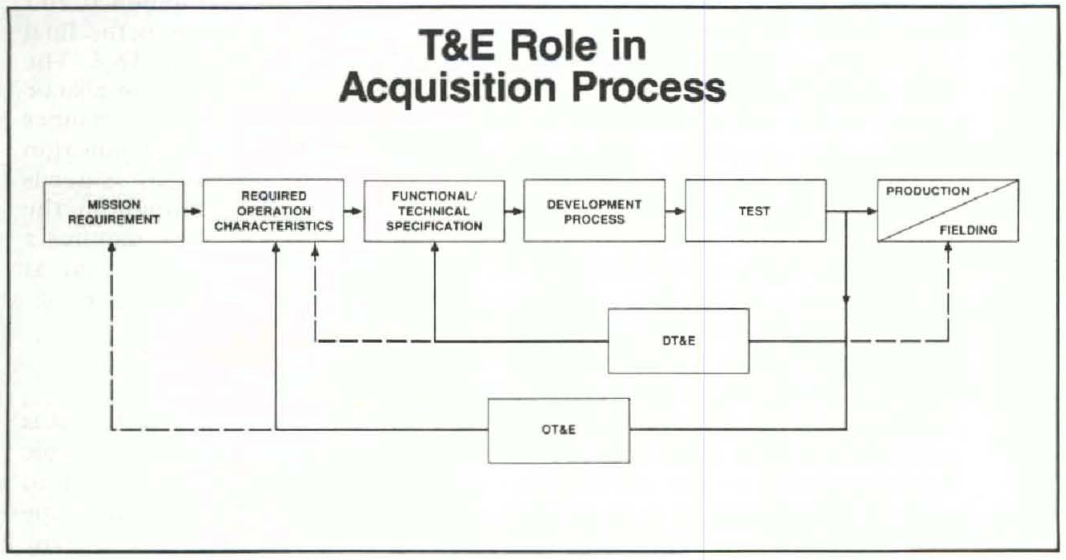
Relationship to Operational Military Doctrine and Tactics

Another facet is the relationship between test and evaluation and its contribution to the improvement of operational military doctrine and tactics. The primary challenge of this facet is the need to know about the performance characterizations. This relationship is particularly evident in the aviation community where so often high technology solutions are procured before the military tactics have been solidified. A recent example might be the Aquilla remotely piloted vehicle (RPV). In this instance, the period of test was unable to demonstrate the utility of the technology embedded within the airframe. In addition, one need only to imagine all the diverse operational sorties that might emerge for tactical airframes consisting of exotic composite and/or radar absorbing material such as the Air Force and Navy's tactical fighter and attack aircraft. In the end, T&E must assess the system performance claims via demonstrated capabilities.

Meanwhile, test and evaluation continues to be recognized as a key element of the weapon system process. By both long-standing practice and directive, weapon system test and evaluation is divided into two principal categories — Development Test and Evaluation, DT&E, and Operational Test and Evaluation, OT&E. As defined by the governing Department of Defense Directive (DoDD 5000.3, "Test and Evaluation"), DT&E is conducted throughout various phases of the acquisition process to ensure the acquisition and fielding of an effective and supportable system by assisting in the engineering design and development process and verifying attainment of technical performance specifications, objectives and supportability. OT&E is the field test, under realistic conditions and by typical users of the weapon system (or element thereof) to determine its operational suitability and effectiveness.

While DT&E emphasizes engineering design and technical performance, its ultimate goal, like that of OT&E, is to ensure the acquisition fielding of systems that are effective and supportable under combat conditions. One should not expect DT&E, by itself, to be sufficient to fully ensure effective, supportable combat operation; key elements of realistic testing are reserved to OT&E, e.g., operation by typical military users in as realistic representative field conditions as possible against threat-representative hostile forces. Nonetheless, it is clear that the utility of DT&E as an acquisition tool is increased when Development Test (DT) results can serve as a reliable predictor of Operational Test (OT) performance.

Similarly, in examining the formal distinction between DT&E and OT&E, one should view the test and evaluation process as a continuum of activities interwoven within the acquisition process. In reality, the maturing DT&E and initial phases of OT&E (IOT&E) do not fit into rigid or discrete compartments; both are involved with broad, system-level concerns. This relationship is a matter of on-going interest and often the cause of confusion and misunderstanding. In addition, recent enactments by the Congress have drawn attention to



Together development test and evaluation (DT&E) and operational test and evaluation (OT&E) seek to ensure the acquisition and fielding of defense systems that are effective and supportable under combat conditions.

The T&E challenge is to ensure that the adequacy of planned tests will truly 'test and stress' the sought after system to provide sufficient and quality results for the evaluators engaged in the decision process

DOD's T&E management, execution and actions. Certainly, those engaged in weapon system acquisitions need to understand the relationship of those collective T&E interests that are so vitally needed to support the acquisition process.

In a similar fashion, the determination to know when to model and when to simulate must be better understood. Certainly, developmental focused modeling and simulation can provide viable support to acquisition decisions. But left unto themselves, private and public sectors are pursuing a class of models and simulations which can be described as "a.c.," which stands for "advocacy collaboration." Many of these have or can have the tendency to grow into an elegant model that provides a useful, yet limited solution for the immediate area of focus; thereby gaining a reputation as an "advocacy collaboration."

Meanwhile, many believe that testing is becoming increasingly more expensive and less credible rather than more realistic. This trend must be reversed even in light of limited airspace due to civilian encroachments and security concerns. One method will require "d.c." modeling and simulation. In this context a foundation for experiments to resolve a given problem setting can have "direct correlation," and hence d.c., in a hierarchical fashion to build a basis for the complete spectrum of acquisition decisions — from concept through engineering and test. The objective of d.c. modeling and simulation is to satisfy the spectrum of private sector hardware designers and materiel producers while supporting public sector strategists, tacticians, force developers and trainers as well as acquisition decision makers. To be accepted, d.c. modeling and simulation must be operationally verifiable and analytically flexible.

Timely Relevance and Balanced Testing

The third facet deals with the timely relevance of system testing that must be in concert with the program's acquisition strategy. To be sure, the challenge is to bring out the key information early. This is particularly true if the information clearly establishes a qualified tested system or a clearly unqualified weapon system. To hedge against the latter results, many electronic warfare as well as command, control, communication/intelligence systems are an evolution of a deployed or existing design. For such evolutionary acquisitions, there exists every reason to suspect that the original test method can be adapted successfully. The converse is equally valid. Regardless, the attainment of a balanced test program is a challenge in light of the complexity and synergistic relationships associated with the current trends embodied in acquisition strategies and system performance evaluation criteria.

Balanced testing is achievable once the functional areas of test methodology, technical resources and management realize the value-added necessity to obtain an accurate and trustworthy performance evaluation. In addition, as our reliance upon models and simulations become more pronounced, evaluations will become increasingly predicated upon abstract test conditions.

Testing alone will not satisfy our needs. The accompanying process of evaluating test results and determining the degree of achievement and satisfaction of both developmental and operational requirements is the final prerequisite for balanced T&E. The combined T&E program must also be structured and executed in a manner that is consistent with the acquisition strategy and the information needs of decision makers throughout the acquisition process. This requires a systematic T&E program that is responsive, valid, and predictive.

Validity Review

It follows then that the fourth facet is validity review, an area of immeasurable consequences. The key challenge is to record the need to review the full scope and detail of the test method thereby

reducing the perception of lighthearted relevance to the Test-Analysis-And-Fix doctrine of defense system engineering. For example, the increasing recognition for software validity occurs at the precise time that the Congress is calling for more comprehensive realistic testing and budget decisions virtually make full compliance not practical. Hence, synthetic representations of realistic military environments is a challenge to be reconciled.

As we approach the 21st century, it is very likely that development testing will evolve into computer-based assessments of projected performance. Similarly, operational (user) testing will become increasingly important due to the nature of confirming projected "end points" on the performance envelope. Thus, we will be concentrating on the major, most significant aspects of weapon system performance. Meanwhile, the bandwidth of implicit, less significant aspects may in and of themselves be five or 10 percent off the mean, but the cumulative contribution of 50 percent degradation must not be overlooked.

In an analogous sense, computers and development tools, such as wind tunnels and static radar cross section instrumentation, will replace or virtually eliminate the need for access to range or flight time, let alone environmental testing. Prototyping emphasis will take on a new dimension, one that emphasizes software rather than hardware engineering. Meanwhile, hardware in the loop simulators will become increasingly important as fewer hardware prototypes will be constructed prior to the initial production decisions. In addition, simulations consisting of real time, manipulation of immense data bases will further reduce the need to gather and reduce physical flight test data. As this prophecy comes true, the aviation, electronic and munition T&E challenge will be to merge the physical and abstract realisms embedded within the abyss assumptions of models and simulations algorithms into an acceptable, integral element of the evaluations necessary to support the acquisition process. A major part of this challenge lies in our ability to validate software-driven simulators so that test results and evaluations can be truly representative and predictive of the weapon system performance, not just that of the simulator.

Predictive Results

The fifth and last facet is predictive results. The key challenge here is to be the Monday morning quarterback on Saturday morning. Being able to predict tomorrow's areas of technical, development or test risk is an area that requires a great deal of attention. This is particularly important since many system requirements reflect mature "end point" performance levels, whereas evolutionary acquisitions with interim system configurations and performance thresholds can provide a roadmap to system maturity. To be effective, a balanced T&E program must be capable of extrapolating from current technical performance levels to determine the likelihood of achieving mature operational performance.

It is neither feasible nor practical to advocate a single process to test and evaluate the full spectrum of avionics, propulsion, material science, or even naval technology intended for use in military systems. Rather, generic "sets" of approaches for different types of applications might be possible with a core of uniformity and commonalty among them. Such an approach is compatible with existing DOD policy, but lacks definitive support beyond Service preferences. For example, system developers and users are reluctant to tailor performance evaluation criteria to permit the application of a more "universal" method to provide accurate and complete performance evaluation results verified by historical applications. Typically, Service program offices become engaged in adapting a previously executed method as their approach. This course of action may, at best, afford an improvement over the original method, but at the risk of perpetuating unintentional deficiencies.

It is important to note that predictive and evaluative aspects of testing can provide useful insight into both the weapon system and its associated acquisition process. For example, in a non-development item acquisition, test results may indicate both a failure to achieve performance thresholds in the current configuration and an uncertainty in maintaining previous performance levels of existing fielded systems. This, in turn, can lead management to a "brilliant flash of the obvious" conclusion that their test program was not adequately structured to ensure no degradation of existing capabilities.

Summary

To be sure, even a two percent real growth for defense spending over the next five years represents a major reduction over the previous period. Therefore, attention must be provided to achieve realistic and trustworthy test results to support defense and Congressional decision makers. Certainly as the defense budget reflects significant force structure reductions to include fewer ships, aircraft and weapon systems, test resources for instrumentation, targets and/or test articles will not come easily. Therefore, if our activities are to remain viable, we must focus our endeavors into quality efforts that produce a balanced approach to test and evaluation; balance with expectations and, most importantly, trustworthy, militarily relevant results, whether they be factual or predictive. We will have failed in our efforts if we somehow evade the methodical verification of technical performance only to have the media and Congress use test data to reach the conclusion of less than adequate operational, suitable and effective defense system performance.

The streamlining of acquisition programs is certainly warranted. The T&E challenge is to ensure that the adequacy of planned tests will truly "test and stress" the sought after system to provide sufficient and quality results for the evaluators engaged in the decision process.

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ITEM-LEVEL WEAPONS MODELING: VULNERABILITY/LETHALITY ANALYSIS

By Paul H. Deitz

Introduction

In the previous issue of the *Army RD&A Bulletin* the topic of item-level weapons analysis was introduced. Item-level weapons modeling involves the study of a single military system such as a tank, aircraft or communications shelter; the system may be examined from many quantitative aspects including size, weight, mobility and vulnerability to various threats.

Item-level modeling requires a two-step process in which a three-dimensional geometric and material description of an object is generated and then linked to an application code to provide estimates of system performance. Many detailed item-level analyses have been developed over the years. In this article, the techniques of conventional ballistic vulnerability/lethality analysis will be illustrated for direct-fire weapons versus armored fighting vehicles (AFVs).

Vulnerability/Lethality (V/L) Overview

The *vulnerability* of a combat system is an assessment of its susceptibility to damage given a specific encounter with a particular threat. Therefore the term *vulnerability* is associated with the ability of military systems to continue fighting, subsequent to an interaction with a lethal mechanism delivered by an opposing force. By contrast, *lethality* is the effectiveness with which an attacking weapon can inflict damage on a particular target. The assessment of vulnerability plays a key role in many Army studies including: concept tradeoffs, vulnerability reduction and lethality optimization, inputs to war games, cost and operational effectiveness analyses (COEAs), spare parts requirements for repair of battle damage, and logistics.

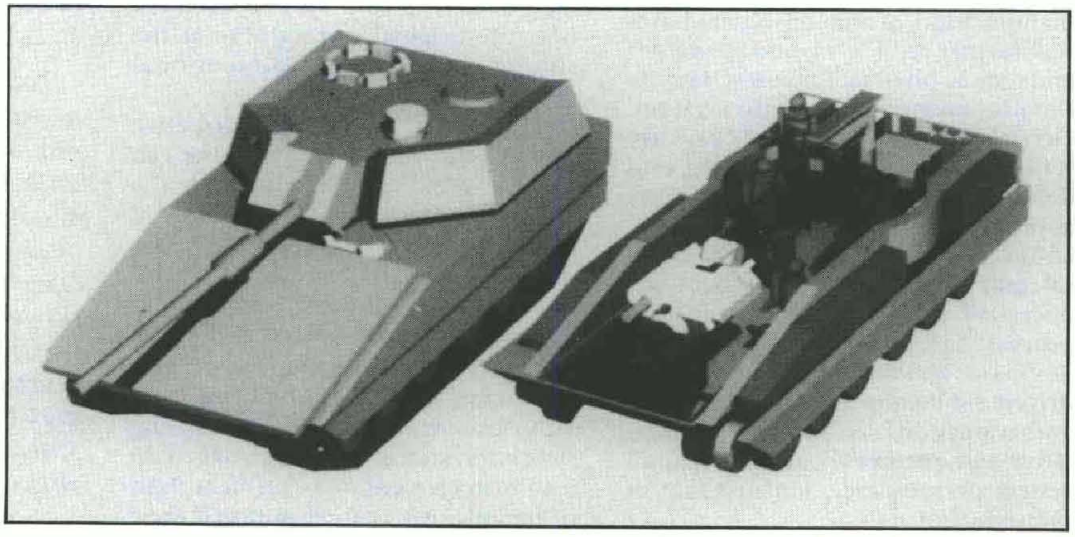

Figure 1. Concept design for a Mobile Protected Gun System.

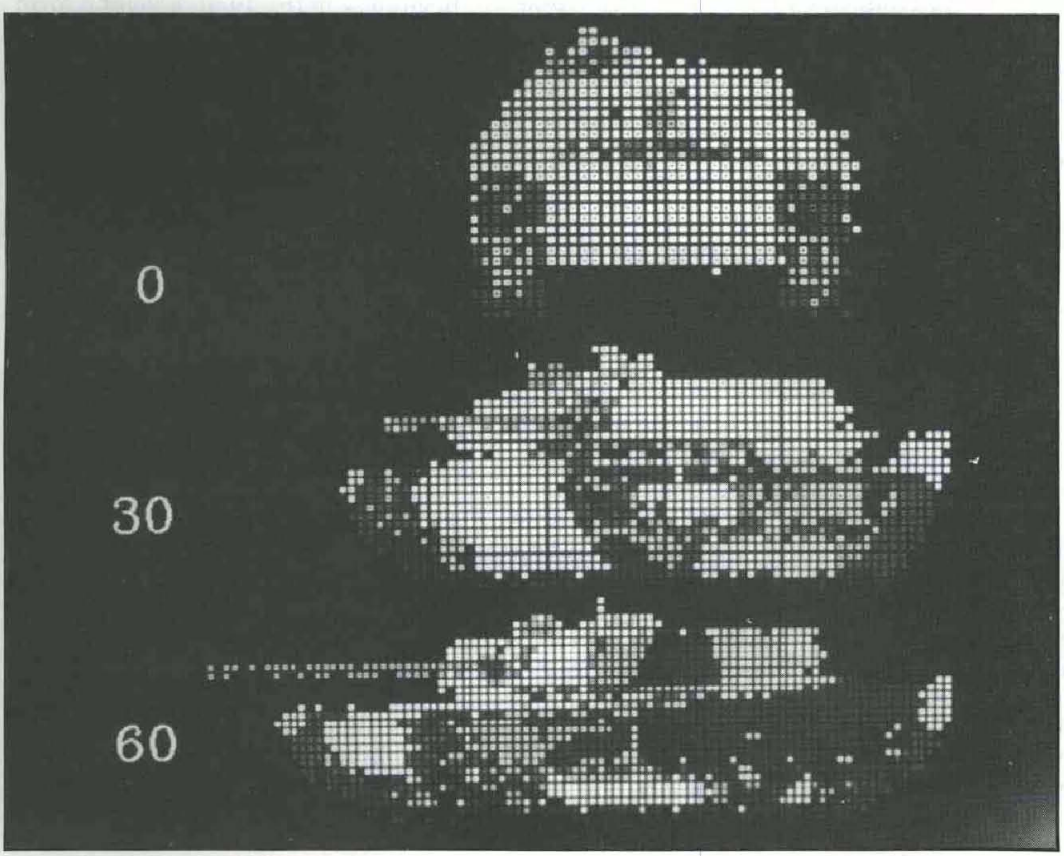

Figure 2. Standard cell plot used to display estimates from vulnerability analysis.

Over many years the requirements for weapons life-cycle support in the area of V/L have resulted in a set of estimation tools. We give a listing in order of increasing complexity: Penetration Performance, Lumped Parameter Probability of Kill Modeling, Expected-Value Point Burst Modeling, Spare Parts Estimation, and Stochastic Point-Burst Modeling.

Penetration Performance

Probably the most fundamental vulnerability question that can be raised about an armored fighting vehicle pertains to the protection from threat munitions afforded by its armor. The first figures of merit computed at the early concept phases of an AFV are usually protection levels for various threats versus the ballistic hull and turret (BH&T). In order to accomplish this, a number of inputs must be assembled. The threats must be specified; this task is the province of the intelligence community. The target geometry must be constructed using the CAD tools discussed in the previous article. Finally, appropriate warhead/armor algorithms and data must be identified for the threats to be analyzed.

Figure 1 illustrates a concept target description generated for the Mobile Protected Gun System (MPGS) program a few years ago. Ignoring for the moment the exterior suspension system and interior components such as the crew, main gun, fuel, etc., this geometry is appropriately detailed to support penetration calculations. In the case of some of the more advanced technology combinations, insufficient data exist and vulnerability analysts must make projections.

Once the target geometry and threat performance information is constructed, a BH&T study can proceed. Normally, a 4-inch grid is projected onto the target from a series of standard aspect angles. A single shot-line is passed through each cell of the grid and the penetration performance calculated. Figure 2 illustrates a cell plot for an AFV for three horizontal attack azimuths. For the case of perforation, the cells can be color-coded according to the magnitude of residual penetration.

Framework for Vulnerability Assessment

The systematic study of AFV vulnerability originated during the 1950s when many firings of antitank rounds were performed against full-scale tanks. By 1960 over 1,400 firings had been completed. A *catastrophic kill (K-Kill)* was defined as the total loss of the vehicle through explosion or burning. However it was observed that penetration into interior AFV space did not necessarily result in total vehicle loss. As a result, new measures of effectiveness called probability of kills (or PKs) were developed for mobility and firepower functions. A *firepower kill (F-Kill)* results from an inability to deliver controlled fire within 10 minutes of being hit and the dysfunc-

tion is not repairable by the crew on the battlefield. A *mobility kill (M-Kill)* results from an inability to execute controlled movement within 10 minutes of being hit and the dysfunction is not repairable by the crew on the battlefield.

The steps in the vulnerability logic process can be shown as:

1) Threat/Target Interaction
2) Component Damage State(s)
3) Loss of Automotive/ Firepower Capabilities
4) Probability of M-Kill/F-Kill

Step 1 *defines* a particular bullet/target combination. After a shot, a set of damaged components may be encountered (Step 2). If components or systems are killed which support mobility or firepower, there may be partial or total loss of these functions (evaluated in Step 3). The reduction in these measures of performance (MOPs) is then related to a probability of M- or F-Kill (Step 4). During the late 1950s, an armor board was convened to develop relationships between severity of AFV damage and M- and F-Kill values. The result of that study was the *Standard Damage Assessment List (SDAL)*; it relates damage in Step 2 to PKs in Step 4 and in modified form is still in use today.

Lumped Parameter Modeling

The AFV tests of the 1950s, together with the kill definitions and SDAL, were used to develop the first ground vehicle vulnerability model. Called the *Compartment Code*, the model is built on the following data inputs:

- Simple geometry such as shown in Figure 1. The BH&T, exterior suspension, main gun, ammunition and fuel must be represented explicitly.
- Penetration relations for the warhead/armors under evaluation.
- Compartment damage correlation curves.

The correlation curves have been developed from field tests and, in effect, relate the warhead/armor interactions of Step 1 directly to PKs given in Step 4. The Compartment Code methodology accounts explicitly for warhead penetration at the impact point. This process is used to estimate the probability of a K-Kill due to possible residual penetration interaction with ammunition or fuel. However, the effects of all other damage mechanisms, including Behind-Armor Debris (BAD), are lumped into the correlation curves. These curves are then used to make the M- and F-Kill estimates. The model is efficient to run, and over many years, the BRL and other organizations have used it as the principal AFV assessment tool. However, because of the way in which many complex damage mechanisms combine in a full-up field test, this model can only be used to predict shots for warhead/targets which have already been fired! Its extrapolatory capability to new vehicle configurations (e.g. spall liners, new armors) and/or new weapons is limited.

Although the outcome of any given ballistic event can be highly random, this model is built by averaging over many samples of field data. Thus, lumped-parameter modeling yields an *average* (or first-moment) predictor of PK.

Expected-Value Point Burst Modeling

Because of the Compartment Code limitations, vulnerability analysts beginning in the 1970s sought a form of simulation which could be constructed from a series of ballistic submodels rather than built on data from full-up firings. This model would have the potential to evaluate AFVs significantly different from previously tested systems. This model, however, requires detailed Behind-Armor Debris and component-kill data bases.

Called *Expected-Value Point Burst* or in some cases *Component Models*, this class of simulation estimates explicitly both the effects of behind-armor warhead residual and debris.

To support Point-Burst vulnerability assessment, the following inputs must be assembled:

- A highly detailed target description. Every component (both critical and shielding) of the system must appear explicitly. If components are missing, they can't be assessed, and the final results may be biased towards a low estimate of vulnerability. Figure 3 illustrates the interior of an Abrams target description capable of supporting this level of assessment.
- As in simpler models, penetration relations are needed for all warhead/armor pairings that will be encountered; also for all components.

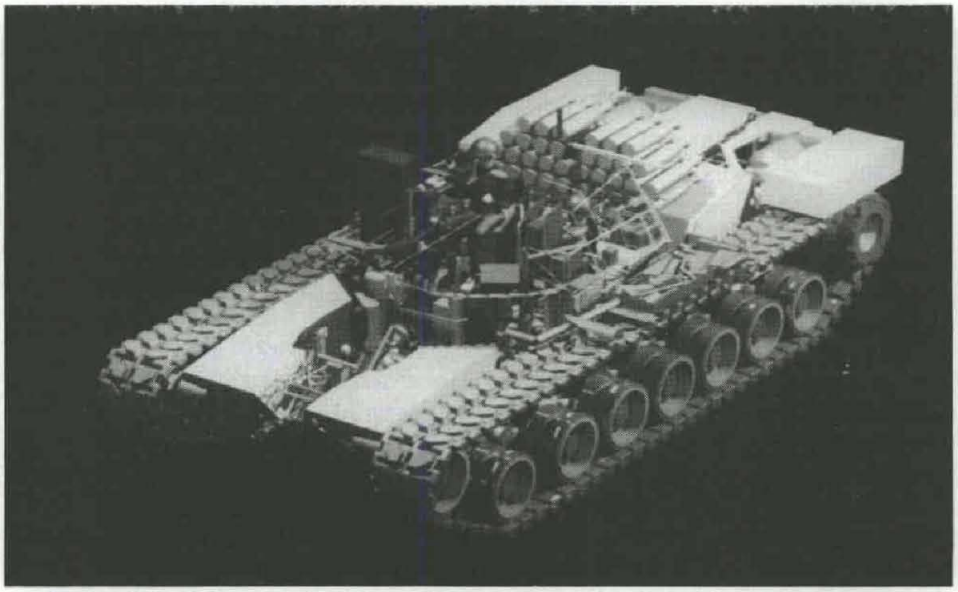

Figure 3.
From elevated view of current Abrams target description with armor and armament stripped away.

- BAD relations describing spall generation for all armor burst conditions as a function of penetration encounters.
- Component PK assessments for all vehicle critical components (those which support mobility or firepower functions). The form of the component PK characterization and the means used to describe the BAD must be compatible.
- A set of fault trees (or "wiring diagrams") which reflect the system function of all critical components. In the course of the computer simulation, if a given critical component is judged to have been killed, the accompanying fault tree shows whether residual mobility or firepower functions remain.

In the last decade, a half-dozen variants on the Point-Burst model have been generated which differ only in the manner in which spall and component PKs are characterized.

In addition to the detailed inputs, computer run time increases markedly, mainly due to the shot-line interrogation of the high-resolution target description needed to model the spall process. As in the case of the Compartment Model, the output of these models is an estimate of *expected* M and F PKs.

Spare Parts Estimation

During the past 10 years, interest has grown in the areas of battlefield resupply and spare part stockpiling. The point-burst methodology described above was modified to account for two metrics: component damage sufficient to warrant replacement and required repair time. In effect, the component PK metrics of the Point-Burst methodology were lowered to reflect a damage threshold rather than a kill condition.

The input detail and run constraints for Spare Parts Estimation are commensurate with Point-Burst methods.

Stochastic Point-Burst Modeling

In the last few years, many live-fire test programs have been initiated as a result of the National Defense Authorization Act for FY 1987. One of the earliest AFVs tested with overmatching munitions was the Bradley Fighting Vehicle. When the BRL was confronted with the requirement to predict each of some 150 shots before the actual firings, it chose an existing (Expected-Value)Point-Burst Code. Since the Bradley had never been extensively tested with overmatching munitions, exercising a version of the Compartment Model was not possible.

When the field-derived PKs were compared with the estimates from the model, certain variations were observed. Critics of vulnerability modeling rated the quality of predictions in terms of the percent variation with field value.

There were three substantial problems at the time in using the extant Point-Burst models in support of live-fire testing:

- ***Lack of Randomness:*** Some reflection on the complexity of the destructive processes of ballistic vulnerability soon leads one to the conclusion that there are many aspects of armor penetration, fracture, spall generation, and component dysfunction that could lead to significant shot-to-shot variability were it possible to repeat a given shot configuration many times. In practice the costs of testing and the availability of expensive materiel mean that precision repeated shots are a rarity.
- ***No Predicted Component Kill Combinations:*** The extant Point-Burst models predicted the probability of killing components *individually*, but not the probability of killing components by specific *groups*. And it is the latter which is the primary observation in live-fire testing.
- ***Improper Use of Statistics:*** Various critics of vulnerability modeling rated the quality of assessments by comparing directly the single field PKs with the (first-moment) predictions. This is the equivalent of comparing a single sample from a gaussian (bell-curve) distribution with the average of the same curve; no useful inferences can be drawn.

At the onset of the Abrams Live-Fire program, a new stochastic point-burst code called SQUASH was developed. Using probability methods, this code varies the penetrator hit location over a small area, the magnitude of warhead performance, the deflection of residual penetrator, the statistics of spall generation, and the component PKs.

SQUASH was used to predict the 48 Abrams live-fire shots. Although the model predictions and field observations are still being analyzed, it is clear that an extraordinarily large number of variations in component damage can occur in live-fire testing. In one shot simulation more than 1.8 million distinct damage states were calculated as possible outcomes (Step 2, *Framework*). When these damage states were mapped via the SDAL to generate PK histograms, disperse and ill-behaved statistics were observed. In some cases, 20 percent of the PKs were zero, another 20 percent were unity, and the rest were distributed between the extremes. Not atypically, the average PK (first-moment) occurs where not a single outcome is found!

Much more work, both analytical and experimental, will be required to provide precise uncertainty limits on this class of computation.

Summary

We have reviewed here a set of item-level vulnerability tools used mainly to evaluate AFVs for various direct-fire threats. Although the nature and relative importance of certain damage mechanisms are different, a similar set of codes can be found in the evaluation of air targets. In general, as an item moves from concept towards development and beyond, the vulnerability assessments become more detailed and resource intensive.

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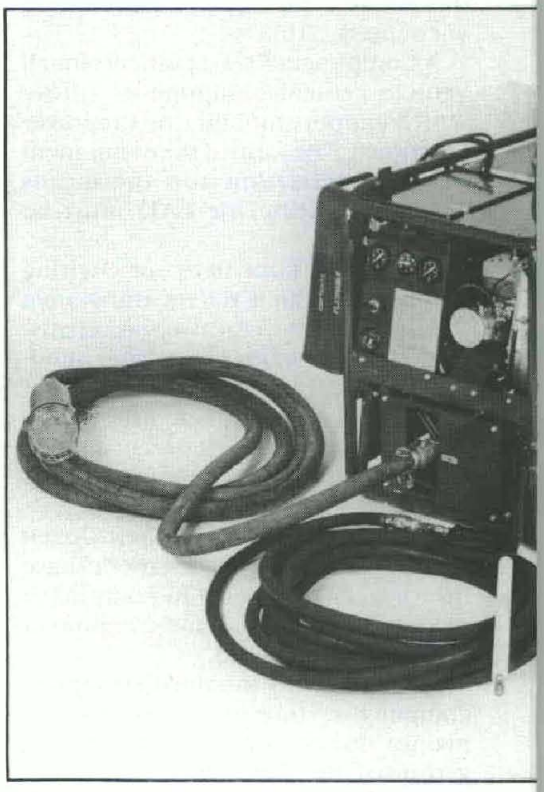
ARMY LIGHTWEIGHT DECONTAMINATION SYSTEM

By Rinaldo J. Bucci and
Steven R. Harlacker



Lightweight Deco

With the increased emphasis on chemical warfare defense, along with the movement by the U.S. Army toward a highly mobile force structure, a need for a lightweight decontamination system was essential. This need has been met by the Lightweight Decontamination System (LDS) recently adopted by the U.S. Army. It provides the soldier with a man-portable means of dispensing steam/hot water or detergents for decontamination. The item consists of a pumping and water heating apparatus; a self-supporting, rubberized fabric water tank; and an accessory kit containing hoses, spray wands, shower hardware, and a siphon injector for applying detergents during decontamination operations.

The LDS program was managed by the U.S. Army Chemical RDE Center (CRDEC) under the weapon system management team concept with direction from the office responsible for development of decontamination equipment within the Physical Protection Directorate at CRDEC. Program review and decision authority for the LDS program consisted of representatives from the Army Materiel Command, materiel developer and chairman; the U.S. Army Training and Doctrine Command, combat developer; and the U.S. Army Logistics Evaluation Agency, logistics evaluator.

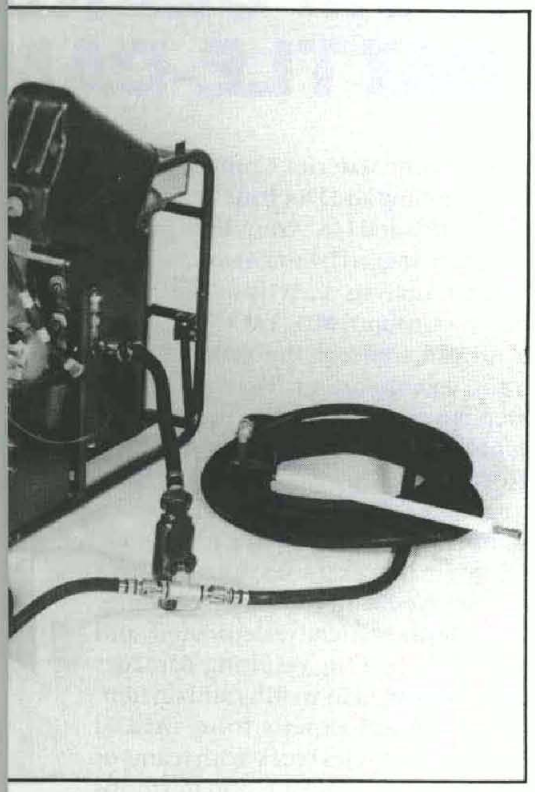
When the need was identified for an LDS, the NBC Sanator, a non-developmental item available from Norway was identified by U.S. Forces in Europe as a possible solution. Following an initial evaluation sponsored by the U.S. Army Foreign Science and Technology Center and conducted by CRDEC and the 82nd Airborne Division, the item was evaluated under an International Materiel Evaluation program.

The initial LDS was adopted by the U.S. Air Force. However, it was found to not fully meet the U.S. Army's field requirements. A decision was made to procure the item on a limited basis through the U.S. Air Force, provide for the needed improvements, conduct the required user test, and then procure the uniquely improved Army model for final distribution throughout the U.S. Army. It was recognized that the normal development and acquisition process would not be responsive to this immediate need.

A streamlined acquisition strategy was developed at CRDEC which incorporated only the essential aspects of the normal acquisition process. This streamlined strategy included the conduct of user tests even prior to formal development tests, and the acquisition of technical manuals and technical data during the production phase of the effort. The strategy eliminated the entire advanced development phase and markedly shortened the full scale engineering development.

To meet the critical fielding date, production activities, including the negotiation of a license to allow for competition, were conducted in parallel with the final development. Contract award for production units was scheduled immediately after type classification. The entire effort was planned and conducted within only 19 months from receiving program go-ahead.

User testing was conducted at U.S. Army sites under various climatic conditions. The developer, CRDEC, worked closely with user elements during the conduct of training and



tamination System

test planning, and during the conduct of the tests. The success of any program is very dependent upon the early and continued feedback of the test community. Each problem area must be assessed and engineering solutions provided.

To assist in the decision-making process, the U.S. Army Test and Evaluation Command provided a risk assessment to support the accelerated Milestone III production and deployment decision even though development tests were not yet completed. This assessment concentrated on determining risk with respect to reliability, availability, and maintainability (RAM) and helped to identify problem areas for which immediate corrective actions were implemented.

Analysis of the risk and a complete engineering assessment of the risks with the RAM engineers was completed early in the program and definitive action initiated on any identified engineering problem.

Users, logisticians, procurement and contractor personnel, and producibility and development engineers cooperated as true professionals on this high priority project. Without this team effort, the LDS could not have been fielded within the short time frame. In addition, the development/user team was dedicated to the program and sheltered as much as possible from administative needs. This approach provided for the best technical efforts and a useful end item.

The problems with providing an effective LDS, now designated the M17, for use by the U.S. Army has been solved in record time. The M17, shown in the accompanying photograph, not only provides greatly improved decontamination capabilities, but also provides for increased mobility on the battlefield.

Associated equipment fielded with the M17 includes an auxillary pump to increase pumping distance and a trailer for added mobility. The selective use of the limited-procurement, non-developmental item for the initial fielding added an early combat capability while the technology was being improved for a more fieldworthy, standard system.

This program achievement epitomizes the results which can be achieved through the streamlined acquisition process. The use of new initiatives and the willingness to take calculated risks on new designs and program approaches was key to the technical success and overwhelming user acceptance of the resultant item.

Elimination of advanced development along with the streamlined engineering development, supported by the contractor's initiatives to make the needed design changes was a major innovation. In view of the need to perform on the complex battlefield of today and the future, the LDS has provided a significant advancement in the field of NBC decontamination.

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TACOM SEEKS FOR BATTLE-DAM

By George Taylor

For the soldier on the battlefield, there will always be the possibility that his vehicle will sustain damage and become immobilized, leaving him stranded in a life-threatening situation. But help may be on the way for troops facing such circumstances in the future.

The U.S. Army Tank-Automotive Command (TACOM) and other agencies of the U.S., British and West German armies are now participating in an ongoing program aimed at testing temporary quick-fix procedures designed to restore combat functions to battlefield-damaged vehicles that would permit the vehicles to continue with some or all of their combat missions, or to move to a safer location for conventional repair.

The program has been under way since 1986. Its objective is to conduct battlefield damage assessment repair (BDAR) training exercises with vehicles damaged by live fire under simulated combat conditions to determine the most expedient ways of making on-the-spot repairs of vehicle battlefield damage.

The exercises are held annually in Meppen, West Germany, and are referred to as the Meppen Live-Fire Trials. They are managed by the West German Army Office, which has invited the United States and Great Britain to participate in the trials and share BDAR ideas. By doing this, it is hoped that some ideas may become standard quick-fix procedures for NATO forces which could enhance NATO equipment survivability and improve all three nations' combat capabilities.

The U.S. Army's involvement in the three-nation effort includes elements of the Army Materiel Command, the Army Training and Doctrine Command (TRADOC), and U.S. Army, Europe, and is being managed by the Army Materiel Systems Analysis Activity at Aberdeen Proving Ground, MD. TACOM's role is to furnish some of the vehicles used in the exercises, provide technical direction of the vehicles in use, provide technical direction of the U.S. BDAR efforts, develop and evaluate repair procedures and provide maintenance support to the participating soldiers.

During the exercises, the vehicles are damaged with typical threat munitions (both statically detonated and launched), and the resulting damages are documented in writing and on film. Then technical experts from TACOM and other agencies work with teams of U.S., British and West German troops to assess the damage and attempt to repair it.

Soldiers repair radiator tubes.

QUICK FIXES AGED VEHICLES

The repairs are attempted using existing TACOM-published BDAR technical manuals (TMs). Procedures that exist for the specific damages that occur are "validated." If no procedures exist for the specific damages, the steps the troops use to make repairs are closely monitored by the TACOM/TRADOC personnel and recorded as potential candidate procedures for inclusion into BDAR TMs.

According to TACOM's Alvin Hardy, who coordinates RDE Center BDAR program involvement in the center's Logistics Technology Office, the first three live-fire trials were highly successful. He talked about some of the promising quick-fix ideas that have been tested to date.

One concept is a field-repairable radiator that has been used commercially in off-road construction equipment and in train locomotives. Unlike a conventional radiator, whose core is a one-piece mesh design, the field-repairable version uses a core consisting of a series of vertically mounted individual tubes with cooling fins on their outer surfaces. The ends of each tube fit securely into rubber grommets in a tank at the top and bottom of the radiator. The grommets provide a tight seal that prevents water from leaking as it circulates between the tanks and tubes.

If a tube is damaged, it can be removed and replaced quickly with a pair of pliers. Or, if a replacement tube is not available, a 7/16-inch bolt can be inserted into the hole in each tank vacated by the damaged tube. The loss of a tube does result in a small reduction in the radiator's cooling efficiency, but the bolts temporarily plug the leak and permit continued vehicle operation.

"In the 1987 live-fire exercise," Hardy said, "a test of the field-repairable radiator concept was highly successful. Troops replaced several damaged radiator tubes in a HMMWV (High-Mobility Multipurpose Wheeled Vehicle) within 15 minutes, and the vehicle was able to resume normal operation."

"The one thing we still don't know yet," Hardy said, "is how the cooling efficiency of the field-repairable radiator compares with that of the standard version. But plans are under way to test the radiator in a 5-ton truck."

Another item tested at Meppen that appears to have great BDAR potential is a self-igniting portable torch. This torch is much lighter than the traditional oxygen-acetylene torch, which requires heavy, bulky tanks to supply sufficient amounts of oxygen and acetylene. yet it can cut through almost any material, even concrete, and can cut through metal four times faster than the standard torch. It is used throughout the commercial construction industry as well as by Naval construction battalions.

The torch consists of an oxygen tank, an oxygen regulator, a hose, a hand control grip, a steel splatter shield, and a collet which holds a 36-inch long, 3/8-inch-diameter hollow steel rod. The grip contains batteries which provide energy for ignition, on/off oxygen controls and safety interlocks.

The operator ignites the torch by turning the oxygen regulator on, depressing the ignition button, and squeezing a grip lever to start the oxygen flow. As oxygen passes through the rod, an electric spark ignites a pyrotechnic material surrounding the tip of the rod. This heats the tip, and, when the oxygen reaches it, a chemical reaction takes place that causes the rod to burn at an intensely hot temperature. The rate of burn is determined by the regulator's setting on the oxygen tank.

According to the Design and Manufacturing Technology Directorate's James Ogilvy, who took part in this year's live-fire exercises, the self-igniting torch has great potential in a variety of battlefield applications. He said it has demonstrated that it can help to provide a quick fix for the soldier by allowing him to cut through armor rapidly, to eliminate a damaged or destroyed component and maintain mobility.

"Troops cut a road-wheel arm off an M60 tank in less than five minutes," said Ogilvy. "And the GIs who participated in the exercises told us that it would normally have taken about a half hour to cut it off. The troops loved the torch," Ogilvy added, "because it can do so much more than an oxygen-acetylene torch and yet is so totally portable and much easier to use."

Noteworthy among other ideas tested in the live-fire trials was the feasibility of using a fiberglass patch impregnated with resin to make temporary vehicle repairs. The patch, which is widely used commercially for making emergency repairs, is glued in place by first spraying it with a chemical that reacts with the resin to make it sticky, then placing it against the damaged surface.

According to Ogilvy, troops this year successfully patched a hole in an oil pan and a fuel tank. "In both cases," Ogilvy said, "the patches held and we were able to operate the vehicles normally."

Hardy said that future BDAR efforts at TACOM will be aimed at developing armor patches, as well as procedures for repairing electrical wiring harnesses, fuel cells, hydraulic/fuel lines and mechanical linkages.

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ARTIFICIAL NEURAL NETWORK TECHNOLOGY

By Dr. Barbara L. Yoon

Introduction

The Defense Advanced Research Projects Agency (DARPA) has initiated a major new program in Artificial Neural Network Technology. This technology may lead to solution of complex information processing and autonomous control problems (including problems that require real-time processing and response) that have persistently evaded solution by conventional techniques.

If its promise can be realized, artificial neural network technology will provide powerful tools for a broad range of military applications, including sophisticated systems for target recognition and tracking and for real-time guidance.

What Are Artificial Neural Networks?

Artificial neural networks are systems for processing of information, the structure and function of which are motivated by analogies with biological nervous systems. These analogies lead researchers to hope that mature artificial neural networks will be:

- able to deal effectively and rapidly with information processing tasks involving complex patterns, which may vary in space and time as the system deals with them;
- capable of solving a wide range of challenging real-time processing and control problems; and
- highly resistant to failure of individual hardware components.

These analogies provide an architecture for advanced computers that deals inherently, in a very natural way, with the problems of distribution of processing tasks and information that are central to the performance of massive networks of parallel, distributed processors.

They also provide, in their analog for biological learning, a rich and potentially powerful substitute for the algorithmic programming required by conventional information processing systems. This substitute (in the context of an artificial neural network processing system) should be:

- well-suited to interpretation of limited or imperfect data sets;
- capable, in many cases, of providing appropriate responses to unforeseen stimuli; and
- able to adapt flexibly (without major reprogramming) to conditions that evolve during the course of use of the information processing system.

Artificial neural networks are systems for processing of information, the structure and function of which are motivated by analogies with biological nervous systems.

Although it will require careful planning and execution, training of artificial neural networks is expected to be much quicker and much less demanding than either conventional algorithmic programming or capture of expert human knowledge within the framework of an expert system shell. That the training procedure is tolerant of errors, omissions, and ambiguities in the elements of training data sets contributes further to the relative ease of use of this technology.

Conventional algorithmic programming is a difficult, time-consuming, and error-prone process that can only be carried out by scarce, highly skilled, highly paid practitioners. Even after conventional programs are written and debugged, verification and lifecycle maintenance remain major undertakings. These factors have made software the major cost element of present complex information processing systems.

Expert system solutions also require large amounts of highly-skilled labor, on the part of both a human expert who already knows how to accomplish the target task and a "knowledge engineer" who knows how to capture the expert's knowledge in an effective system of rules. Its potential advantage in this

respect is one of the most attractive aspects of artificial neural network technology.

DARPA Program

DARPA has budgeted $33M for a 28-month exploratory seed program in artificial neural network technology. Accomplishments in this initial effort will determine the future direction of the program. Objectives of the DARPA program are:

- to identify, investigate, and measure the advantage of artificial neural networks over existing conventional technologies in addressing challenging problems of military interest;
- to advance the state-of-the-art in artificial neural network theory and modeling; and
- to develop advanced hardware implementation technologies as the basis for future construction of artificial neural network computing machines.

The components of this initial phase of the program are comparative performance measurements, theory and modeling, and hardware technology base development efforts.

Comparative Performance Measurements

This component of the DARPA program will measure the performance of software emulations of artificial neural networks (or of hybrid systems incorporating neural networks) in classification tasks that strain the capabilities of "competing" technologies. The following applications were chosen as examples: automatic target recognition, continuous speech recognition, sonar signal identification, and seismic signal discrimination.

DARPA will provide a standard set of training data, appropriate to each application, to be used as the basis for developing the classification systems. The systems developed will then be tested in classification of standard sets of test data, and their performance compared to that of the best available alternative technologies. In addition to classification accuracy, performance criteria will include:

- Ease, Economy, and Speed of Application Development: The extent to which use of highly skilled specialized personnel and other resources (including time) are minimized during design and training of the system;
- Fault Tolerance: Robustness to failure of one or more processing elements;
- Adaptability: Time and human effort required to modify the system to address similar classification problems involving different classes of data;
- Generality: Ability to correctly classify inputs within the same class of data, but significantly outside the range of the training data;
- Computational efficiency: Projected problem solution speed when the system is implemented in specialized neural network hardware; and
- Size and Power Requirements of the neural network hardware likely to be required for a system of the developed complexity and capability.

The goal of the hardware technology base development component of the DARPA program is to develop advanced hardware implementation technologies that are sufficiently flexible and modular to accommodate evolving neural network architectures.

Theory and Modeling

The objectives of the theory and modeling component of the DARPA program are:

- to foster development of the next generation of artificial neural network model architectures;
- to develop faster, more powerful, and more efficient training procedures;
- to develop strategies for scaling up efficiently to large-sized networks; and
- to determine the specific properties, limitations, and data requirements of new and existing artificial neural networks.

In the area of model architectures, topics of particular interest include the use of nodal elements with enhanced processing capability; modular networks composed of multiple interconnected subnets; hybrid systems combining neural and conventional information processing; means for developing model architectures and internal data representations that are particularly well adapted to specific tasks; and networks that modify their behavior in response to external consequences of initial actions.

In the area of training, emphasis will be on development of faster, more efficient training procedures that are robust to the presence of noise in the training data and well-adapted to accommodate delayed feedback; on novel techniques that minimize the need for external intervention for feedback; and on methods for developing internal models of the external world and guidance for interaction with the external world through learning.

In the area of theory, topics of particular interest include determination of scaling properties of new and existing neural network models; the proper relationship of system complexity to the nature and quantity of available training data; analytic treatments of the performance capabilities, stability, convergence, and fault tolerance of new and existing networks; and analyses of formal relationships between neural networks and conventional techniques.

Hardware Technology Base Development

The goal of the hardware technology base development component of the DARPA program is to develop advanced hardware implementation technologies that are sufficiently flexible and modular to accommodate evolving neural network architectures. The technologies developed are to be appropriate for future compact, low-power artificial neural network systems, with the high fan-out/fan-in properties characteristic of these densely interconnected systems. They are to have high throughput capabilities, to achieve rapid processing of large volumes of data.

Base technologies required for future development of artificial neural computers include media for implementation of modifiable-weight synaptic connections and artificial neuron processing units, and neural network

chip architectures. Technologies that are not currently under development or that have high potential utility in other applications are of particular interest.

Broad Agency Announcements (BAAs) covering the three components of the initial DARPA Artificial Neural Network Technology Program appeared in the Dec. 16, 1988 issue of *Commerce Business Daily*. Under terms of these BAAs, proposals of potential participants had to be submitted to DARPA by 4:00 P.M. on Mar. 1, 1989. It is anticipated that work will begin on the first contractual efforts on or about July 1, 1989. This initial phase of the DARPA program will span three government fiscal years.

The main goal of the first-phase DARPA program is to produce and evaluate those results and prototypes upon which sound predictions of the ultimate utility of artificial neural network technology can be based.

Prognosis for the Future

It is expected that the future generations of artificial neural networks will incorporate new, more capable architectures and training methods that will make them very fast and powerful in appropriate important applications. Some of these improvements will come from dedicated artificial neural network research and some will be guided by improved understanding of biological nervous systems. Artificial neural network information processing systems that perform (or model) the "high-level" functions of the human brain are likely to remain an elusive challenge.

During the next few years, artificial neural network hardware implementation technologies are likely to advance to the point where they can support fabrication of devices composed of flexible modular building blocks, with on-chip learning capability. Some of these devices will be based on conventional electronic VLSI techniques, and some will be based on alternative technologies, for example optical technologies. Eventually, if work continues, technologies will become available to produce very powerful machines capable of solving very challenging large-scale information processing problems.

Applications

Over the next few years, as the first-phase DARPA program bears fruit, a clearer understanding should emerge of the appropriate role, advantages, and disadvantages of artificial neural networks relative to (and in conjunction with) conventional information processing technologies. It should be possible to plan a sound program for future development, based on better understanding of present deficiencies.

Powerful application systems, many of them hybrids of artificial neural networks and conventional information processing systems, will probably be demonstrated (or at least convincingly simulated). A limited number of advanced pattern recognition systems, implemented in specialized hardware, may begin to appear.

At this point, predictions farther in the future would reflect guesses and hopes, not expectations based on research results and prototype demonstrations. The main goal of the first-phase DARPA program is to produce and evaluate those results and prototypes upon which sound predictions of the ultimate utility of artificial neural network technology can be based.

DR. BARBARA L. YOON is the program manager for the artificial neural network technology program, Defense Advanced Research Projects Agency. She has a Ph.D. in theoretical physics from Massachusetts Institute of Technology. Prior to employment at DARPA, she was a senior scientist at RDA Logicon.

SUBJECT MATTER ASSESSMENTS: AN R&D TOOL FOR SUCCESS

By Ron Lloyd

Introduction

The U.S. Army Materiel Command (AMC) Management Engineering Activity (AMCMEA) located in Huntsville, AL, has both a unique and challenging mission. Charged with the responsibility of assessing specific research and development (R&D) areas of concern, the R&D Division personnel of AMCMEA accept that challenge. They take topics directed by the HQ AMC Command Group and conduct a Subject Matter Assessment (SMA).

Each SMA is a comprehensive analysis and evaluation of a major AMC functional area. The SMA process analyzes functions across organizational lines to determine the most efficient and effective process and procedure for accomplishing the function. Through a sequence of events, the SMA process takes approximately six months (Figure 1).

The first real involvement of AMCMEA in the R&D arena began in mid-1985 with the SMA on Institutionalization of the Mission Area Materiel Plan (MAMP). The main objective of this SMA was to evaluate the current (at that time) MAMP format and procedures, emphasizing standardization of that process throughout AMC. The study effort did just that. Since that time, an SMA on MAMP modification, which included the U.S. Army Training and Doctrine Command (TRADOC), was also completed.

Two of the most recent R&D study efforts have included the Long-Range Research Development Acquisition Plan (LRRDAP)/Mission Area Materiel Plan (MAMP) Lessons Learned Conference and the SMA on Institutionalization of International Cooperative Programs (ICP). Both of these efforts will be discussed in more detail in the ensuing parapraphs.

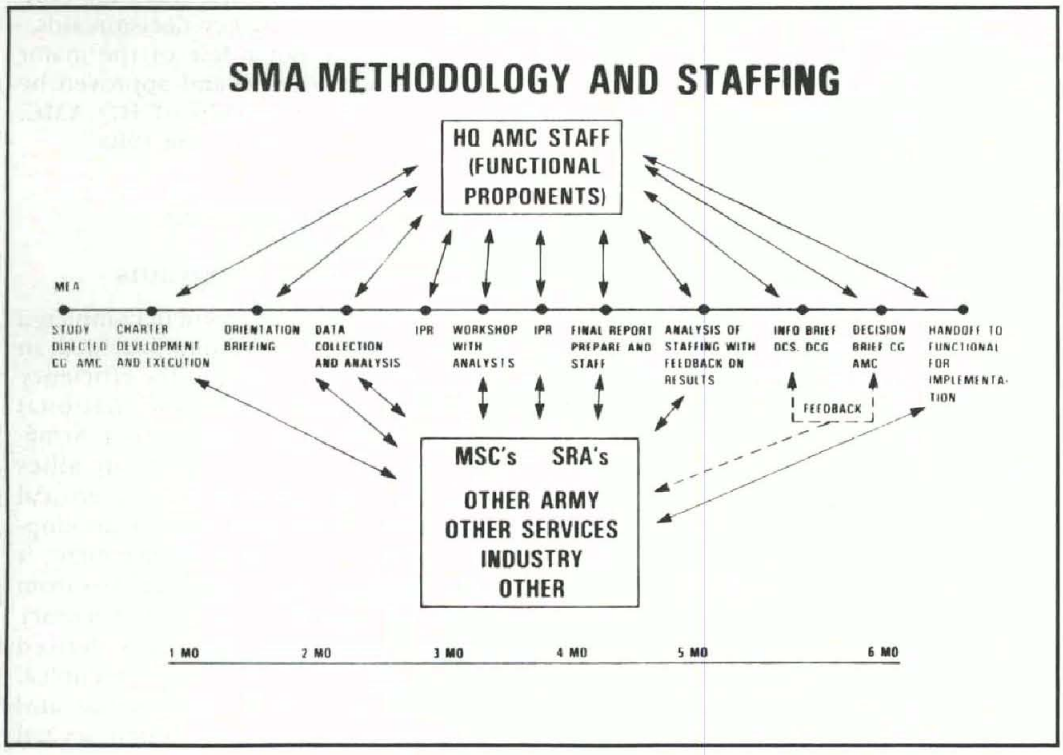

Figure 1.

The overall goal of international cooperative programs is to develop, field, and support, through equitable burdensharing, the most effective and interoperable conventional military equipment for our forces and those of our allies and friends.

LRRDAP/MAMP Lessons Learned Conference

Due to the previous successful involvement within the LRRDAP/MAMP arena, AMCMEA was asked to help chair this conference. This joint AMC/TRADOC/Information Systems Command (ISC) conference was conducted in Huntsville, AL, from Jan. 26-29, 1988. More than 180 attendees represented the entire Department of the Army. They provided significant input to ensure the LRRDAP/MAMP cycle would meet the needs of the Army. A total of 19 enhancements were developed to improve the LRRDAP/MAMP process. By streamlining the process, AMC, TRADOC, and ISC can better focus on long range planning. Let's discuss the major improvements developed during the conference.

First, was the recommendation for HQ, Department of Army (DA) to provide improved up-front guidance in their next HQDA Letter of Instruction (LOI) for building the LRRDAP. The guidance to AMC, TRADOC, and ISC would include an overall Program Objective Memorandum (POM) strategy, force structure objectives, key operational capabilities desired, programs with Congressional/Office of Secretary of Defense (OSD)/DA special interest, and focus for the tech base, base operations, test and evaluation, training, information management and ammunition mission areas.

The TRADOC/AMC/ISC guidance to the field should parallel that of HQDA to include level of program detail required by the Mission Area Integration Team (MAIT)/4-stars. This up-front initial guidance and a data base which represents a solid starting point would eliminate much of the previous turbulence in building the field LRRDAP.

Another area of concern was the need to establish a better methodology or guidance for development of Program Development Increment Packages (PDIPs). Improved PDIP increments provide an equitable departure point for building the field LRRDAP. To accomplish this, HQDA, HQ TRADOC, and HQ AMC must provide a methodology and up-front guidance for PDIP incrementing.

Key pieces of the increments must be visible to facilitate any restructuring that may be necessary during the TRADOC/AMC LRRDAP review process and to ensure the structure meets guidance. Additionally, related PDIPs must have a visible crosswalk scheme to facilitate integration. By adhering to this change, this modified methodology will facilitate a better start point for development of the field LRRDAP.

Another aspect of the process that required correction was early Commanders-in-Chief (CINC) involvement. To accomplish this, CINCs will be invited to all major Mission Area Manager (MAM) planning sessions and strategy reviews. Attendance will be at their option. As a minimum, CINCs will "laydown" their needs during the first week of Mission Area Integration Team deliberations. In this manner, CINCs can influence field LRRDAP priorities early on. Feedback on subsequent decisions will further ensure that the CINC's needs are adequately addressed.

Also identified during this conference was the need to standardize the format for "horseblankets" (desk-side briefing papers) to be used at all levels of the field LRRDAP review. The recommendation was for the horseblankets used during the Chief of Staff of the Army (CSA) field LRRDAP review to depict information frequently requested by all decision makers during the building of the field LRRDAP. The format would be used during all FY 92-06 Field LRRDAP reviews (MAMs, MAIT, 2-star, 4-star and HQDA reviews). The standardized formats would eliminate guess work and time consumed in building key decision aids.

These are but a few of the major changes briefed to and approved by the senior leadership of HQ AMC, TRADOC and ISC during 1988.

Institutionalization of International Cooperative Programs

This is the most recent of completed R&D SMAs. The results provided an overall improvement to the efficiency and effectiveness of international collaboration and cooperation. Armaments cooperation with our allies has become an increasingly critical element in weapon system development and acquisition management. It has received increased emphasis from Congress and the Office of the Secretary of Defense. This impetus is derived from the escalating cost and technical complexity of developmental and acquisition programs. When several

countries enter upon duplicative development/acquisition efforts, there is a significant waste of resources, and if carried through the deployment cycle, the result may be little or no standardization and interoperability.

The overall goal of international cooperative programs is to develop, field, and support, through equitable burdensharing, the most effective and interoperable conventional military equipment for our forces and those of our allies and friends. To support this goal, recent legislation, known as the Nunn and Quayle Amendments, were enacted by Congress. These amendments are intended to obtain more results for a given level of R&D funding through pooling of resources with other North Atlantic Treaty Organization (NATO) and specific foreign countries.

An SMA conducted by AMCMEA revealed there was a lack of an effective central focal point within the AMC major subordinate commands (MSCs) for international cooperative programs. This deficiency resulted in the underutilization of valuable R&D conducted by allies and other friendly countries. In this regard, the AMC deputy commanding general for research, development, and acquisition (DCGRDA), requested an infrastructure be established within each MSC to support international cooperative programs.

In late 1987, the AMC commanding general took a major step by "dual-hatting" the DCGRDA as the deputy commanding general for international cooperative programs, and established an Office for International Cooperative Programs. While HQ AMC has had a similar structure in the past, this is the first time an attempt has been made to create an infrastructure throughout AMC and its MSCs.

One of the many recommendations evolving from this SMA was for AMC to provide guidance on submission of the Nunn Amendment project submission policies to each AMC MSC and research, development and engineering center. This effort was to insure the Army did not miss opportunities to obtain critical R&D funding.

Another concern was to ensure the integration of emerging technologies into the research, development, test and evaluation process. There is a need for a record of successful efforts of foreign technology integration. The Army research community should be aware of what each laboratory and center is accomplishing through the use of foreign technology. Lessons learned in problem definition and problem solving associated with the integration of a foreign technology into a U.S. system should be collected and disseminated. This can be accomplished by each location's ICP office. The documentation on successes of the integration of foreign technology will foster future successful efforts.

Another concern was to ensure the integration of emerging technologies into the research, development, test and evaluation process.

To improve the compatibility of security classification of documents between the U.S. and foreign countries, several solutions evolved. The necessary recommendations for changing current DA regulations were made and forwarded to HQDA for consideration. The recommendations for handling classified and unclassified NATO documents will provide both a compatible and rationale system to the Army.

Finally, numerous recommendations have been forwarded to HQDA to better support the entire Defense Professional Exchange Program (DPEP). Formerly named the Scientist and Engineer Exchange Program, this program did not have the emphasis and awareness necessary. To ensure the program is more viable and solicits the support necessary, a recommendation was made to provide funds from the OSD level. Additionally, incentives were created at the laboratory and center levels to ensure an attractiveness to the scientists and engineers who make the program a success. The ICP study effort was approved in September 1988 by senior Army leadership within HQ AMC.

Summary

As of this issue, a total of 29 SMAs has been approved. These studies have not only improved the way AMC does business, but also reached into other commands such as the U.S. Army Training and Doctrine Command, the U.S. Army Information Systems Command, and the U.S. Army Forces Command, as well as HQ, Department of Army.

The SMA process has a proven track record for providing a service to the R&D community, AMC and the Department of the Army. The AMCMEA study teams remain ready to provide that service to assess specific R&D areas of concern.

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In the Procurement Trenches. . .

THE QUALITY ASSURANCE REPRESENTATIVE

By MAJ Charles S. Fulmore

As the government representative enters the small company, the tension on the manufacturing floor is thick enough to cut with a knife. The 15 or so employees have been told by the owner that if the product fails to be accepted this time around, the firm will have to shut down. What he has neglected to tell the employees though is that he and the production supervisor had failed in the past to ensure the product met all of the specifications. The government man's inflexibility, not the fact that the product did not meet specifications, had been blamed as the reason for previous rejections.

The Quality Assurance Representative (QAR) from the Defense Contract Administration Services (DCAS) feels the anxious stares as the owner leads him past the workers back to the shipping area. The uneasiness confirms his suspicion that the owner has told the employees that their collective fate depends upon his decision to accept or reject.

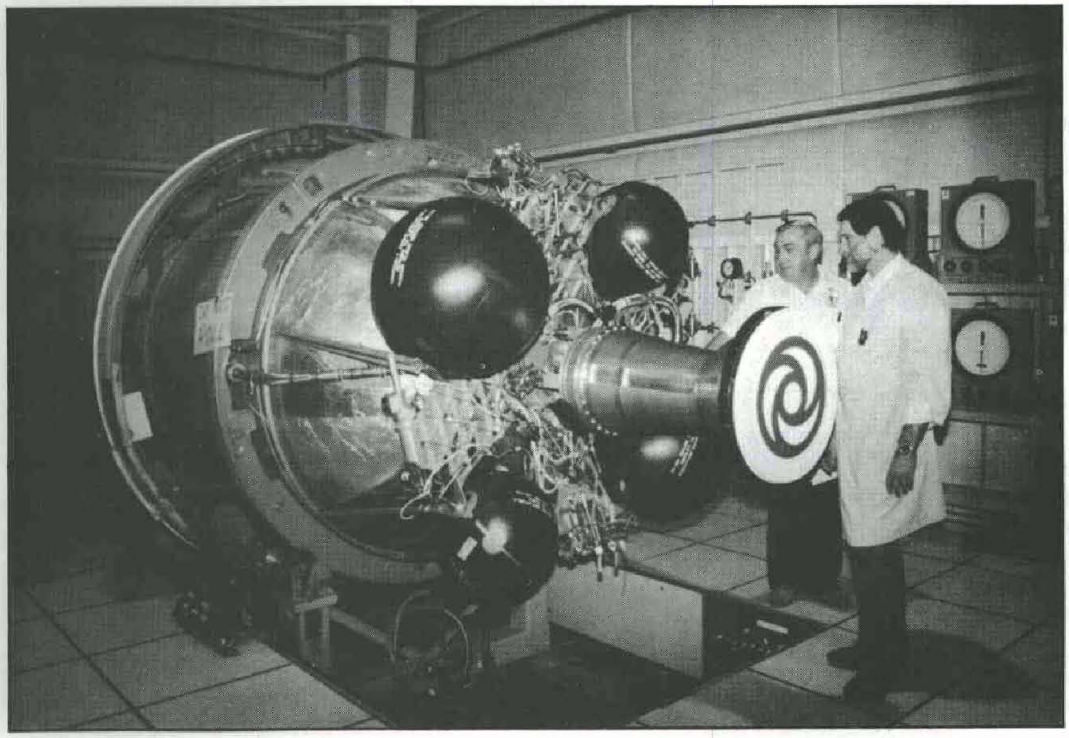
The QAR knows that if these folks loose their jobs, that it is unlikely they will find work elsewhere in the small town. But, he also knows the buying activity is depending upon him to ensure that the company delivers a product in accordance with specifications. His integrity and reputation are on the line when he signs that acceptance document on behalf of the government. Yet, it is he alone who must look those employees in the eye if he rejects the product.

This is where the rubber meets the road in the acquisition process. The situation described above is real. Fortunately, it does not happen very often. It is part of the world of the DCAS QAR, a world that few of us in the acquisition community know much about. Yet, this corps of dedicated men and women may very well be the most critical link in that long chain of events known as DOD procurement.

QARs are part of the quality assurance specialist (QAS) field. Most enter government service as a GS-09. All are high school or equivalent graduates and usually have some technical experience. Many have served on active duty with one of the services. After at least one year of government civil service, they are eligible to compete for a GS-11 position. Those who are selected to be an 11 and given responsibility for quality surveillance of a contractor or group of contractors, are designated as a Quality Assurance Representative.

In order to accept a product on behalf of the government, a QAR must be certified in that particular commodity field. There are some 13 different areas in which certification is given: aerospace, aircraft, ammunition, automotive, chemicals, clothing, computer software, electronics, materials (metallic, rubber or wood), mechanical, and nuclear. Certification comes after successful completion of a core of quality assurance courses, a number of commodity field courses, and on the job experience.

Quality Assurance Specialist Buddy Makin (right) verifies the testing of a digital communications terminal with a Litton Data Systems employee.



Quality Assurance Specialist Mac McDermaid (left) inspects the second stage of a Delta II Rocket at McDonnell Douglas Space Systems in Pueblo, CO.

There are basically two types of QARs; those assigned to a contractor facility (resident QARs) and those responsible for a number of contractors (non-resident or itinerant QARs). Resident QARs are most often found in large companies, usually with a number of government contracts, that require (by contract) constant quality surveillance. If the workload is sufficient, there may be a staff of quality assurance personnel in plant. It is common to find a QAR and three to five GS-09 QASs. While the GS-11 is not a supervisor, he must perform certain supervisory functions. This in itself can present certain challenges for both the QAR and the QASs.

The non-resident QAR is usually responsible for 10 to 20 contractors. It was a non-resident that was in the middle of the situation described at the beginning of this article. While they deal primarily with small businesses, some do handle larger companies that may have only a few government contracts.

When a delegation is received from a buying activity, the QAR is responsible for developing a surveillance program that will ensure that the customer receives a product in accordance with the desired specifications. That program is much more than simply inspecting the product at the end of the assembly line.

Surveillance encompasses everything from ensuring that subcontractors and their work is verified, component parts purchased from vendors meet requirements, inprocess testing is completed in accordance with the buyer's directions, the final product meets all contract specifications, and even that the product is packaged and shipped per the contract.

While the QAR is part of the government team, there are occasions when he is viewed as an obstacle not only by the contractor, but by the buying activity as well. Most often this situation occurs when frequent design changes are not supported by written contract modifications. While it may seem like typical bureaucratic red tape to a program office, place yourself in the QARs shoes. Their signature on that final acceptance document certifies that "listed items have been made under their supervision and conform to contract" (DD Form 250, Material Inspection and Receiving Report). A price tag of several hundreds of thousands of dollars for an item puts that QARs reputation right on the line. If the contractor gets one by him, the customer will not be pleased to say the least. Once again, they find themselves in the middle.

Of course, the big challenge for the QAR is the contractors. Their day to day interface is with contractor personnel who usually take home a significantly bigger pay check and most often possess considerably more educational and work experience. Yet, the QAR cannot be intimidated, they must hold their own. Their power to stop production or prevent shipment of a product has a way of balancing out the relationship. However, they must be extremely careful in the way in which they exercise this power.

Most contractors will not hesitate to challenge a QAR. If he is wrong, it is not the end of the world, but cracks in credibility can lead to an array of other problems. A good QAR knows what is important to push and what is not. Value-added to the overall process is the basis for decisions in the discretionary arena. The "Book" itself does not bend, but the pages do and must.

The system places a great deal of responsibility on these "non-professional" GS-11s. To be successful, they must possess more than just technical skills. It is an incredibly challenging job. They are out there on the front line, really in the trenches.

MAJ CHARLES S. FULMORE is officer-in-charge, Colorado Springs Residency. He has a B.S. in political science from Utah State University.

FOURTEEN PAPERS RECOGNIZED AT ARMY SCIENCE CONFERENCE

The 16th Army Science Conference was held last year at the U.S. Army Training and Doctrine Command (TRADOC) at Fort Monroe, VA. About 250 scientists and engineers exchanged information concerning "Science — The Competitive Edge" — the theme of the 1988 conference.

Army scientists and engineers from research laboratories and other installations submit papers competitively during the year of the conference. The conference is highlighted by presentations of selected papers and awards for those papers which are considered to be outstanding.

Ninety-six papers were chosen for presentation at the conference. As in the past, these papers reflected a broad spectrum of Army R&D highlighting the diverse nature of our military's interest.

The papers were selected from proposals submitted by military and civilian scientists and engineers engaged in research and development efforts at numerous research activities. Selection was based on the scientific value of the material to the Army, the originality of its applications to an Army project or problem, and the clarity and conciseness with which the proposal was submitted.

GEN Maxwell R. Thurman, commander, TRADOC, addressed the attendees welcoming them to the conference. GEN Thurman highlighted the key technological challenges and placed the ultimate responsibility for meeting those challenges on the attending scientists and engineers.

Dr. Hamed M. El-Bisi, deputy director of research and technology (research), Office of the Assistant Secretary of the Army (RD&A), and conference chairman, provided opening remarks for the general session focusing attention upon the conference theme.

Dr. Hamed M. El-Bisi, chairman of the Army Science Conference and the deputy director of research and technology (research), Office of the Assistant Secretary of the Army for Research, Development and Acquisition, gave the opening remarks for the conference.

Three guest speakers addressed the attendees during the general session.

The keynote address was given by Dr. Wilson K. Talley, professor, Department of Applied Science, University of California, Davis/Livermore, advisor to President Reagan on science and space during the 1980 transition, and chairman of the Army Science Board from 1983 to 1986.

The topic of Dr. Talley's speech was *To Preserve and Defend the Tech Base.* Talley reminded the audience that the first article of the U.S. Constitution mandated the national pursuit of science and support of the Army. Also, he cautioned against any weakening in our firm commitment to a competitive national and defense technology base.

Dr. Al Sievers, senior professor of physics at Cornell University, spoke on *High Temperature Superconductivity.* His address dealt with superconductivity since its first discovery in 1911 to the recent breakthrough discovery of certain complex ceramic structures exhibiting the phenomenon at relatively high temperatures (liquid nitrogen). Sievers cautioned strongly against the mad rush to invent more and better ceramic superconductors without a prior sufficient understanding of the quantum physics and the quantum mechanics underpinning these complex structures.

Dr. Thomas White, senior director of research and development, CETUS Corp., Emeryville, CA, reviewed the recent advances in biotechnology in his address, *Biotechnology and Genetic Engineering.* Specifically, he addressed the incredible power and opportunity gained through the revolutionary deciphering and manipulation of the genetic code. He recognized the Army biomedical community for being at the forefront of these new discoveries and their successful applications towards developing several revolutionary vaccines and advancing the AIDS testing methodology through the advanced tools of biotechnology.

From the 96 papers presented at the conference, a panel of the Army Science Board selected 14 for special recognition at the awards ceremony. Cash awards were made under the Army Incentive Awards Program. Contractors were ineligible to receive awards. LTG Donald S. Pihl, military deputy to the assistant secretary of the Army for research, development and acquisition, delivered the banquet address and made the award presentations.

LTG Donald S. Pihl presents the Paul A. Siple Silver Medallion to COL Jerald C. Sadoff, Walter Reed Army Institute of Research

One paper was selected as most outstanding and received the Paul A. Siple Award. The authors each received a silver medallion and shared a $2,500 cash prize for their research project.

Titled *Immunologic Prevention and Treatment of Septic Shock*, the paper was authored by: COL Jerald C. Sadoff, Dr. Apurba K. Bhattachargee, Dr. Nelson H. Teng, and Dr. Elizabeth Ziegler, of the Walter Reed Army Institute of Research.

Additionally, three papers were recognized for outstanding achievement. Authors of each paper were awarded certificates of achievement, a $1,000 cash prize, and bronze medallions. Recipients, their organizations, and the titles of their papers were as follows:

- Author: Dr. Mark B. Tischler. Organization: Aeroflight Dynmamics Directorate, Moffett Field, CA. Title of Paper: *Advancements in Frequency-Domain Method for Rotorcraft System Identification.*
- Authors: Dr. Walter B. Sturek and Dr. Harry A. Dwyer. Organization: Ballistic Research Laboratory, Aberdeen Proving Ground, MD. Title of Paper: *Prediction of In-Bore and Aerodynamic Heating of KE Projectile Fins.*
- Authors: CPT Charles K. Stover and Dr. Edwin V. Oaks. Organization: Walter Reed Army Institute of Research, Washington, DC. Title of Paper: *Development of Improved Recombinant DNA Techniques in Support of the Effort for a Recombinant Scrub Typhus Vaccine.*

Ten papers were selected for honorable mention and each author received a certificate of achievement and a share in a $500 cash award for each paper. Recipients were as follows:

- Authors: Dr. George F. Adams, Dr. Roger D. Amos, Dr. Nicholas C. Handy and Dr. Robert T. Kroutil. Organizations: Ballistic Research Laboratory and Chemical RD&E Center, Aberdeen Proving Ground, MD. Title of Paper: *The Prior Synthesis of Infrared Spectra for Chemical Agents.*
- Authors: Dr. Andrzej W. Miziolek, Dr. Brad E. Forch, and Dr. Rosario C. Sausa. Organization: Ballistic Research Laboratory, Aberdeen Proving Ground, MD. Title of Paper: *A Novel Laser Igniter Based on Resonant Multiphoton Excitation.*
- Authors: Dr. William R. Anderson, Dr. Andrzej W. Miziolek, Dr. Rosario C. Sausa, Dr. Anthony J. Kotlar, and Dr. S. Randolph Long. Organizations: Ballistic Research Laboratory and the Chemical RD&E Center, Aberdeen Proving Ground, MD. Title of Paper: *Laser Photofragmentation and Fluorescence Studies of CW Agent Simulants.*
- Authors: LTC Thomas H. Johnson, CPT Harry E. Cartland, and Dr. Thomas C. Genoni. Organization: U.S. Military Academy, West Point, NY. Title of Paper: *Xenon Chloride Laser Kinetics.*
- Author: Dr. Scott E. Graham. Organization: Army Research Institute, Fort Knox, KY. Title of Paper: *Enhancing Reserve Component Maintenance Performance with Computer-Based Training.*
- Author: Aivars Ozolin. Organization: Ballistic Research Laboratory, Aberdeen Proving Ground, MD. Title of Paper: *Stochastic High-Resolution Modeling Support for Live-Fire Test Programs.*
- Authors: Paul Weinacht and Dr. Walter B. Sturek. Organization: Ballistic Research Laboratory, Aberdeen Proving Ground, MD. Title of Paper: *Computation of the Roll Characteristics of Finned Projectiles.*
- Author: Donald G. Albert. Organization: Cold Regions Research and Engineering Laboratory, Hanover, NH. Title of Paper: *Experimental and Theoretical Studies of Acoustic-to-Seismic Coupling.*
- Author: Louis J. Piscitelle. Organization: Natick RD&E Center, Natick, MA. Title of Paper: *Mathematical Investigation of the Reaction-Diffusion Equations for Heterogeneous Catalytic Systems.*
- Authors: Dr. Henry L. Meier, Dr. John P. Petrali, and Clark L. Gross. Organization: Medical Research Institute of Chemical Defense, Aberdeen Proving Ground, MD. Title of Paper: *Niacinamide Prevents Sulfur Mustard-Induced Pathology and Biochemical Changes in Human Lymphocyte and Mixed Human Leukocyte Preparations.*

Current plans call for the 17th Army Science Conference to be held in June 1990 at the U.S. Military Academy.

Year Group 82 Functional Area Designation

Each year the AMC proponency office provides input to PERSCOM on the recommended number of officers from each branch to be assessed into FA 51. Beginning with YG 82, a computer model was used to help standardize the FA designation process. The four criteria used in the model are: officer preference, acedemic degree, grade point average, and military training.

PERSCOM has already begun the FA designation process for YG 83. The intent is to eventually designate FAs at the fifth year of service so officers will have more time to plan their careers and allow for more latitude in scheduling FA training.

YEAR GROUP 82 FUNCTIONAL AREA ACCESSIONS FOR FA 51

BRANCH	ACTUAL (Number)	RECOMMENDED (Percent)	ACTUAL (Percent)
11 IN	40	7	7.6
12 AR	44	10	8.4
13 FA	83	10	15.7
14 AD	21	9	4.0
15 AV	86	9	16.3
18 SF	14	4	2.7
21 EN	38	7	7.2
25 SC	47	10	8.9
31 MP	15	2	2.8
35 MI	33	8	6.3
42 AG	3	0	0.5
44 FI	1	0	0.2
74 CM	30	5	5.7
88 TC	5	5	1.0
91 OD	54	10	10.2
92 QM	13	4	2.5
TOTAL	527	(14.7 percent of YG 82)	

For YG 82 only 2643/3581 (74 percent) of the officers submitted preference statements. Of those officers submitting preference statements, 72 percent received their first or second choice. With the computer algorithm being used, the preference statement is very important. Pass the word on to YG 83 officers to complete and return their preference statements to PERSCOM. (Note: FAs 41 and 54 are currently very overstrength).

Tank-Automotive Command

TACOM needs Armor officers to apply their muddy boots, tanker experience in the research, development and aquisition world. Interested Armor officers would begin their entry level FA 51 training after branch qualification. After their initial 51 assignment, the Armor Branch will assign the officer back to the field for troop time as a major. This is a great opportunity to make a significant contribution to the future of combat fighting vehicles while serving in the challenging field of acquisition.

1989 Majors Board Results

The promotion rates for the latest Major's board continue to show overall selection rates below the DOPMA goal of 80 percent to major. The rates shown for FA 51 represent the percentage of officers who hold FA 51 that were selected. The Army average is the percentage for those officers who were selected in the primary zone. Selection floors for FAs do not exist for promotiom to Major. Floors and subfloors are used at the LTC and COL level.

	FA 51	Army Average
FY 83	70.9	78.8
FY 84	74.4	78.0
FY 85	70.0	76.9
FY 86	75.5	75.4
FY 87	76.4	72.4
FY 88	63.9	64.8
FY 89	66.9	68.7

Command and General Staff Officers Course

Only 50 percent of all officers selected for promotion to Major will be picked to attend resident CGSOC. All officers not selected for attendance at the resident course should consider the non-resident course. All CPT(P)s not selected after their second look, are strongly encouraged to enroll. To enroll, an officer must have completed eight years (AFCS), graduated from a resident AOC, and have completed the resident phase of CAS3.

You can mail inquiries to: Commandant, U. S. Army Command and General Staff College, ATTN: ATZL-SWE-R, Fort Leavenworth, Kansas 66027-6940.

CAREER DEVELOPMENT UPDATE

Promotion Pin-on Points

The current promotion pin-on points for due course officers (i.e., selected in the primary zone of consideration) are shown below. The DOPMA "goal" is shown for comparison.

GRADE	DOPMA GOAL	DEC 89 PROJECTION
CPT	4 yrs	4 yrs 3 mos
MAJ	10 yrs + 12 mos	11 yrs 10 mos
LTC	16 yrs + 12 mos	17 yrs 10 mos
COL	22 yrs + 12 mos	22 yrs 8 mos

CAS3

Most Branches are no longer sending officers to CAS3, TDY enroute. This responsibility has been placed on the commanders and units in the field. Presently, over 100 officers in year groups 80, 81, and 82 still need to complete the resident phase of the course. Officers in Year Group 79 and later must finish CAS3 by completion of their 9th year of active federal commissioned service (AFCS). While CAS3 is not a prerequisite for selection to Major it is in the best interest of the officers concerned to complete CAS3 as soon as possible.

MAM Selection Board

A MAM Program Selection Board was held on March 6-7, 1989. The next MAM Selection Boards are scheduled for July 10-11 and Oct. 16-17 1989. Officer applications should be received by PERSCOM NLT June 30 and Oct. 6, respectively. Requests must be addressed through your branch to the MAM Program Officer, ATTN: TAPC-OPB-A.

Army Streamlined Acquisition Program Courses

The FY89 series of pilot Army Streamlined Acquisition Program Courses will begin soon. This training is available to both Army personnel and representatives from industry. Information on the pilot courses may be obtained by calling Ivory Fisher on (703) 274-5100 or AV 284-5100.

Address Changes

A reminder to active duty officers in functional areas 51, 52 and 97 or with a 6T skill: Since the *Army RD&A Bulletin* uses your address as listed in your Officer Record Brief (ORB), it is important that you keep your ORB updated. A number of requests for change of address have been mailed directly to us, but the bulletin office does not have the ability to make those changes. Your address is submitted to us on a computer printout from PERSINSCOM, which is taken directly from your ORB. If you have moved or changed your address recently, please change your ORB so the bulletin can reach you at the proper address in a timely manner.

Army Approves New High-Tech Artillery Fuzes

The Army has approved for production a new series of high-tech electronic time (ET) fuzes that for the first time will enable its howitzer projectiles to take advantage of the latest digital electronic technology.

The new fuzes are easier to operate, more accurate and reliable and as cost effective as their predecessors, say the fuze and artillery weapons developers at the Army Armament RD&E Center, Picatinny Arsenal, NJ. Another advantage is that the new fuzes — the M-762, for rounds that carry and dispense submunitions over the target area such as mines and grenades — and the M-767, for standard high explosive rounds — can be used with all existing 105mm, 155mm and 8-inch munitions.

They'll be easier to operate because, unlike their predecessors, they can be hand set without tools, enabling Army gunners to set them by simply adjusting their liquid crystal display (LCD). To set, operators simply press a button on the fuze and turn the nose, watching the LCD until the initial setting is reached. This procedure is repeated three more times; then the fuze is set. In case of error, the entire procedure can be repeated any number of times. Their digital workings also provide greater accuracy.

Although not a required near-term capability, engineers have also developed a portable prototype device that can set the ET fuze by simply putting an attached magnetic coil over its nose. In this case, fuze settings are pre-programmed into the device before the coil is positioned.

When tested recently by the Army's Human Engineering Laboratory at Aberdeen Proving Ground, MD, they had a third less error rate than the current mechanical time fuzes. The average soldier's experience with digital devices also produced faster setting times, the tests revealed. Recent electromagnetic tests performed by the U.S. Army Vulnerability Assessment Laboratory in White Sands Missile Range, NM, demonstrated superior survivability characteristics under simulated firing conditions.

M762 ARTILLERY ET FUZE

Key to their development was cost considerations, with the requirement to produce a new series that would be no more expensive in full production than its predecessor. Not only was that accomplished, but additional savings due to further technological improvements, such as that seen in the hand-held calculator and digital watch market, are expected in the out years of the program.

Even though the mechanical fuze's price tag has been kept to a reasonable range over its 18 years of production, it has limited potential for further cost savings.

The recent award of the initial $23 million contract — for the first 161,000 fuzes — will be divided among Motorola, the developing contractor, and another manufacturer based on competitive bidding. The early splitting of the contract was required to foster competition among fuze producers. Production of the new fuzes will start by this fall.

Although the ET fuzes will initially cost $142.86 each, their average price will drop to about $50 per fuze by 1993, equaling the production costs of the current M-577A1 fuze over its life cycle. Bulova and Hamilton have been producing the M-577A1 fuzes.

To foster competition, engineers at Picatinny Arsenal required that the fuzes be designed so they could be commercially produced without the need for substantial production line changes or special equipment. The inexpensive design requirement immediately garnered interest from the industrial community; in 1987 an Army market survey elicited 17 responses from potential manufacturers. There are currently 45 requests for the production proposal package from industry.

Due to the industry standard design, there are many electronic manufacturers in the United States that would be capable of producing the new series, thereby providing a more easily expandable production base to meet wartime fuzing needs. Industry was first approached in 1979, when the Army asked for developmental proposals.

The Army's user community has anticipated the completion of the development of this improvement in its fighting capability. The fuzes can produce the increased rates of fire, survivability and range required by the Army's long range field artillery planning document, called the Fire Support Master Plan, which was developed by the Army's Field Artillery School at Fort Sill, OK.

Reactive Armor Applique System Developed

Recent advances in armor protection have led to the development at the U.S. Army Armament RDE Center, Picatinny Arsenal, NJ, of a "reactive armor applique system" which significantly increases the protection of tanks and armored fighting vehicles when fired upon by shaped charge warheads.

According to Bill Kozar, a mechanical engineer with the Heavy Armored Division, Close Combat Armaments Center, the system, which is a formation of armor tiles for the M60A3 Main Battle Tank, was initially conceived and designed by the Ballistic Research Laboratory at Aberdeen Proving Ground, MD. The BRL design concept was then transitioned

RD&A NEWS BRIEFS

Armor Applique (Continued)

to ARDEC for development, testing and production engineering into a mature design that was type classified and approved recently by BG Joseph Raffianni for full release.

The U.S. Marine Corps has taken the first DOD option on the tiles and will be equipping 170 of its tanks with the system. Officially called the XM1 and XM2 reactive armor tiles, the system consists of a configuration of 95 tiles, 52 XM1s and 43 XM2s. Each tile contains a relatively insensitive explosive which reacts with the jet from an incoming shaped charge warhead and reduces its effectiveness before it reaches the main armor of the tank.

The XM1 tile is a square metal box measuring approximately 12 inches by 12 inches by 2 inches thick which contains reactive armor plates and explosive. The XM2 consists of the same materials but is larger, measuring about 12 inches by 18 inches by 2 inches thick. The tiles weigh 19 and 28 pounds each respectively and are mounted to the M60A3 Tank by a unique system of mounting bars and adaptor clips. The 3,000 added pounds to the Main Battle Tank have little effect on its mobility.

Kozar said, "Since the concept of putting an explosive item on the external structure of a tank was a first, the program came under heavy scrutiny from both a logistic and a safety point of view. Because of these concerns, the tiles got the full "what if" treatment: "What if they got hit by lightning, or a power line falls on them?" "What if someone mistakenly drills into them in a maintenance operation?" "What if another tank crashes into them?" "What happens if a tank catches on fire or gets sprayed by a machine gun?"

"These questions and others," Kozar continued, "and their answers were addressed in an extensive safety test program. None of the "what if" situations proved to be a problem and the tiles were demonstrated to be safe under all test conditions." The Milan Army Ammunition Plant in Tennessee is producing the tiles which were 18 months in development.

CONFERENCES

Army Holds Prognostics Symposium

The U.S. Army conducted the first prognostics symposium late last year at the U.S. Army Logistics Center, Fort Lee, VA. Personnel from OSD, DA, TRADOC, USAF, and numerous other Army organizations attended this first of what is hoped to be an annual symposium.

The symposium provided the government with an overview of what industry is doing to develop prognostic capabilities and what the present status is with respect to real implementation. Prognostics, according to Military Standard 1309C, is defined as the use of test data in the evaluation of a system/equipment for determining the potential of impending faults.

In general, the meeting highlighted the fact that mechanical prognostics is a reality and is being actively pursued for use on military systems. Prognostics for military electronics systems, however, is still only in its infancy.

Two briefings, "Prognostics for Helicopter Drive Systems and Structures" and "Adaptive Diagnostics and Feedback Analysis-Precursors to a Fault Prognostic Capability," addressed the physics of mechanical prognostics. Other discussions included acoustic emission, oil debris monitoring, stress, and historical or experimental data collection. Although these subjects are not new, there is still considerable effort required before mechanical prognostics is a viable technical solution in identifying potential maintenance problems. However, this is a real technical capability rapidly becoming available for practical use.

Briefings on "Why Prognostics-Assessing Benefits/Risks" and "Preventing Prognostic Errors" examined the use of prognostics. Specifically, they probed the potentially disastrous effects of faulty prognostic equipment and monitor readings. For example, if faults are predicted erroneously, mission after mission will be aborted and weapon systems will appear failure prone when in fact they are not. Eventually, this could destroy the confidence soldiers have in their equipment.

Two final briefings, "Expert System Techniques Benefit Prognostics Applications" and "Marginal Checking-A Technique to Detect Incipient Failures," described how expert systems can collect and analyze failure data. Those data are then used to do prognostication of various system parts to predict their expected failure times.

The conferees also discussed how an expert system can effectively utilize the resources available for monitoring and determining system health. More specifically, checking can provide weapon system status and predict future readiness (i.e., an entire helicopter) by monitoring and collecting data on a variety of weapon subsystems using on-board sensors. These techniques, in combination, show promise for alerting combat personnel of imminent equipment failures, providing timely instruction, and answering technical questions.

It should be stressed that many problems still exist which need resolution before a military system can use a prognostic capability. The technology for detecting incipient failures in electronic equipment requires considerable advancement before a prognostics capability will be available. However, some mechanical equipment, such as transmissions, have begun to capitalize on the advantages of prognostics.

The major supportability issue facing the Army in the next 10-15 years is the need to maintain an increased operational availability level of our emerging war fighting platforms. The Army has an exciting challenge: to use technology in the form of prognostics. Through prognostics, we can increase our war fighting capability (with increased support efficiencies), reduce maintenance time and maintenance requirements, while decreasing our logistics tail. The need is real. The potential payoff is high. We must press on.

The preceding article was provided by the PM, Test Measurement and Diagnostic Equipment, and the U.S. Army Logistics Center.

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