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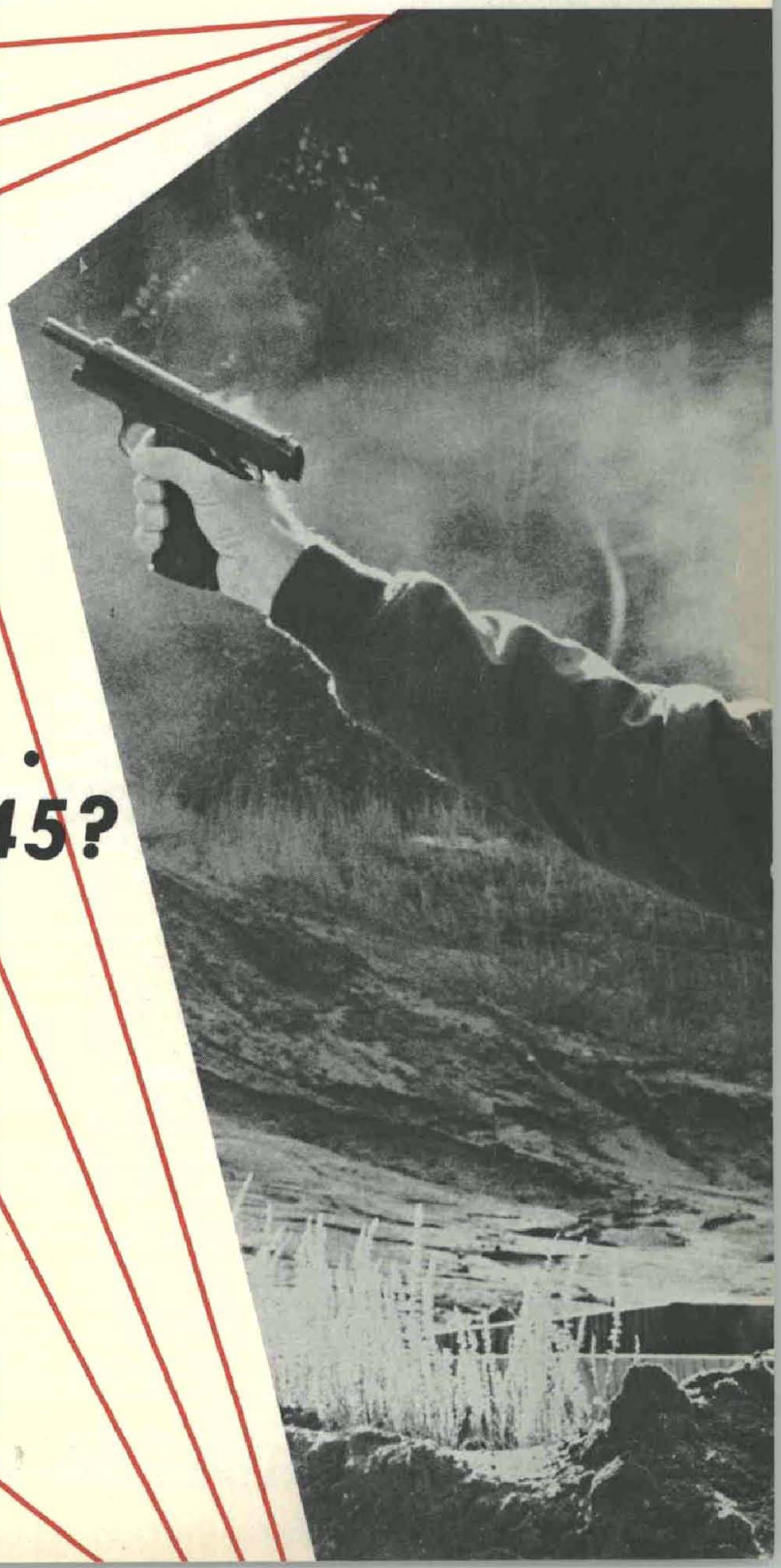

End of an Era . . . . .
9mm to *Replace .45?*

(See page 1)

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FEATURES

DEPARTMENTS

ABOUT THE COVER:

Front: The .45 caliber, shown in full recoil (one of its detracting characteristics), has been the sidearm of the U.S. military for 70 years. Back: DARCOM officials inspect various models of the 9mm pistol that may replace the .45.

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

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Toward a New Hand Gun!!!

Unanimity of opinion is difficult on most subjects, but among the military it is virtually impossible when it comes to the selection of uniforms, food, and personal weapons. Perhaps the most controversial of these is that of the handgun.

Sincere individuals often find themselves unable or unwilling to differentiate between emotion and fact on this subject. For example, there will always be those who contend that the .45 caliber pistol bullet is unsurpassed in stopping power, despite evidence of the 9mm being just as effective.

Each type of handgun, revolver or semi-automatic, as does each caliber - .38, .357 magnum, 9mm, .45ACP, etc., has its backers. However, there is one clear fact that cannot be mistaken as emotion. All of the U.S. armed services now appear to be headed toward formal adoption of a standardized 9mm handgun.

The recommendation of the Joint Service Small Arms Program (JSSAP) study, dated 5 June 1980, is to have all U.S. armed services adopt a single family of 9mm caliber semi-automatic handguns. The gun would be in a standard size for general issue, plus a small limited issue in a concealable version of the same type weapon. The NATO standard 9 x 19 parabellum ball cartridge was recommended, along with limited quantities of other rounds such as sub-sonic, signal/tracer, blank, etc.

The .45 pistol is unique in the history of modern gunpowder weapons, having served as a standard weapon in a virtually unchanged design for almost three quarters of a century. The changeover to 9mm, when it is finally directed, will have been a long time in the making.

In 1952, the Army had shown an interest in possibly replacing its venerable M1911A1 .45 semi-automatic pistols. At that time, Army Field Forces Board No. 3 at Fort Benning, GA, evaluated a number of off-the-shelf revolvers and semi-automatics, in various calibers, i.e., .32, .38, 9mm, and .45 ACP. The Board's report of April 1953 indicated that there had been some prior interest too. It reported that "development since the end of World War II has aimed at providing a lightweight, effective, simple, and relatively inexpensive handgun in the smallest acceptable caliber."

Criticism of the M1911A1 .45 centered on its weight and size. The report concluded that the .45 semi-automatic government model pistol was "unsuitable for Army Field Forces use due primarily to weight of weapon and ammunition."

The Board's recommendation was to have the .45 be declared obsolete and to standardize on a semi-automatic pistol in 9mm caliber for issue on a one for one replacement basis. However, no action was taken, allegedly due to existing adequate stocks of .45 pistols and ammunition in the inventory.

At least twice more during the 1960s and 1970s the issue was reconsidered at various U.S. defense levels. Again, the caliber of 9mm was recommended, but no action was taken, because of existing stocks and cost. From 1962-1966, 13 participating NATO countries had ratified or forecast implementation of STANAG 4090 covering small arms standardization of the 9mm parabellum ammunition for use in handguns and submachineguns. The only nonparticipating country is the U.S.

The most recent action for replacement has been driven by the fact that current U.S. pistols - revolvers and semi-automatics - are rapidly wearing out with rebuild costs now greater than original cost and in some cases greater than replacement cost, and a renewed stress on NATO Standardization.

In addition, there is some dissatisfaction among the services' handgun users with the durability, reliability, performance and weight of current systems. This is particularly true of the aviation community and its normally carried .38 revolver.

There is also a new factor, not present in previous deliberations. It is the need for a handgun more easily handled by the growing number of women in the services.

Capping all of these actions were the findings of a study in 1978 by the House Appropriations Committee Surveys and Investigation Staff. It reported the existence, in the defense establishment, of "more than 25 different makes, models, and types of handguns", and deplored the logistic problems that ensued from this proliferation.

The committee obviously felt prompt action was required. The following year the committee expressed its dissatisfaction with progress to date. It further stated that should insufficient progress be made in the next year, the committee would consider legislative action!

In November 1979, the Principal Deputy Under Secretary of Defense for R & E directed the services to undertake "a joint study to determine the minimum number of types of handguns to meet essential service requirements and to determine if the U.S. should adopt the NATO standard 9mm handgun cartridge." The Army, as the executive agent for small arms, was designated the lead service responsible for compiling the study.

Guidelines provided by the Secretary directed an analysis of the advantages and disadvantages of a single family of handguns and ammunition, and its impact on such factors as current and future operational requirements, to include the implication of increased numbers of women in the armed forces, domestic production facilities, costs, and NATO's standardization aspects. Only the .38, .45, and 9mm NATO calibers were to be considered.

The task was passed from DA to the Army Materiel Development and Readiness Command in early December 1979, with directions to have the recently formed Joint Services Small Arms Program (JSSAP) conduct the joint study. JSSAP management committee representatives of the Air Force, Army, Coast Guard, Marine Corps and Navy, coordinated their service inputs.

This study was comprised of two principal parts, the first being the ongoing Air Force Evaluation of handguns which was being conducted at Eglin Air Force Base, FL, in which various model 9mm pistols were evaluated against the M1911A1's and M15 .38 cal revolvers. The second part of the study considered a review and compilation of all existing historical reports and studies relative to pistols, handguns and their performance. An example of some inputs are discussed briefly.

For instance, a 1978 survey of Army aircrews was reviewed as was the report of 1978 by the Army's Human Engineering Laboratory on handgun

STAR MODEL 28

Manufacturer: Star, Bonifacio Echeverria, S.A., Apartado 10, Eibar, Spain

Mechanism Type: recoil operated, semi-automatic, single- or double-action
Caliber: 9 mm Luger
Magazine Capacity: 15 rounds
Overall Length: 8.65"
Height: 5.39"
Width: 1.38"
Barrel Length: 4.31"
Sight Radius: 6.28"
Weight: 2.88 lbs., loaded with 15 rds.
Trigger Pull: 4.42 lbs. (single-action), 12.50 lbs. (double-action)

SMITH & WESSON MODEL 459A

Manufacturer: Smith & Wesson, 2100 Roosevelt Ave., Springfield, Mass. 01101

Mechanism Type: recoil operated, semi-automatic, single- or double-action
Caliber: 9 mm Luger
Magazine Capacity: 14 rounds
Overall Length: 7.57"
Height: 5.75"
Width: 1.38"
Barrel Length: 4.12"
Sight Radius: 5.72"
Weight: 2.36 lbs., loaded with 14 rds.
Trigger Pull: 10.29 lbs. (single-action), 19.21 lbs. (double-action)

COLT SSP

Manufacturer: Colt Industries, 150 Huyshope Ave., Hartford, Conn. 06102

Mechanism Type: recoil operated, semi-automatic, single- or double-action
Caliber: 9 mm Luger
Magazine Capacity: 14 rounds
Overall Length: 8.07"
Height: 5.44"
Width: 1.41"
Barrel Length: 4.47"
Sight Radius: 5.97"
Weight: 2.73 lbs., loaded with 14 rds.
Trigger Pull: 4.00 lbs. (single-action), 15.93 lbs. (double-action)

BERETTA MODEL 92S-1

Manufacturer: Pietro Beretta, S.p.A., Gardone, V.T., Brescia, Italy

Mechanism Type: recoil operated, semi-automatic, single- or double-action
Caliber: 9 mm Luger
Magazine Capacity: 15 rounds
Overall Length: 8.54"
Height: 4.61"
Width: 1.47"
Barrel Length: 5.00"
Sight Radius: 6.34"
Weight: 2.57 lbs., loaded with 15 rds.
Trigger Pull: 5.50 lbs. (single-action), 12.33 lbs. (double-action)

Photos, courtesy of U.S. Air Force and American Rifleman Magazine. The pictured pistols were among those recently tested by the U.S. Air Force.

HECKLER & KOCH VP 70 MACHINE PISTOL

Manufacturer: Heckler & Koch, Germany
Mechanism Type: blow-back operated, selective-fire, semi-automatic or three-shot burst, double-action only, with detachable shoulder stock
Caliber: 9 mm Luger
Magazine Capacity: 18 rounds
Overall Length: 8.11" (without stock)
Height: 5.65"
Width: 2.24"
Barrel Length: 4.63"
Sight Radius: 6.95"
Weight: 2.59 lbs., loaded with 18 rds., without stock
Trigger Pull: 13.07 lbs. (double-action only)

HECKLER & KOCH P9S

Manufacturer: Heckler & Koch GmbH, 7238 Oberndorf-Neckar, FRG
Mechanism Type: recoil operated, roller locking, single- or double-action
Caliber: 9 mm Luger
Magazine Capacity: 9 rounds
Overall Length: 7.62"
Height: 5.54"
Width: 1.29"
Barrel Length: 3.94"
Sight Radius: 5.85"
Weight: 2.30 lbs., loaded with 9 rds.
Trigger Pull: 3.25 lbs. (single-action), 10.69 lbs. (double-action)

FN BROWNING M1935 HIGH POWER

Manufacturer: Fabrique National d'Armes de Guerre, S.A., B-4400, Herstal, Belgium
Mechanism Type: recoil operated, semi-automatic, single-action
Caliber: 9 mm Luger
Magazine Capacity: 13 rounds
Overall Length: 7.82"
Height: 5.03"
Width: 1.32"
Barrel Length: 4.75"
Sight Radius: 6.34"
Weight: 2.38 lbs., loaded with 13-rds.
Trigger Pull: 8.33 lbs. (single-action only)

FN BROWNING "FAST ACTION"

Manufacturer: FN, Herstal, Belgium
Mechanism Type: recoil, operated, semi-automatic, single-action, self-cocking
Caliber: 9 mm Luger
Magazine Capacity: 14 rounds
Overall Length: 7.85"
Height: 5.19"
Width: 1.38"
Barrel length: 4.74"
Sight Radius: 6.36"
Weight: 2.44 lbs., loaded with 14 rds.
Trigger Pull: 5.52 lbs. (single-action), 6.30 lbs. from hammer down position

Photos, courtesy of U.S. Air Force and American Rifleman Magazine. The pictured pistols were among those recently tested by the U.S. Air Force.

hit probability as part of a test of suitable weapons for women.

In addition, FBI, Secret Service, and the Army's Ballistic Research Laboratory data were also significant considerations. The report of the Illinois State Police, in justification for its adoption of the 9mm pistol, was also studied. Current and future potential production capacity data and cost data were gathered by the JSSAP Support Office, Fire Control and Small Caliber Weapon Systems Laboratory, and the Army Armament Research and Development Command.

There was continuous active participation by the Air Force, Navy, Marine Corps, and Coast Guard. Each contributed materially to the methodology, content, conclusions, and recommendations of the report. Based on inputs from these services, a draft Joint Service Operational Requirement had been prepared. One major factor impacting on the study's conclusions was the magnitude of the handgun inventory. Shown below was the inventory as determined by the study: (In approximate thousands)

WEAPON	AF	ARMY	CG	MC	NAVY
M1911A1 .45	2	240	7	81	89
* .38 2" bbl	7	7	-	-	-
* .38 4" bbl	61	26	-	8	20
M15.38	0	1	-	-	-
(M3) (S MG)	0	57	-	-	-
TOTAL	70	331	7	89	109
				GRAND TOTAL - 606	

* Various Mftr/models

The study concluded, with few special exceptions, that the services can meet their essential needs with two types of handguns- a standard size semi-automatic for general issue and a lighter more compact concealable pistol for special applications.

The study indicated this approach would provide an across-the-board capability for all users plus simplification of training and logistics. Major disadvantages were the problems of disposing of some 420,000 .45s and 130,000 .38s, many of which are still serviceable, and, the need to modify the support system for a completely new handgun.

The selection of the 9mm caliber was an area where emotion clashed with available scientific evidence. The crux of the issue was the need for a bullet with "stopping power." The issue is not whether death is the immediate result of being struck by a pistol bullet. Rather, near instantaneous incapacitation is the desired result, given the fact that a handgun is used generally for last-ditch close-in self defense. Any handgun is capable of inflicting a fatal wound - the .22 caliber bullet is the largest single bullet killer in the U.S., but many handguns do not possess the desired stopping power.

A variety of theories on stopping power were reviewed. These included the Hatcher theory that says that stopping power is proportional to a bullet's impact momentum times its cross-sectional area, and the 1960s Army derived theory that incapacitation is a function of the kinetic energy deposited in 15 centimeters of gel tissue simulant. Also considered were findings done by the Army's Ballistic Research Laboratory in 1973 in response to a request from the National Institute of Law Enforcement and Criminal Justice on terminal effects of police handgun ammunition. Secret Service tests of 1979 and a 1978 FBI report on law enforcement officers killed were also taken into account.

The stopping power issue was resolved largely by the "BRL Computer Man," an elaborate 3-dimension computer code of human anatomy and the medical determination of effectiveness of hits on various parts of the body. Ballistic data and bullet cavitation data from experiments on a gelatin target closely resembling human tissue were fed in.

The conclusion of these evaluations was that the most important property of a handgun bullet is its velocity. It was shown too, that for a given velocity, larger caliber bullets have greater stopping power than smaller ones. However, large caliber bullets such as the .45 (the current U.S. standard) need not be as massive in order to retain stopping power, i.e., masses on the order of 158-170 grains are sufficient.

Perhaps the most significant factors favoring selection of a 9mm handgun were a preference for this type of gun by a segment of military handgun users, a stated preference in a draft Joint Services Operational Requirement (JSOR), and most importantly, the NATO interoperability aspect. The Coast Guard has been one of the strongest advocates among the services for a changeover as rapidly as possible.

The JSOR has identified some important safety features which are required. These include the capability to completely load, unload and clear the weapon without actuating the trigger; and lowering the hammer from cocked position to an uncocked position without actuating the trigger. Also, the handgun must be one handed ambidextrous operable, allowing a safe carry with draw and fire by one hand, left or right.

Although the services may agree to go the 9mm route, do not expect to see the Army totally reequipped with 9mm pistols in the next few years. However desirable this might be theoretically, from a number of aspects, procurement money for pistols will have to compete with other higher priority programs. As one senior Army official put it, few battles have been decided by the pistol.

As a result, the Army, as this issue goes to press, is considering an acquisition option which phases the 9mm pistol in over a 10-year period. Under such an approach, the .45 would remain in the inventory to fill our operational and mobilization needs until finally replaced.

It may well be "farewell" to the .45, the sidearm of the U.S. military for 75 years, spanning such greats as Pershing and Eisenhower. From the jungles of the Philippines at the turn of this century to it's close, the .45, like old warriors, is destined to fade away.

Microelectronics Availability for the Army's Missiles

By Charles E. Riley

Our modern Army is critically dependent on high technology and in particular sophisticated electronics. Microcircuit technology is the "brain-trust" of our advanced weapon systems. Because of the central role that microelectronics plays in the total acquisition, and maintenance of the Army's weapon systems, it is extremely important that the Army have ready access to this technology. However, the semiconductor industry is not motivated toward serving this need and therefore potential supply problems exist in this crucial area.

Electronics is not the only area of modern technology where supply problems exist. In fact, the total production base which supports the Army's readiness capability is either slowly vanishing or rapidly redirecting its efforts toward other more lucrative markets.

The Army's microelectronics needs are unique. They cannot be satisfied with off-the-shelf standard products produced by large semiconductor manufacturers. Rather, they are typically low volume, high reliability, military standard components — some of which have the added requirement of radiation hardening.

Ready access to the microelectronic components required for the Army's weapon programs is a problem of enormous importance and its impact extends from the laboratory to the battlefield. Although the problem is examined here from a U.S. Army Missile Command (MICOM) point of view, it is characteristic of the entire DOD community.

There are three major issues which affect the availability of military electronics: the possibility of modifying commercial-oriented processing lines; the enhancement of existing facilities and development of new ones aimed at the production of military standard components; and the mobilization of the microelectronics industry, should the need arise.

It is interesting at the outset to examine some of the historical developments surrounding the availability problem.

The semiconductor manufacturing industry is in the midst of being violently restructured. According to a report, this restructuring had linked almost all independent semiconductor manufacturers to major equipment companies. For example, in 1979 Schlumberger Ltd bought Fairchild Camera and Instrument Co. and United Technologies Corp. bought Mostek Corp. These two acquisitions alone involved a capital outlay of almost three-quarters of a billion dollars.

In addition, 20 such acquisitions have been made in the last three years. As a result of this trend, it is anticipated that by the mid-1980s one-third of the integrated circuits will be designed and/or built by the users rather than suppliers.

The computer/data communications business had expanded to the point that it consumes a staggering 44 percent of the worldwide Integrated Circuit (IC) merchant market.

There has been a virtual explosion in the consumer uses for microelectronics, and industry is in full production in an attempt to fulfill this insatiable demand. Semiconductors have become an integral part of calculators, watches, games and toys. Even the automotive industry is undergoing an electronic revolution.

Innovative ideas aimed at employing microelectronics in a myriad of consumer products surface every day, and why not! What other area of technology is so extremely useful and yet continues to experience decreasing costs with increasing performance? For example, in 1981 the circuit cost of storing data will be about one-tenth of what it was in 1975.

Foreign countries are making substantial gains in semiconductors —an area which, in the past, was totally dominated by U.S. industry. For example, the Japanese have pulled out all the stops in attacking semiconductor markets and have managed to capture approximately 55 percent of the 4,000-bit random access memory (4K RAM) market.

Japan's world-wide technological position is not an accident but rather a calculated result of the employment and further enhancement of techniques learned from American industry many years ago. For 15 years the Japanese have been methodically working toward a trident goal—superior levels of automation, productivity and quality control, all of which they believe are highly interrelated.

Japanese industry's vigorous pursuit of the worldwide semiconductor market is significantly enhanced by tax incentives and favorable loan policies of the bank of Japan. For example, the government funding of a joint Very Large Scale Integration (VLSI) development facility will significantly enhance Japan's technological base while simultaneously fueling the modernization of its semiconductor industry.

The Japanese Government has provided a vehicle for their industry to easily enter a market where initial development costs are enormous. This subsidizing mechanism is designed to propel Japan to a global leadership position and history would indicate that they are rapidly approaching that goal.

MICOM'S experience in the Microelectronics arena has been most illuminating and clearly indicates the types of problems which are symptomatic of the availability issue. The Army is experiencing long lead times in the procurement of many components. For example, at present the bare chips used for one military system have delivery times of 50-60 weeks.

Long delivery periods occur because suppliers have little interest in government business because the return on investment is not attractive. There is too much paperwork, and their processing lines have to be changed from standard type production to one which produces devices which are carefully tested and inspected under government standards.

New systems are designed to use large-scale integration circuits because of significant advantages in cost, size reliability which could accrue through the use of this technology. These devices are generally no minimum-time production items. However, they are state-of-the-art components. Nevertheless, the large semiconductor companies are unwilling to commit their engineering talent to a task which is viewed as a "small" government procurement.

The co-production problem, i.e., licensing of foreign companies to produce some of our military-grade semiconductors does not appear to be a serious one at the present time because sophisticated electronics are furnished to foreign countries.

The U.S. currently has the capability to supply these components and does so

to maintain control. However, the pressure is mounting to allow foreign companies to produce these electronics. This trend takes on added significance because a good portion of U.S. industry is not actively pursuing government work.

Finally, in view of the historical relationship between the military and the U.S. semiconductor industry, the potential for mobilizing this industry in case of emergencies becomes an issue of significant importance. In order to achieve this mobilization, if necessary, the many facets of such a transition must be thoroughly and carefully examined. For example, industry is not currently oriented toward meeting DOD's current and future needs. Their efforts are directed toward producing integrated circuits for high volume commercial applications, thereby permitting high initial design costs to be written off over many production units.

Defense-oriented integrated circuits typically require special testing procedures. In addition, on-chip, built-in test and the use of fault tolerant techniques are absolute requirements in order to provide acceptable logistics costs to the military.

From a commercial perspective, military electronics is a low volume business. However, the applications require the ultimate in performance. Therefore, there is little motivation on the part of industry to spend sizable R&D funds which yield a low return on investment. It is estimated that the same number of engineers in a microelectronics manufacturing company can design two military chips with an expected volume of 20,000 per year or 10 commercial chips with an expected volume of 120 million per year.

In view of these figures one can hardly fault industry for taking the tack they have. They are in business to make money.

The military then, finds itself in a rather precarious position. Its requirements are too specialized to allow for off-the-shelf products, and its volume is too low to interest the big semi-conductor manufacturers.

However, it should be noted that there exists a large degree of commonality between the processing techniques employed for commercial and military-grade semiconductors. The process modifications necessary to produce military products are not unreasonable and are centered primarily in the testing phases.

Tightly coupled with this strategy is the issue of co-production. There is no doubt that this concept is viable from a foreign viewpoint. However, one must carefully assess what could be a negative impact on the U.S. military production base and the fragile supply lines which could exist in emergency situations.

One can also speculate that if foreign companies successfully expand into the commercial market, then the military market may become more attractive to U.S. semiconductor firms, thus enhancing the military production base.

The reality of the situation, however, is that even without the military market there exists insufficient capacity to meet the commercial demands for microelectronics. Therefore, a time and economic analysis of the conversion scheme from commercial to military products is needed. Such a conversion involves two items, design and processing.

Because many military designs are strictly custom, commercial designers must be reoriented and retrained for military applications. It would take a minimum of 12 months and nominally 24 months to change a commercially-oriented design team into one that is truly effective for military applications.

Approximately 10 companies and 300 to 500 experienced microelectronics design engineers would have to be retrained so that they were capable of defining, learning and implementing military requirements into design.

Facilities dedicated to the production of custom microelectronics are also of extreme importance to the military. They are both needed for both the development of new weapon systems which employ state-of-the-art devices and the maintenance of field-deployed systems which employ more mature electronic technologies.

At the present time there appears to be a growing divergence between the military and commercial technological goals. This deviation in emphasis has caused major problems for defense contractors who depend upon specialized electronic companies or vendors to provide components for missile controls, avionics and smart munitions.

In order to fill this void in component availability, many large defense contractors have restructured their organizations to develop the in-house capability for design, development, and production of the microelectronic components required to satisfy contract demands.

In the case of missile systems, the development time is so long and advances in microelectronics technology are so fast that parts cannot be obtained for maintenance of these systems when they are deployed.

Production lines have been dismantled and changes made to reflect the newest technology. Even with built-in testing and repair capability, which complicates the design phase, there is an inevitable need for spare parts.

Consequently, dedicated custom fabrication facilities, capable of producing and repairing a variety of electronic technologies, are necessary ingredients for supporting the total military electronic needs.

Such dedicated facilities are typically GOCO (Government Owned Contractor Operated) Plants. The cost of a typical GOCO facility for microelectronics is approximately 20 million dollars and about one year is required to bring about such a facility. However, this facility, would be capable of supplying the latest technology and the components for maintenance in a short period of time.

The U.S. semiconductor industry has done an absolutely remarkable job in producing high quality, low cost microelectronics for commerical uses. They have managed to do this in the absence of certain types of government help, such as tax incentives.

Although their lack of interest in military electronics is understandable and predictable in light of the economics involved, it would be possible to convert this awesome industrial might into a highly efficient military supplier.

Industry currently has the personnel, equipment and technology required to support military electronics. In a national emergency these organizations would unquestionably redirect their efforts to supply the necessary items.

Most major semiconductor companies build their military products on the same processing lines which are used for commerical and consumer products. It is typically the screening and testing of components that separates the military products from the others.

Radiation hardened technology is also available but there are fewer companies which possess expertise in this area because of its limited interest. In order to mobilize this industry, however, government and industry must work together to develop a detailed transition plan which serves the interest of both.

The most critical factor for mobilization is planning. This is an absolute necessity for which there is no substitute. Government simply must meet with industry leaders now and lay out a step by step contingency plan to define the problem areas and conceive a strategy for solving them.

This planning will involve identification of components, pipelines, weak links, stockpiles, and the like. The plan must identify capabilities together with a specified time frame. A time frame for conversion, which is unquestionably long in this context, together with the attendant cost has been previously identified.

Because of the long time required in the conversion, it is extremely important that those industries who currently supply military electronics be well supported in their efforts in order to insure that those supply lines are immediately available.

For modern systems, components are currently being made. Therefore, the problem in this case is capacity and quantity. However, for older but useable systems, obsolescence is a problem. Required components may no longer be available and thus alternative designs should be established. This task would require 1 to 3 years and cost from 5 to 20 million dollars. Obviously, for mobilization, it is time that is the critical factor.

The U.S. Army Missile Command is keenly aware of the major issues which impact its ability to obtain the types and quantities of semiconductors that are required to sustain its development and maintenance programs.

MICOM is also aware that the large military and aerospace contractors have slid from a position where they accounted for 70 percent of the semiconductor sales to a position of only 7-8 percent, a percentage decrease of almost an order of magnitude.

Within this framework, however, MICOM is diligently pursuing the problems which impede their ability to obtain the components they need. This is obviously a multifaceted issue with tentacles which extend into the depths of government and industry.

MICOM intends to vigorously support those organizations which are working to solve these problems and to pave the way for other industry to join the attack. Specifically, MICOM has developed an integrated philosophy involving a total cradle to grave approach for microelectronics.

MICOM is committing both resources and time to provide significant support for industry in this area so that advanced manufacturing technology can be applied on the production floor as soon as possible.

This approach, which involves a coordinated effort from research through the manufacturing methods and technology program to production, is designed to increase productivity, guarantee availability and decrease costs.

The major weapon employed by MICOM in this approach is the judicious and strategic use of the manufacturing methods and technology program. Through this program, MICOM supports the following critical developments designed to minimize the problems inherent in the availability of custom electronics:

- Manufacturing techniques for multiple chips employing multiple technologies that are not only in vogue but are projected to be in the mainstream of the semiconductor marketplace for many years to come.
- Electronic computer-aided manufacturing and hybrid computer aided design and manufacturing in order to automate microelectronic production lines and therefore improve productivity, increase fabrication speed and decrease per unit costs.
- Elimination of precious metals from military hybrid micro-circuits and their replacement with viable materials which are universally available and economically attractive.

One alternative to the solution of these problems is to implement a cooperative arrangement between the large semiconductor companies and the major aerospace industries. This arrangement would maximize delivery of components by optimizing the tasks performed by each, e.g., wafers supplied by a semiconductor company would be totally inspected, tested, packaged and qualified by an aerospace contractor.

Techniques developed under this program will not only significantly enhance the ability to produce the types and quantities of low volume, highly diverse, customized high technology components, but will attempt to exploit in every way possible the high quality, commercially-oriented product lines.

This program, which attempts to stimulate industry to invest its own capital for process innovation, is akin to the technology modernization program currently spearheaded by the Air Force for DOD.

MICOM's strategy also involves contingency efforts for mobilization in emergencies. Scenarios are being examined which provide the necessary advanced planning data. Under examination are technologies such as digital processes, e.g., complimentary metal oxide semiconductor linear processes, e.g., bipolar, dielectric isolation, and radiation hardened, together with the companies which possess expertise in these areas.

An analysis indicates that all the necessary ingredients are in place. The importance of this analysis is that it is in a mobilization situation that the availability problem becomes absolutely critical.

In summary, MICOM has developed a sound policy for insuring the availability of its required custom microelectronics. It has accomplished this primarily through the MM&T program which is the catalytic agent which produces an economical manufacturing arena capable of ultimately reducing the cost of hardware in the field.

CHARLES E. RILEY is director of the Engineering Directorate at U.S. Army Missile Command. He served formerly as director of the Advanced Systems Development and Manufacturing Technology Directorate in MICOM's Engineering Laboratory. His academic credentials include a BS degree in mechanical engineering from Auburn University and an MS degree in engineering management from Vanderbilt University.

Making Tactical Communications Work . . .

The Communications Systems Engineering Program

By Geoffrey B. Charest

"There is an urgent need to take positive action to upgrade the current communications posture in Europe. Field exercises, after action reports, critiques, and commander's notes confirm the unsatisfactory nature of our tactical communications systems. While there are numerous developmental actions underway to enhance various phases of the communications systems, these actions must be unified into a single program, which bears the responsibility and the authority to effect resolution of the European communications problems in the near term . . ." - LTG H. Dickinson.

There are numerous actions being taken to correct communications difficulties in the tactical Army. However, there has been no central focal point for management coordination of these actions. The Communications Systems Engineering Program (CSEP) is an attempt to develop tactical communications systems into a single program and resolve problems in an effective, timely way. The scope has rapidly broadened since LTG Dickinson first articulated the need in March 1978 to address not only the European theater, but the tactical communications needs of the whole Army.

Objectives of the CSEP are two fold. First, to provide near term assistance in the form of quick reaction projects through military adaptation of commercial items, product improvements, accelerated development within existing technology, and development of new procedures and recommendations for commander's consideration.

The second objective of the CSEP is to obtain long term benefits by providing a vehicle for action on user problems and requirements in the communications arena and by modification of performance specifications for those systems under development.

CSEP was formed in early 1978 under a Memorandum of Understanding between the U.S. Army Communications R & D Command (CORADCOM), the U.S. Army Communications and Electronics Materiel Readiness Command (CERCOM), the U.S. Army Signal Center and the U.S. Army Field Artillery School. The purpose of CSEP is to present a forum for cooperative efforts and to achieve significant improvements in the area of tactical communications support.

Management coordination of the program is performed by a senior review board consisting of one 0-6 from each of the commands. Meeting quarterly, the board conducts a review of ongoing projects and strives for rapid, aggressive action in tactical communications improvement.

Key to accomplishment of the senior review board management is the active participation of elements of DARCOM, TRADOC, FORSCOM, USAREUR, DA (ACSAC, DCSOPS, DCSRDA) and other involved agencies.

Day to day responsibility for administration of the CSEP rests with CORADCOM's Center for Systems Engineering and Integration (CENSEI). This asasignment stems from CENSEI's responsibilities for Army Tactical C3 system engineering.

To date, five contact team visits have taken place, all to units in Europe. It is anticipated that the scope of these contact teams will eventually include other tactical units in CONUS, Korea, and other parts of the world.

To tie the many efforts together for those factors which impact on the performance of a tactical communications system requires management and engineering on a fairly broad scope. Initially, the CSEP focused on the communications systems within the division and has considered problems in equipment design, operation and maintenance, the logistics support, tables of organization and equipment authorizations, training, personnel, and requirements development and documentation. The CSEP has also begun to address units in tactical echelons above division.

In its efforts to improve tactical communications systems, a total systems engineering approach is used. After being viewed as a complete system, sub tasks and objectives are established leading to upgrade of the entire system.

Once the CSEP Contact Team identifies and articulates communications problems, initial solutions are proposed. Efforts are then directed towards establishing/obtaining prototypes in the case of equipment, and conduct of subsequent field evaluation in active tactical units. Based on these concept evaluations, requirements are refined and documented and operational concepts are developed.

Funding needs are established and forwarded. Materiel developments are then turned over for management through project management offices. Every effort is made to expedite solutions to the field. NEAR TERM MEANS FIELD IT NOW!

The viability of the CSEP can be seen in an analysis of the AN/VRC-12 series and related radios. This radio system

is chosen because it is the major communications means for all front line soldiers in the Army. Yet this system suffers a wide variety of weaknesses which can be eliminated with properly engineered improvements.

The FM tactical communications system is not new. It has been in field use for over 15 years, yet a variety of indicators demonstrate a lack of total system engineering. It is also clear that solutions to problems do not generate from the field. In fact, quite the opposite occurs in many cases with the field fix failing to solve the problem and often generating new, unrecognized ones.

The tactical FM system is made up of many other factors besides the radio/receiver itself. Indicators of communications system difficulties are as follows:

- In 1977, 68 AN/VRC-12 series radios were inspected in V Corps. Only two were considered operational pursuant to appropriate specifications.
- Also in 1977, 381 radios were checked in a divisional artillery at Fort Hood, TX, with the following results: all 381 radios required a direct support maintenance alignment; 40.9 percent had bad antenna matching units; 36.5 percent matching unit cables were missing or bad; and 25 percent of the lower antenna sections were bad.
- Later in 1978, 101 radios were checked in an armored cavalry regiment in Europe with the following results: 100 radios needed repair or alignment; 16 units had bad antenna matching units; 25 had missing or bad matching unit cables; and 40 had bad lower antenna sections.

Maintenance problems also reveal a large number of system failures besides those cited above. Organizational level radio repairmen have no tools or capability to test critical performance parameters of the radio. Maintenance trouble shooting winds up being performed by random substitution, frequently resulting in good components incorrectly identified as bad and bad items overlooked. With this witchcraft approach to maintenance, non-operational radio systems become extremely difficult to correct efficiently and effectively.

In the direct support, or second echelon maintenance effort, eight pieces of discrete test equipment are required to troubleshoot, repair, and align a radio. This circa 1955 technology equipment is interfaced together with a variety of various home built cable and wire systems. If not careful, maintenance personnel can damage test equipment and further damage to the radio can result from improper hookup. All together it takes over four hours to properly align each radio.

Antennas have long exhibited problems for the combat soldier. Numerous antennas in tactical command posts cause increased visual signature. Since each radio requires its own antenna, mobility is decreased because of needed antenna set up and tear down time.

Closely spaced antennas result in mutual interference and radiation pattern distortion. The design of the best FM antenna commonly available, the omnidirectional RC-292 antennas, requires antenna element adjustment for proper performance. Since frequencies are generally changed at midnight, these antennas are supposed to be lowered (through the camouflage net), in the middle of the night, adjusted properly, and set back up.

This is not the only system weakness, however. Extended ranges are required because of wide frontages covered by the divisions in Europe. These ranges exceed the capability of the available omnidirectional antennas. Directional, increased range antennas are not available.

Directional antennas, besides increased ranges, also provide the equally important feature of an inherent electromagnetic counter measure due to the directionality of the radio wave propagation. The simple application of directional 1/2 rhombic or log periodic antennas can reduce the probability of radio intercept or directional finding by several orders of magnitude. ECCM in the field has been talked about for years, yet very little has been done to improve the current system while waiting for new systems such as SINCGARS, PLRS, JTIDS etc.

The present method for coping with extended ranges is FM retransmission station. Certainly, directional antennas will not eliminate the need for these retrans stations. They too, warrant a closer systems evaluation. Also, these stations exhibit many poor system design indicators. They are invariably employed in a fixed location (not mobile) for relatively short, to extended periods of time.

No protection in the form of shelter is provided for the equipment or operator. No improved antennas are provided nor any of the unique requirements for tactical operation, such as operation in blackout, are specifically considered in retransmission system design.

The frequency management of the FM system and the mechanics of call sign assignment and net structure is accomplished through the Communications-Electronics Operative Instructions (CEOI). This paper system, published by NSA, is bulky, and inflexible. It takes 13,000 lbs of paper to supply one division a months supply of CEOI material.

It takes a 6-month lead time to change a paper CEOI format item such as is needed to support a commander's task assignment of his forces or even the simple change of adding or deleting or call sign. Low level codes used with the FM system are similarly awkward.

Field commanders have sought for years to get subordinate units to use these low level, approved and effective codes rather than home made, ineffective and dangerous brevety codes such as the point of origin method of coding grid coordinates. Yet, homemade codes continue to be used.

Though the indicators sound like a litany, the tactical FM radio system has certainly demonstrated its robust nature for suboptimal performance by functioning as the major communications means below brigade level. However, with the emerging digital and other add on devices, like VINSON, digital message devices, facsimiles, etc., the effect is to reduce the opera-

tional robustness. The system will fail if the root problems of these indicators remain unsolved.

Field units, while recognizing these problems and difficulties have, by and large, been unable and incapable of establishing proper, lasting, effective fixes even with limited R & D command help. Many attempted, and still currently used field fixes, are marginally effective and frequently create new difficulties. For example: Large numbers of bad radios, matching units etc, have resulted in field demands for better radio repairman training and crash drills.

Maintenance personnel are still unable to increase productivity and effectiveness without proper, and effective TMDE. No effective method could be established for proper testing of critical performance parameters. At best, equipment upgrade projects are short lived and chronically needed.

In an effort to increase radio performance, mobility, and reduce antenna numbers, two RC-292 antennas have been mounted on AB903 antenna mast. While this action increases antenna height for increased range and reduces the number of masts, thereby increasing mobility, new problems are created.

Increased power loss in the longer coaxial antenna cable decreases power delivered to the antenna and reduces the benefit in range created by increased antenna height. The approximate 3-foot separation of the antennas is far too close and may result in severe radiation pattern distortions. Still, the adjustment problem of the RC-292 antenna during the nightly frequency change has not been solved.

Further attempts have been made at attaching up to five radios directly to one antenna using field fabricated direct connection devices.

The result of the use of such a device is certain, though not immediate, failure of certain components in the radio. With sufficient "spare parts," radios abused in this manner can be kept operational for limited periods, but at excessive cost. This is an atrocious solution, but the perceived need to reduce the number of command post antennas is sufficient in some instances to tolerate this practice.

Field expedient, directional antennas such as a half rhombic antenna have been well known for many years. Diagrams of such antennas are available in a number of Army publications such as a survival handbook, etc. Some of these have actually been built and used. However, to get such an antenna to properly operate requires a properly designed balun or termination/matching device.

Where does the soldier in the field find a 500 ohm impedance matching balun? How does he make one? The answer is, he can't. The result is the soldier tries but only makes an antenna that performs equally poorly to the omnidirectional whip antenna he already has.

For retransmission stations, virtually every signal battalion in the U.S. Army builds a plywood shelter to house the equipment and operators during extended operation, particularly in adverse weather. The design and effectiveness of such plywood shelters varies. Often the result is a fire hazard, increased electrical shock potential from a poorly installed grounding system, and only marginal protection for man and equipment. The overal result is hardly indicative of the world's premier military force.

What has the Communications systems Engineering Program done to solve some of these problems? First, a tool was developed for the organizational level FM radio repairman to check the critical performance parameters of the radio. This test set, the AN/PRM-34, enables the field mechanic to test the proper operation of the receiver, squelch circuitry, power output, and insure correct transmit frequency. Initially, 55 of these sets were built and have been field tested.

Observations of V Corps have been mirrored in the 1st AD where the PRM-34 has been received with unbridled enthusiasm at both operator and managerial levels. It has filled what here to fore has been a void in our maintenance TMDE. The first production contract for this test set was awarded in September 1980.

Besides giving the organizational mechanic the correct tools to perform his job effectively, a closer look was taken at the training he received. It was discovered that he was taught a lot about the radio itself but very little about how it fits into a system with power connections, various antennas, and other ancillary devices such as crypto equipment, etc. Systems type training has been greatly expanded so that the mechanic understands how the radio set relates to the overall FM system.

The longer term effort has also taken place towards developing a fully automatic piece of TMDE. Seven models of a completely automatic test set, with software packages for diagnostics, alignment, and quality control, will begin field testing in February-March 1981. It is anticipated that this test set will virtually revolutionize procedures now used in the DS maintenance shop.

A variety of efforts have taken place to help the FM radio system operationally. In the area of antenna difficulties, it was discovered that a broad band FM antenna, the OE-254, had been designed and built for use with the SINCGARS radio. Efforts were taken to expedite this antenna from depot stock to the field as a replacement for the RC-292, thus eliminating the need to readjust the antenna during frequency changes.

To reduce the number of antennas needed to be set up in the command post, a development of a properly designed multicoupler device, the TD-1289, was accelerated with a first production contract award in May 1980. This device enables up to five radios to be connected to a single broad band antenna such as the OE-254.

To compliment the omnidirectional antennas, two directional antennas have been built and field tested with excellent results. The OE-303, half rhombic antenna and OE-314 log periodic antenna provide significantly increased range. They also have the added benefit of degree of Electronic Counter-Counter Measure (ECCM)

protection. With these antennas, the field tactical communications officer now has the ability to tailor the communications system to better suit and support the commander and his needs in a wider class of situations.

Another major effort to improve the tactical FM system is development of a properly designed FM retransmission/ Radio Wire Integration system with all the equipment needed to fit a variety of missions and uses. A prototype should be completed in early 1981.

A second development is the Hand-Held Encryption and Authentication Device, the HEAD, which can replace the currently used paper CEOI. This small, "pocket caculator" type device has the potential to revolutionize the current method of paper assignment of frequencies call sign and use of low level encryption codes.

Thirty HEAD prototype devices have been built and are about to undergo concept evaluation. Electronic transmission of the CEOI can eliminate the delays inherent in printed paper. Greater ease of use will facilitate wider field use of low level codes.

All of these efforts toward improvement of the current tactical FM communications system, plus a variety of others such as VINSON, SNAP (Steerable Null Antenna Processor) (an ECCM device), use of Digital Message Devices etc, must fit in a logical, systems engineered way.

It is the efforts of CSEP which will insure that these individual efforts succeed as intended and do not result in unforseen failure due to a system oversight. The overall result is a viable, survivable, flexible and effective system for the field commander.

The ultimate reason for the continuation of a program is demonstrated results. Realizing that the purpose of the CSEP effort is to recognize and articulate problems and subsequently provide quick reaction solutions where viable, two critical assumptions must remain valid. First, it must be understood and accepted that it may be necessary to cut across some traditional procedures and capitalize on any existing methods for expedited action. Second, that the personnel resources supporting the CSEP effort receive the authority commensurate with expedited action. The CSEP effort has demonstrated results and must continue towards its objective.

Actions are underway to more formally structure and support the program effort. This institutionalization has a number of essential facets which take place. First, we must establish a firm funding base with the availability of RDTE funds to identify and articulate problems, develop solutions, and field evaluate these solutions.

Second, a method must be established to evaluate needs and provide needed procurement funds to support near term, quick reaction purchase of low dollar items faster than the current congressional budgeting procedures permit.

Emphasis must also continue to be placed on development of realizable, affordable solutions to problems that meet the needs of the field before they are obsolete.

The CSEP does involve some risk. These risks are carefully evaluated and calculated, but it is clear that quick reaction channels are needed. If the path of no risk, business as usual is taken, it is clear that no solutions will evolve in the near term (if ever).

CPT GEOFFREY B. CHAREST is assigned to the Communications Systems Engineering Program at the U.S. Army Communications Research and Development Command (CORADCOM). He has a BS degree from the United States Military Academy and an MS degree in engineering from Princeton University. He has served in various positions in Division and Corps signal battalions, both in the United States and in Europe.

DATAMAP: A Versatile Data Management and Analysis System

By Donald J. Merkley

Have you been overwhelmed with more time-history data than you could manage or analyze? Could your time be more productive if you did not have to tediously plot data by hand? Could your interpretation and presentation of data be more meaningful if you could interact with it directly and perform various analyses, derivations, plot and replot the data in a variety of formats? If your answer to any of the foregoing questions is yes, then DATAMAP is for you and your applications.

DATAMAP (Data from Aeromechanics' Test and Analytics-Management and Analysis Package) is a computer software system which provides direct access to large time-history data bases, performs analyses and derivations, and provides the user with various options for output display, interactively or through batch processing.

DATAMAP was designed to utilize a comprehensive data base consisting of simultaneously recorded rotor aerodynamic forces, aero-elastic loads, blade motions, acoustics and the attendant responses of the control system and airframe that result from flying operational maneuvers.

The Applied Technology Laboratory (ATL), U.S. Army Research and Technology Laboratories (AVRADCOM) developed the functional descriptions for the DATAMAP software system to utilize this data base and yet be general enough to use with other large time-based data sets, both analytical and test.

Functional descriptions required the system to provide access, data reduction, and a variety of formats of presentation of digitized data. In addition, operation in batch, interactive and interactive graphics modes were required. The functional descriptions also included a need for a high degree of user interaction and computer generated step-by-step explanations of user inputs, user options, and menus of data available for processing.

Most analytical methods commonly used for helicopter data analysis, selectable by the user in any appropriate combination, were specified. Modular design requirements were stressed to permit other methods to be added as the need arises.

Design requirements included execution on an IBM 360 Model 65 with Time Sharing Option (TSO), Tektronix 4014 graphic terminal, Houston Instruments DP-1 incremental plotter, and IBM 2741 typewriter terminal. The mandatory computing language was FORTRAN IV. Since then, DATAMAP has successfully been installed on IBM 4341 and Digital Equipment Corp. VAX 11/780 computer systems.

Bell Helicopter Textron, Scientific and Technical Computing, was selected as principle performer to develop this software, which is now known as DATAMAP. DATAMAP meets all of the above mentioned design requirements with an easy to learn user oriented format.

DATAMAP consists of two major programs, the File Creation Program and the Processing Program, as well as several utility programs. The File Creation Program reads data from some storage medium (digital tape or disc), selectively transfers data to a direct access disc called the Master File and creates a directory of the data thus stored. The Master File is then the data input source for the Processing Program.

The Processing Program retrieves data from the Master File, accepts user commands interactively or in batch mode, processes the data, and outputs data in graphic or printed formats. The Processing Program provides various analyses that may be performed on the basic data contained on the Master File and, in addition, certain parameters may be derived from the basic data.

These analyses and derivations can be performed in multiple dimensions (e.g., time, blade chord, and rotor radius). Sequences of analyses and/or derivations can be performed on a set of data in any appropriate combination.

Basic data and processed outputs can be presented in various formats. Simple X-Y plots or multiple-curve X-Y plots are available. The user also has the options of specifying log-log or semi-log axes, scaling on X and Y and whether the plot has grids and/or tic marks.

When X-Y plots are produced on the Tektronix 4014 terminal, the user may specify that the crosshair cursor be activated immediately after the plot is completed. The crosshairs may be used to evaluate points on the screen in user coordinates.

Three-dimensional outputs in the form of contour plots and surface perspective drawings in rectangular and cylindrical coordinate systems are available. Auto scaling is available on all plots or the user may specify the scale values.

All output options are available on a Tektronix 4014 terminal in the interactive graphics mode of operation or on an incremental plotter in the batch mode. Printed listings are available in either mode, or on an interactive typewriter terminal.

DATAMAP can analyze and display time history data from tests (full scale, model scale, flight, wind tunnel, whirl tower, etc.) and analytics. This not only provides a versatile tool to interrogate and interpret any given set of data, but also provides the means of direct comparison and correlation between different sets of data. Analytical results from a helicopter simulation can, for example, be directly correlated with actual flight test data to evaluate

the accuracy of the analytical simulation.

Four utility programs are provided in the system. Two of them are for file initialization in the Master and Command Sequence Files. The Command Sequence File is a permanent disc file on which sequences of command steps can be stored.

Another utility program is provided to develop complete input sequences for the File Creation Program in an interactive mode. Questions are asked to prompt input for every possible specification. The output of the program is a data set which can then be specified as the user input for the File Creation Program. This program assures the user that his input to the File Creation Program is correct in syntax and that all possible specifications have been considered, and is particularly useful to new users of DATAMAP.

A File Maintenance Program is provided such that a designated data base monitor at each user installation can maintain the Master File. Various functions are provided in the File Maintenance Program such as listing the contents of the Master File, location of each partition, the date each was created, its user's name and the last date the partition was accessed. The contents of each partition may be listed. Partitions may be deleted, saved on tape, or restored through use of this program.

DATAMAP is a data analysis and management system that has been shown to be versatile and user oriented. It provides an engineering user, not necessarily computer oriented, a powerful tool to interactively analyze and interpret a vast amount of data which may otherwise be unmanageable. Most of the derivations and some of the analysis procedures are helicopter oriented; however, other processing capabilities, data management features and the graphics functions can readily be used for non-helicopter applications.

DONALD J. MERKLEY is an aerospace engineer with the Aeronautical Technology Division of the Applied Technology Laboratory, U.S. Army Research and Technology Laboratories (AVRADCOM). He graduated from the University of Texas at Arlington with a BS degree in aerospace engineering (1969) and an MS in mechanical engineering (1971). Prior to joining ATL in 1971, Merkley was an aerodynamics design engineer at LTV Aeronautics.

Tests Justify Easing of Ammo Storage Restrictions

Researchers at the U.S. Army Armament R & D Command's Ballistic Research Laboratory (BRL) reportedly have determined through a series of extensive tests, that current safety restrictions could be amended that govern the storage of small quantities of ammunition and explosives in earth-covered igloos.

What this means, according to Mr. Harry Reeves, a BRL physical scientist who spearheaded the investigative project, is that the current 400-meter (about 1300 feet) minimum distance requirement between inhabited buildings and igloo magazines is clearly excessive for storage of small explosive weights.

Reeves, a researcher in BRL's Vulnerability/Lethality Division, gave the BRL test results at the 19th annual Department of Defense Explosive Safety Seminar. He presented the evidence for a possible alternative requirement of the 1976 "Manual on NATO Safety Principles for the Storage of Ammunition and Explosives."

"We've shown that earth-covered igloos used to store 450 pounds of explosives need not be restricted by the 400-meter minimum distance requirement and could be located closer to areas where the munitions or explosives are needed," Reeves said.

All tests were conducted at the Navajo Army Depot near Flagstaff, AZ. A total of four excess reinforced concrete igloo magazines were used for the destructive tests. Covered with at least two feet of earth, the igloos each held 450 pounds of TNT charges that were statically detonated from a remotely located mechanical-electrical safety block.

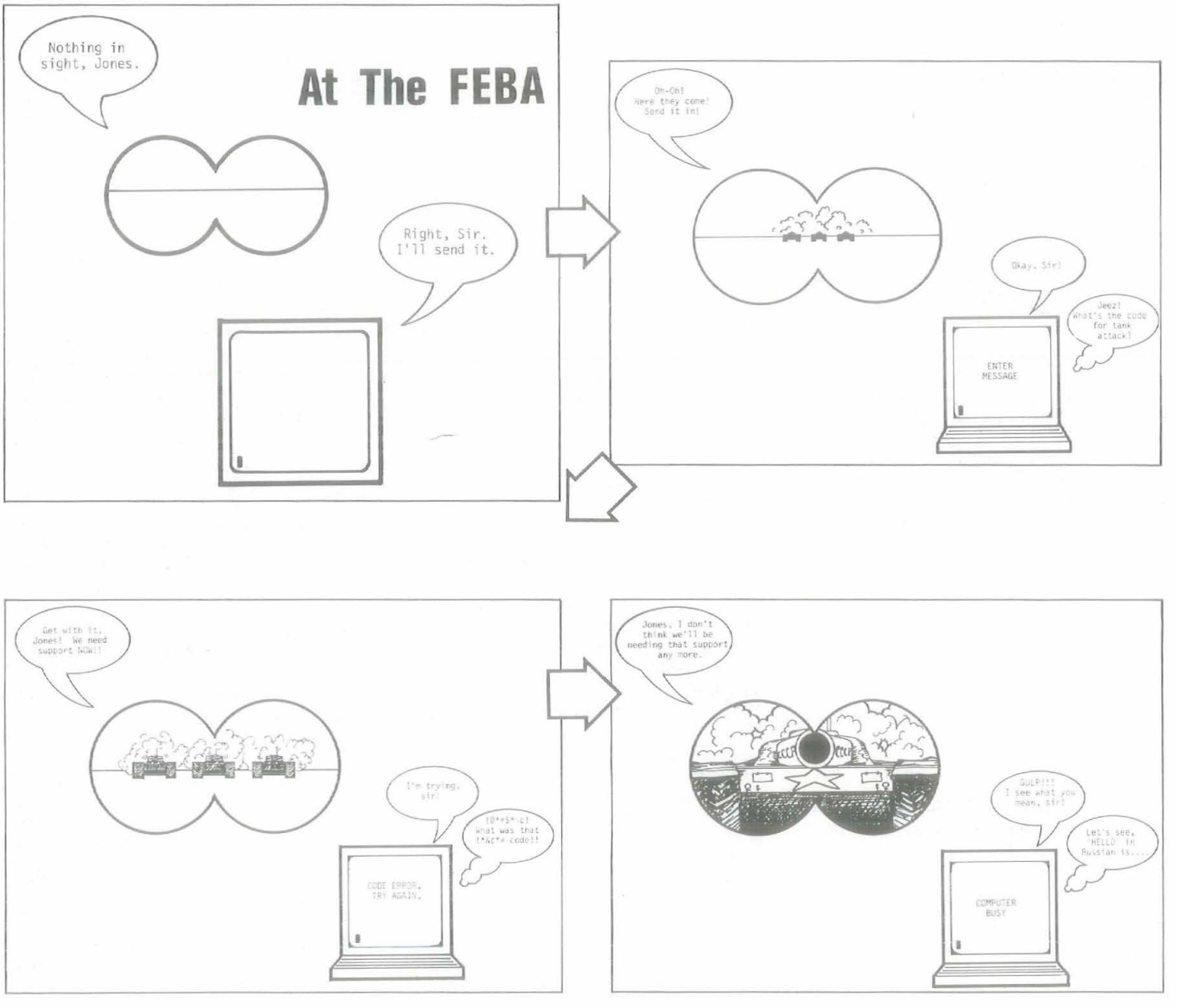
"The igloo doors were expelled from the test site, remaining airborne for up to 300 feet, and the earthen covers rose up 60 feet and then settled. The igloos' headwalls were fractured into several hundred pieces, many weighing more than 100 pounds," Reeves said.

After analyzing airblast profiles and fragment weights and locations, the BRL researchers were able to conclude that the safe distance limits currently required between inhabited buildings and igloos containing small explosive weights may be excessive, leading the way for possible revision of the NATO manual on safety principals.

GET THE MESSAGE?

The Problems of Abbreviations and Battlefield Automated Systems

By Dr. Sam Ehrenreich and Dr. Franklin L. Moses



So articulate and poignant is the above cartoon, provided by the authors to accompany their text, that the magazine broke with past tradition and decided to use it, as it constructively serves to illustrate and highlight a serious communications problem — abbreviations and acronyms.

Automated command and control systems for the battlefield are coming, and so are the many advantages and challenges they will present to the users. These automated systems will accomplish many of the tactical functions now performed manually.

For example, G2 personnel will use remote terminals to enter and to retrieve intelligence data at locations scattered across the battlefield. These terminals will also provide access to specialized computer routines to aid the analysis of raw data and to sanitize reports in order to protect information sources. In addition, the new systems will distribute reports to the field.

Another function for battlefield automated systems will be in tactical fire control. New systems will aid preparation of artillery firing plans; that is, they will provide coordinates for and project the damage to be expected from alternative firing plans. The systems will then execute the plan chosen by their human users.

While the advantages of automated systems are clear, problems can occur at the point where the human exchanges information with the computer, the human-computer "interface." Potential incompatability exists not only at the physical level (e.g., poorly designed keyboards, hard to read display screens), but also at the level of mental processes (e.g., human reasoning, memory and perception.) The Human Factors research team at the Army Research Institute for the Behavioral and Social Sciences (ARI) is conducting a program to facilitate user-system interactions and produce design guidelines and criteria for user-operator transactions with battlefield systems.

The level of mental processes is where most critical problems arise. If the information to be entered into a fire control system is so complex that the operators consistently make errors, then the firing coordinates generated are suspect. Even if a fire control system is designed so well that it provides information of highest quality, the information will be of minimum value if it is presented in a format that most users find difficult to understand.

Diametrically different qualities of humans and computers are the source of the trouble. Whereas humans are highly intelligent and versatile, they have limited memory and attention span. Computers are exactly the opposite. They have almost boundless memory and can attend unerringly, but they are also very rigid.

Until now, the versatility and intelligence of humans have compensated for the shortcomings in the design of human-computer interfaces. However, as these interactions become more complex, humans can be overwhelmed in their efforts to compensate for limitations in interface design. Interactions become a critical problem when the user cannot function at the level required by the system.

Consider a simple yet important problem involving computers. Most computer systems use abbreviations. Abbreviations allow information to be entered quickly and reduce the tedium associated with data entry. They also increase the amount of information that can be simultaneously displayed on a screen and decrease the amount of computer memory required. However, abbreviations also create problems. The computer must remember the correct abbreviations for a number of words.

Most computers are extremely rigid; an entered abbreviation is either *exactly* right or it is all wrong. If a single letter is missing or out of place, the computer rejects the entire statement and waits for it to be entered again. If the abbreviations in a battlefield automated system are so hard to remember that its users make frequent errors, then the system's ability to do its job is degraded and may even be compromised.

Thus, abbreviations can cause severe problems depending upon the number of them to be remembered, the intelligence and level of training of the user, and the stress under which the user is working. Let us look in detail at the question of abbreviations.

Why are "good" abbreviations important? One answer appears in the accompanying cartoon. If a person forgets an abbreviation and has to look it up, that abbreviation is inconvenient. Even if the user can recall the abbreviation but requires a second or two to do so, that is still inconvenient. People become impatient with such short interruptions because they disrupt their train of thought and thus reduce their work efficiency. The situation is analogous to a jogger who is running laps on a track which has gates across it. The jogger must continuously break stride to open the gates and continue. Likewise, the interruptions caused by poor abbreviations result in inefficiency, and this in turn causes negative attitudes toward the job and the automated system as a whole.

There are good reasons for difficulty in recall and use of abbreviations. First, abbreviations usually violate the phonetic and orthographic rules of natural language. That is, they sound unnatural when pronounced and their spelling involves queer sequences of letters. For example, one Army standard data element dictionary lists CATK as the abbreviation for COUNTERATTACK. However, the letter sequence "TK" at the end of an English word is queer and CATK is difficult for an English speaker to pronounce. It has been empirically determined that unnatural terms are difficult to remember.

Another problem is that abbreviations are not standard across systems. For example, FM 6-20, Field Artillery Tactics and Operations, lists AP as the code for AIM POINT, while a proposed battlefield automated system uses DGZ for its code. Abbreviations are difficult enough to remember without this change from system to system.

A final problem is that abbreviations are inconsistent because of the arbitrary manner in which they are generated. One standard data element dictionary lists DEF as the abbreviation for DEFEND. If a user tries to memorize this abbreviation by using the mnemonic (i.e., memory aid) that D,E, and F are the first three letters of the word DEFEND, then that user will be confused by the fact that the same dictionary lists ATK (the first, second, and last letters) as the abbreviation for ATTACK and DLY (the first, third, and last letters) as the abbreviation for DELAY.

Abbreviations presently represent the personal preferences of their designers. Because a small group of designers prefers GRSLND as the abbreviation for GRASSLAND does not mean that it will be preferred by operators in the field, nor that operators will find GRSLND easy to learn and use. A better system for forming abbreviations is needed.

The means by which abbreviations are created and learned can be improved. When abbreviations differ, those that were learned for one system interfere with the ability to learn the abbreviations of another system. All Army systems should use the same abbreviations. If operators are able to transfer their experience and knowledge from one system to another, they will benefit from what psychologists call positive transfer of learning.

There are other benefits of improved abbreviations. With a systematic rule for generating abbreviations, their recall can be greatly improved. For example, they can be formed by retaining the first five letters of a word *(the truncation method).* Thus, TOPOGRAPHIC, ACTIVITY, and GUERILLA would become TOPOG, ACTIV, and GUERI. Once users know the rule, they can always form the correct abbreviations (i.e., encode it). Decoding the abbreviation (i.e., like being able to identify the word by seeing its abbreviation) may not be improved by this system, but decoding is not much of a problem to users. The truncation method need not be the abbreviation rule that is used. Instead, abbreviations could be formed by removing all of the word's vowels (a, e, i, o, u, y) except for the first letter in the word *(the contraction method).* Thus, TOPOGRAPHIC, ACTIVITY, and GUERILLA would become TPGRPHC, ACTVT, and GRLL.

Other rules are also possible. The deter-

mination of the rule that produces the best abbreviations for recall and recognition is a current research effort of the Army Research Institute for the Behavioral and Social Sciences. The Human Factors Technical Area is in the process of developing an algorithm (i.e., systematic method) for creating easy to use abbreviations. However, the main point is that by learning a rule and using existing knowledge about spelling of words, everyone can form the recognized abbreviation for any word.

To create the abbreviation algorithm, a number of questions first have to be answered empirically. Experiments needed to answer some of these questions have already been completed; others remain to be performed. Participants for the experiments that have been performed were Army personnel in grades E3 to E7 with various MOS's. Words used in the experiments were ones likely to be abbreviated on a battlefield automated system. However, the nature of both the participants and the words were such that the algorithm being created will be applicable for use with most classes of operators and with most sets of words.

Candidate abbreviation methods for forming the basis of the algorithm are truncation, contraction and existing abbreviations from an Army data element dictionary (these abbreviations were originally created through the consensus of a committee). Specific questions that have already been addressed in the Army Research Institute's abbreviation project, along with their test results, include:

- What are people's personal preferences with regard to abbreviations formed by the different abbreviation methods?

  Answer - People expressed equal preference for abbreviations formed by the truncation and contraction methods. Abbreviations found in an Army data element dictionary were least preferred.

- How do the different abbreviation methods compare when people are presented with a word and asked to recall its abbreviation (i.e., encoding)?

  Answer - Abbreviations formed by the truncation method were recalled most often.

- How do the different abbreviation methods compare when people are presented with an abbreviation and asked to recall the word that it abbreviates (i.e., decoding)?

  Answer - There was no difference between the three methods in the number of correctly decoded abbreviations.

- When people are instructed in the rules underlying the different abbreviation methods, which method results in abbreviations that are easiest to encode and decode?

  Answer - The truncation method produced almost perfect encoding performance when people were aware of the abbreviation method. All three of the methods resulted in comparable decoding performance (about 70 percent correct with minimal training).

Some empirical questions remain to be investigated: When participants are informed of an abbreviation rule, how do they perform on abbreviations which violate the rule? Should abbreviations be of a fixed or variable length? Can endings (e.g., -ing, -ed, -s) be effectively incorporated into abbreviations? How should different words that have identical abbreviations be handled (e.g., when using the truncation method, both TRANSLATOR and TRANSPORT are abbreviated as TRANS)?

Answers to these latter questions will complete the empirical base needed to form an abbreviation algorithm. The desired algorithm is one which completely specifies the abbreviations that it generates. Using the algorithm, the designer of battlefield automated systems should have minimal decision-making tasks in determining the abbreviation to be created. Although the algorithm that is being constructed will not be based on a complete investigation of all possible factors, it should result in abbreviations which are significantly easier to use than the arbitrary and inconsistent abbreviations presently being proposed for battlefield systems.

The work to improve abbreviations is only one of the efforts being carried out at the Army Research Institute to facilitate user-system interactions and to produce design guidelines and criteria for user/operator transactions with battlefield automated systems.

DR. SAM EHRENREICH is a research psychologist at the U.S. Army Research Institute (ARI) for the Behavioral and Social Sciences, Alexandria, VA. He holds a PhD and an MA in experimental psychology from New York University and a BS in physics from the Cooper Union. Dr. Ehrenreich's professional interests are in the area of cognitive information processing as it relates to human-computer interactions.

DR. FRANKLIN L. MOSES is an acting team leader and a research psychologist with the Human Factors Technical Area, ARI, where he is responsible for planning, organizing, and carrying out research on human factors of systems, information processing, and decision making. Dr. Moses holds a PhD and MS in experimental psychology from Tufts University and a BA in psychology from the University of Pennsylvania.

XM 249 Machinegun

Selected as Candidate for SAW

A Belgian XM 249 machinegun, built by Fabrique Nationale, has been selected as prime candidate for the Army's Squad Automatic Weapon (SAW), following a 4-way competitive shoot-off at Aberdeen Proving Ground, MD.

According to Mr. George Niewenhous, SAW test director for the Materiel Testing Directorate's Small Arms and Automatic Weapons Branch, the test entries were all 5.56mm weapons and represent a major step toward filling the SAW need.

He said that a recent Marine Corps study of infantry weapons requirements showed an urgent need for such a weapon, indicating that all U.S. ground forces could benefit when the SAW is fielded.

Awareness of the need for a new SAW first surfaced in 1973, and tests were begun on several weapons in 1974. Early models were produced in a special 6mm caliber, but were dropped because of problems in fielding an extra class of ammunition and other reasons, he said.

Niewenhous said that after intensive review and design specification changes, 54 requirements were developed which the new weapon should possess. A new round of testing was begun in the late 70s, with four versions of the SAW selected for the shoot-off. A Ford Corp. entry, tagged the XM248; the FN XM 249; a German entry called the XM 262; and a Ballistic Research Laboratory version of the M-16, the XM 106, were entered.

Environmental Tests

The weapons were subjected to 10 months of severe tests under all types of conditions: extremes of heat, cold, sand, dirt, mud, extended firing until barrels glowed red; and other tests to check reliability and safety.

Raw data from the tests were made into useful information by MTD's Analytical Branch, Army Materiel Systems Analysis Activity and Army Armament Research and Development Command.

The Department of the Army adopted the new weapon after Army Materiel Development and Readiness Command officials recommended that it be selected winner of the tests.

Operator Tests

In addition to Proving Ground technical tests, the competing models were subjected to operator tests using soldiers at APG and Fort Benning, GA.

What did all that testing and competition produce?

The Army hasn't had a real SAW since the Browning Automatic Rifle (BAR) was retired, said Niewenhous. Normally, he added, a squad will have two automatic riflemen assigned, but they haven't had a weapon that fits squad fire supression needs for a long time. This type of gun is good enough to be called the successor to the BAR, Niewenhous noted. In its current form, and according to present doctrine, the SAW is not intended to replace the M-60 machine gun.

"The M-60 was never intended to be a SAW, but more of a platoon or company support weapon. But because there was nothing else available, it was often used in that role. Nor does the M-16 have the SAW capability. The SAW has advantages over both the M-60 and the M-16 in the role it's designed for," he said.

The M-60 is heavy and the M-16 is limited to 20 to 30 rounds at a time. A fully-loaded SAW weighs less than an unloaded M-60, and with its 200-round-at-a-time capacity, gives better fire suppression capability than the M-16, according to Niewenhous.

Another advantage of the SAW, he said, is that it will use a bullet which is nearly identical to M-16 ammunition, making the two interchangeable. But because the SAW will be asked to shoot out to longer ranges than the M-16, some slight differences in bullet weight and ballistic flight will be built into SAW ammunition.

The BAR's shoes will reportedly be hard to fill, so test requirements were tough. General criteria called for: accuracy beyond M-16 capabilities; functioning without fail in extreme climates; a quick-change barrel which is replaceable in 10 seconds, even when hot; adaptability to night vision device use; being belt-fed but capable of exepting M-16 magazines for emergency use; the meeting of stringent technical requirements; have few moving parts; come with a self-contained cleaning kit; have a built-in bipod; be mountable in standard issue tripods; and be useable by soldiers wearing heavy winter gear, combat garb, and CBR suits.

Testing Criteria

"There were 54 criteria. No one gun met them all, but the Belgian entry met more than the others. One of the important things about competitive testing is that features from other weapons can be incorporated into the final product", Niewenhous noted.

Niewenhous stressed that the weapon was tested for endurance, parts interchangeability, accuracy, noise, smoke-flash signature, cook-off, and other types of things. Data were recorded for evaluation of maintenance, reliability, safety, and human factors. More than 600,000 rounds were also fired.

Niewenhous added that the weapon will bring a big improvement to squad fire power at a relatively low cost. Said he: "It is a multi-million dollar project, but it's small compared to other weapon systems."

Now that the first series of developmental tests are over, maturity testing will begin. This next phase of testing will look to make refinements in the weapon and allow human engineering factors to be more closely defined, he said.

The XM 249 has not been type classified, but Niewenhous said he expects a version of it — or a direct derivitive of it — to be in soldier hands in the next few years.

Nuclear Munitions Acquisition

By Sheldon E. Blaustein

When you look at the wild array of regulations and activities required to field a new weapon system, - like Army Regulations, Department of Defense Directives, Test Programs, and Logistic Log Jams, are you ready to find a new career? "You ain't seen nuttin" - till you look at nuclear munitions programs. Why? - - - - You say? Glad you asked!

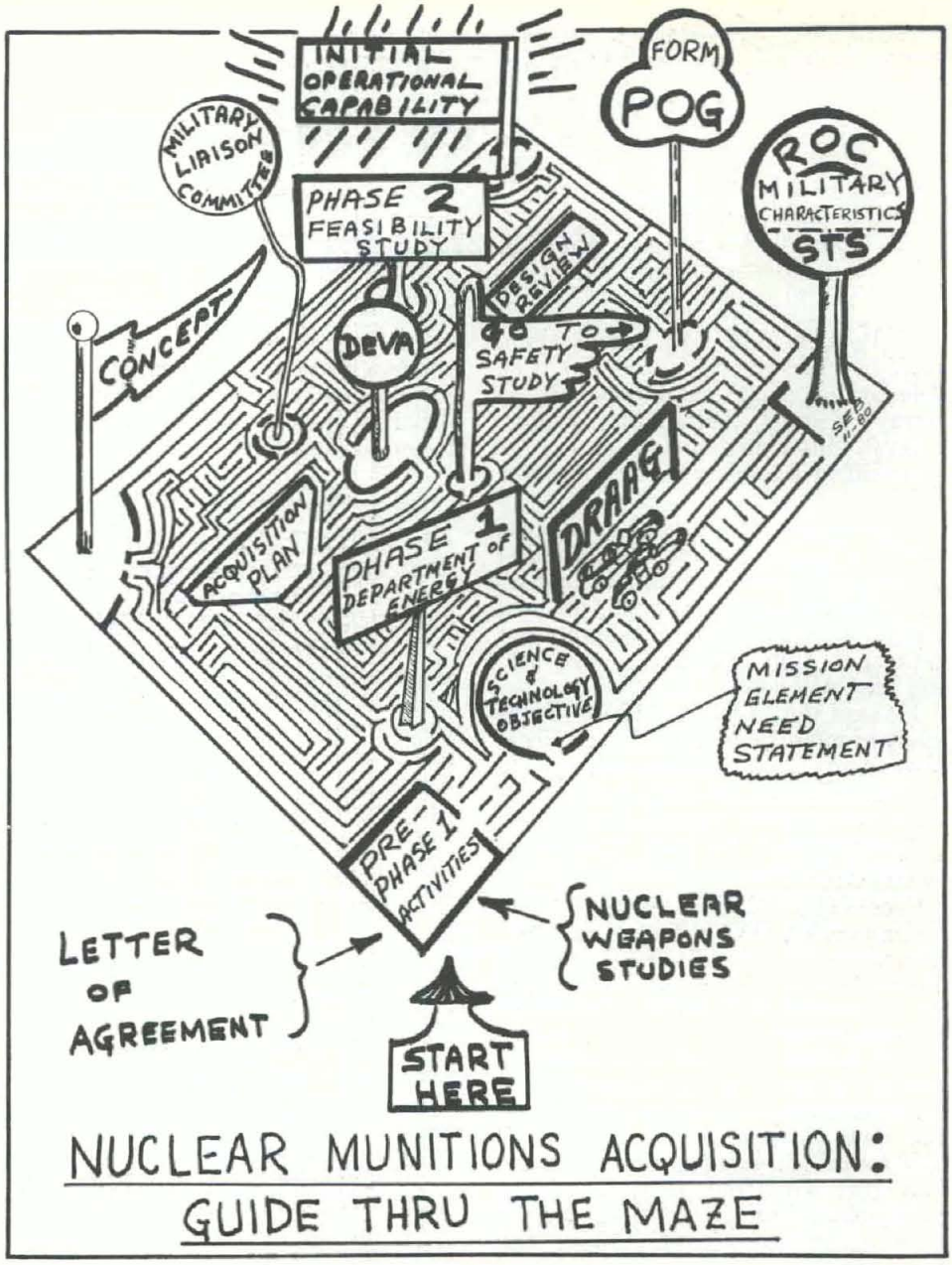
Nuclear munitions programs not only have to meet all the above, ... but they also have to dovetail with Department of Energy (DOE, - or for you old timers, the Atomic Energy Commission) phases for nuclear weapons. To add to the confusion, the DOE is a "name caller". It has its own names for Army terms, - as if the Army names are so easy?

BUT, - - TAKE HEART! We can successfully lead you thru the MAZE for nuclear munitions acquisition.

The U.S. Army Materiel Development & Readiness Command, Office of the Project Manager for Nuclear Munitions (PM-NUC) has published a guide to smooth the way. It's a pamphlet called *Life Cycle System Management Model For Army Nuclear Munitions.* It first appeared 28 February 1978 and was an immediate best seller in the nuclear community. Revision two was issued in July 1978 and Revision three is presently being prepared to be consistent with recent regulation up-dates.

Objectives of the *Life Cycle System Management Model* (LCSMM) *For Army Nuclear Munitions* are to:

- Outline the general procedures for development and acquisition of Army nuclear munitions from materiel concept investigation through the ultimate disposal of obsolete systems.
- Provide a basis for supporting models and publications.
- Provide a convenient outline for checking the completeness of coordination and correlation of: combat development, research and development, production, product assurance and test activities, logistic support, training and personnel requirements, and among: Department of Army (DA), Department of Defense (DOD), and Department of Energy (DOE) relating to the development, acquisiton and maintenance of Army nuclear munitions.



The pamphlet uses the LCSMM presented in DA Pamphlet No. 11-25 for standard Army materiel and adapts it for use with nuclear munitions. In other words, it superimposes the nuclear munitions phasing onto the existing LCSMM.

Right up front, in Appendix A, the pamphlet provides a list of abbreviations to help the reader keep up with the ever changing alphabet soup. For recent changes, it keys in the new terminology.

To help in locating specific events, or to aid in cross referencing, Revision three will include a numerical listing of events and an alphabetical listing of events in Appendix A. To help keep track of the meanings of terms, an explanation is provided in Appendix B.

Another goody, to help you thru the maze, is a list of references. All directly applicable regulations, directives, pamphlets, military standards, technical manuals, memoranda of agreement, etc., including revision dates, are listed in Appendix D. These references are keyed in the detailed descriptions for each event discussed in the body of the pamphlet corresponding to each event block.

The LCSMM applies to Army nuclear munitions and displays events important to the progression of nuclear materiel throughout its life cycle. LCSMM provides a flow chart outlining the life cycle of Army nuclear munition acquisition from concept study to ultimate retirement (phase-out) and disposal.

The top portion of the model depicts the basic events, essentially as presented in DA Pamphlet (DAP) 11-25, for the purpose of decision making, documentation, and testing required to deploy a system.

The middle portion of the model depicts those events characteristic of nuclear munition programs. It relates the seven DOE nuclear munition acquisition phases to the five acquisition phases of DAP 11-25. The bottom portion of the model depicts the events associated with integrated logistic support and stockpile reliability.

As in DAP 11-25, the model is event oriented rather than time constrained. The size of any block or length of lines connecting consecutive events has no relation to event duration or the time interval between events. It is possible for some events to be bypassed by a responsible command or agency as long as the intent and continuity of the events is maintained.

Events can be bypassed when it can be demonstrated that sufficient information to support the decision-making process is available without that event. The numbering system applied to events is primarily for identification and only has a general relationship to the sequence of events.

The model incorporates the latest policy changes reflecting management having case-by-case flexibility, with emphasis on shortening the system development process. Thus, development test/operational test (DT/OT) I and validation are not required where technology is verified and the requirement is certain.

DT/OT III is no longer mandatory. Systems will normally proceed from successful completion of DT/OT II to production after a decision at the Development Acceptance In Process Review (DEVA IPR) or Army Systems Acquisition Review Council (ASARC) III.

A limited production option requiring DT/OT III is an exception and will require justification. Generally, systems will not proceed into production until DT/OT II has been successfully completed and the results justify the production decision.

The DARCOM Project Manager for Nuclear Munitions (PM-NUC) developed this pamphlet with the intention that it serve as a useful working tool in nuclear munition systems management. We hope we led you thru the maze successfully and you will delay finding a new career because you were getting swamped. Hang in There!!! It's not as bad as it looks!

If you'd like a copy - send request to: Commander, U.S. Army Materiel Development and Readiness Command, Office of the Project Manager for Nuclear Munitions, ATTN: DRCPM-NUC-A, Dover, NJ 07801. The AUTOVON is 880-3655.

SHELDON E. BLAUSTEIN is a project leader in the Materiel Acquisition Division of the U.S. Army Materiel Development and Readiness Command, Office of the Project Manager for Nuclear Munitions. He has a BEE from the College of the City of New York, and has extensive experience in nuclear and conventional weapon systems development and management.

Army Gets First DAS3 Production Models

The first three production models of the Decentralized Automated Service Support Systems (DAS3) were presented to the Army during recent ceremonies at the General Electric Space Center, King of Prussia, PA. A total of 179 of the units will eventually be produced.

Developed by the U.S. Army Computer Systems Command, Fort Belvoir, VA, the DAS3 is a commercial computer system installed in a military standard 10-ton semitrailer van. It is designed to provide combat service support for Army field units.

The heart of the system is a Honeywell Level 6 Model 47 minicomputer with disc and tape storage and video display terminals. The DAS3 replaces the 15-year-old National Cash Register (NCR 500) system for which spare parts are no longer available. The DAS3 is able to handle the same functions as the NCR 500 in a fraction of the time.

Under the current production schedule, 71 systems will be produced the first year, 72 systems the second year, and 36 the third year, according to LTC Neil J. Senkus, DAS3 project officer. There are also two contract options-which if exercised - could total 324 DAS3 systems, Senkus said.

Senkus added that the system will be produced and distributed at the rate of six per month. The U.S. Army Europe, will receive a total of 51, and in August or September, the Army will begin distributing the system in Korea and the continental United States. The DAS3 hardware will be fielded with the interim ADP system known as "Phonenix" until the DA Standard Direct Support Unit Supply System (DS4) is ready for fielding.

Improving Productivity Through Manufacturing Technology

By John Larry Baer

The following article originally appeared in the U.S. Army ManTechJournal.

United States defense firms are operating with a shortage of skilled personnel, aging equipment, and constantly growing requirements for occupational safety and health and for pollution abatement. They are facing accelerating competition from overseas by dedicated workers, new and efficient machinery, and growing export demand.

These problems can be offset by our improving productivity through development and use of the latest manufacturing technology concepts and principles, which are within our grasp through the Army's manufacturing technology program.

Manufacturing methods improvement has been the key to increased productivity since the beginning of the industrial revolution. However, a centralized Manufacturing Technology (MT) program for the defense establishment, as outlined elsewhere in this article, is less than 17 years old. In this brief review, we will cover the Army's approach to the objectives for the MT effort and summarize several of the most significant projects.

A major impetus for the Army's MT program came from the 1975 guidance of then Deputy Secretary of Defense Clements. His direction was for a centralized office to manage the transition from hand crafted development models to low rate initial production of all Army commodities by identifying and exploiting MT cost reduction opportunities.

Present program emphasis is on end item development - i.e., MT projects should be directed toward increased productivity of a specific item and only secondarily to more generic applications. However, spinoffs applicable to other commodities will obviously result.

The Army's MT Office provides the expertise for effective program management in all those areas listed. However, success of the program depends largely on the MT offices and project engineers in the field and their counterparts in industry. The generation of project proposals and the performance of MT projects-whether the fruit of Government engineers or the product of industry-are, however, only precursors to implementation.

Unless they are effectively utilized, the results of MT projects are like wax fruits in a basket-ornamental but not nourishing. However, just how well they are utilized is sometimes hard to determine. Like a wholesaler, the Army can usually trace the project only to the first buyer.

Working through the Industrial Base Engineering Activity (IBEA) and the Manufacturing Technology Advisory Group (MTAG), the Army is now attempting to document first applications and, through followup reporting, to trace additional implementations.

These reports will become a part of the Army's MT Management Information System. Here, industry cooperation in careful reporting and documentations of results become important. IBEA can only ascertain whether the technology transfer seeds have fallen on fruitful soil if industry acknowledges its utilization of these tax supported MT project results. Hopefully, readers of this article and those who will hear this message at many symposia will heed this call for implementation reports.

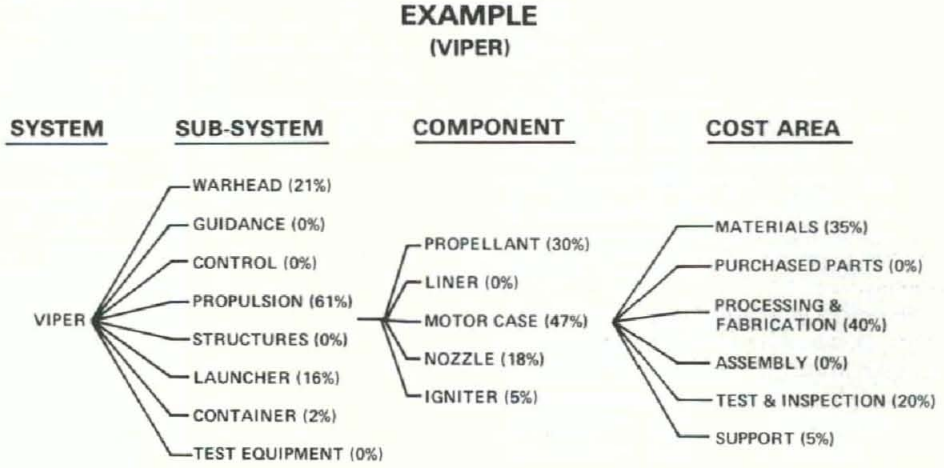


Figure 1

Along with the thrust away from extensive program planning review and toward greater emphasis on implementation, we must recognize that the MT program is evolutionary, not revolutionary. Resources cannot pour directly into improved producibility.

The real need is to assure our readiness for manufacturing military hardware from a warm or laid away cold base with minimum lead time and to reduce production costs for increasingly complex materiel in the face of shrinking budgets. However, the MT program faces serious restraints in safety and health regulations, pollution abatement requirements, and the urgent need to conserve energy and critical raw materials, frequently with less than skilled workers.

The Army's MT objective is to develop and implement manufacturing processes that emphasize energy efficiency, pollution abatement, and computer control. Although necessary, program improvements in safety, energy, and pollution hardly seem to be the stuff of enhaced productivity (the ultimate MT goal) or quantifiable cost benefit.

In most cases large savings are clearly evident and without many of these MT projects to date production could have been completely halted pending conformance to the appropriate regulations. Most savings in the manufacture of Army procured materiel have been achieved through the design or adaptation of special purpose equipment, processes, or material. A goodly amount, however, has resulted from reduction of needed resources, such as raw material, water, or energy. Let's consider some of the past programs.

Development of hot isostatic pressing for near net shape forming probably has the broadest application to the array of Army commodities supported through the MT program. Savings on the Army's T700 turbine engine alone are estimated at $3.7 million. As an extra benefit, these HIP'd parts have improved low cycle fatigue.

- An adjunct process, isothermal powder metal forging, has demonstrated threefold improvement in material utilization (and hence vast reduction in scrap) and has reduced the number of machining steps by 50 to 65 percent. As a result, 50 percent cost savings have been realized through MT programs for items from simple vehicle yokes to precision turbine blades and vanes. The potential for enhanced, low cost producibility with this process is limited only by the ingenuity of the designer and production engineer.
- In a completely different vein, consider a way in which water is saved through an MT project. The arrangement of effluent handling at Radford Army Ammunition Plant not only provided a nice cost avoidance because an $11 million water treatment plant didn't have to be built, but it cut daily water consumption tremendously — from 3.3 to 0.3 million gallons per line. Of course, it drastically curtails downstream pollution and, as an extra benefit, allows recovery and reuse of 32,000 pounds of salts that otherwise would have been washed down the river.
- Value engineering is an adjunct to MT efforts that is usually invoked on production processes. The luxury of cheap energy is a thing of the past; the profligate energy consumption in our country at a per capita rate twice that of European nations can no longer be tolerated.

We have neither the nonrenewable energy source to waste, nor can we recklessly pump the waste heat or its concomitant particulate and gaseous pollutants into the atmosphere. Whether through value

engineering or through novel MT adjustments to the manufacturing process, we must modify our ways in order to pass on a viable biospace to the next generation.

• Engineers at Watervliet Arsenal demonstrated that a little ingenuity can go a long way to replace the 40 hours of tedious hand filing needed to remove sharp corners in the bore of 152 mm cannon tubes with 2 hours of simple mechanical abrading, using nothing more than a glorified dentist's drill.

Similar automated finish grinding jobs, called benching, not only overcome such tedious hand work but also remove the health hazard created by the fine particulate generated as a gun breech block is honed to the fine fit demanded of it. For a project cost of $35,000, the total savings through 1977 were $2.5 million.

• As a result of an MT program at Rock Island Arsenal, the loads applied on artillery recoil mechanisms and carriages by live firing are now simulated with an impulse generator developed at a cost of $525,000. The load is applied by firing just $3 worth of propellant rather than $168-105mm or $256-155mm rounds. And the simulation of applied loads does more than save money and time.

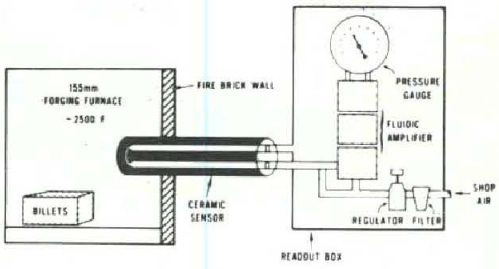
This arrangement, which has saved the Army some $12 million in the 8 years it has been in use, also does away with the need for having special ranges, for shipping the gun to such ranges and back for proofing, and for all the labor and paper work connected with such a procedure. Such large scale simulation, carried out to test the effectiveness of our production processes, has application in many areas.

• In another program, equipment was developed at a cost of $250,000 for automated inspection of precision fuze parts. This equipment can evaluate the precision with which fuze parts are made much more accurately and rapidly than the human eye ever could-and without fatigue and the deteriorating quality of inspection that goes along with it. It provides printouts of results and can be used for 100 percent inspection when needed. The technique is adaptable to a variety of parts and has already paid for itself many times over.

There are two areas where enhanced mechanization of production is critical to improving productivity. The first is in the manipulation of parts that are either so small as to try the manual skill of the artisan or so large as to require extensive power assist — as for example with large caliber gun barrels or tank hulls. The second is in areas where a cost driver analysis, as illustrated for the Viper missile in Figure 1, has identified a part as contributing a disproportionate percentage of total system cost.

Where size or complexity are not self evident justification for mechanization, a cost driver analysis will identify where MMT dollars can be wisely spent. With limited funds, we cannot afford to fritter them away on tasks of limited utility or marginal productivity increases.

Sensing various process parameters can be a critical part of a manufacturing process. However, sometimes even our mechanical aids, superior as they are to human senses, are no match for the pressures, stresses, and temperatures we must use to create the Army's materiel. Such is the case in measuring and controlling the heat input to smelting furnaces.



SCHEMATIC OF TEMPERATURE SENSING SYSTEM

PROJECT NO: 5794189

TITLE: HIGH FRAGMENTATION STEEL PRODUCTION PROCESS

COST: $100,000 ($100,000 FOR SENSOR)

BENEFITS

- ENERGY CONSERVATION
- IMPROVE QUALITY
- LOW COST CONTROL SYSTEM
- STABLE, LONG TERM PERFORMANCE
- POTENTIAL SAVINGS – 10% OF PROCESS ENERGY CONSUMPTION
- INCREASED SENSOR LIFE – 50:1

Fig. 2. DARCOM Prior Year MM&T Accomplishment Fluidic Temperature Sensing.

Conventional instruments give only crude estimates of the temperature in or near a molten bath or a tempering furnace and have time lags built in that preclude swift correction of unnecessary overheating. The simple fluidic high temperature sensor shown in Figure 2 overcomes those shortcomings. Using readily available shop air in a ceramic anulus, it provides virtually instantaneous measurements of furnace temperature. This allows rapid adjustment so that no more heat is provided than is absolutely necessary to treat the part or melt the pour.

Automation frequently lets us do things much more efficiently than we can do them manually. The automated tape layup (ATLAS) of helicopter blades is a case in point, resulting in a cost reduction of $19,000 per blade. During MMT development of this process, a flexible 6 degree of freedom machine was used to demonstrate the potential effectiveness.

The 2 degree of freedom machine ultimately used in production has all the necessary versitility to generate a blade with a life expectancy 10 times that of the hand laid up version. It also permits field repair of bullet holes or other damage and, by virtue of the smoother layup, generates more lift. These are unexpected, but very welcome, benefits of this automation applicable not only to helicopter blades but also to missile bodies and similar structures.

The same type of process used to lay up helicopter blades automatically, evenly, and smoothly is being considered to replace the pile hand layup for a helmet by the automated random laying up of the reinforcing fibres onto a matrix.

Merely by virtue of using a continuous fibre rather than cut strands, the helmet is expected to be not only more uniform, but materially stronger and more impact resistant for its weight than the hand laid up version.

A superior product is not always the driver behind MT projects. Sometimes it's the potential loss of certain skills in the labor force. Such a skill is reticle scribing in the manufacture of fire control instruments. Even with the pantograph, which permits simultaneous creation of 10 uniform reticles, a sneeze or hesitation that mars one part mars all 10.

In an MT program, a computer-controlled engraver was developed to do this job. Applicable to reticles for binoculars, periscopes, telescopes, and range finders, it saves 60 percent of preparation costs and 50 percent of labor costs. Automated scribing can do the job faster, more uniformly and more reliably — hence more efficiently than the fast disappearing craftsman.

Not only do we acquire greater productivity, we also generate a computer capability to fill in for the craftsman when he's sick, when he retires and there's no replacement, or, more importantly, if a sudden mobilization requirement overloads the available capacity.

Computer controlled manufacture on a much larger scale was developed during the Small Caliber Ammunition Modernization Program (SCAMP), which involved automation of the complete production, testing, and packaging facility. Automation, at a cost of $18 million, has eliminated over a period of 8 years the crude methods, the dirt, the waste, and the human wear and tear needed to make small caliber ammunition in the past.

SCAMP doesn't produce the small caliber ammunition as cheaply as predicted yet. But, when the rent and overhead have to be paid to produce 5 to 6 million rounds

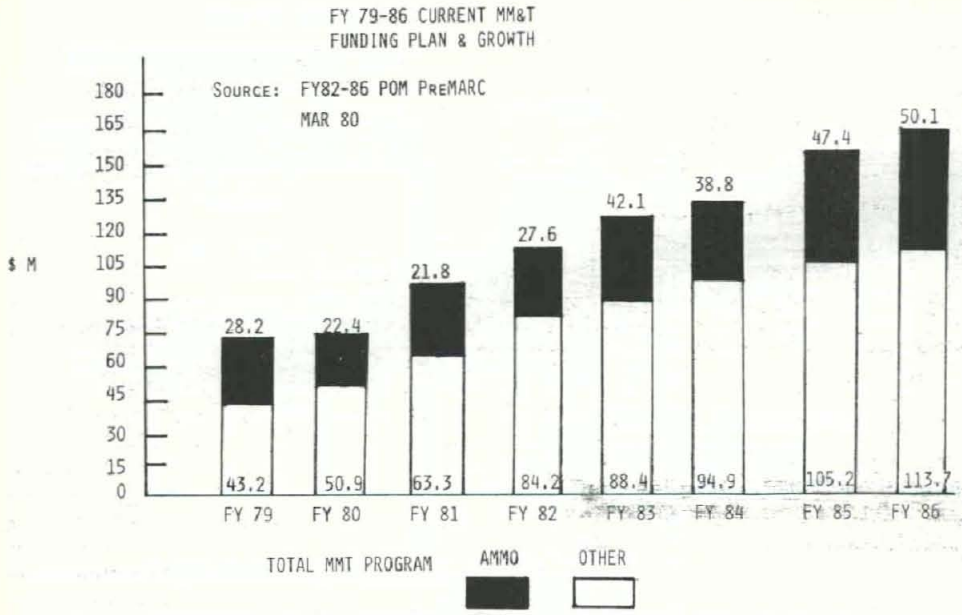


Figure 3

per month on a machine system designed to operate at a minimum rate of 7 million rounds, price has to be sacrificed until the system can be brought up to speed and is completely debugged. The productivity enhancement potential is irrefutable, with projected savings of $45 million over 10 years when the lines are fully operational.

This gives you some idea of the scope of Army MT efforts and the significant accomplishments to date. With the improved MMT project monitoring provided by the MT Management Information System at IBEA, the Army can now pay closer attention to tracking and implementing successful MMT projects and at the same time improve future planning.

The productivity growth picture, so dismal for the U.S. overall, is really fairly good in the manufacturing sector, which was able to boast an annual 1.7 percent growth rate for the years 1973-78. Even while the non farm business sector productivity has declined steeply, the productivity in the manufacturing sector of the economy managed to rise at an annual rate of 3.3 percent during the 3rd quarter of 1979.

It is factors like these that have caused foreign firms like SONY to build plants in the United States, citing as incentives, lower transportation and raw materials costs and lower utility and tax rates than in Japan as well as good worker productivity.

While Japan, France, Sweden, the United Kingdom, and Germany are fast approaching U.S. productivity at growth rates exceeding ours, they still lag behind our industrial productivity in terms of output per man-hour.

As indicated in Figure 3, the forecast for the Army MMT budget is one of modest increase commensurate with modest growth in procurement of military hardware. However, this budget will permit the funding of many worthwhile projects in both government laboratories and to a greater extent in private industry.

Peacetime savings over the next 5 years from MT projects already completed are estimated at $530 million. A few individual projects, like ATLAS, have projected 10 year savings that would pay for the whole MT program over the last 10 years.

An area that can be expected to impact on MMT is international technology transfer. The U.S. cooperates, and at the same time competes, with industries in friendly, allied and maybe even "unfriendly" or third world nations.

In an increasing number of areas, overseas industries have developed unique and often superior technologies that we have eagerly adopted or are obliged to use. Examples are the Austrian Rotary Forge, Swiss Conicell NC Purification system, and Swiss carbide hobs.

We must continue, for our national well being, to seek out and utilize the best foreign manufacturing technologies. At the same time, we have the moral obligation to share some of our technologies with our allies, while carefully scrutinizing and protecting critical technologies from inadvertent transfer to unfriendly nations through third country sales.

In summary, the Army's MT goals are consistent with Congress' and GAO's concerns: maintain close control on project selection and prioritization; follow up to ensure successful completion and utilization; and improve implementation and its documentation through the implementation plan.

An implementation plan and road map are now required with all P-16 project proposals to cover the activity up to and through the final implementation follow-up. The Army will work closely with industry counterparts through the Manufacturing Technology Advisory Group and all its subcommittees for a stronger free world and a more productive America.

JOHN LARRY BAER is leader of the Chemical and Mechanical Engineering Group in the Office of Manufacturing Technology, HQ U.S. Army Materiel Development and Readiness Command. He is a registered professional engineer and holds a bachelor's degree in chemical engineering from City College of New York, an MS in chemical and industrial engineering from Iowa State, and a master's degree in business administration from Temple University.

In Brief . . .

Gurthrie Reviews 1980 Productivity Growth

Commander of the U.S. Army Materiel Development and Readiness Command GEN John R. Guthrie was the keynote speaker at a Tri-Service Manufacturing Technology Advisory Group Meeting earlier this year. His presentation, which was themed on productivity growth in the 80s and its impact on the military and economic security of the U.S., follows in summary format.

GEN Guthrie opened his remarks by stating that the interdependence between industrial productivity and military and economic security, and their impact on U.S. international political standing, is more acute than ever before and will become even more so during the next 10 years.

He noted that as a defense establishment and as an industrial nation, the U.S. must commit itself firmly and quickly to redressing the military and economic imbalances that were allowed to develop in the 1970s.

We in the armed services, and particularly we in the Army, Guthrie said, need to simplify and define our requirements better. He added that there must be better identification of the major thrusts in defense research so that those in academia and industry can focus their research efforts.

The DARCOM commander stressed that there must be a strong focus in two areas: identifying precisely the elements and strictures of the military, social, and economic structures within which U.S. manufacturing is performed, and identifying the ways industry and the military, separately and together, can influence positively the productivity of American technology in an era dominated by human minds and computer electronics.

These two areas of focus were addressed this past summer, explained Guthrie, when the Defense Science Board met to develop specific actions to improve the degree of industrial responsiveness to military requirements.

The Defense Science Board indicated that the defense industry, in general, suffers from major under-capitalization (resulting from inflation, money costs, tax policies — in short, reduced profitability), from critical shortages of engineers and skilled workers, and from growing dependence on foreign sources for critical components such as semiconductors.

Additionally, the Defense Science Board found that increased costs for parts and labor, together with increases from longer lead times, are causing weapon system costs to rise at an annual rate of at least 20 percent. This is double the inflation factors used by DOD.

GEN Guthrie singled out two recommendations of the Defense Science Board which are directly related to the problem of productivity:

• First, the Board recommended that the DOD manufacturing technology program should be given increased emphasis in all the services by funding manufacturing technology to one percent of each services' procurement budget annually.

Guthrie indicated that he would prefer a funding level rise of two percent or even higher when special opportunities arise. Said he: "Whatever base percentage is finally agreed upon, that figure should represent a floor which should not be breached by DOD or any of the services."

The General added that while there is a lot of verbal support for manufacturing technology programs, there is a tendency, when money becomes tight, to withdraw from earlier commitments. This, consequently, is to the detriment of the Army, industry, and the nation as a whole.

• The second Defense Science Board recommendation is that the DOD phase out the "largely obsolete" government-owned machine tool base. More than 75 percent of all DOD owned metal working tools are now 20 years old — or older.

Guthrie indicated that he had mixed feelings regarding the phase out of the government-owned machine tool base. He explained that while the age of these tools cannot be disputed, the Army has been working steadily both to identify the tools that could be integrated into modern production lines and to rehabilitate them.

Specifically, the General noted that the Defense Industrial Plant Equipment Center remanufactures machine tools which, with the capabilities added, can be used on short notice in current production, thereby eliminating lead times and producing significant cost avoidances.

He emphasized that he did not advocate this as the solution to national productivity problems. However, he continued, with defense costs as high as they are and lead times getting longer, the government simply must achieve maximum return from taxpayer dollars.

GEN Guthrie emphasized that DARCOM is beginning to focus more of its productivity enhancing efforts in those areas where direct interaction with industry is possible. Our project managers, he said, are also stressing greater use of micro computers and integrated manufacturing systems to improve productivity.

He noted also that a portion of DARCOM's total manufacturing technology program is committed to engineering and "return on investment" analyses on which sound decisions can be made by industry to acquire (or defer purchase of) production equipment reflecting the latest available technology.

The DARCOM commander stated that he believed that the potential now exists economically, technologically, and psychologically for industry, both defense and non-defense, to begin to regain the productivity superiority that the U.S. once had in virtually all fields of manufacturing.

The Office of the Secretary of Defense and the services, he said, can help the move toward greater productivity by taking the lead in many areas, foremost of which are program stability, revisions in contracting policy to promote capital investment, and better forecasting of major areas of service interest so that industry and academia can more profitably direct independent research and development efforts.

Guthrie also called on industry and the academic community to continue to be willing to invest talent, time and treasure to help in revitalizing American manufacturing technology. Said he: "We cannot afford another decade like the 1970s where the number of men and women engaged in R & D and/or technical activity in America rose at an average annual rate of only 2.8 percent.

The General concluded his remarks by stating that productivity or its past decline in America should not be made a "moral issue" in which various segments of society blame others for what has happened. All of us, he said, are, to a greater or lesser extent, equally guilty.

Guthrie noted that the blame must be shared because some are guilty of demanding the final five percent capability of systems while incurring unreasonable cost and time delays; others are guilty for acceding to that demand and trying to meet it; some are guilty for insufficient planning; many are guilty for a reluctance to take even small risks and modernize at a reasonable rate; some are guilty of not developing a long-range strategy for America; and almost all are guilty for not encouraging procedures and products which provide equipment of equal performance and capability to that which we now have but at substantially reduced cost.

Conferences & Symposia . . .

Supply Assurance Stressed . . .

ADPA Conferees Examine DOD Energy Requirements

How is the energy crisis impacting on U.S. defense preparedness? This was the question posed at a recent seminar hosted by the American Defense Preparedness Association in Arlington, VA, and attended by representatives of the DOD, Department of Energy, other government agencies and industry.

Former Secretary of the Army Mr. Martin R. Hoffmann moderated the seminar and presented opening remarks. He noted that in the decade of the 70s, the U.S. received a number of energy surprises, such as the Mideast war, the oil cutoff, and the fall of Iran. He asked the following question: When are we going to stop being surprised?

Hoffmann predicted that there will be another energy crisis in the near future. The key question, he said, is how will we allocate petroleum in the event of an emergency? He also briefly discussed the new Economic Regulatory Administration and its potential impact on DOD.

Mr. William J. Sharkey Jr., Director of DOD Energy Policy, followed Hoffmann with a discussion of DOD energy requirements. He explained that petroleum is essential to military readiness and that the DOD has asked for legislation to let the Secretary of Defense waive certain rules in obtaining fuel during times of crises. Said he: "Our highest priority is supply assurance."

Sharkey noted that the DOD now has a supply assurance strategy. It consists of securing domestic crude sources; assuring procurement of domestic synfuels; improving the procurement process; and developing necessary regulatory tools. He added that the new Defense Production Act, which was activated in November, should help prioritization of fuel supplies.

Sharkey stressed that if fuel is disrupted in peacetime it is worse than if it is disrupted during a war. This is because during peacetime, the DOD often has its supplies diverted for civilian uses. He concluded by stating that contingency planning is a long and tedious process. The DOD needs a flexible, pragmatic approach to energy contingency planning, he said.

The U.S. Department of Energy system for addressing contingency energy planning was described in a presentation by Mr. Barton R. House, Deputy Administrator for Operations and Emergency Management, Economic Regulatory Administration.

House noted that in the past, energy planners were overly concerned with the "what if" instead of the "how to." Basically, he said, the DOE is trying to form a core group to do contingency planning. This core group would integrate all concerned elements and provide guidance to decision makers.

I have found, said House, that voluntary cooperative action rather than more regulations is the answer to good contingency planning. Regulations should serve only as boundaries for those who don't want to cooperate.

House noted that the DOE is actively working with a number of other organizations relative to energy planning. These groups include the National Petroleum Council, the American Petroleum Institute, the DOD, the National Academy of Engineering, and the National Association of Manufacturing. All of these groups, said House, must have some type of contingency energy planning.

A perspective of private industry to the energy crisis was provided in a brief presentation by Mr. Bonner Templeton, Vice President, Supply and Transportation, Mobil Oil Corp. He began by stating that the best way to deal with energy shortages is to permit the free market to operate as it should. Price and allocation controls foster too many special exceptions, he said.

Templeton indicated that what is really needed is an improved rationing program that can be implemented in 90 to 120 days rather than the proposed six months. A well managed rationing program, he noted, will reduce crude demand and demonstrate that price controls are not necessary.

Mobil Oil, said Templeton, has some concerns regarding the existing Defense Production Act and the new Economic Regulatory Administration's rule for giving crude oil priority to the DOD. Said he: "There is no need for giving priority allocation of crude to the DOD, and there will be no benefit from it. In fact, by exercising that provision the government could send the wrong crude to the wrong refineries and, thus, be as counter-productive as price and allocation controls."

The final speaker for the seminar was Congressman (NY) Samuel S. Stratton who presented a luncheon address on the shortage of petroleum for U.S. defense needs. He indicated that since half of U.S. petroleum is obtained from abroad, the DOD must be prepared for emergencies.

Congressman Stratton reported on some recent findings and recommendations of Congressional hearings on the energy shortage. Some of his major points were:

- Stocks of JP4 and FP5 fuels are dangerously low.
- All DOD petroleum products in general are dangerously low. One of the reasons for this is that industry often does not bid on filling government requirements because of the massive red tape they must go through.
- The DOD, itself, was found not to be overly concerned with the energy situation.

Among the Congressional recommendations cited by Stratton were: there should be a complete overhaul of government requirements regarding the purchase of fuel; there is a need for legislation to let DOD be first in purchasing fuel during emergencies; construction of facilities for storing war reserves abroad should be expedited; and that all production from the DOD's own oil fields at Elk Hill should be exclusively for the DOD.

ECOM Plans Frequency Control Symposium

Leading experts from industry, academia and government will consider frequency control state-of-the-art advances and solutions to problems during the 35th Annual Frequency Control Symposium, 27-29 May 1981, in Philadelphia, PA.

Sponsored by the U.S. Army Electronics R & D Command's Electronics Technology and Devices Laboratory, the symposium is considered one of the most important gatherings for the discussion of all aspects of frequency control and precision timekeeping.

General areas of discussion will include: properties of natural and synthetic piezoelectric crystals; theory and design of piezoelectric resonators; resonator processing techniques; filters; surface wave devices; quartz crystal oscillators and frequency control circuitry; laser frequency standards; and specifications and measurements.

Additional information on the Frequency Control Symposium can be obtained from: Lee Hildebrandt, DELET-MF, Army Electronics R & D Command, Fort Monmouth, NJ 07703. Autovon: 995-4805 Commercial: (201) 554-4805.

ARO Sets Review/Symposium at Wisconsin

A Topical Review of Computation and Analysis of Reacting Flows, and a Symposium on Transonic, Shock and Multidimensional Flows will be held 11-12 May 1981 and 13-15 May 1981 respectively at the University of Wisconsin - Madison.

The Topical Review will describe work, conducted primarily by Army scientists, on combustion, detonation and related subjects. This will be followed by the Symposium which will feature lectures by 15 experts in various fields of technological interest.

Additional Topical Review information may be obtained from Dr. J. Chandra, Mathematics Division, U.S. Army Research Office, P.O. Box 12211, Research Triangle Park, NC 27709. More information on the Symposium is available from Mrs. Gladys Moran, Mathematics Research Center, 610 Walnut St., Madison, WI 53706.

Capsules . . .

CERCOM, CORADCOM Consolidated . . .

New Communications-Electronics Command

The U.S. Army Materiel Development and Readiness Command (DARCOM) had announced establishment of a new command at Fort Monmouth, NJ, known as the U.S. Army Communications-Electronics Command (CECOM). It will be formed by consolidating the U.S. Army Communications and Electronics Materiel Readiness Command (CERCOM) and the U.S. Army Communications R & D Command (CORADCOM), both now collocated at Fort Monmouth.

The change will be effective 1 May 1981 but implementation will be phased over a period of time to hold turbulence to an absolute minimum. Total employment will remain at current combined CERCOM and CORADCOM manning levels. There will be no physical relocations of people from the Fort Monmouth area.

The new command will assume total management responsibility for communications electronic logistics support and materiel readiness now assigned to CERCOM and research, development and acquisition now assigned to CORADCOM. The commander will report to the commander, DARCOM, in Alexandria, VA.

The realignment will reportedly reduce indirect overhead costs, and permit better use of engineering and logistic talent. It will also facilitate the transition from development to production and operation of command, control and communication systems.

The merger of the two commands results from a continuing DARCOM review of its installations and agencies to use available resources in the best possible manner and to insure that Army manpower is used in an efficient cost-effective manner.

New Kit Detects Chemical Agents in Water

Advanced development of an improved chemical agent testing kit — which is designed to quickly detect chemical warfare agents in water supplies — has been announced by the U.S. Army Armament R & D Command's Chemical Systems Laboratory.

The compact, lightweight kit will reportedly detect hazardous levels of nerve, mustard, lewisite and blood agents quickly and easily. Troops will also be able to analyze water at temperatures ranging from 32 to 125 degrees Fahrenheit, using a newly designed enzyme-ticket in the XM272 kit.

Housed in a drop-and-shock-resistant case, the kit requires no power source, and contains simulants for each of the chemical agent classes so that senior personnel can train soldiers in the kit's use. It is expected to be used primarily by engineer and medical personnel.

Mr. Achille Silvestri, project officer for the kit development, has indicated that design testing will begin very shortly.

DOD Specifications To Go Metric in 1990

Under Secretary of Defense Dr. William J. Perry has established 1990 as the goal for converting specifications and standards to metric dimensions throughout the Department of Defense and within Defense contracts. Additionally, DOD's Acquisition Policy Office has published implementing guidelines entitled, "Guidance for Using Metric Units of Measurement in Preparing Standardization Documents."

Availability of such standardized documents is considered a key factor in the ability of DOD to use metric units in developing new design programs and in increasing the capability of U.S. industry to produce cost-efficient equipment — all in support of the U.S. Metric Conversion Act of 1975 (PL 94-168). In addition, metric conversion is expected to assist in the compatibility and effectiveness of U.S./NATO-produced weapons systems.

Contract Calls for New Tanker Mooring System

The Army will soon have a tactical mooring and off-loading pipeline system that is air-transportable and capable of handling tankers as large as 25,000 deadweight tons, according to a recent announcement from the U.S. Army Mobility Equipment R & D Command, Fort Belvoir, VA. A $3.39 million contract has been awarded to Ocean Search, Inc., Lanham, MD, for the fabrication of two such systems.

The Multileg Type Tanker Mooring System, developed by MERADCOM, is designed to unload bulk liquid fuel from tankers over undeveloped beaches, where port facilities are unusable due to battle damage or natural disaster. All mooring and support equipment can be delivered by C-130 transport planes and the system can be installed in 72 hours.

Each leg of the Multileg Mooring System is a packaged unit incorporating a high holding power explosive embedment anchor. The system also includes buoys, boat launching and recovering equipment, motor surf boat, underwater survey equipment and tanker unloading equipment.

Mooring sites can be located up to 5,000 feet from shore, and the ships will discharge their bulk fuel through submarine pipelines to onshore storage facilities. The new system can be deployed rapidly, and offers quick and easy installation, rapid off-loading capability and maximum mooring reliability.

The tactical mooring system gives the Army the capability to quickly establish a marine terminal in an unimproved area to assure adequate fuel supplies for troop deployment and sustaining operations.

Paper Describes Antitank Mine Problems Solutions

Two scientists at the Army's Ballistic Research Laboratory (BRL), Aberdeen Proving Ground, MD, have published evidence of a new method to get troops under fire safely through a mine field.

Mr. Andrew Mark, of BRL's Launch and Flight Division, and Mr. Charles Kingery, who is assigned to the Terminal Ballistics Division, collaborated on the paper, "Predicting Blast Activation of M15 Anti-Tank Mines" in which they outline some solutions to ballistic problems involving antitank mines.

Pointing out that fuel-air and dust explosives are just two of the newest countermine threats, both scientists agree that breaching a minefield under fire required an efficient, fast-moving method.

To prepare the report, the research team used a theoretical technique to predict how mines react to various kinds of pressure. Their approach combined mathematical modeling with experimental data gathered from tests conducted with BRL's shock tubes, to determine how a mine will react when subjected to blasts created by an explosive cloud or line charge.

Subsequently, the scientists would like to provide data that allows hardening of U.S. antitank mines to prevent effective clearing by the enemy.

They point out that this could be a favorable spinoff, creating the kinds of blast pressures that could in turn defeat the enemy's own mines.

MERADCOM Orders More Water Purification Units

The U.S. Army Mobility Equipment R & D Command (MERADCOM), Fort Belvoir, VA, recently exercised a contract option with Univox-California for the production of 11 more 600-gallons-per-hour Reverse Osmosis Water Purification Units.

The contract, originally awarded in fiscal year 1980, now calls for a total production of 41 units at a cost of 14.77 million. Univox made initial delivery in November, and the unit has undergone first article testing. When available in the field, the ROWPU will do the work now performed by four different purification processes.

The reverse osmosis water purification system uses spiral-wound membranes to treat fresh, brackish or saline water and to decontaminate the water. Each unit is capable of producing up to 600

gallons of pure water per hour from brackish or polluted water, and up to 400 gallons per hour from salt water.

Unlike commercial units, the MERADCOM-developed reverse osmosis elements can be wet, dried out and re-wet several times without damage. The membrane can also be frozen and thawed without hampering its desalination capability. These features are of paramount importance to military units that must be ready to operate in all types of weather, all over the world.

$54 Million Awarded for Mortar Locating Radars

A contract for almost $54 million has been awarded to Hughes Aircraft Co., Fullerton, CA, for production of 48 AN/TPQ-36 mortar locating radars. In awarding the contract, the Army Electronics R & D Command exercised an option to the original 1978 contract of $106 million for production of the highly mobile radars.

The fully automatic battlefield radar relies on the speed and precision of a minicomputer to search out hostile weapons. Scanning the horizon with a pencil-shaped beam so quickly that an electronic curtain is dropped over the sector covered, the device greatly increases the early warning capability for front-line troops.

The radar is believed to be the first designed for use by ground troops. The TPQ-36 has been live-fire tested at Yuma Proving Ground, AZ, and it is expected that the equipment will be added to the Army inventory later this year.

Tobyhanna Getting Electrical Surge Arresters

Limited initial production units of F1483/G electrical-surge arresters are in the process of being delivered to Tobyhanna Army Depot, PA, according to a recent announcement from the U.S. Army Electronics R & D Command's Harry Diamond Laboratories.

Under development since 1976, the electromagnetic pulse arrester (EMP) hardens telephone circuits, typical in multichannel radio terminal sets, against high-altitude nuclear electromagnetic pulse threats. It achieves this by forcing most of the energy into the ground and reflecting the remainder into the field wires to be dissipated.

Mounted in modified S-280 shelters, the sets provide the Army with basic integration of radio, pulse-code modulation, and voice-grade (telephone) communications. The arrester, which was successfully tested in shelter-mounted sets at Tobyhanna, is believed to be the first EMP arrester to be given full Army logistics support.

Moving - Being Transferred?

To ensure continued receipt of the magazine, persons, both Active and Reserve, who are authorized individual copies, should give timely notice of their new address. Instructions on where to send address corrections are given on the inside of the front cover. DO NOT SEND CORRECTIONS to the magazine editorial office, as mailing labels are provided to the magazine by the agencies mentioned in the instructions. Change of address must be given to your duty station military personnel office. Regulations also require that you receive the magazine at your duty station address, not your home.

Awards...

ETDL Selected as Army Lab of the Year

The Army's top award for 1980 Laboratory of the Year has gone to the Army Electronics Research and Development Command's Electronics Technology and Devices Laboratory (ETDL). Presenting the award to Dr. C.G. Thornton, director, ETDL, was Dr. Joseph Yang, Deputy Assistant Secretary of the Army for Research, Development, and Acquisition.

The selection of ETDL was made by the Army Science Board, based on several criteria involving program accomplishments, people management and development, management initiatives and accomplishments, fiscal obligations performance, and significant improvements. Thirty-five Army research and development laboratories throughout the U.S. competed for the honor. This is the first time ETDL has recieved this recognition.

Among ETDL's recent accomplishments are innovative devices for new millimeter wave systems (lightweight 2.5 kW 95 GHz amplifier for RPV and air defense radars, 10-lb 94 GHz pulsed radar transceiver, binocular radio); high-density, high-speed, 4k static RAMS for advanced communications systems; high shock-resistant precision quartz crystals for ground, airborne and satellite applications; high-energy density, all-weather lithium batteries for man-pack communications and weapons applications in the Army; synthesis of the highest purity built gallium arsnide ever obtained for microwave field effect transistor substrates; and efficient infrared emitters for airborne countermeasure service.

The Army has also charged ETDL with the responsibility for operational management of its very-high-speed integrated circuit (VHSIC) program, part of a DOD effort to take a major step forward in microelectronics technology for military applications.

3 Receive Outstanding Civilian Service Medals

ARMY SCIENCE BOARD members (left) Dr. J. Ernest Wilkins Jr., Dr. Phil E. DePoy, and (far right) Robert M. Lockerd, with Under Secretary of the Army, Dr. Robert H. Spiro Jr.

Distinguished contributions to the Department of the Army were recognized recently when Under Secretary of the Army, Dr. Robert H. Spiro Jr., presented Outstanding Civilian Service Medals to the chairman, vice chairman, and a member of the Army Science Board.

The Army Science Board, which is comprised of a maximum of 90 members from industry, academia, private research and consulting agencies, and former government officials, advises the Secretary of the Army and Chief of Staff on RD&A matters.

Dr. J. Ernest Wilkins Jr., chairman of the Army Science Board since its formation in 1978, and deputy general manager of EG&G Idaho, Inc., received the Outstanding Civilian Service Medal for superior technical expertise and outstanding organizational abilities which provided for a cohesive, multidisciplinary group.

He was also credited for his personal participation in numerous activities, including the Chemical Decontamination Subgroup; a review of Military Computer Family; the Ballistic Missile Defense Panel; Summer Studies of 1978-80; participation on the ammunition panel; and advisory visits to Panama and Alaska.

Dr. Wilkins holds PhD, MS, and BS degrees, all in mathematics, from the University of Chicago, and BME and MME degrees from

New York University. His professional memberships include the American Association for the Advancement of Science, American Mathematical Society, Mathematical Association of America, and the Optical Society of America.

Dr. Phil E. DePoy, vice chairman of the Army Science Board, and director, Operations Evaluation Group, Center for Naval Analyses, was presented with the Outstanding Civilian Service Medal for contributions in both managerial and technical fields.

DePoy was specifically recognized for his assistance in developing and implementing the founding principles of the Army Science Board and for providing guidance relative to its missions, organization, and activities. He also prepared special newsletters outlining current and future Board activities.

Additionally, DePoy was cited for his chairmanship of a panel which reviewed Radford Army Ammunition Plant accidents; chairmanship of a review group which examined Army electronic/mechanical time fuze decisions; and chairmanship of the 1980 summer study, Statistical Techniques in Testing.

DePoy received his PhD in chemical engineering from Stanford University, his MS in nuclear engineering from the Massachusetts Institute of Technology, and his BS in chemical engineering from Purdue. He is a member of the Operational Research Society of America, and the NATO System Science Panel.

Mr. Robert M. Lockerd, a member of the Army Science Board and its predecessor organization since 1970, and chief engineer/manager, Advanced Technology Division Equipment Group, Texas Instruments, Inc., received the Outstanding Civilian Service Medal for achievements resulting from his participation in the command and control systems Ad Hoc Sub-Group, the Joint USAF/USA Summer Study, and the High Technology Light Division Summer Study.

Lockerd was also recognized for his assistance and counsel relative to studies of LORAN Manpack, HAVE NAME, Logistics, Counter-battery Radar, the 1976 Summer Study on future Scientific and Technical Objectives, Single Program Element funding, and Telecommunication Forecast.

Graduated with an MS degree in mechanical engineering from Yale University, Lockerd also holds BA and BS degrees in electrical engineering from Rice University. His memberships include the Institute of Electrical and Electronics Engineer, and the American Association for the Advancement of Science.

Lebegern Receives BRL's 1980 Kent Award

Mr. Charles H. Lebegern, an internationally recognized authority on ballistic firing tables, has been awarded the 1980 R. H. Kent Award by the U.S. Army Armament R & D Command's Ballistic Research Laboratory (BRL).

Established in 1956, the award honors BRL's most prominent scientific leader, the late Dr. Robert H. Kent. It is the highest commendation made annually by the laboratory to recognize distinguished professional achievement in the scientific or engineering fields.

Lebegern, who is chief of the Firing Tables Branch of BRL's Launch and Flight Division, was chosen in recognition of his immense influence in the science of firing tables on laboratories and military activities in the U.S. as well as throughout the NATO and the entire artillery community of Western European armies.

A member of the BRL staff since 1950, Lebegern serves as consultant in mathematical methodology, delivery accuracy and state-of-the-art of U.S. Army weapon systems.

He also chairs the NATO panel on accuracy, ballistics and chemistry of surface-to-surface artillery and has made many exceptional contributions to the interoperability of artillery weapons used by NATO nations.

In addition, Lebegern led the effort to assess the ballistic similarity of artillery projectiles firing by NATO nations and developed simple procedures which will permit NATO gunners to fire foreign ammunition using national techniques.

Since 1967, he has served as chairman of the steering committee of the Joint Munitions Effectiveness Manual, Surface-to-Surface, a group initiated by the Secretary of Defense to provide simple comprehensive interservice source of effectiveness information on the non-nuclear, surface-to-surface inventory.

Personnel Actions . . .

McCorkle Directs MICOM Missile Laboratory

Dr. William C. McCorkle

Dr. William C. McCorkle was selected to be technical director and director of the U.S. Army Missile Command's Missile Laboratory, Redstone Arsenal, AL.

McCorkle, a major figure in Army missile and rocket programs at Redstone since the late fifties, succeeds COL Robert J. Feist, acting director who will remain as his deputy.

MICOM's Army Missile Laboratory is composed of several laboratories covering a broad spectrum of research and development activities, ranging from basic research and production engineering to missile improvement programs and support of fielded weapons.

Since coming to Redstone in 1957, McCorkle has filled several scientific and engineering positions, including assignments as director of the Advanced Systems Laboratory and more recently, director of the Systems Simulation and Development Directorate.

During 1974-75, McCorkle was science advisor to the Director of Weapon Systems, Office of Chief of Staff for Research, Development and Acquisition.

He holds several patents for guidance systems, and has a BS degree in physics and math from the University of Richmond, and a doctorate in physics from the University of Tennessee.

ARRADCOM Names Mathis as BRL Commander

COL Robert N. Mathis

COL Robert N. Mathis, a veteran of more than 22 years of active military service and former chief of the Armament Concepts Office, U.S. Army Armament R & D Command (AARADCOM), has assumed duties as deputy director and commander of ARRADCOM's Ballistic Research Laboratory.

A graduate of the U.S. Military Academy, COL Mathis has a master of science degree in physics from Tulane University, and has completed requirements of the Artillery School, the Command and General Staff College and the Defense Systems Management College.

He served as inspector general of the Eighth Infantry Division, Bad Kreuznach, Germany, from 1977-78, prior to his assignment as project coordinator of the Army's DIVAD Gun Project Office at the AARADCOM headquarters, in Dover, NJ.

COL Mathis has served at Fort Sill, OK, at Fort Bliss, and Fort Hood, TX, at Fort Benning, GA, and in El Monte, CA. Key assignments have also included assistant professor of physics at West Point and battalion commander of the 1st Battalion, 59th Air Defense Artillery of the 8th Infantry Division, Germany.

His military honors include the Bronze Star Medal with Oak Leaf Cluster (OLC), the Meritorious Service Medal with two OLC, the Army Commendation Medal with two OLC, and the Vietnam Cross of Gallantry.

Horvath Heads DARCOM Public Affairs Office

COL Richard L. Horvath, former chief, Print Media Branch, Command Information Division, Office, Chief of Public Affairs, DA, has assumed new duties as chief of Public Affairs, U.S. Army Materiel Development and Readiness Command, Alexandria, VA.

Graduated from the University of Detroit with a BS degree in journalism in 1956, COL Horvath has also completed courses at the Defense Information School, and has completed requirements of the Army Command and General Staff College.

His previous assignments have included tours at HQ, Fourth U.S. Army, Fort Sam Houston, TX; 101st Airborne Division, Vietnam; HQ U.S. Army Base Command, Ruykyu Islands; and U.S. Army Readiness Region V, Fort Sheridan, IL.

COL Horvath is a recipient of the Bronze Star Medal with "V" device and Oak Leaf Cluster (OLC), Meritorious Service Medal with OLC, Air Medal with OLC, and the Army Commendation Medal with three OLC.

Baldwin Becomes Command/Control Deputy PM

LTC E.R. Baldwin, Jr.

LTC (P) Edward R. Baldwin, Jr., has assumed duties as deputy project manager for Command and Control Systems, U.S. Army Communications Systems Agency/Project Manager DCS (Army).

He is a graduate of the U.S. Military Academy and has earned an MS degree in electrical engineering from the University of Arizona and an MBA in industrial engineering from Fairleigh Dickinson University.

Baldwin's military education includes the Army Signal School (Basic) Course, Artillery School (Advanced) Course, Army Command and General Staff College, Army War College, and the Defense Systems Management College (Program Manager Course).

Listed among his key assignments are project officer, Management Information Systems Directorate, Office of the Chief of Staff of the Army, HQDA; and commanding officer, 34th Signal Battalion, VII Corps.

His decorations and awards include the Legion of Merit, four awards of the Meritorious Service Medal, and two awards of the Army Commendation Medal.

Barmore Named Transmission Systems Deputy PM

LTC F.E. Barmore, Jr.

LTC (P) Frederick E. Barmore, Jr., has been assigned as deputy project manager for Transmission Systems, U.S. Army Communications Systems Agency/Project Manager DCS (Army). He is responsible for management of electronic transmission systems in support of DOD deployed forces.

Graduated from Drexel University with a BS in electrical engineering in 1959, Barmore earned an MS in systems management from the University of Southern California in 1974. His military education includes: Airborne School; signal officer basic and signal officer career courses; R & D Management course; Command and General Staff College; and Program Management Development course.

Listed among Barmore's key assignments are: plans officer, USARV ACSC-E, Vietnam; plans/programs officer, USARPAC DCSC-E, Fort Shafter, Hawaii; C-E staff officer, Data Communications Division, Defense Communications Agency, Washington, DC; and operations research analyst, Joint Tactical Communications (TRI-TAC) Office, Fort Monmouth, NJ.

His decorations and awards include a Bronze Star with Oak Leaf Cluster (OLC), Meritorious Service Medal with OLC, Joint Service Commendation Medal, Army Commendation Medal and the Parachutist Badge.

Career Programs . . .

Denoncourt Chosen for Executive Training

Mr. Gerard H. Denoncourt, a materials engineer at the Army Armament R & D Command's Chemical Systems Laboratory, has been selected for a 6-month executive training program.

Assigned since 1974 to the Respirator Section of CSL's Physical Protection Division before his selection as the 38th trainee to participate in the executive program, Denoncourt will complete a 3-month tour in the CSL headquarters before a similar stint at the Army Materiel Development and Readiness Command headquarters in Alexandria, VA.

He graduated from Northeastern University in 1959 with a bachelor's degree in chemical engineering and was commissioned a second lieutenant in the Reserve Officers Training Corps. He served as an officer at Dugway Proving Ground until 1962 when he received a civilian appointment as a chemical engineer.

In 1965 he was assigned to Edgewood Arsenal until 1970 when he was employed by the Army Test and Evaluation Command at Aberdeen Proving Ground as a general engineer until 1974.

A member of the Society of Plastics Engineers, Denoncourt serves as a lieutenant colonel in the 2071st U.S. Army Reserve School in Owings Mills, MD.

Microbiology Academy Elects Houston as Fellow

LTC William E. Houston

LTC William E. Houston, deputy commander of the U.S. Army Bio-medical Laboratory, Aberdeen Proving Ground, MD, was recently elected a Fellow in the American Academy of Microbiology (AAM). The AAM is the professional services arm of the American Society of Microbiologists.

A research microbiologist, LTC Houston served as executive officer with the Army Institute of Infectious Diseases from 1978 to 1979, and with the Army Medical R & D Command in the Office of Biology and Disease Control from 1976 to 1978.

He received his PhD in microbiology, molecular biology and bio-chemistry from Vanderbilt University, and has completed the Command and General Staff College, the AMEDD Advanced Officer Course, Mass Casualty Management Course, and a DA labor relations course.

Additionally, LTC Houston has authored numerous scientific articles, technical reports and staff position papers and has served on national committees of the National Registry of Microbiologists and the American Society of Microbiologists.

Listed in American Men and Women in Science, he is also a member of the American Society of Microbiologists, National Registry of Microbiologists, New York Academy of Science, and Sigma Xi.

Battelle Forecasts $68.6 Billion for 1981 R&D

Federal Government funding for R & D during calendar year 1981 is expected to be about $33.7 billion, an increase of 14.0 percent from 1980. This represents 49.1 percent of the total 1981 national R & D projection of $68.6 billion.

Industrial funding for 1981 is forecast to be $32.4 billion, up 12.9 percent from 1980. This sector will account for 47.2 percent of the total R & D funding. Funding by academic institutions is projected at $1.4 billion (2.1 percent of total), and nonprofit organization at $1.1 billion (1.6 percent).

These R & D estimates were prepared by Dr. Jules J. Duga, with assistance from Dr. Halder Fisher of the Department of Resource Management and Economic Analysis at Battelle's Columbus (OH) Laboratories. Data were drawn from numerous sources, including the National Science Foundation Reports, and the McGraw-Hill Annual Survey of Business Plans for R & D Expenditures.

The 1981 national R & D estimate of 68.6 billion represents an increase of $8.2 billion (13.7 percent) over the $60.4 billion that the National Science Foundation estimates was to be actually spent for R & D in 1980. While most of the increase will be absorbed by continued inflation, Battelle forecasts a real increase in R & D expenditures of 3.8 percent. This is slightly higher than the 7-year average rate of 3.4 percent in real R & D effort that has been experienced since 1973.

While the federal government continues to be the dominant *source* of research funds, industry remains as the *dominant performer*. In 1981, performance of R & D by industry is expected to rise to $48.0 billion, or 70.0 percent of all research performed. This compares with $9 billion (13.1 percent) for the federal government, $9.1 billion (13.3 percent) for academic institutions and $2.5 billion (3.6 percent) for other nonprofit organizations.

The Battelle forecast notes that federal funding supports research performance in all four sectors. Currently, about one-fourth goes to support R & D conducted by the government itself; almost half goes to industry; approximately one-fifth goes to colleges and universities; and the rest, less than one-twentieth, goes to other nonprofits.

Industry absorbs almost all of its own funds, either performing the R & D itself or contracting with other industrial performers. Its contracts and grants to colleges and universities slightly exceed those of other nonprofit institutions. Other nonprofits finance both themselves and the academic institutions about equally; colleges and universities use up all the funds they originate.

Four government agencies dominate the federal R & D scene and are expected to account for 86.7 percent of total federal R & D funding in 1981. These are the Department of Defense, 45.0 percent; the National Aeronautics and Space Administration, 15.7 percent; the Department of Energy, 15.1 percent; and Health and Human Services, 12.1 percent.

The forecast notes that national security, reflected in the Department of Defense budget, is a principal force in furthering R & D spending. Also, the continuing emphasis on energy, and the associated problems of balance of payments and insecure resources, will result in increased efforts in the research, development, demonstration, evaluation, and diffusion of new energy technologies.

Additionally, it is anticipated that R & D funds will continue to support the biological and "soft" science areas; educational research directed toward support of expanding technical areas; "impact" research that covers environmental, ecological, and socio-economic consequences of technological or related actions; and research on methods to comply with regulations.

Industrial support of research is growing in fields affected by regulations and in those fields most directly influenced by the need for more energy-efficient products and processes. R & D will be heavily self-funded in the manufacturing industries, where on the average, only 32.9 percent of the total will be supported by the federal government. The non-manufacturing industries do relatively little R & D, and support for this activity will be divided almost equally between federal and industrial support.

As part of the forecast, Battelle estimated the industrial versus federal support for the R & D performed by several broad industrial sectors. In 1981, Battelle expects electrical machinery and communications to be the industrial manufacturing sector leader in total R & D, with total funding support of nearly $10.8 billion. Of that, 56 percent will be industrially funded. The aerospace industry is forecast to have the second largest total R & D support with more than $9.8 billion. Of that, 19.9 percent will be industrially funded.

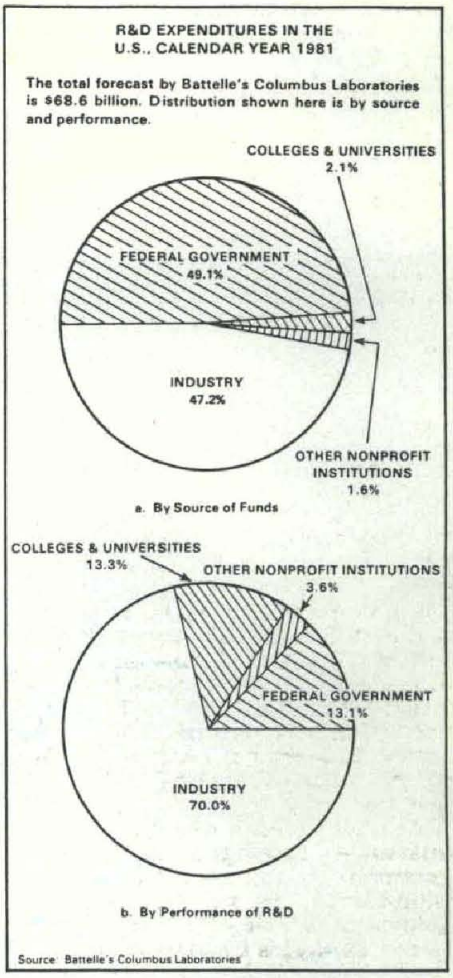
Other industrial sectors Battelle estimates will receive more than $1 billion in R & D funds include: machinery — $6.7 billion, 89.4 percent of which will be industrially funded; autos, trucks and parts, and other transportation — $5.1 billion, 90.4 percent of which will be industrially funded; chemicals — $5.3 billion, 89.5 percent of which will be industrially funded; professional and scientific instruments — $2.3 billion, 91.3 percent of which will be industrially funded; and petroleum products — $1.8 billion, 82.8 percent of which will be industrially funded.

The Battelle report also compares the four performing sectors in terms of their relative costs of R & D. From 1972-1981, costs of all R & D, as an average, are estimated to rise by 84.7 percent. Increases in the individual performing sectors are expected to be: federal government, 92.4 percent; industry, 79.5 percent; colleges and universities, 104.7 percent; and other nonprofits, 94.3 percent. During 1981, the overall cost increase for all R & D is estimated to be 9.9 percent. By sectors, the increases are estimated as government, 13.7 percent; industry, 9.2 percent; colleges and universities, 10.2 percent; and other nonprofits, 9.5 percent.

In addition, the forecast discusses the impact the new Administration and changes in congressional leadership are likely to have on R & D expenditures in 1981. According to the report, it is anticipated that the new Administration's posture relative to business and industry may provide an atmosphere more conducive to industrial R & D. In particular, greater efforts will be directed toward both short-term and long-term R & D aimed at an improved competitive position vis-a-vis foreign competition. Furthermore, there are indications that industry may judge the overall government attitude to be more conducive to increased business profitability, causing industry to increase investment in R & D.

In this connection, however, any new initiatives proposed by the incoming Administration and Congress in 1981 would not have noticeable impact until at least 1982, and therefore would not affect this year's forecast significantly.

In addition, the report says leadership changes should encourage greater efforts in those R & D areas to which the major portion of present federal support is committed. Even modest increases in defense, aerospace, electronics, and energy research — all deemed to be particularly important by the new Administration — should more than offset decreases in most other directions.



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Headquarters
U.S. Army Materiel Development & Readiness Command
5001 Eisenhower Avenue
Alexandria, VA 22333

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