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NOVEMBER - DECEMBER 1993

Aviation

Automotive

Environment

DUAL-USE TECHNOLOGIES

Food Technologies

Optoelectronics

Manpower & Personnel

Medicine

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Research Development Acquisition

ARMY RD&A BULLETIN

Professional Bulletin of the RD&A Community

FEATURES

Dual Use Special

DEPARTMENTS

★ ★ ★ **SEE IMPORTANT NOTICE ON PAGE 56** ★ ★ ★

COVER

This issue highlights the subject of dual-use technologies—those technologies having both military and commercial applications. Included are articles on aviation, medicine, food technology, the environment, manpower and personnel, space, and automotive technology.

ARMY/NASA JOINT AGREEMENT: THREE DECADES OF DUAL-USE AVIATION TECHNOLOGY DEVELOPMENT

Part I: History and Mechanics

By Robert V. Kennedy

Editor's Note: The following is the first of a two-part article on Army aviation dual-use technology. The second part begins on page 5.

Introduction

We are clearly entering the era of dual-use technology development. All three services are now focusing on technologies that have benefit to both the military and civil markets. Army aviation, however, has been in the business of dual-use technology development for three decades.

Under a unique agreement, initiated in 1965, between the U.S. Army Materiel Command (AMC) and NASA, the Army established three aviation research and development laboratories at NASA's three aeronautics centers. Since the agreement's inception, the Army and NASA have participated in joint research and development to their mutual benefit. Cooperative and integrated research efforts, shared resources, and close physical proximity have fostered the development of technologies in aeromechanics, human-machine integration, structures and materials, and propulsion that have had and continue to have both military and civil application.

The agreement, that has made this natural dual-use technology development a reality, has become known simply as the Army/NASA Joint Agreement.

Discussion of the Army/NASA Joint Agreement will be presented in two parts. Part I focuses on the history and fundamental nature of the agreement. The founding premise, the spirit, and the mechanics of the agreement will be discussed all within the context of dual-use technology development. Part II focuses on both the dual-use technology development successes resulting from the Army/NASA Agreement, as well as the potential further exploitation of the agreement.

Background

In the early 1960s, with the build-up of

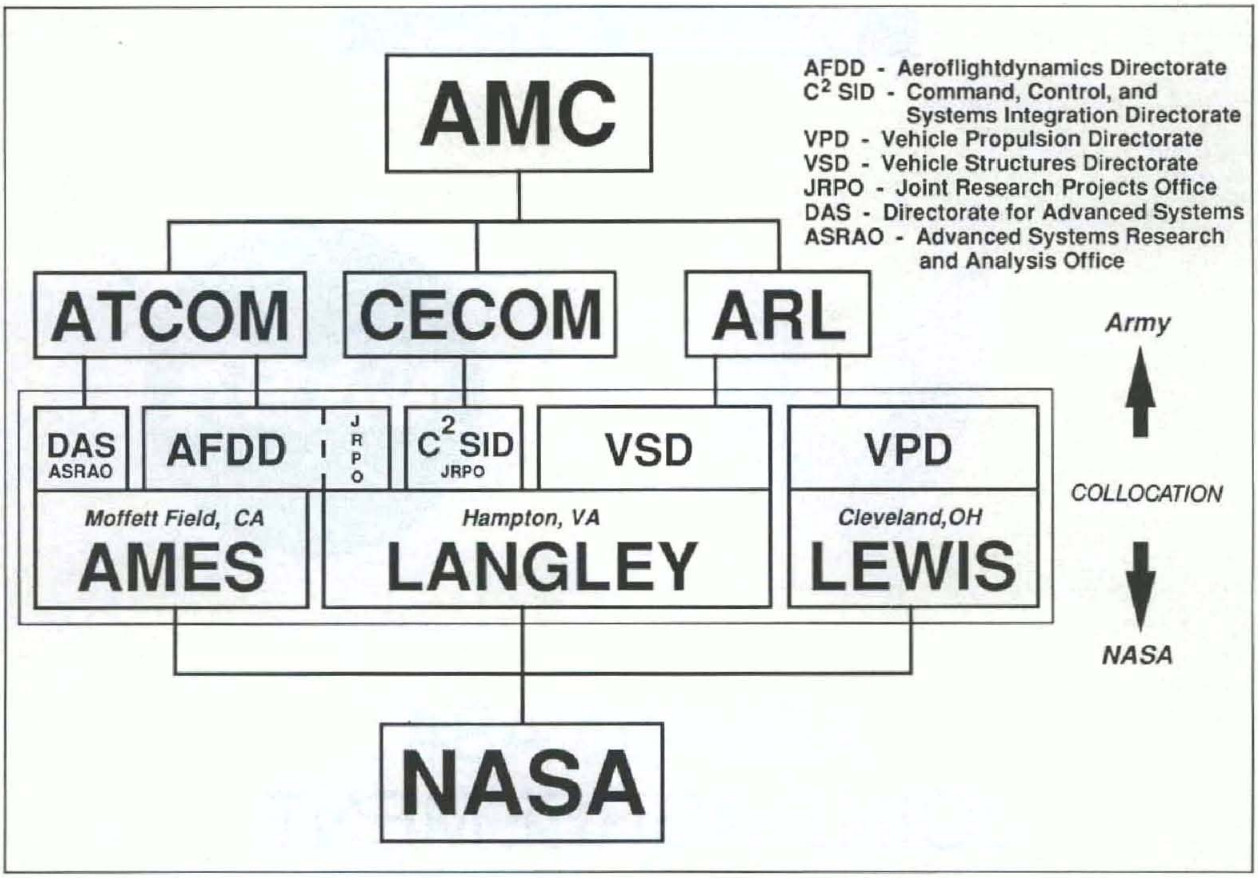

Figure 1
Current lab collocation structure.

U.S. forces in Vietnam, air mobility began to emerge as a key element of new warfighting concepts and doctrine. The helicopter became the cornerstone of the air mobile assault and, in turn, air mobility became the enabling capability behind new maneuver tactics and success on the battlefield. With this evolution occurring on the battlefield, Army leadership began to acknowledge the dependence on the helicopter and recognize the need for helicopter research and technology development.

At the same time, NASA, determined to reach the moon by the end of the decade, was emphasizing their space program. The resulting de-emphasis in aeronautical sciences was leaving valuable aeronautics facilities under-utilized. Despite this change in emphasis, NASA continued to acknowledge the need for aeronautics research and development.

The recognition of the Army's need and NASA's desire to continue aeronautics research and development resulted in a unique concept of operation that was transformed into reality by the development and execution of a joint agreement between the AMC and NASA. In 1965, a new era in Army aviation research and development was born with the signatures of MG William B. Bunker, then the deputy commanding general, AMC, and Robert C. Seamans Jr., then a NASA associate administrator, on the original Army/NASA Joint Agreement.

This is the opening statement and founding premise of the original agreement between AMC and NASA: "WHEREAS, the National Aeronautics and Space Administration and the United States Army Materiel Command both recognize that subsonic, as well as VTOL, aeronautical research is necessary on a continuing basis in order to lead to the development of advanced aircraft; that projected Army concepts and doctrine indicate a greatly increased dependence upon air mobility; that performance of aircraft currently limits concepts of air mobility; and that accelerated research in the low speed area will be necessary if air mobile weapons systems are to keep pace with other technological improvements..." It is interesting to note that this premise, which motivated the development of the original agreement in the early 1960s, is still valid today.

The original agreement was consummated with an open-ended permit issued to the Army Aeronautical Research and Development Laboratory for the use of NASA's 7-by-10 foot Subsonic Windtunnel located at NASA Ames Research Center (ARC). The agreement also established general provisions for Army scientists and engineers to work side by side with NASA Ames specialists in pursuit of technology development of common interest.

The unqualified success of this original agreement spawned the establishment of two additional Army laboratories collocated at NASA Lewis and Langley Research Centers (LeRC and LaRC, respectively). In 1969, AMC and NASA executed a master agreement establishing the top-level terms of the Army/NASA relationship. Shortly after, three individual agreements were signed between the U.S. Army Aviation Systems Command (AVSCOM) and each of the NASA aeronautics centers, establishing the terms of the local Army/NASA relationships.

Although the Army Aviation research and development structure has evolved over the years, the Army/NASA Agreement has remained the bedrock of the Army's basic research and technology development capability in aeromechanics, aviation human-machine integration, structures and materials, and propulsion.

Involving elements of the Aviation and Troop Command (ATCOM), the Army Research Laboratory (ARL), and the Communications-Electronics Command (CECOM), the current collocation structure is illustrated in Figure 1.

How It Works

The uniqueness of the joint agreement and its implication on dual-use technology development can be seen in the level and nature of integration of personnel, programs, and facilities.

Structure. The same basic structure is in place at each of the NASA collocated Army laboratories. Each laboratory is composed of a directorate office, several research divisions, and a research support division. The local Army director of each laboratory is responsible for administering the individual agreements. The research divisions parallel the laboratories' mission areas and are composed of scientists and engineers. The research support divisions are composed of engineering, technical, and administrative specialists.

In many ways, the Army directorates are treated by NASA as NASA organizational elements. NASA supplies the Army directorates with a full array of support services, direct access to NASA world-class research facilities, and unparalleled opportunities for collaborative research. As part of the "quid-pro-quo" agreement, some Army personnel are assigned to NASA organizational elements. In a number of appropriate areas, Army scientists and engineers from the research divisions are placed directly in the NASA organization to work side by side with NASA specialists.

In some areas, Army scientists and engineers are even assigned supervisory responsibilities within NASA organizational elements. Other personnel assignments are made from the Army support divisions into NASA infrastructure elements which include technical services, procurement, and financial management. Whether assigned to a NASA research division or infrastructure element, these collocated Army employees serve as though they were NASA personnel, typically reporting to a NASA branch chief as well as their Army first-line supervisor.

Even where scientific and engineering staff are assigned within NASA, the Army scientists and engineers work on programs of Army interest as negotiated by the Army director, and division or branch chiefs. With this and complete control of Army program funding, the Army directorates can ensure that Army resources are focused on Army priorities.

This structure permits both the Army and NASA to accomplish more with less, regardless of whether efforts are collaborative or focused on a unique need of either organization.

Programmatic and Technology Osmosis. The synergistic nature of the activity facilitated by the Army/NASA Joint Agreement can be highlighted by examining the common mission areas of the Army laboratories and the respective NASA centers. Figure 2 details this synergism.

Army and NASA programs in the above areas span the spectrum of technology development from basic research to advanced technology demonstration. Formal collaborative efforts in many of the common mission areas have and continue to facilitate direct dual-use technology development. While these formal efforts are most visible, by far, the predominance of dual-use technology development occurs through a natural, informal, two-way flow of ideas and information. The "technology osmosis" is facilitated by the nature of the Army/NASA Joint Agreement.

Facilities. Collocation with NASA centers was an ideal solution to the potential problem the Army faced in the 1960s. One of the primary objectives of the Army/NASA Joint Agreements was to permit the Army direct access to the major facilities required to conduct helicopter R&D without incurring the cost of facility development, maintenance, and operations. Born with the use permit for NASA Ames' 7 by 10 foot wind-tunnel, the Army's access to NASA facilities has grown over the years. Figure 3 details some of the facilities available for Army use at each of the centers.

These facilities represent a substantial capital investment for NASA. As an example,

ATCOM / AFDD NASA AMES & LANGLEY	ARL / VSD NASA LANGLEY	ARL / VPD NASA LEWIS	CECOM / C^2SID JRPO NASA LANGLEY
ROTORCRAFT CFD	COMPOSITE APPLICATIONS	GAS TURBINE SYSTEMS	ADVANCED ANTENNA TECHNOLOGY
UNSTEADY AERO	COMPOSITE FATIGUE	RECIPROCATING ENGINE SYSTEMS	ELECTROMAGNETIC ANALYSIS AND MEASUREMENT
CONFIGURATION AERO	STRUCTURAL ANALYSIS METHODOLOGY	TRANSMISSION SYSTEMS	ADVANCED DISPLAY TECHNOLOGY
ACOUSTICS	VEHICLE STRUCTURAL INTEGRITY	ADVANCED CYCLES	ADVANCED FAULT TOLERANT AVIONICS ARCHITECTURES / VALIDATION TECHNIQUES
AEROELASTIC STABILITY	VEHICLE CRASHWORTHINESS	COMBUSTION	
VIBRATORY LOADS		HIGH TEMP MATERIALS	
HANDLING QUALITIES		HEAT TRANSFER	
COMPREHENSIVE MODELING		COMPUTATIONAL FLUID MECHANICS	
OPTIMIZATION		MECHANICAL COMPONENTS	
SIMULATION		MECHANICAL SYSTEM DYNAMICS	
MAN-MACHINE INTEG / HUMAN FACTORS		SYSTEM CONTROL / DIAGNOSTICS / PROGNOSTICS	
CREW STATION DESIGN			

Figure 2.
Joint Army/NASA R&D mission areas.

NASA AMES / AFDD	NASA LANGLEY / VSD & AFDD JRPO	NASA LEWIS / VPD
HOVER ANECHOIC CHAMBER	14x22 FT WINDTUNNEL	3000-5000 HP TRANSMISSION STAND
7x10 FT WINDTUNNEL	30x60 FT WINDTUNNEL	300-500 HP TRANSMISSION STAND
40x80x120 FT WINDTUNNEL	LOW TURBULENCE PRESSURE TUNNEL	ENGINE COMPONENTS RESEARCH LAB
FLUID MECHANICS LAB	8 FT TRANSONIC PRESSURE TUNNEL	PROPULSION SYSTEMS LAB
NUMERICAL AERODYNAMIC SIMULATOR	TRANSONIC DYNAMICS TUNNEL	ICING RESEARCH TUNNEL
VERTICAL MOTION SIMULATOR	IMPACT DYNAMICS CRASH TOWER	1x1 FT SUPERSONIC TUNNEL
CREW STATION R&D FACILITY	FREE-FLIGHT TEST FACILITY	COMPRESSOR LAB
HELICOPTER HUMAN FACTORS RESEARCH FACILITY	MATERIALS RESEARCH LABORATORIES	TURBINE LAB
AUTOMATION SCIENCES RESEARCH FACILITY		COMBUSTOR LAB
IN-FLIGHT SIMULATORS AND RESEARCH AIRCRAFT		LUBRICATION AND TRIBOLOGY LAB
		MECHANICAL COMPONENT LAB

Figure 3.
Facilities available to the Army at each center.

the Army has access to NASA facilities, at Ames Research Center, with a capital value of more than $1 billion and annual operating cost of more than $60 million; yet, the Army directly incurs less than 1 percent of the annual operating cost.

In the spirit of the original basic agreement, the Army has the same access to the NASA operated facilities as any NASA organizational element. Furthermore, through the collocated Army laboratories, this access extends to all Army research, development, and acquisition organizations.

The Spirit of Common Interests

"WHEREAS, the NASA and Army have common interests in fostering research and development of subsonic and VTOL [Vertical Take-Off and Landing] aircraft on a continuing basis . . ."—again, a quote from the original agreement in 1965. "Common interests"—this is the premise that best captures the spirit behind Army/NASA dual-use technology development. This spirit has driven extraordinary dual-use aviation technology successes and continues to serve as a critical element of Army aviation's science and technology investment strategy.

Building on the foundation established in Part I, both the past successes and future influence of the Army/NASA Joint Agreement will be presented in Part II. Major contributions in aeromechanics, human-machine integration, structures, and propulsion, directly resulting from the agreement, will be enumerated. Army aviation's current dual-use technology development strategy, centered on the exploitation of the established Army/NASA relationship, will also be discussed.

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ARMY/NASA JOINT AGREEMENT: THREE DECADES OF DUAL-USE AVIATION TECHNOLOGY DEVELOPMENT

Part II: The Successes and the Future

By John B. Johns

Editor's Note: The following is the final part of a two-part article on Army aviation dual-use technology. Part one begins on page 1.

Introduction

Army/NASA cooperative and integrated research efforts, shared resources, and close physical proximity have fostered the development of dual-use technologies in aeromechanics, aviation human-machine integration, structures, and propulsion. The relationship that has produced these successes will also serve as a key element of Army aviation's science and technology (S&T) investment strategy.

Dual-Use Successes

Only through examining the extraordinary accomplishments can the future potential of the Army/NASA Joint Agreement be imagined.

Tiltrotor Technology. By the late 1960s, NASA, Army, and industry engineers believed they had solved the instability problems that had plagued the first tiltrotor aircraft, the XV-3, and in 1972 the joint NASA Ames/Army XV-15 program was begun. This program resulted in development of two tiltrotor research aircraft capable of demonstrating, in flight, the viability of the concept for entry into the military and civil transportation systems. ("A perspective on 15 Years of Proof-of-concept Aircraft Development and Flight Research at Ames-Moffett by the Rotorcraft and Powered-Lift Flight Projects Division, 1970–1985," by David D. Few, NASA Reference Publication 1187, August 1987.)

Initial development activity included testing of a 25-foot diameter proprotor in NASA Ames 40-by-80-foot windtunnel and aeroelastic testing at NASA Langley. Bell won the contract for aircraft design and fabrication in April 1973. First flight took place, in vertical take-off and landing mode, on May 3, 1977. Full-scale tests of the XV-15 were conducted in the NASA Ames 40-by-80 in 1978. First conversion to and from airplane mode occurred on July 24, 1979. The XV-15 is shown in Figures 1a and 1b. It is interesting to note that the only surviving XV-15 aircraft continues to support flight research at Ames Research Center.

In December of 1981, the Department of Defense initiated the JVX (Joint Vertical-Lift Aircraft) Program. The Army Aviation Systems Command, exploiting its experience with the XV-15 and tiltrotor technology, led the JVX program development. By December 1982, however, the Army had reassessed its priorities and interests in a tiltrotor transport and the Navy assumed control of the program. In April 1983, the Bell-Boeing team was awarded the JVX Preliminary Design Contract. In 1985, the program moved into full-scale development and was renamed the V-22.

Human-Machine Integration. More than a decade of cooperative efforts between the Army, NASA, industry, and academia, on the Army AFDD/NASA Ames Aircrew/Aircraft Integration (A3I) Program, served as the foundation for the development of MIDAS

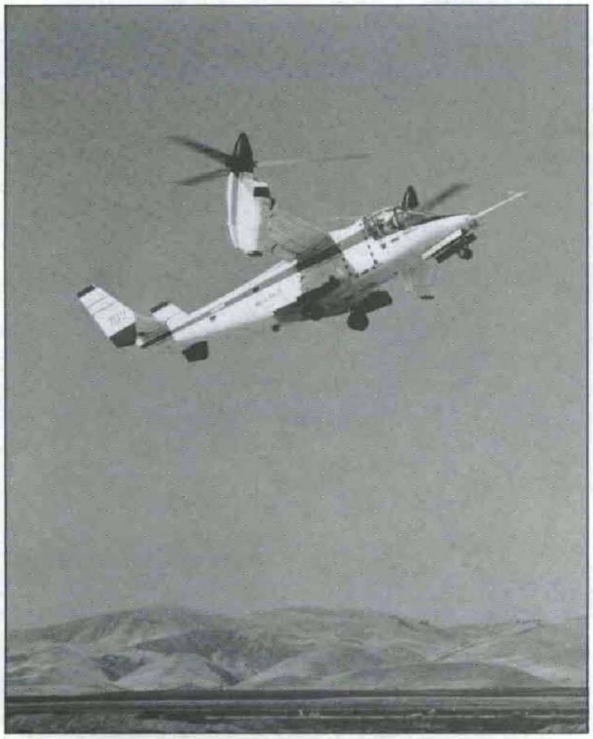

Figure 1a.
The XV-15.

Figure 1b.
The XV-15.

(Man-machine Integration Design and Analysis System). MIDAS, a computer-aided human factors engineering system, gives designers an opportunity to "see before they build," to ask "what if?" questions about all aspects of crew performance. Figure 2 shows a snapshot from the continuous visual output produced during a typical aircrew activity anaylsis using MIDAS.

The Army and NASA have a Technical Exchange Agreement with Boeing Helicopters, and are currently working on a second with Boeing Commercial, in support of the development and application of MIDAS. Further, MIDAS as well as basic human factors design concepts are being applied under a Cooperative R&D Agreement with Communications Research Co. and the Richmond, CA, police department for design and integration of 911 dispatch/in-vehicle systems.

Aerodynamics/Aeroperformance. For the last seven years, the Aeroflightdynamics Directorate has actively applied fixed-wing Computational Fluid Dynamics (CFD) methods developed by NASA researchers towards rotorcraft related problems. With AFDD scientists serving as an integral part of a NASA Ames Branch, the Army has ready access to a number of the world's leading CFD researchers and computer facilities such as the NASA Ames Numerical Aerodynamic Simulation facility.

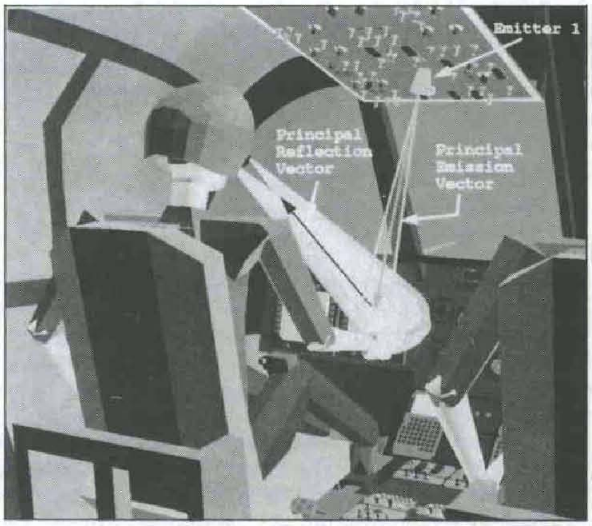

Figure 2. Continuous visual output from a typical aircrew activity analysis using MIDAS.

Building on advanced NASA-developed codes, the Army has pioneered the development of adaptive multi-grid modeling methods that tailor the grid resolution to accommodate the local flow characteristics near the vehicle. These Army developed techniques are, in turn, used by NASA in civil application. The entire technical community benefits from the group's research as highlighted by the flowfield simulations of the V- 22 and the Comanche helicopter shown in Figures 3a and 3b, respectively. The technology developed to simulate these vehicles has direct application to any potential civil tiltrotor as well as problems of interest to the Army.

In 1973, in an attempt to address the phenomenon of loss of directional control in low-speed flight, U.S. Army engineers at Langley Research Center initiated an investigation to examine the flowfield around the helicopter's empenage. Through years of analytical study, experimental work in NASA Langley's 14-by-22-foot windtunnel, and flight testing, they were able to characterize the complex flow field created by a combination of relative wind and main rotor downwash.

By 1979, Army engineers had found that by adding strakes to the tail boom, the flow field and, in turn, the airloads can

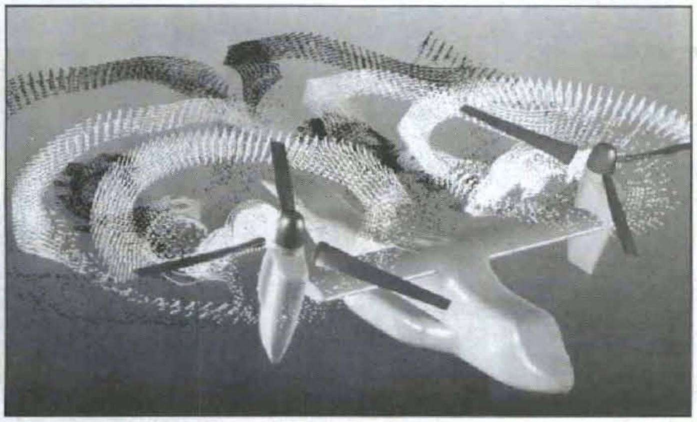

Figure 3a.
Flowfield simulation of the V-22.

Figure 3b.
Flowfield simulation of the Comanche.

be sufficiently altered as to increase the directional control margin.

In-flight experimentation was performed on the Army's OH-58A, UH- 60, and AH-64, as well as McDonnell Douglas Helicopter Company's (MDHC) Modified NOTAR (No Tail Rotor) 500 and a Bell 412. However, the most exhaustive and quantitative testing was performed on NASA Langley's Bell 204B with full instrumentation. This work led to the incorporation of the strake concept into several civil helicopter modifications and development programs. In fact, MDHC has integrated the strake concept into their MD Explorer's and 530N's NOTAR tail boom design.

Structures. Army and NASA engineers at Langley Research Center were among the pioneers of rotorcraft composite structures research and application. The Advanced Composite Component Development Program was initiated more than a decade ago when there was still considerable doubt that "plastic" could be superior to metallic structures. The objective of the program was to design, fabricate, FAA certify, install, and monitor composite components with an emphasis on demonstrating durability, survivability, and economy.

Following extensive research and development, more than 170 composite parts were field tested, during the last decade, on 40 Bell 206Ls and 11 Sikorsky S-76s. These parts are on a defined retirement schedule to permit life cycle evaluation. Three composite components, developed and tested as a part of this program, are shown in Figure 4. The program's unqualified successes paved the way for all current composite applications on both military and civil rotorcraft (e.g., Comanche and MDHC's MD 900).

Propulsion. The Army's capability to quantify the effects of inlet flow distortion was a fallout of earlier NASA programs. Both concepts and facilities were refined and adapted to test the Army's LHX powerplant, the T800 engine. Figure 5 shows NASA's Propulsion Systems Research Laboratory with the T800 engine under test. Inlet flow distortion investigations, conducted jointly with the Army's engine contractors, provided the data needed early in development to define stability margins. Furthermore, data obtained from testing in this facility were used to satisfy a portion of the engine qualification process.

Other NASA Lewis facilities are being used to determine the overall performance of the T800 engine at altitude conditions. Results from these activities continue to be transferred directly to the engine industry and incorporated in advanced engine designs.

The Army and NASA have also focused on compressor design with the goal of increasing the compressor pressure ratio and increasing the efficiency so that fewer stages will be needed to achieve large improvements in fuel consumption and power-to-weight ratio.

With data derived from in-house research using unique NASA facilities, Army and NASA Lewis specialists have directed their efforts toward formulating the necessary analysis and design tools, to refine methodology and reduce development time. In particular, access to NASA's Large, Low-speed Centrifugal Compressor facility, shown in Figure 6, has provided a unique opportunity to obtain the measurements needed to develop improved flowfield models. The resulting models, analyses, and design tools have been widely integrated into industry propulsion system design methodologies.

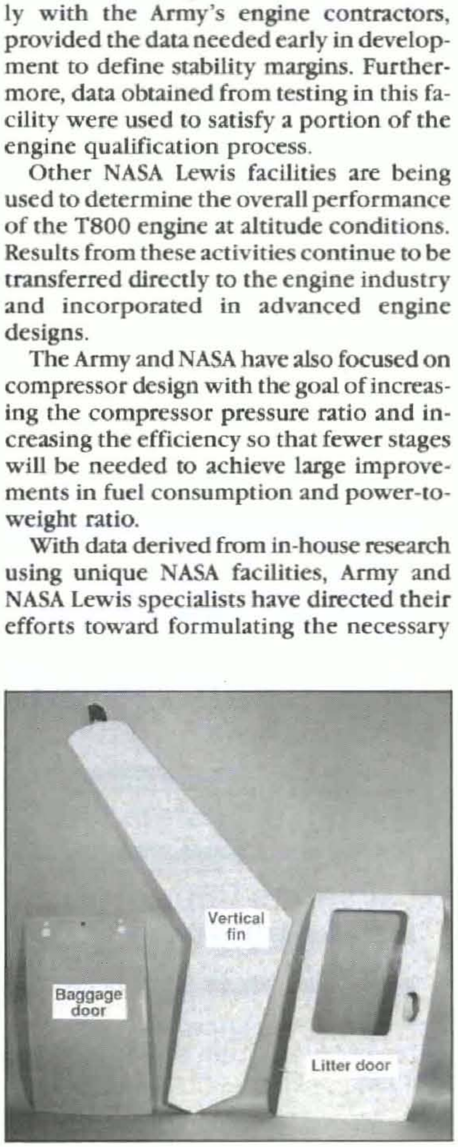

Figure 4.
Three composite components.

The Future

With the mechanics of the Army/NASA Joint relationship serving as one of the tools, and the spirit of "common interests" as the driving force, Army aviation is sharpening its focus on dual-use technology development.

Restructuring. In 1992, the Army's propulsion laboratory at Lewis and the structures element of the Army's laboratory at Langley were realigned into the new Army Research Laboratory. The emerging mission of the Vehicle Propulsion Directorate and Vehicle Structures Directorate is to apply its composite structures expertise and propulsion technologies, respectively, to serve other major commands in the introduction of advanced technology into their systems. This multi-customer mission will not only bring aerospace technologies to those commands but will broaden the dual-use market. In this regard, technologies developed at Langley and Lewis, under the Army/NASA Agreement, will be applied not only to aviation, but also to ground vehicles and bridges.

Aviation Science and Technology Program. The aviation S&T program has been oriented toward developing and demonstrating technologies that could be applied to next generation military and civil rotorraft as well as fielded systems upgrades. The program focuses on critical technologies that offer quantum improvements in performance. Program goals target improved safety, improved reliability, reduced operations costs, improved readiness, increased

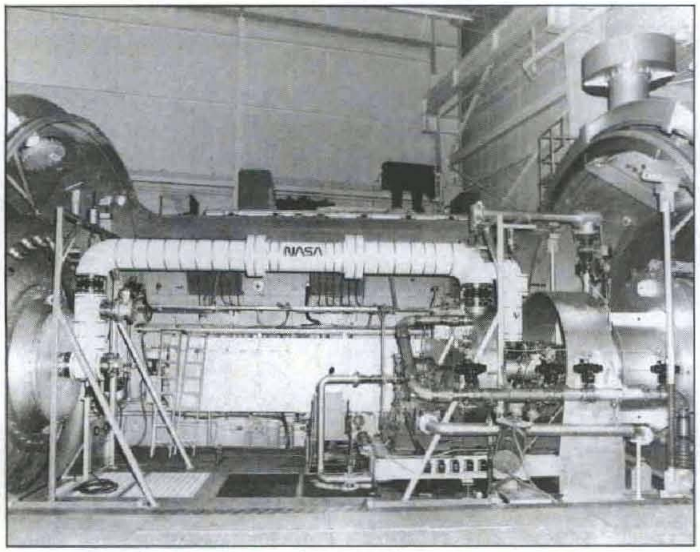

Figure 5.
T800 engine tested at NASA's Propulsion Systems Research Lab.

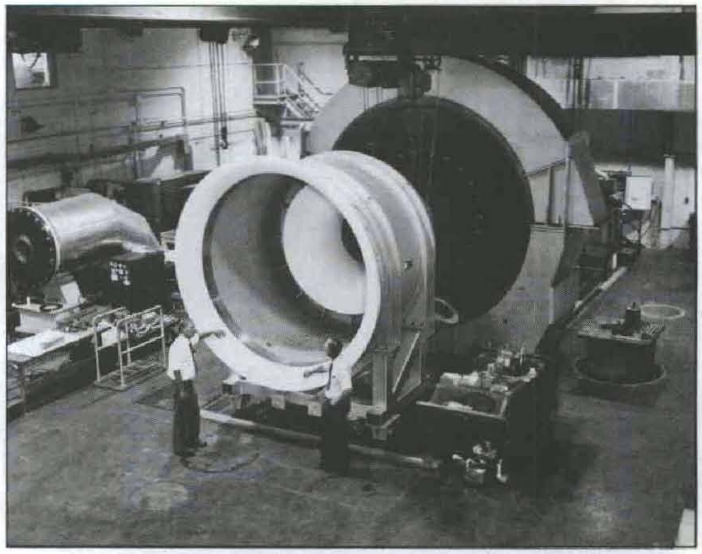

Figure 6.
NASA's large, low-speed centrifugal compressor facility.

service life, reduced pilot workload, day/night and all-weather operations, and increased payload and range.

Technology Demonstration (TD) programs will integrate and demonstrate technologies within the technology thrust areas defined in Figure 7. Basic research and exploratory and advanced development, conducted at the Army/NASA collocated laboratories, will continue to provide a foundation for TD execution.

The National Rotorcraft Transporter (NRT). As an example of the focus on dual-use technology, Army aviation is currently leading the program formulation of a TD focused on cargo/commuter rotorcraft technologies. This program, the National Rotorcraft Transporter, strongly supports the dual-use initiatives of the executive and legislative branches.

NRT embodies a national strategy, organizing a government industry coalition including the Departments of Defense and Transportation, NASA, and both rotorcraft manufacturers and users.

Army technology development will be completely integrated with NASA's Tilt-Rotor Technology Program and the Advanced Research Projects Agency's Technology Reinvestment Project. With a strong dual-use focus, national strategy, and critical technologies emphasis, NRT will position the U.S. to clearly capture and maintain "world" leadership in cargo/commuter VTOL technology.

"Root," medium-lift technologies in propulsion, structures, aeromechanics and controls, will be developed jointly by the Army/NASA collocated laboratories and industry. This development will be accomplished through existing and planned exploratory and advanced development programs. To complete transition of the root technologies, a series of NRT-related TDs, demonstrating advanced propulsion, structures, and aeromechanics technologies, will feed into the NRT demonstration/validation beginning in 2000.

Conclusion

Since 1965, the Army/NASA relationship has provided the Army with the opportunity not only to leverage NASA resources and programs to satisfy Army needs but also to contribute both directly and indirectly to civil technology development. The spirit created by "common interests" is stronger today than ever. Now, with the Defense Department's S&T focus shifting toward dual-use technology development, Army aviation is well postured to accelerate and sharpen this refocusing.

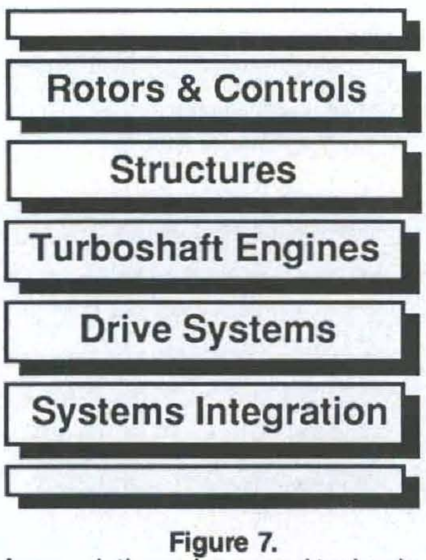

Figure 7.
Army aviation science and technology thrusts.

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NATIONAL AUTOMOTIVE CENTER EMPHASIZES DUAL-USE TECHNOLOGY

By Anthony Comito

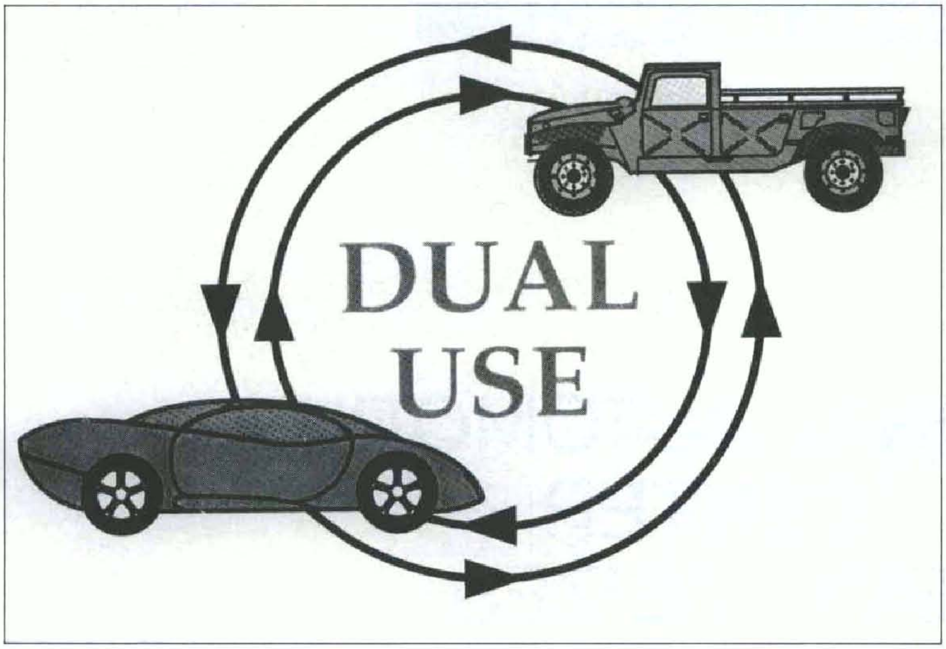
Introduction

"Dual-use" for research and development is for real! To meet today's challenge of building a strong and viable post-war defense base, the military is refocusing its research, development and engineering (RD&E) efforts to identify mutual commercial and military technological needs. The idea is to encourage the use of "dual-use" technology; where the military "spins on" technology from the commercial industrial base and "spins off" technology from the defense industrial base. The concept of dual-use technology encourages collaboration between the military and commercial industrial bases. Through collaboration, technology exchanges save time and money by preventing repetitive, time consuming research and development.

To promote dual-use technology for ground vehicles, the U.S. Army Tank-Automotive Research, Development and Engineering Center (TARDEC), in Warren, MI, established the National Automotive Center (NAC) to serve as a catalyst linking government, industry and academia. The center strives to foster and facilitate basic automotive research, technology development, manufacturing development, as well as professional development. This groundbreaking initiative focuses on research, development, manufacturing, and education. The NAC is working to draw the automotive industry, government laboratories, and academia together to collaborate on technology and manufacturing research development projects.

The center's dual-use collaborative R&D efforts started with a Broad Agency Announcement (BAA) for advanced automotive development for ground vehicles that was published in the *Business Commerce Daily* in November 1992. This solicitation generated enormous interest from industry, academia, and non-profit organizations. More than 700 abstracts were received with innovative suggestions for commercial automotive technology applications for military ground vehicles. The NAC requested 130 proposals from these abstracts and plans to award approximately 27 contracts. These contracts will cover technical areas

The concept of dual-use technology encourages collaboration between the military and commercial industrial bases. Through collaboration, technology exchanges save time and money by preventing repetitive, time consuming research and development.



in mobility, electronics and sensors, materials and processes, robotics, software, simulation and automation design.

These key technology areas were selected in accordance with the major thrusts identified by the Defense Science and Technology Strategy. Some specific examples of contract topics include:

• Determining the benefits of thin thermal barrier coatings on diesel engine components.

• Demonstrating the feasibility of a laser based radar three dimensional imaging system for potential identification benefits.

• Improving the electromagnetic shielding for electric drive systems.

• Developing a nickel metal hydride battery for electric drive vehicles.

• Adopting a digital control bus to a military vehicle.

• Investigating a resin transfer molding process for composites manufacturing. These are only a few of the areas TARDEC and its partners are investigating to illustrate the many potential spin-on applications to the Army.

Cooperative R&D Agreements

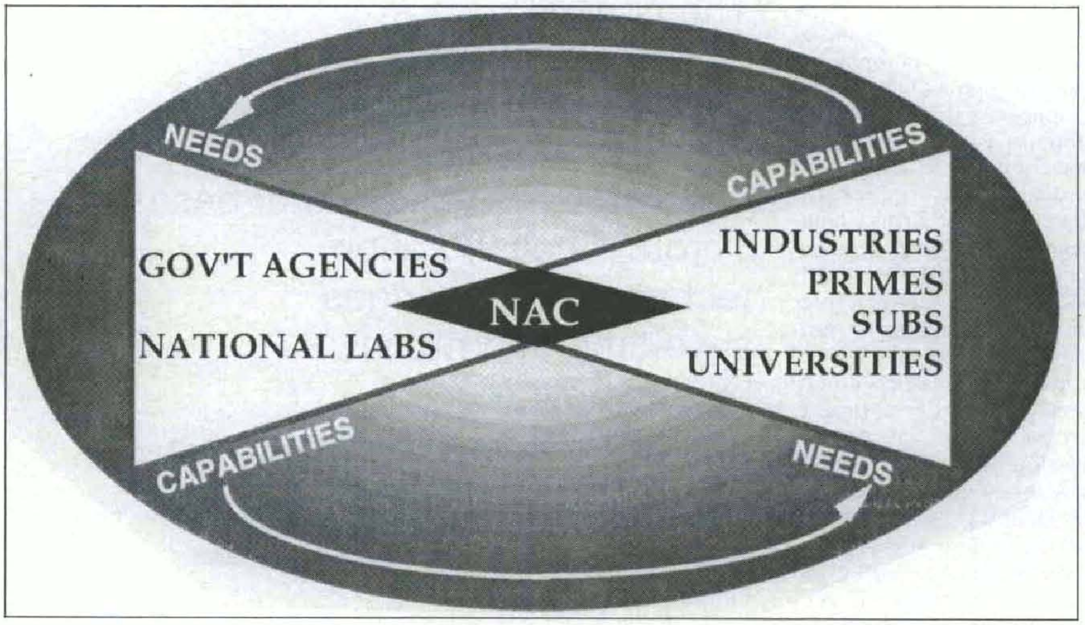
Cooperative Research and Development Agreements (CRDAs) compose another element of the NAC's mission. Since its inception, the NAC has facilitated the implementation of 11 CRDAs with industry and academia.

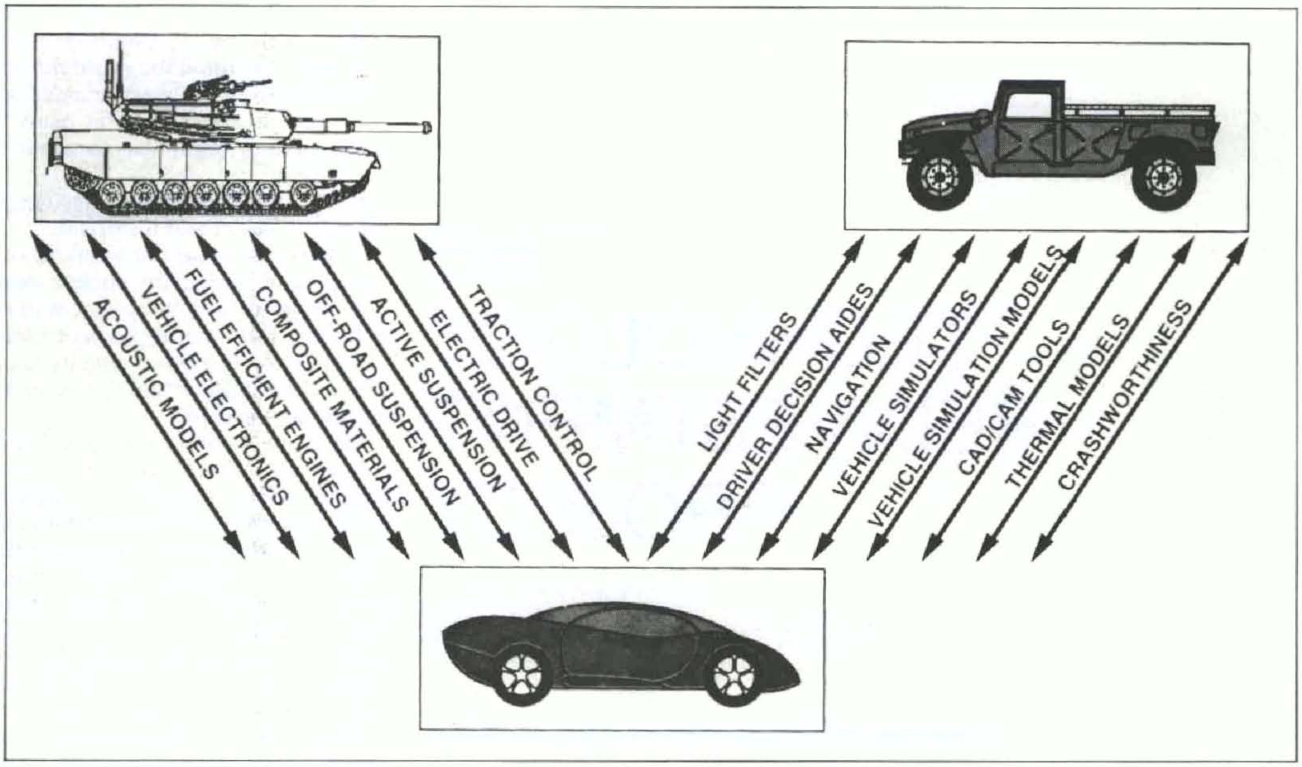
The NAC has worked extensively with the U.S. Council for Automotive Research (USCAR) in an effort to identify common technological needs with the automotive industry. USCAR is a coalition comprised exclusively of technical experts from General Motors Corporation, Ford Motor Company, and Chrysler Motors. Its purpose is to work jointly on what are pre-competitive technologies—those which would have common benefits, such as the development of improved batteries for electric vehicles. The NAC and USCAR have identified six technical working groups which will be pursued for collaborative development. These areas include flexible manufacturing, product validation, combustion monitoring, power switching, electronic circuit simulation, and government data bases.

The NAC, in conjunction with the Department of the Army Domestic Technology Transfer Office, is involved in developing a blanket CRDA that can be implemented with each of the Big Three as well as other automotive corporations. General Motors Corporation and the NAC established the first blanket CRDA which was approved in July 1993 and formally signed later. This ground-breaking blanket agreement opens all U.S. Army Materiel Command RD&E centers and labs to General Motors for technology sharing. It eliminates redundancy of boilerplate and facilitates processing of specific task oriented CRDAs between government engineers and General Motors. It is really Total Quality Management applied to the technical and scientific community.

Benefits

Both industry and government can reap benefits from the efforts of the NAC. Commercial and federal R&D initiatives certainly will be strengthened. By sharing resources,





each partner can focus on critical technologies, save money, avoid duplication of effort, and access a larger data base of ideas. The government will infuse commercial technology into its military products and gain support for its defense conversion plan.

Industry will benefit from the application of defense technologies into its products and build a stronger vendor base for its products. The commercial sector will also have access to unique equipment, test ranges, simulators, computer data bases, and technical expertise previously available only to defense contractors. Through shared technology, the commercial industry can better compete in the global economy and produce improved products at lower cost.

Other Cooperative Efforts

In addition to the BAA proposals/contract activity, TARDEC and the NAC's technology transfer to industry include the Army's development work on the *low heat rejection engine* for the M109 and the *dynamic infrared (IR) tire test.*

TARDEC modified the M109 truck diesel engine by using advanced ceramic engine parts and adding a high efficiency turbocharger. This cleaned up the exhaust and provided greater cooling capacity while increasing performance and fuel economy. This engine is now being adopted for commercial truck use.

The other TARDEC project involved the use of IR technology to detect faults in the tire wall while under dynamic load. Using an IR high speed camera, defects can be identified before tire failure. With this technology, the standard 47-hour endurance test to identify tire defects can be reduced to under four hours; thereby cutting test time and costs. This important information is being shared with the Department of Transportation and industry.

Spin-On Benefits

An example of spin-on technology to the government is an adaptation of the General Motors Lotus racing car *active suspension* for military vehicles to improve off-road mobility and stability. The technology topics previously cited will produce similar spin-on benefits. The NAC is working to match government needs to commercial capabilities in order to gain the most leverage from its relatively modest investment. These technologies will be integrated and demonstrated in existing or planned test beds and/or laboratory simulations.

Conclusion

Dual-use collaborative technology will provide a means for the military to maintain a viable, strong defense base while operating in an environment of reduced defense expenditures. Through shared research and development, the nation's defense industry can eventually convert to working on civilian projects, and even produce commercial products. It should be possible to switch from civilian to defense programs and back as needed by the nation's requirements. This is in line with President Clinton's Defense Conversion Plan.

The National Automotive Center is pioneering "dual-use" programs for U.S. Army ground vehicles and is cutting new paths to facilitate more cooperation on future R&D to strengthen the nation both militarily and economically. TARDEC and the NAC are proud to have forged this innovative program and stand ready to "bridge the gap" for dual-use R&D technologies.

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THE TECHNOLOGY REINVESTMENT PROJECT

By Dr. H. Lee Buchanan III

The dual-use strategy of the DOD depends on maintaining access to critical technologies that are viable (and affordable) because they also have commercial appeal.

Despite the end of the Cold War and the demise of the Soviet Union as a massive, well-organized force, the world still remains a very dangerous place. Secretary of Defense Les Aspin has spoken on this many times, and he defines four threats currently facing our nation:

- Diplomatic instability deriving from regional conflict and terrorism;
- The proliferation of weapons of mass destruction, particularly nuclear weapons;
- The potential consequences of failure of reform in the former Soviet Union; and
- The loss of economic vitality to our apparently diminished ability to compete in worldwide markets.

President Clinton has given the last threat—the threat to our economic growth—top priority in his domestic and international policy. From the point of view of the Department of Defense, the engagement of this threat is normally discussed within the context of *defense conversion* and is specifically concerned with finding ways to convert away from a system of two separate industrial bases, one for defense and another for commercial products, toward a unified industrial base which can provide both affordable military systems and competitive commercial products. There are four facets to the problem:

1. Diversification of our defense industry from defense to commercial products to preserve and create high quality jobs. This is a terribly difficult problem that industry and its leaders will have to sort out. Government can not—and should not—try to impose a solution or approach upon them.

2. Integration of defense and commercial production facilities into a flexible unit that is capable of meeting demands of those customers. Since World War II, our defense and commercial industrial bases have steadily separated. Until recently, the Department of Defense could finance its own industrial base. We simply can't afford to do that anymore. The largest part of defense products and materials will have to be obtained from *commercial* sources at *commercial* prices. This is a major challenge to the private sector, but the DOD can assist by investing in new flexible manufacturing technologies and moving swiftly towards major reform of the defense procurement system.

3. Development of new dual-use technologies. Dual-use technologies are those that have relevance to both commercial and defense markets. The dual-use strategy of the DOD depends on maintaining access to critical technologies that are viable (and affordable) because they also have commercial appeal.

Defense Dual-Use Critical Technology Partnerships	**$81.9**
Commercial-Military Integration Partnerships	**42.1**
Regional Technology Alliances Assistance Program	**90.5**
Defense Advanced Manufacturing Technology Partnerships	**23.5**
Manufacturing Extension Programs	**87.4**
Defense Dual-Use Assistance Extension Program	**90.8**
Manufacturing Engineering Education: Grant Program	**43.6***
Manufacturing Experts in the Classroom	**4.6**
Small Business Innovative Research Program	**7.2**
Total	**$471.6**

***Includes $20.1M of FY 1992 Funds**

Figure 1.
FY 1993 Title IV appropriations for TRP programs ($ millions).

4. Deployment (movement and utilization) of technology out of the laboratory and into products and processes to fully leverage our research and development investment dollar. This has been a major failing of both commercial and defense industry within the U.S. What is particularly vexing is that this is as much a sociological as a technological problem.

The proper government role in the first two of these areas is not clear. These are essentially questions which concern the structure of businesses and markets where the greatest experience and influence is in company executive offices. The third and fourth areas, technology development and utilization, are more traditional roles of the DOD which can now be modified to great advantage. It is not surprising, then, that technology should emerge as a critical building block of the larger strategy.

Technology has always been recognized as a keystone of defense, whether as a countermeasure or as a force multiplier. Every one of our recent military operations has clearly hinged on our ability to apply an appropriate force with speed and precision. This is only possible with superior weapons systems coupled with state-of-the-art networks for acquisition and use of information. Future threats may pop up anywhere in the world, in-and-among civilians and neutrals, with unknown and even irrational intentions. Thus, the continued access to the most advanced technology by the DOD is crucial.

But today, because of significantly reduced defense budgets, the introduction of advanced technology into the military must be done in a very different way. We can no longer afford new high tech weapons at the costs of the past. Two approaches may work: we must develop new, flexible manufacturing and management processes for DOD-specific products which do not depend on high volume for affordability and, where large commercial markets can be identified for critical defense technologies, they must be used as leverage to lower cost. The Technology Reinvestment Project is one implementation of these principles.

The Technology Reinvestment Project

On March 10, 1993, in a speech at the Westinghouse Corp., President Clinton announced his defense reinvestment and conversion program: a conversion package totaling $1.7 billion appropriated under the Defense Conversion, Reinvestment, and Transition Assistance Act of 1992. Under Title IV of this Act were 11 programs totaling $575 million. These programs all emphasize technology, not just research and development, but also deployment and education. The competition for eight of those 11 programs, for a total amount of almost $500 million, embodies the Technology Reinvestment Project (TRP).

The funding that goes with each TRP program is shown in Figure 1. The mandatory Small Business Innovative Research (SBIR) set-aside has been removed from the eight statutory programs but in a break with conventional policy, it is included as a separate TRP solicitation. This was done in part to make the TRP more attractive to small business, but the main benefit is to expand the SBIR opportunity. In the conventional SBIR program, Phase I awards (this year as high as $100,000) are followed by larger Phase II awards (as much as $750,000). Phase III, the ultimate commercialization of an idea, is expected to be funded by the small company itself. In the TRP, Phases I and II are unchanged, but selected small companies can now enter the main program for a *cost-shared* Phase III. We expect this to be very attractive to worthy small businesses.

The eight programs are separate, but they have more common elements than differences.

1. All of them require competitive awards. The statutes did not require competition under a single solicitation, but doing so amplifies the definite synergies that exist naturally.

2. All the legislative programs require certain structure. There are certain participants that must be included in each proposal; statutory requirements differ from program to program. Some, for instance, require partnerships, others call for two or more eligible firms. Some require a state or local agency to provide sponsorship. Some are directed specifically at institutions of higher learning, including community colleges.

3. All of the programs require cost-sharing. All of them require cost sharing of at least 50 percent. Some require more; 50 percent the first year, 60 percent the second year, 70 percent the third, fourth and fifth year. All require that cost sharing be by non-DOD money. Most of them require that the cost sharing be by non-federal money: state, local or private investment. In-kind contributions are also allowed and will likely dominate in the case of small businesses, but the quality of match is very much an issue since the intent is to form a real partnership with each partner "at risk" and fully committed to success.

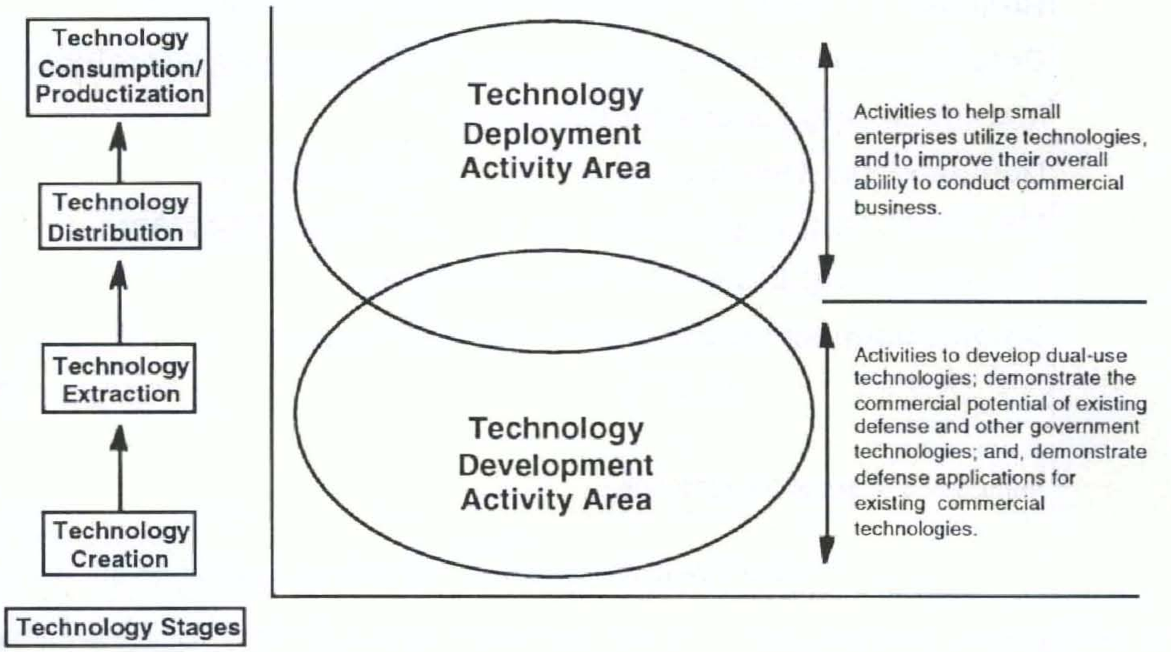


Figure 2. Technology stages and activity areas.

4. All of the programs require that proposals demonstrate relevance to defense objectives. This is a real, statutory requirement, but in practice probably the least restrictive. As we contemplate the Defense Department of the future, there is very little technology that will be of no relevance.

A study of the legislation reveals that the eight programs fall into two large categories: those that have to do with technology creation (development), and those that have to do with utilization (deployment). A third category—manufacturing, education and training—serves to connect these two in very specific ways.

Figure 2 illustrates four stages of the progression of technology and the relative positions against them of Technology Development and Technology Deployment activity areas. The first stage, technology creation, is most often the successful result of research in either the public or private sector. The second stage, technology extraction, is the transitioning of a result away from the initial point of creation in a direction towards some general application. This is often accomplished by performing a product feasibility demonstration or an early prototype, and, as a consequence, this stage is still very much "technology push."

At the third stage, technology distribution, the technology is identified with a particular product or application and its development can be focused with precision. This stage is the beginning of "user pull." Finally, with technology consumption/productization, the technology is fully incorporated into a product or a process that is sold.

Technology Development activities occupy the lower two-thirds of the chart, indicating that these activities are farther away from the point of sale. Successful TRP development activities will not engage in final, differentiated product development, marketing, promotion, product packaging, or distribution. Within this part of the TRP, technologies will be developed only to the point that they emerge as viable and enabling of a commercial or defense product or process. At that point, we presume that it's the responsibility of the industrial concern or a military Service to take it farther.

Technology Deployment occupies the top two-thirds of the chart, indicating that these activities are not meant to be much involved with either research or development, but rather with drawing technology out of the places where it's created and putting it into the hands of somebody who will turn it into a product or a process. Typically, these will be third-party kinds of activities where some individual is engaged full-time in assuring that opportunities for utilization are identified and the needs of technology consumers are met.

The fact that the chart shows a large area of intersection between the development and the deployment activity areas is purely intentional. The process of deploying technology is very complex and almost never resembles the passing of a baton between runners in a relay race. What is most successful is a process where developer and user work elbow-to-elbow until the technology naturally moves from one to the other. It is our intention that the TRP will stimulate just that kind of close collaboration and make the utilization of technology efficient.

Figure 3 plots the eight statutory programs as they span the stages of technology evolution. Two points emerge: first, no program on the chart spans the entire distance from the bottom, technology creation, to the top, ultimate productization. However, *in aggregate* they all do. Thus, a major decision was made to emphasize the similarities of the statutory program as a way to unify the effort. By executing the programs as a coordinated unit, natural relationships could be enhanced.

But the task of managing this whole in a coherent way is beyond any single agency. That prompted a second major decision: to invite other agencies to join with ARPA in execution of all these programs together. Hence, the TRP is a joint effort involving six agencies: the Departments of Defense, Energy, Commerce, and Transportation, the National Science Foundation, and the National Aeronautics and Space Administration. To our knowledge, this has not been done before and represents a new mode of thinking within the government.

Current Status of the TRP

Thus far, this effort has truly been joint, not merely collaborative. The project's pre-solicitation "Program Information Package" was jointly written and jointly issued in March 1993, and it desribes the programs in detail. In mid-May, a joint solicitation

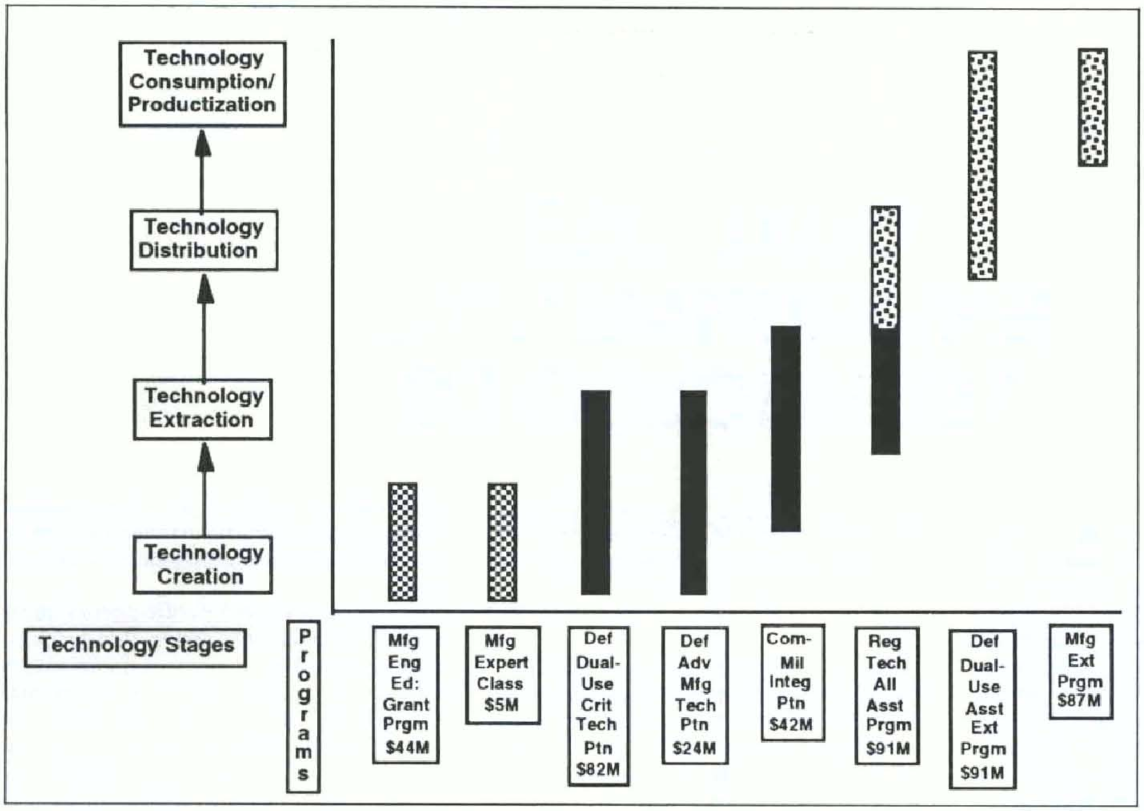


Figure 3. The position of the eight statutory programs.

of proposals was issued and proposals were received at the jointly staffed TRP office at the end of July. By the time of this publication, a six-agency effort of evaluation and selection of proposals will be nearing completion. Each selected proposal will be managed by one of the six TRP member agencies together with ARPA.

The deadline for the TRP solicitation was July 23, and the response of American industry to the TRP was very strong. At the close-of-business on that day, the TRP had received nearly 3,000 proposals, seeking a total funding of nearly $9 billion. Proposals were submitted from all 50 states, the District of Columbia, American Samoa, and several foreign countries.

The task of evaluating these proposals is huge and has involved more than 300 government experts. By this publication, some selections may already be announced. These announcements will continue as selections are finalized.

But selection of a proposal only begins the task of negotiating the final deal. It is important to be aware that the TRP is not a normal procurement in any sense. In fact, we hope to minimize the use of traditional procurement instruments, grants and contracts. Under recent legal authority, unique at this moment to ARPA, we hope to negotiate most efforts as cooperative or "other" agreements. These instruments are far more relevant to research and development activities, especially those that involve partnerships and cost sharing such as the TRP. And these agreements provide for a much greater flexibility in terms. For instance, intellectual property will in most cases become the exclusive property of the proposer and efforts will be managed according to traditional accounting methods.

In summary, several points are worthy of reiteration. First, the TRP is a joint effort among six agencies, a venture that is very different from business as usual within the federal government. We are working to eventually include state and local governments as full partners. This represents a very different way of doing business and will take some adjusting. Thus far, it is a model that seems to be working and deserves expansion to incorporate other federal agencies as well. It is, in fact, one real experiment in reinventing government.

Similarly, we are asking performers to do business differently: to work in consortia and partnerships, to share in the cost, and to show a commitment to exploit successes. To help the process along we have new legal authorities and instruments. Early feedback indicates that changes are already occurring. Even before the first TRP dollar is awarded, organizations have been stimulated to explore new relationships with new partners to do things in new ways.

According to some, the greatest value of the program may already have been realized. It may be some time before the real truth is at hand.

DR. H. LEE BUCHANAN III is the director of the Defense Sciences Office at the Advanced Research Projects Agency.

DUAL USE ENVIRONMENTAL TECHNOLOGIES

By Dr. Robert B. Oswald and Jeffrey Walaszek

Introduction

President Clinton's National Technology Policy calls on federal laboratories to play a key role in helping the private sector develop and profit from federally developed technologies. The president's program includes refocusing federal laboratories towards developing technologies which both meet government needs and spur growth in businesses and the economy.

The four U.S. Army Corps of Engineers (USACE) research laboratories conducted more than $400 million of research in FY93. The USACE research program focuses on combat engineering, facilities infrastructure, environmental quality, and civil works.

The U.S. Army Corps of Engineers (USACE) environmental research program is particularly suited to provide numerous technologies with potential dual-use applications. The military's effort to preserve and maintain the environment has many parallels with public and private environmental activities. The military focuses on the four environmental pillars of restoration, prevention, compliance, and conservation. Industry and other public agencies are equally accountable for environmental issues pertaining to those same focus areas and have active programs underway in these areas.

Many industry and public agency partners are already involved in the development and transfer of many of the products coming out of the USACE environmental research program. This private sector involvement is critical to the success of the USACE research program. The technology exchange between USACE laboratories and the private sector occurs in one of three ways: spin-off transition, dual-use development, and spin-on use.

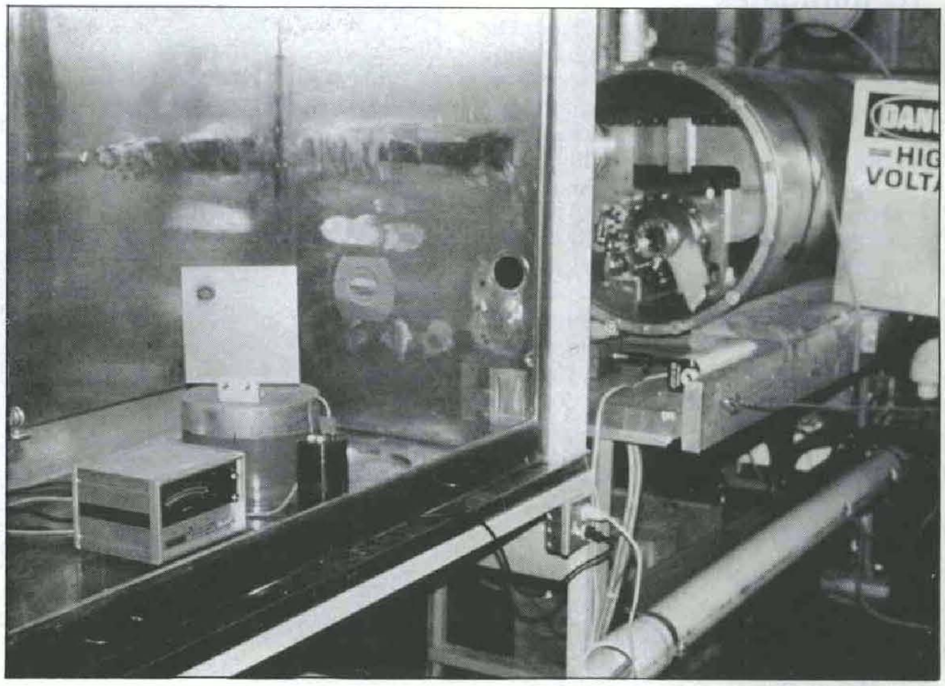
The USACE laboratories have a long tradition of the spin-off and spin-on

The SCAPS truck contains separate components for the data acquisition and processing equipment and the hydraulic ram handling machinery. In addition to the WES-operated SCAPS truck, three additional trucks are being constructed for the Army Corps of Engineers, Navy, and Department of Energy.

traditional view of technology transfer in which technology products and information from Army laboratories are made available for use by non-military public agencies and the private sector. Spin-on use is the application of private sector technologies in support of military missions. In both cases, technologies may be applied and developed for uses other than those initially intended by the developer.

The dual-use development effort is a relatively new interaction made possible by recent technology transfer legislation allowing federal laboratories to enter into partnerships to jointly develop a product through Cooperative Research and Development Agreements. The ability to enter into agreements such as this facilitates the transfer of technology by having a partner in place to ultimately bring the product to market. The partner in turn benefits from having a new product or service to offer to customers.

The many USACE environmental research activities currently underway offer much potential for partnering with industry and public agencies in support of the dual use initiative. This article provides some examples of environmental technologies coming out of the USACE research program which have dual-use application.



Laboratory model of laser paint removal equipment used to conduct pilot tests of the concept.

Spin-off Environmental Dual-Use Technologies

The Site Characterization and Analysis Penetrometer System (SCAPS). SCAPS is a rapid and cost-effective means to characterize soil conditions and to screen for contaminants in soil. The SCAPS uses existing cone penetrometer technology to evaluate in situ geophysical soil properties such as soil type and strength while simultaneously using contaminant-specific sensors to determine the presence of petroleum, oil, or lubricants (POL) contaminants. SCAPS was jointly developed by the U.S Army Waterways Experiment Station (WES) and the Army Environmental Center.

The SCAPS platform consists of a 20-ton truck equipped with vertical hydraulic rams that are used to force a sensor probe into the ground to depths of up to 45 meters. On board are a data acquisition, processing, and data storage computer system and electronic signal processing equipment. A trailer-mounted grout pumping system places a grout as the probe is retracted from the hole to prevent vertical subsurface contamination.

The multisensor penetrometer probe simultaneously measures resistance to penetration at its tip and frictional resistance developed along its cylindrical exterior. These geophysical movements are used to determine soil layer boundary and soil type. A laser induced fluorescence sensor using a fiber optic linked sampling window on the probe has been effective in detecting fluorescent compounds in soil and water contaminated by POL products.

SCAPS will reduce the time and cost of site characterization now done using conventional drilling, sampling, analytical laboratory testing, and installation of monitoring wells. A complementary objective is to determine sites that are free from contamination. This will result in cost avoidance by eliminating monitoring wells and the associated analytical costs. Additional research will be conducted to determine additional sensors for detecting explosives such as TNT and volatile organic compounds.

The transition of SCAPS will include personnel training and production of additional SCAPS trucks prior to licensing the technology to the private sector. The contractual procedures necessary to license the technology to the private sector have also been initiated. In the interim, a combination of government and private sector personnel will conduct production mode operation of SCAPS equipment and technical support for government use.

Biocells for Treatments of Organics Contaminated Soils. Biological treatment is emerging as one of the most promising technologies for treating biologically degradable organic contaminants in soil. In the past, biotreatment has taken the form of landfarming, composting, and above-ground bioslurry systems.

A new option being developed by the Waterways Experiment Station (WES) is the biocell system. The biocell is a variation of the above ground bioslurry system. Biocells are compartmentalized cells that supply nutrients, moisture, and air to treat small volumes of contaminated soil. Biocells can handle a few yards to several hundred cubic yards of contaminated soil.

Biocells treat contaminants at slower rates, but with less energy requirements than bioslurry systems. Consequently, they are better suited for more easily degradable contaminants like petroleum hydrocarbons and some wood preserving wastes.

Significant numbers of projects containing small quantities of petroleum hydrocarbon contaminated solids and sediments are encountered daily in the military and civilian sector. The biocell treatment system will enable onsite treatment and potential use of the soil as fill or other beneficial uses.

Composting and bioslurry system costs range from \$90 to \$250 per cubic yard of material to be treated. Estimated biocell costs will range from \$15 to \$80 per cubic yard. System delivery and setup should be in a day or two.

WES is currently developing the design and installation protocol which details simple fabrication and onsite requirement for biocells for field testing this year. Once the designs and field testing are completed, efforts will be made to commercialize the technology.

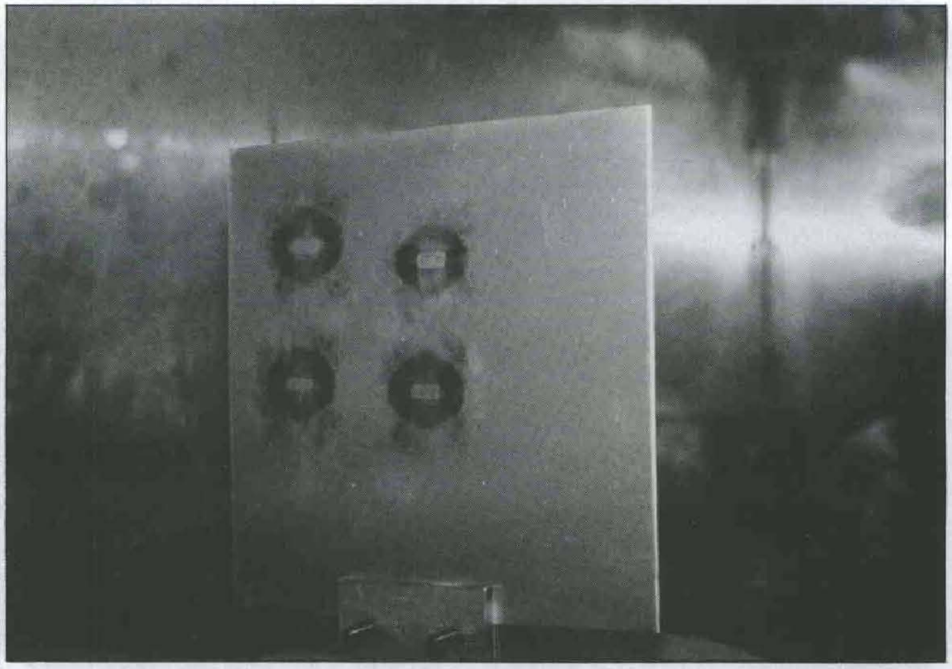
Joint Development of Dual Use Environmental Technologies

Laser Removal of Lead-Based Paint. The U.S. Army Construction Engineering Research Laboratories is working with Tetra, Inc., of Albuquerque, NM, to exploit laser technology for removal of lead-based paint on bridges, locks, and dams. The project was initially funded under the Small Business Innovative Research program. The Federal Highway Administration (FHWA) is also providing funding to support this research project.

The phase one research effort determined the practical feasibility of the laser system for removing lead-based paint. The laser was tested on 10 coated surfaces. The substrates were painted according to seven different paint system specifications at various coating thicknesses. The phase two effort currently underway will develop and fabricate a marketable system and demonstrate its use.

The development of the laser system will provide the capability to remove paint from flat and complex-shaped surfaces, collect paint residues, and protect the operator and any observers from exposure to the scattered laser light.

The phase two contract is in its second year. The product is expected to be field tested in FY94. The FHWA is interested in using the system for removing lead-based paint on highway bridges.



Laboratory tests proved lasers could effectively remove lead-based paint from metal surfaces with minimal impact on the surface.

Construction of Soil Liners for Landfills. The effects of freezing and thawing on alternatives to landfill soil layers are being examined in hopes of reducing landfill construction costs. EPA guidelines require an additional soil layer to protect compacted soil landfill covers from frost. This extra soil layer costs an additional $16,000 per acre of landfill or $320,000 for a typical 20-acre landfill.

The U.S. Army Cold Regions Research and Engineering Laboratory is teaming up with five private sector companies to study this problem. Partners include CH2M Hill Engineers and Waste Management, Inc.

Laboratory and field studies are being conducted on several soil materials and substitute geosynthetic composite materials. A thin layer of bentonite clay bonded to a synthetic membrane or sandwiched between two layers of synthetic fabric are just some of the alternatives being examined.

Field test sections have been built near Milwaukee, WI, and have been subjected to one winter of freezing. The sites are instrumented for temperature and in-place permeability measurements. Test results show that the permeability of the clay materials increases by a factor of 100 when subjected to freezing and thawing. Preliminary tests on the geosynthetic materials indicate that their performance is not adversely affected by frost action. Thus, millions of dollars may be saved if these new materials are used.

This study is being augmented by two additional studies for private companies. These studies are looking at the impact freeze-thaw on soil layers for a spill containment basin around a liquid fertilizer tank in Minnesota and a Superfund site in Vermont. These studies will ultimately produce new design criteria for these alternative materials.

Spin-On Dual Use Environmental Technologies

Advanced Oxidation Systems for Treatment of Explosives Contaminated Groundwater. Advanced oxidation processes (AOP) are those technologies that use chemical oxidizers such as ozone and hydrogen peroxide to produce hydroxyl radicals for the destruction of organic contaminants. AOPs are often used in conjunction with ultraviolet (UV) irradiation. The photons emitted by the UV sources are absorbed by the ozone or hydrogen peroxide to produce the hydroxyl radicals.

WES has established the feasibility of using AOPs to treat explosives contaminated groundwater at military installations. A problem with these systems is that the elevated temperatures produced by existing UV lamps contributes to lower process efficiencies and higher costs.

WES is working with several manufacturers of UV lamps to identify and evaluate alternative lamp sources. The goal is to increase the reaction rate, minimize the heat produced by the lamps, and ultimately decrease the operational cost of AOPs. Once a suitable UV source has been selected and identified in the laboratory, pilot tests and field demonstrations will be conducted for a variety of UV-systems.

Use of the UV-based AOPs is not restricted to the cleanup of explosives contaminated groundwater at military installations. AOPs are being used in the restoration and control of a variety of organic contaminants in groundwater at many Superfund sites. More efficient and effective UV-based AOPs can contribute significantly to environmental restoration projects throughout the public and private sectors.

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A Case Study... DUAL-USE TECHNOLOGIES AND UNIVERSITY RESEARCH INITIATIVES

By Dr. Nicholas George, Dr. B.D. Guenther and Dr. Vincent Piarulli

Introduction

Since its founding in 1951, the U.S. Army Research Office has been actively sponsoring basic research that has led to technological advancements of direct use to the missions of the U.S. Army. This article illustrates, by a case study, how this research has also led to the development of dual-use technology in the areas of optoelectronics and imaging important to both military and civilian sectors.

The subject of this case study is a partnership involving DOD, the university community, and industrial corporations. The case study is authored by participants in the partnership from the Physics Division of the U.S. Army Research Office, the Center for Opto-Electronic Systems Research at the University of Rochester, and the Commercial and Government Systems Division of the Eastman Kodak Company.

We trace this case history of an ongoing experiment to optimize dual-use technology starting with the description of a successful University Research Initiative (URI) program in Opto-Electronic Systems Research at the Institute of Optics of the University of Rochester, and describe the challenge to expand it to a dual-use activity that led to the formation of the Center for Electronic Imaging Systems. We conclude with a discussion of the technologies included in this highly innovative cooperative research and development effort that involves government, university, and corporate members in a new partnership.

The decision to establish this Center for Opto-Electronic Systems Research was in recognition of the key role played by optoelectronics in providing the Army the capability of target acquisition. As noted in Figure 1, the program is organized around a canonical optoelectronics and imaging system. This figure serves as a basic definition for an optoelectronics system. The faculty research spans materials, devices, and systems and is organized to promote technology transfer of a generalized system nature to the Army. Dr. Nicholas George directs this ARO-URI at the university. The Army Advisory Board for this URI program is chaired by Dr. Rudolf Buser, director of the Night Vision and Electronic Sensors Directorate at Fort Belvoir. Dr. Buser deserves credit for many management innovations that have allowed the development of meaningful interactions between university and Army research organizations.

Need for Optoelectronics

In 1987 the Institute of Optics of the University of Rochester was designated as a center-of-excellence in optoelectronics. Funding was provided under the University Research Initiative program after an intensive competition involving 40 universities. The Center for Opto-Electronic Systems Research was established with the goals of: contributing basic scientific knowledge in the critical technology areas of signal and image processing and photonics, and participating in technology interactions with Army laboratories.

After five years of operation and a new competition, URI support for this center was continued for the period of 1992 to 1997. There are currently 10 faculty and 10 doctoral scholars participating in the URI program. Each faculty participant makes four trips a year to Army laboratories. The center's research topics are kept relevant through a review process that involves ratings by two advisory boards: the Technology Advisory Board and the Executive Advisory Board.

A number of examples of relevant research topics at the center that have led to technology transfer are: laser locator, optimization software for lens design, surface emitting circular laser beam from semiconductor lasers, theoretical limits of focusing laser beams, resolving subwavelength features in scanning systems, and classification of images independent of scale and angle of orientation. Five of the six listed technology transfers have dual-use applications. For example, the optimization software is now available in two commercial programs: *CODE V* and *Oslo*. Of particular interest to the Army is the effort in Automatic Target Recognition (ATR) that led to the sixth technology transfer.

Automatic Target Recognition

Vision, one of the seemingly simplest of all human activities, is still far beyond the reach of computer builders. Although the new generation of supercomputers performs billions of arithmetic operations a second, the current machine vision systems perform much less efficiently than the human visual system. Since so much of human activity is associated with vision, research on robotic vision has great allure. The military needs vision machines to help guide land vehicles and planes and to provide ATR to the soldier.

An ATR system is the connection of an optoelectronic system to a computer which, in combination, have some facsimile of the attributes of the human visual system. The long-term objective is for the ATR system to be capable of making operator-independent decisions about scene content. In short, an ATR system must be able to receive the incoming imagery, process it for information content, and present the critical decision.

An important Army ATR mission is to locate targets by a helicopter in a pop-up mode. Breakthroughs in ATR research offer great potential for changing the scope of industry and defense. At the Institute of Optics, significant accomplishments have been made in ATR such as the classification of images independent of scale and angle of orientation. This remains an important system goal in the URI Center.

Imaging in the Information Age

Stimulated by the activities at the Army URI Center in ATR, the Rochester Imaging Consortium was formed three years ago by faculty from the University of Rochester (UR) and the Rochester Institute of Technology (RIT). It was formed as a special interest (working) group to concentrate on imaging in the information age. At first, the emphasis was to accomplish jointly some worthwhile research in electronic imaging and to experiment on some management strategies that would promote technology transfer, as we viewed it, at the bench-level across universities and corporate boundaries. Initially, two companies, Xerox and Eastman Kodak, were very responsive and contributed knowledge, technology, and funding. The initial effort was kept small and we concentrated our research on digital half toning and image quality. From this working group we developed the concept of the research triplet (Figure 2), grouping a faculty member with a corporate engineering-scientist and postdoctoral scholar or Ph.D. student.

Since faculty conducting research generally work in an autonomous and independent fashion, it seems natural to build in the technology transfer at the working group level. This innovative organizational plan has worked well and was used as the basis for the next step in technology transfer. One reason for its success is that each triplet is autonomous and failure of one does not jeopardize others. Also, this structure minimizes the need for middle-level managers.

Center for Electronic Imaging Systems

Both in the Rochester community and in major laboratories of the Army, leaders have expressed the need for leveraging of RD&A activities for a number of years. Dr. Gerald Iafrate, the director of ARO, suggested that efforts to leverage the ARO-URI research by obtaining the support of the industrial leaders in electronic imaging would create incredible possibilities. Spurred on by this encouragement, we began in earnest to seek corporate, New York State, and national support.

This work led to the creation of a major Center for Electronic Imaging Systems in Rochester by joining the university community—the University of Rochester and the Rochester Institute of Technology—with industrial leaders in electronic imaging—the Xerox Corporation, the Eastman Kodak Company, 3M, Harris' RF Communications, and a rapidly increasing number of other companies in New York State. Major funding has been obtained from a National Science Foundation (NSF) grant under the Industry University Cooperative Research Centers Program (IUCRC) that also includes funding from the New York State Science and Technology Foundation (NYSSTF), ARO, and the Night Vision and Electronic Sensors Directorate of the Army Communications-Electronics Command. In March 1993, we were designated by NYSSTF as the Center of Advanced Technology in Electronic Imaging Systems (CAT-EIS).

Our long-term vision is to establish and maintain a national center for all phases of electronic imaging systems with an impact that attracts national attention and provides a national service. As stated by Dr. Steven

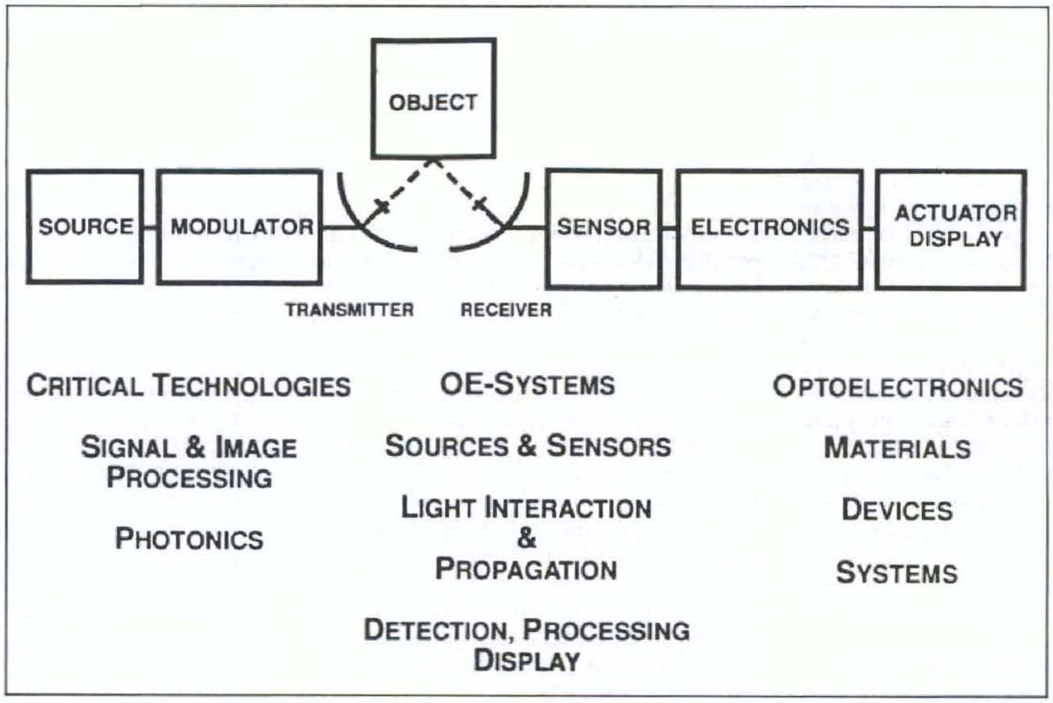


Figure 1.
Canonical opto-electronic system.

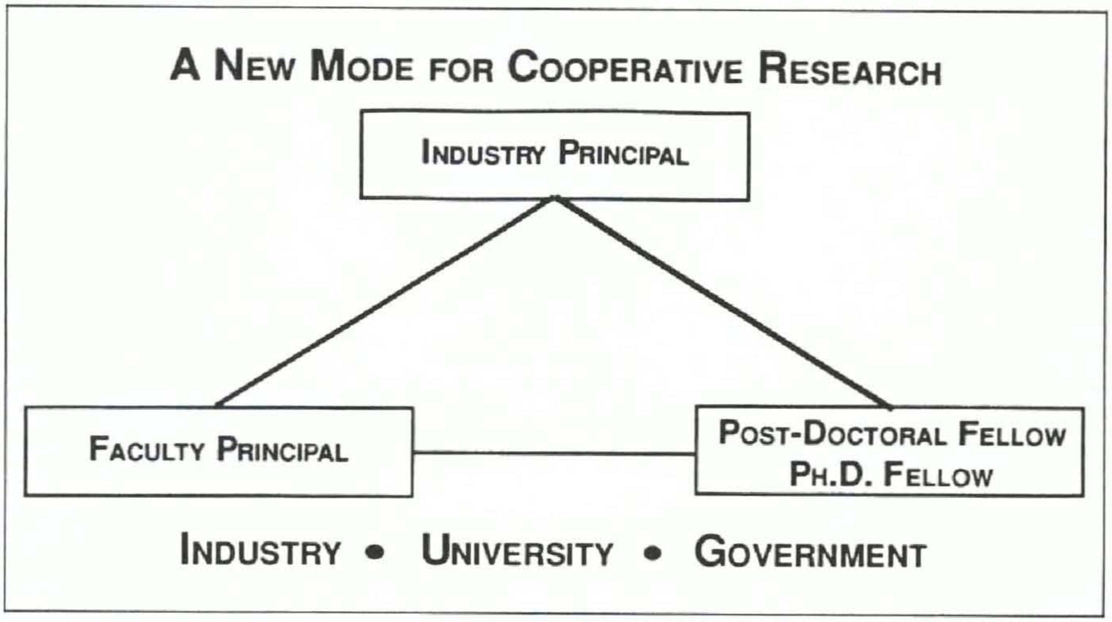


Figure 2.
Research project triplets.

B. Bolte, manager of the Webster Research Center, vice president, Xerox: "The University serves as the common meeting ground for corporations, and it is a natural place for pre-competitive research conducted cooperatively by faculty and company personnel."

An electronic imaging system can be approached from several viewpoints. The development engineer thinks in terms of the imaging chain: acquisition, capture, processing, storage, retrieval, transmission, display, editing, and printing. This is the same generic optoelectronic system (Figure 1), being used as the systems platform in guiding the research of the original Army URI Center.

For the systems planner, the strategic planner, or the CEO, it is useful to think in terms of program themes or systems goals. Hence, we have added to the generic imaging system eight major themes that serve as a framework around which we organize, report, and evaluate our research projects in our new CAT-EIS: Electronic Imaging Systems, Sequences of Images, Image Quality, Image Processing, Color, Imaging Through Turbulence, Automatic Pattern Recognition, and Visualization and 3-D Display.

In setting up the CAT-EIS as a joint venture between many organizations having different goals and perspectives, we found it useful to adhere closely to five requirements for successful alliances (described in the study "When Giants Learn to Dance" by Rosabeth Kantor). These points are paraphrased as follows:

• CEO Approval. For a successful alliance, the senior management of all

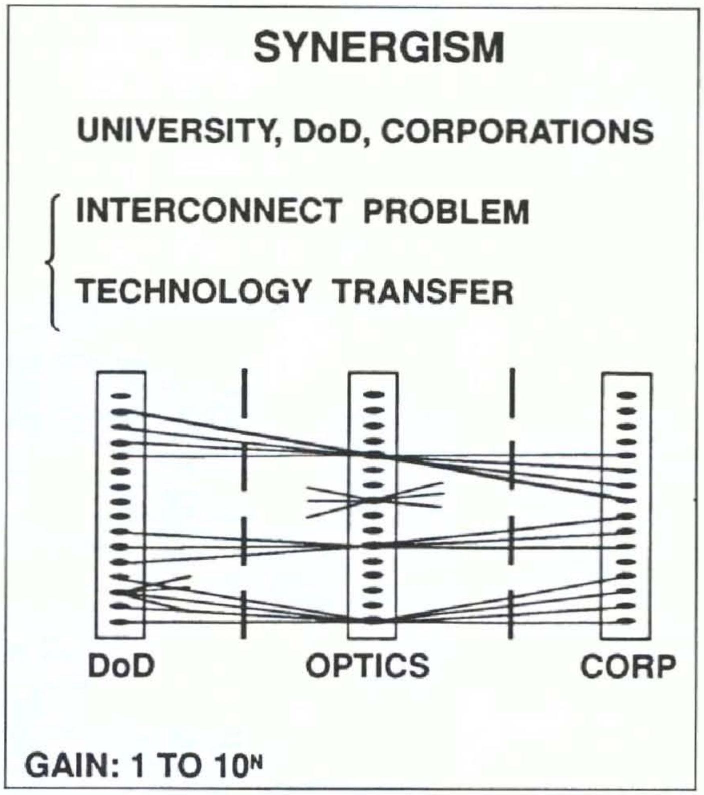


Figure 3.
Neural model.

ARO-URI Center for Opto-Electronic Systems Research ⟷ **NSF-NYSSTF Center for Electronic Imaging Systems**

ARO-URI Center for Opto-Electronic Systems Research	NSF-NYSSTF Center for Electronic Imaging Systems
Faculty	Faculty
Govind Agrawal	Nicholas George, Director
Robert W. Boyd	G. Michael Morris
Gregory W. Forbes	Kevin J. Parker
Nicholas George, Director	A. Murat Tekalp
Dennis G. Hall	Shen-ge Wang
Susan N. Houde-Walter	Emil Wolf
Stephen D. Jacobs	Ronald Yeaple
G. Michael Morris	Roger Easton (RIT)
Carlos R. Stroud	Mark Fairchild (RIT)
Emil Wolf	Zoran Ninkov (RIT)

Figure 4.
Defense technology conversion.

participating organizations must agree on and support the goals. Hence, it is important to keep senior managers of all participating companies and agencies properly informed.

• Formal agreements to define the rewards for all participants.

• Continuing interdependence is needed among all participants.

• The consortium must insure that information flows between participants. For this we have expanded the working model of research triplets described earlier. It is a useful management technique for ensuring technology transfer and for optimizing the communication between industrial, government, and university laboratories.

• Informal association is necessary in order to build understanding and trust.

Both in the ARO-URI and for the CAT-EIS, technology transfer across 25 or more research disciplines is required. Putting the faculty investigator in charge has been effective for stimulating interaction. We have developed a neural network model in which individual faculty are shown as the "hidden layer" in Figure 3. Management establishes as many random, but reasonable, interconnects as possible with engineering personnel in governmental and corporate laboratories. After a learning period, we expect some of the interconnects will flourish for each faculty member. This neural model also shows management that the complex resulting interconnects are as hard to evaluate and count as are research publications. On the other hand, contributions to major themes are much easier to evaluate in simple terms.

Dual-Use Technologies

Both imaging and optoelectronics are central to DOD missions and to industrial applications. With the presence of the ARO-URI Center for Opto-Electronic Systems Research and NSF-NYSSTF-CAT-EIS at the University of Rochester, it is clear that a centralized management can effectively develop a strategic plan that maximizes dual-use technology by the various research triplets. Consider the faculty active on the two programs (see Figure 4). The approximate 30 percent overlap between the two programs promotes the creation of dual-use technology. Clearly, the two groups span a research spectrum that is considerably broader than that by either group alone.

By the addition of Eastman Kodak, Xerox and others to the university-based research effort, clearly the technological capability of the group has been enhanced in all aspects of imaging. We will illustrate this by a few examples associated with automatic pattern recognition, an important element of ATR.

Eastman Kodak has recently released a series of Kodak Photo CD products that allow intelligently managed storage, processing, and retrieval of enormous data bases of pictorial images. A high volume image conversion workstation is shown in Figure 5. Several person years of R&D effort have already gone into the establishment of a document reader for printed alphanumerics and for handwritten characters on Internal Revenue Service documents.

Working on research triplet plans with the Commercial and Government Systems Division of Eastman Kodak (V. Piarulli and A. Mirzaoff), we have formulated specific topics on automatic pattern recognition, as follows: Document recognition, Vehicular recognition (also involving NAC-TACOM), Facial recognition, Fingerprint recognition, and Image quality recognition.

In these areas, the university-based research funded by the Army has developed high-speed algorithms that are independent of scale and orientation. The ability to acquire and digitize images or transforms at high speed has been added by Eastman Kodak with their capability in image recording, processing, and retrieval.

State-of-the-Art in Facial Recognition

As a specific example of automatic pattern recognition, we will present one

Figure 5.
Eastman Kodak workstation for intelligent managed storage and retrieval.

recent experiment on facial recognition by Shen-ge Wang and Nicholas George. The question posed is whether one can train a computer using faces at a forward and a 60 degree view and thereafter recognize the face when it is seen at a 30 degree view. Of course the simpler problem of recognizing the face at the forward look and the 60 degree view has already been answered affirmatively.

Figure 6 shows the faces and Figure 7 shows the results of the experiment in a tabular form. We have used 10 photos at 0 degrees and 10 photos at 60 degrees to learn each of the six different faces, for persons A through F. Then, using data based both on the input image and its spatial transform, we are able to recognize the faces perfectly when they are seen at 30 degrees.

For each person A through F, we test the automatic recognition using 10 separate photographs of each face at 30 degrees. This explains the 10's in the diagonal of Figure 7. We emphasize that the computer was not trained on any of the faces at 30 degrees. We see the remarkable result that the computer has learned to sense that it is looking at the same face but at a different angle. Of course there are many variations possible in this experiment and these are currently being pursued under the ARO-URI Center for Opto-Electronic Systems Research.

Conclusion

The Army made a long-term investment in optoelectronics and imaging at The Institute of Optics beginning in 1987. That investment resulted not only in technology of use to the Army but also in dual-use technology for commercial applications. The research accomplishments attracted investments of both people and money by commercial firms into the resource created by the Army. These joint research activities are stimulating the interest of scientists from these commercial firms in Army problems such as ATR. New management techniques have been developed to insure that this new cooperative venture will develop ideas that are rapidly transferred into both commercial and military applications.

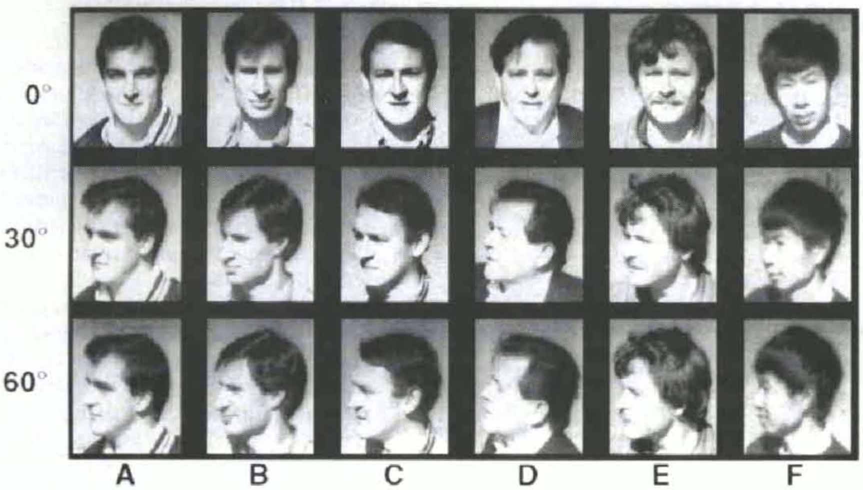


Figure 6. Facial Recognition - Image Database

INPUT		DESIRED OUTPUT A			B			C			D			E			F		
		0°	30°	60°	0°	30°	60°	0°	30°	60°	0°	30°	60°	0°	30°	60°	0°	30°	60°
A	0°	L																	
	30°		10																
	60°			L															
B	0°				L														
	30°					10													
	60°						L												
C	0°							L											
	30°								10										
	60°									L									
D	0°										L								
	30°											10							
	60°												L						
E	0°													L					
	30°														10				
	60°															L			
F	0°																L		
	30°																	10	
	60°																		L

Figure 7. 0° & 60°: Learning, 30°: Testing
Combined Optical Transform and Image Data

DR. NICHOLAS GEORGE is associate dean for research in the College of Engineering and Applied Science and also a professor of optics at the University of Rochester. He is the founding director of both the ARO-URI Center for Opto-Electronic Systems Research and the NSF-NYSSTF-CAT: Electronic Imaging Systems.

DR. B.D. GUENTHER is director of the Physics Division of the Army Research Office. He received his undergraduate degree from Baylor and his graduate degrees from the University of Missouri in condensed matter physics. He has published extensively in optics and solid state physics and is the author of an optics textbook.

DR. VINCENT PIARULLI is the technology coordinator for Kodak's Commercial and Government Systems Group. He is actively involved with development and dual-use transfer activities in many of Kodak's imaging technologies. He holds a Ph.D. degree in mechanical and aerospace science from the University of Rochester where he was a NASA Fellow.

MANPRINT AND DUAL USE

By Dr. Harold R. Booher

Introduction

Significant cost and performance benefits from applying the Manpower and Personnel Integration (MANPRINT) concept to the Comanche and other major Army programs has raised the question of an expanded role for MANPRINT in the new DOD acquisition environment. One issue of particular interest is whether MANPRINT could provide some special assistance in common defense and commercial applications. Historically, the underpinnings of MANPRINT with such domains as human factors, safety, and training have, since WWII, been extensively involved in technology transfer from the military to commercial environments.

The first recorded instance of equipment being designed specifically to accommodate human capabilities and limitations was for a military application. This happened in 1943 where a bomb sight was designed to allow high precision American daylight bombing of Berlin rather than the nighttime saturation bombing of the British. In MANPRINT terminology, this was the first formal tradeoff between equipment design and training where the human was considered an integral part of the system, rather than simply the operator of the system. This fundamental principle of "man-in-the-loop" for systems performance has gradually been adopted worldwide in both commercial and military aerospace systems.

Perhaps the best example has been the successful manned space flights where the status and influence of the astronauts, combined with advances in human factors assessment technology came together with advanced simulation tools to evaluate alternative designs. For 30 years, from the '50s through the '70s, human factors in aviation safety also grew in importance for both commercial and military aircraft design. Later, in the early 1980s, after the Three Mile Island accident, the entire nuclear industry found the lessons learned from aerospace safety invaluable to control room design, procedures, and operator training. In the '80s, the private sector provided advances in human factors technology to the military in a major way through the personal computer. The PC allowed the military to develop entirely new human computer interaction (HCI) tools to stimulate and evaluate total system performance.

With the Army's introduction of MANPRINT, dual-use opportunities expanded rapidly because of its unique human performance contribution. The Army's approach shows promise not only to individual systems, but to all government and industry processes involved in design, development, and manufacture of products. Further, the MANPRINT approach of bringing all human centered domains into a common integrated focus has provided a major advancement for assessing affordability because of systematic attention to manpower, personnel, and training considerations. Excessive life cycle costs due to these factors is a major obstacle to national competitiveness in both military and commercial technology.

MANPRINT Systems Integration Model

Figure 1 shows a simplified model of the MANPRINT process. The primary inputs to any systems integration process are the people, the technology, and the organization itself. At the highest level, MANPRINT adds two modulating inputs: the dedicated focus on the anticipated user of the system; and full utilization of human related technologies and disciplines.

The next level of detail helps clarify the unique contributions of MANPRINT's human centered approach. The highly concentrated user focus is the driving philosophy against which all acquisition issues, methods, and decisions are measured. While TRADOC is the user's representative and TQM philosophy is user oriented, MANPRINT is the discipline which assures, from a human performance perspective, whether the soldier assigned to operate or maintain the equipment is able to do so safely and effectively. Particularly important is a description of the intended user (target audience description) considering such aspects as skill, mental category, or body parameters. This user requirement is for the real user—the operator and maintainer (not everyone in the process)—and is usually stated quantitatively. The fact that the user is quantitatively defined allows human parameters to be analytically evaluated with tools compatible with other system variables.

The human centered technologies include such things as man-in-the-loop simulation, human performance measurement, human system tradeoff, cognitive workload and anthropometrics. For example, HARDMAN III, being developed by the Human Research and Engineering Directorate (HRED) of the Army Research Laboratory, is a human-system tradeoff technology whereas JACK of the University of Pennsylvania is primarily an anthropometric tool.

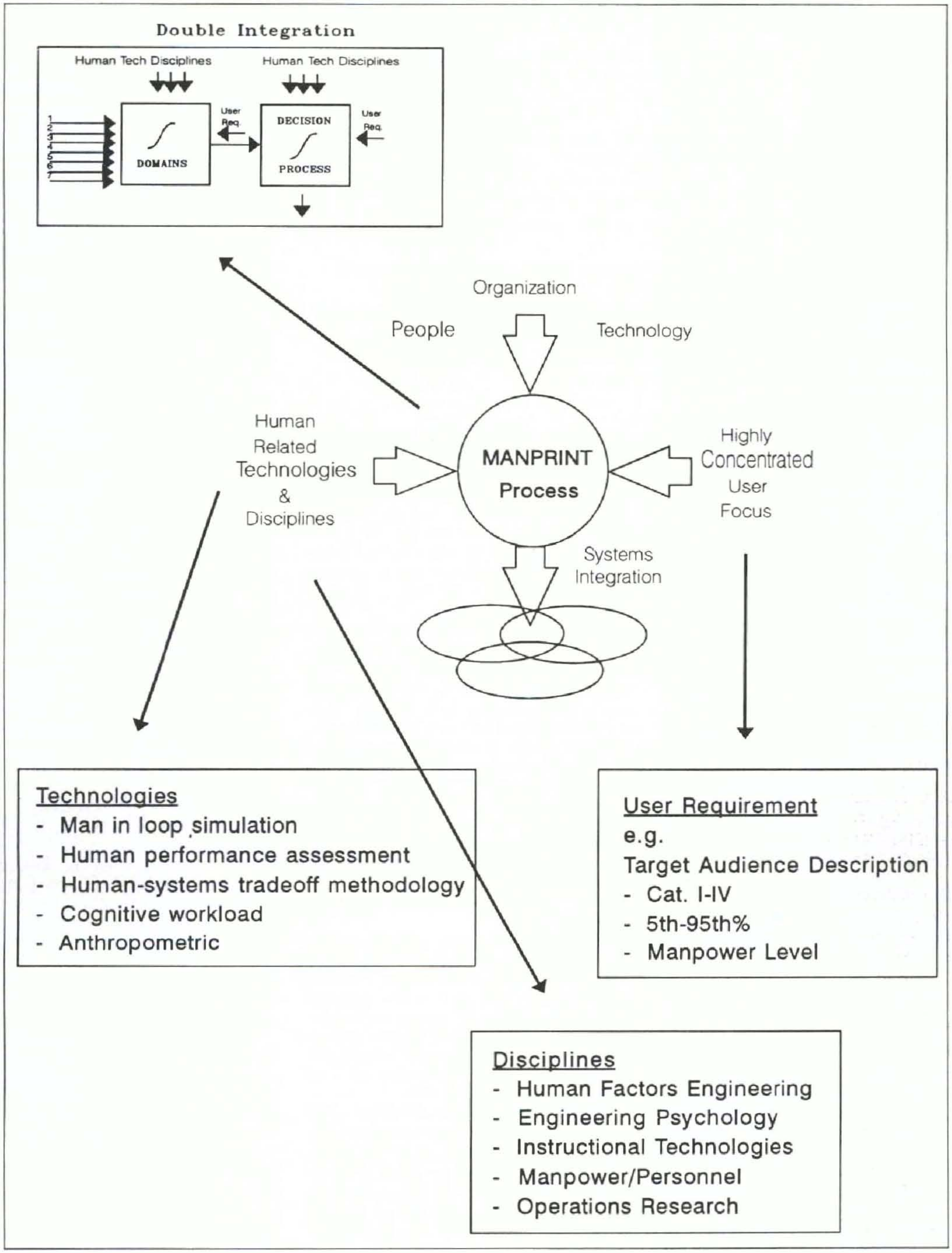


Figure 1.
MANPRINT systems integration model.

- Over 50% of the failures of military systems are the direct result of human error (General Accounting Office).
- 80% of accidents involving Army systems are due to human error (U. S. Army Safety Center).
- 90% of facility emergencies involve human error (American Nuclear Society).
- 62% of hazardous material spills were due to human error (Office of Technology Assessment).
- 65% of all airliner accidents are due to human error (Boeing Study).
- Human error is cited as the cause of 85% of ship accidents (Navy Safety Center).
- 50% of nuclear power plant accidents are due to human error (Nuclear Regulatory Commission).
- 90% of all automobile accidents involve human error (U. S. Department of Transportation).

Figure 2. Incidence of human error. (Malone, 1990)

Human centered disciplines that contribute greatly to the successful application of the MANPRINT are multidisciplinary, consisting of human factors engineers, engineering psychologists, instructional technologists, along with manpower, personnel, health and safety specialists. Also, operations analysts with human performance backgrounds are extremely valuable in the various integration stages.

The process itself can be summarized as a double integration process. The first stage is among the seven MANPRINT domains (Human Factors Engineering, Health Hazards, System Safety, Manpower, Personnel, Training, and Soldier Survivability) where user requirements evaluated by the human centered specialists result in human performance issues. The second integration stage exercises the human performance issues against all other issues in arriving at a full system integration decision at each stage of the overall acquisition process.

Common Human Performance Problems

There are four central human performance problems of national interest that can be considered common to military and commercial interests. These are human error, competitiveness in technology and commercialization, manufacturing and worker productivity, and inefficient government/industry acquisition processes.

Human Error. Figure 2 lists a number of recent studies which show the pervasiveness of human error—anywhere from 50 percent to 90 percent of all accidents and incidents are attributed to human error. Other studies show that the human demand trend has increased over time with much of our new technology reaching the limits for human cognitive abilities. This trend argues for an even greater percentage of human error induced incidents in the future.

As the president of the Human Factors and Ergonomics Society (HFES) stated in his 1993 Presidential Address to the Society, "the total number of incidents due to human error is clearly increasing, considering statistics which show half of all serious accidents recorded in this century have occurred in the past 11 years (1979–1990). Human error is by far the primary cause of these accidents. It follows that the frequency and consequences of human error are major factors in future systems affordability."

Technology and Commercialization Competitiveness. In the past, technological progress has been responsible for up to half the growth of the U.S. economy and is a primary driving force in long-range economic growth and increases in the standard of living. Technological advances also contribute to creation of new goods, jobs and capital and the expansion of services. However, according to W. H. Schacht, Congressional Research Service, there is increasing concern that the pace of U.S. technological advancement is declining, with negative consequences for economic growth, productivity, and international competitiveness.

Another concern is the problem of commercialization of technology. William Cox, also of the Congressional Research Service, notes the economic and social benefits of innovation accrue only when new insights are commercialized; that is, when ideas are refined into processes, products and services that perform useful functions reliably and at reasonable cost.

Commercialization of technology in the U.S. often lags behind that of other countries where governments actively promote it as a part of their economic policies. Consequently, there is a strong congressional interest in concepts like "dual use" to augment private sector technological development. Technological and commercialization innovation success are depending increasingly on the quality shown in the design and manufacture of products, reflected particularly in ways that provide reasonably priced products that are safe and easy to use.

Manufacturing and Worker Productivity. Although not so low as the late '70s, U.S. productivity in the last decade did not reach more than 40 percent of its level in the late '60s and early '70s. To improve productivity, there is a need for labor saving innovations such as improved production processes that permit workers to produce more per hour. Greater investment in education and training of the work force will also be needed. This will be necessary in order to replace old occupations with new ones requiring different skills resulting from advanced technologies and because of reductions in the labor force.

Government/Industry Acquisition Processes. A recent Defense Conversion Commission study reported a significant benefit in better integrating commercial and military technologies, products, and processes (including manufacturing) and in changing DOD procurement practices to resemble commercial practices. Also, suggestions have been made to repeal a number of service-unique regulations. While these may be valid suggestions, caution should be exercised in the case of Army MANPRINT and other service human system integration programs. For example, many of the advanced concepts of Army MANPRINT have not as yet been fully implemented by the other services, so the Army needs to retain its leadership role in this area. There is an added burden to assure commercial equipment is adequate for soldier applications and that critical human performance criteria are not overlooked in the haste to aid commercial interests and to adjust to budget cuts.

Dual-Use Application

The MANPRINT approach provides dual-use potential in reducing the common human performance problems, while offering innovative technologies and methodologies to enhance national competitiveness. Several areas worthy of increased investment are: Human Related Technology, Human Related Disciplines, MANPRINT Process Applied to Organizations, Influence on Other Technology, and User Definition for system requirements.

Human Related Technologies. The DOD has identified human-system interfaces as a key technology area. It is defined as the machine integration and interpretation of data and its presentation in a form convenient to the human operator. Human system interfaces is a fruitful area for both commercial and military investment, particularly in designing software for human-computer interfaces.

According to a recent report, (C. Karat, *Bulletin of the Human Factors Society,* Nov. 1992), the human-computer interface comprises 47 to 60 percent of the total lines of code. Its graphical user interface accounts for at least 29 percent of the software development budget. Eighty percent of

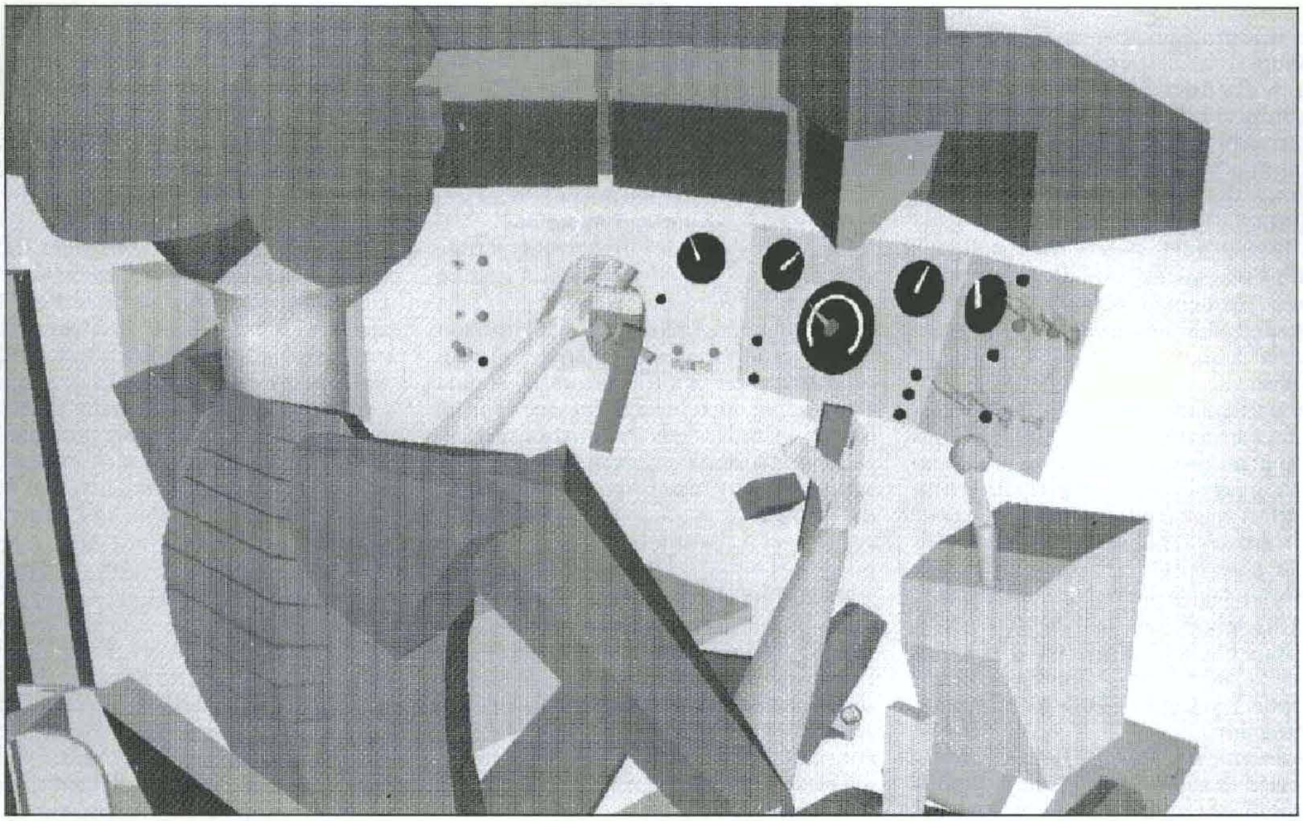


Figure 3.
The Human Performance Model (JACK).

software maintenance activity is attributable to unmet or unforeseen user requirements. The potential benefits to national competitiveness are enormous considering that cost benefit ratios of up to 1:500 were found in case studies which applied human factors to software systems.

The design of any military or commercial system where space for human operator or maintenance is at a premium, such as aircraft, ground vehicles, or command/control rooms, can benefit from anthropometric JACK technology.

Illustrated in Figure 3, JACK is:

• An anthropometrically, bio-mechanically and kinematically accurate scalable figure presentation;

• Interactive, fully animated and multiple figure capable; and

• CAD/CAE and virtual environment compatible. Jack has already demonstrated its capability to play a central simulation role in designing and engineering of conceptual systems.

Another MANPRINT unique technology is HARDMAN III, which can assist in tradeoff analysis for the MANPRINT double integration process. It is a performance-based manpower, personnel and training (MPT) estimation tool on a personal computer. It provides a quantitative evaluation of MPT variables in terms of costs and battlefield effectiveness for any proposed system design. It is applicable to product improvements, new developments, notional concepts, and NDI market surveys.

Two other MANPRINT tools that have dual-use potential are Smart Contract Preparation Environment (SCOPE) and Integrated Design Engineering Aid (IDEA).

SCOPE provides a knowledge base of Human Factors specifications and standards that are routinely used for both military and commercial applications. Provided in an expert system, this information is useful for preparation of requests for proposal and other program management documentation.

The IDEA tool set includes an automated standard process for integrating MANPRINT into materiel acquisition, and tools to support the completion of specific steps in the process. The IDEA approach is currently being assessed for international governments and industrial applications in France, the UK, Holland and Canada.

Analytical tools such as these could have vast application in the private sector as Peter Weddle (*Personnel Administrator*, 1986) forecast during early stages of these MANPRINT tools development. He predicted they could:

• permit product engineers to assess design impact on likely user populations;

• allow tradeoff analyses to be conducted to identify design changes to improve the usability of the product;

• be used to evaluate alternative production strategies to assure the total production process can (with people-in-the-loop) actually meet production and quality goals; and

• help determine the types of skills and skill levels required in manufacturing assembly or for operating process control equipment.

Human Related Disciplines. There is probably no area that offers greater potential benefit to national competitiveness than the "dual use" from investment in the people who apply MANPRINT. The Army's MANPRINT success is not from creating a new bureaucratic program review layer (which is necessary, but not sufficient) but from interjecting quality people into the acquisition system at crucial points. The number of such people in the nation is quite limited, so that any rapid increases in demand for these skills in military and commercial environments cannot be currently met.

A recent study by PRC, Inc. and MTL Services International concluded that the human performance issues (human error, etc.) described above apply to both the DOD and other federal agencies and their cognizant industries. A root cause of these problems is lack of trained and qualified people who understand how to integrate human issues into the process of designing, developing, and implementing new technology. The study further concluded that there is a need for a professional career development program to build a federal MANPRINT work force. In order to be viable, this program should consist of the following:

- Authorized full- and part-time positions with job descriptions and grade requirements within the federal agencies.
- A group of full-time MANPRINT professionals that can be considered the MANPRINT Corps.
- A management system that facilitates recruiting new talent, providing them with required, sequential MANPRINT-specific training and additional academic education and that assigns them to authorized positions.

It is particularly important to develop personnel structures to directly drive the recruiting, training, and retention programs within the agency and indirectly drive the MANPRINT-related education programs in the universities. There are currently more than 60 universities in the United States which offer degree programs in MANPRINT related disciplines. One of these is the Naval Postgraduate School, which has the curricula, faculty and military orientation to readily support a MANPRINT advanced education program.

Organizational Model. The U.S. Army is recognized as the world's leader in application of the MANPRINT double integration management and organizational process. The British Ministry of Defence has adopted the process for all of its services and the U.S. Federal Aviation Administration is attempting to incorporate major aspects of the model in formulating a new agency acquisition policy. Also, the Food and Drug Administration is studying the MANPRINT model as an aid to improve regulation of medical devices. The Nuclear Regulatory Commission can apply some of the MANPRINT techniques to better regulate nuclear power plants. The Departments of Labor and Education and the Office of Personnel Management are also involved in studies to develop a national MANPRINT career field.

There are a number of unique aspects with the Army model which account for the appeal to other federal agencies in their acquisition and regulatory functions with industry. First, the model provides a way for organizations to deal with the human error problem in a systematic way. Second, it provides an improved acquisition process which routinely applies the man-in-the-loop principle, resulting in higher confidence in meeting system performance requirements that are affordable. Third, it assists in raising industry incentives to produce safe and usable products that are internationally competitive. Fourth, it enables greater utilization of shelved research and technology and underutilized personnel in the human factors field. Finally, it offers wider opportunities for jobs, education, and training of the nation's work force.

The benefits to the Army and the other military services are obvious if only a few of these practices are adopted in the commercial sector.

Other Technologies. There are any number of other technologies, not strictly within the domains of MANPRINT or Human-System Interfaces, which can be beneficially influenced by common investments. Such technologies include virtual reality, expert systems, intelligent decision aids, and automated tools.

The concept of battle labs, with horizontal integration and rapid prototyping relies extensively on improvements in simulation and manufacturing. The need for the human-in-the-loop is obvious but such human performance/cost issues as "appropriate task-fidelity match" could be too easily overlooked. It is a common military and commercial problem with simulator purchases.

In Europe much attention has already been given to Computer Integrated Manufacturing (CIM). John Wilson of the University of Nottingham, in *The International Journal of Human Factors and Manufacturing* (July, 1991) discussed the concern for the proper role of people in manufacturing systems, such as dealing with unforeseen and predictable disturbances, and providing control inputs and reasoning capability not possible with automated means. Set-up, maintenance, intervention, and innovation will be enhanced by allowing the fullest use possible of human abilities in modern manufacturing technology design. These principles are being embraced in the U.S. with the advent of shop floor ergonomics directed toward improving worker productivity and safety while enhancing job satisfaction.

MANPRINT demonstrated in the Comanche Program that it elevates technology innovation across the board. More than 500 examples of MANPRINT technology design influence have demonstrated a vastly improved inventive environment. To meet MANPRINT requirements, new challenges were stimulated, inventions were permitted from anywhere, and immediate rewards were given to inventors through heightened self-satisfaction and professional recognition.

User Driven Requirements. Dual uses with MANPRINT in national competitiveness raises the basic philosophical issue of whether the user should drive technology rather than simply be the recipient of the technology at hand. Can one imagine the potential benefits if the nation's medical system was designed outward from the patient first, then the doctor, and the nurse, with technology designed to aid their mission rather than arrived at by a consensus of hospital administrators, insurance agencies, medical schools, and medical technologists?

Conclusion

MANPRINT started with the goal of systematically assuring that the man-in-the-loop principle was adhered to. It has evolved to the point where it appears to be in line with the "Paradigm Shift" occurring throughout industry because of information technology (Tapscott and Caston, 1993). The idea of asking what the user needs within his or her capabilities and limitations in each domain of MANPRINT, and applying this approach throughout the decision process is completely in accord with the broader philosophies of TQM and concurrent engineering. What MANPRINT offers to these philosophies are highly developed skills and technologies of its own, a way of defining quantitatively what the real user (operator, maintainer, patient, passenger) requirements are, and a process which results in the best product possible.

The Army still has a long way to go in institutionalizing these concepts and in developing a career work force. However, progress as demonstrated in the Comanche and T-800 programs shows the concepts are not idle speculation. Dual use provides an opportunity for the Army, other services, other government agencies and the entire commercial industry to adopt any number of the suggestions discussed here.

DR. HAROLD R. BOOHER is director of MANPRINT in the Office of the Army Deputy Chief of Staff for Personnel. Dr. Booher has a B.A. from DePauw University, a B.S. in electrical engineering from Rose Polytechnic Institute, an M.S. in psychology from George Washington University, and a Ph.D. in human factors from The Catholic University.

Dual-Use Technologies...

THE ARMY SPACE AND STRATEGIC DEFENSE COMMAND

By J. Russell Alexander

Introduction

The U.S. Army Space and Strategic Defense Command (USASSDC) was organized in 1992 as a result of combining elements of the U.S. Army Strategic Defense Command (USASDC) and the U.S. Army Space Command. The USASDC has had a formal technology transfer program in existence since 1989 with an impressive history of "spinoffs."

Examples of past USASDC technologies which have found successful commercial applications include advanced composite materials, which were originally developed for lightweight interceptor structures, for orthopedic leg braces and an ion beam texturing process, developed for optical sensors, to texture the electrodes for cardiac pacemakers. Both of these spinoffs received the Strategic Defense Initiative Organization (SDIO) Technology Achievement Award in 1989 and 1991, respectively. The SDIO, which has been renamed the Ballistic Missile Defense Organization, is the primary source of funding for USASSDC.

Current technology efforts at USASSDC focus on technologies necessary to defeat ballistic missiles in all phases of their trajectory. Many of the USASSDC programs are considered to be on the cutting edge of technology. There is also a conception that these technologies are mission specific and highly classified. Many of the technology efforts at USASSDC have potential applications to the public and private sector. Also, in many cases, it is the application of the technology that is classified, not the technology itself. By separating the underlying technology from its intended application, a variety of potential outside applications may be identified.

The USASSDC is divided into seven technology directorates which manage most of the R&D efforts sponsored by the command: Sensors; Systems; Directed Energy Weapons; Kinetic Energy Weapons; Survivability, Lethality, and Key Technologies; Advanced Technologies; and Targets, Test, and Evaluation. This article describes some of the current or recently completed technology efforts in each of these directorates which may have commercial, or dual-use, applications. These applications were suggested by USASSDC scientists and engineers or their contractors. These technologists must remain cognizant of the intricacies involved with the technology efforts as well as the current state-of-the-art in their respective areas.

Sensors

High Speed Analog to Digital Conversion. This effort is aimed at providing an ultra-high speed data acquisition subsystem to digitize signals from various types of electronic devices. The USASSDC utilizes this type of technology to rapidly convert signals from radars and other sensing devices to a digital format so that the data can be analyzed for targeting and discrimination (determining real missiles from decoys).

Analog to digital conversion technologies could benefit virtually any type of electronic device which requires the higher reliability associated with digital signals. For instance, medical instruments such as tomographical imaging systems and commercial communications systems and satellites could benefit from advances in this area. Nuclear reactor control instruments and other high reliability device industries would use these products to minimize product failures. Analog to digital conversion technologies are currently being used in high definition TV designs and applications, commercial video and camcorder designs.

Millimeter wave, microwave integrated circuit technology. Millimeter wave, microwave integrated circuit (MIMIC) technology features high density circuits processed on advanced semiconductor materials. By using these modules on radar and other sensing systems, these modules help USASSDC meet its requirement for extremely high range resolution target detection, as well as providing high reliability at lower costs. The manufacturing methodologies being developed in conjunction with these devices should result in high yield, high volume, and low cost processes.

The MIMIC technology insertion into commercial systems would offer reduced volume and weight features. Therefore, this technology would have potential application in such industries as medical electronics, air and ground traffic control systems, collision avoidance radars, burglar alarm systems, marine radars, home television receivers, and communications satellites.

Systems

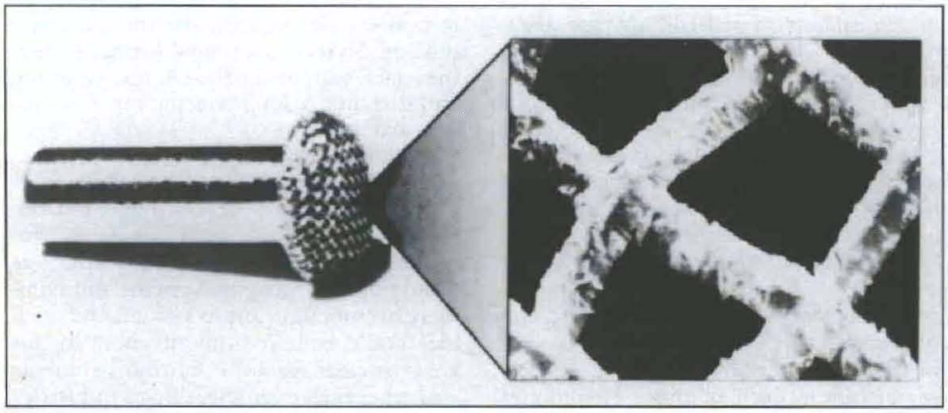
Extended Air Defense Simulation. The Extended Air Defense Simulation (EADSIM) is a powerful analytical tool developed jointly by USASSDC and the U.S. Army Missile Command for evaluating the effectiveness of various command, control, communications, and intelligence, theater missile defense, and air defense architectures, as well as weapon systems. The simulation takes into account the full context of an environment of sensors, command and control centers, communication systems, platform dynamics, and weapons performance. This software may be modified so that it could be used to assess the optimal location for radar equipment in the area of drug interdiction. Other uses may include aircraft flight and air traffic control applications. EADSIM could also be used to asses radio and television signal coverage for new or proposed installations.

Distributed Computing Design System. The Distributed Computing Design System (DCDS) is a software tool that is used to support the development of Ada code for large, distributed, real-time systems. This tool significantly improves software productivity, quality, and reliability by allowing the user to develop Ada systems from code modules and design information contained in the data base. The DCDS provides support for the total system development life cycle, from concept definition through operation and support. This tool is applicable to any industry which utilizes Ada code for its system.

Directed Energy Weapons

Neutral Particle Beam Technology. The Neutral Particle Beam (NPB) technologies being developed by USASSDC offer high-confidence discrimination of nuclear warheads from decoys. The NPB can detect internal rather than surface characteristics, which are more easily disguised. The USASSDC has sponsored research and development of high brightness and/or compact accelerator technology for the transmission of neutral particles such as neutrons. This technology has many potential dual-use applications.

In the medical field, the NPB's capability to produce high energy neutrons and protons makes it applicable to the treatment of localized deep tumors. Malignancies are bombarded by these high energy particles, which results in elimination or stagnation of tumor growth. NPBs could also be used for the destruction of plutonium and long-lived nuclear waste materials by irradiating it with a high brightness beam. This process would produce a short-lived waste along with electric power. The short-lived waste is more readily disposable in an environmentally safe manner. Another use of a compact proton accelerator would be in drug and bomb detection which is accomplished by generating a cone of gamma rays. Luggage is transparent to the gamma rays while a bomb or drugs are opaque.



On the left is a cardiac pacemaker electrode. On the right is a magnified look at the effect of ion beam texturing on the electrode. The process improves electrode contact with heart tissue resulting in 300 percent longer battery life using 50 percent smaller batteries.

Kinetic Energy Weapons

Non-shrinking Epoxy Resins. One of the reasons that composite materials have not received more widespread application, despite their superior strength and weight features over traditional metals, has been the high cost associated with the production of these composites. A non-shrinking modifier for resins has been developed by USASSDC which can be used to produce dimensionally stable composite organic laminates. By varying the ratio of shrink-resistant monomer and epoxy in a resin blend, a means is available for controlling the shrinkage. It would then be possible to produce a laminate with a matrix so tailored that reinforcing fibers would not undergo breakage or pull out of the matrix when stressed. This technology may alleviate some of the problems associated with the production of composites. The commercial applications of this modifier would be in virtually any industry where resin matrix lamination processes are used and volume change or shrinkage control is required such as the automotive and commercial aircraft industries.

Survivability, Lethality, and Key Technologies

Advanced Composite Materials Technology. Composite materials technology developed by USASSDC for missile interceptor applications offers significant increases in stiffness and strength while reducing the weight. The same advantages could be used by the automotive industry through the use of structural components of advanced composite materials. Non-structural composites are already widely used by the automotive industry as interior panels, switches, connectors, dashboards, etc. Typical weight savings range from 50 to 250 percent compared to lightweight metals while increases in strength of 150 to 300 percent are expected. The most significant factor relative to advanced composite materials is cost. These materials are expensive and fabrication techniques are labor intensive. Low cost fabrication methods are currently being developed by the USASSDC program.

Advanced Optical Material Processing. Optical sensor systems require exceedingly dark interior surfaces, or optical baffles, to achieve adequate stray light rejection and pointing accuracy. Previously, commercially available baffle materials consisted of either black paints or acid-bath anodized metals.

The advanced optical materials program

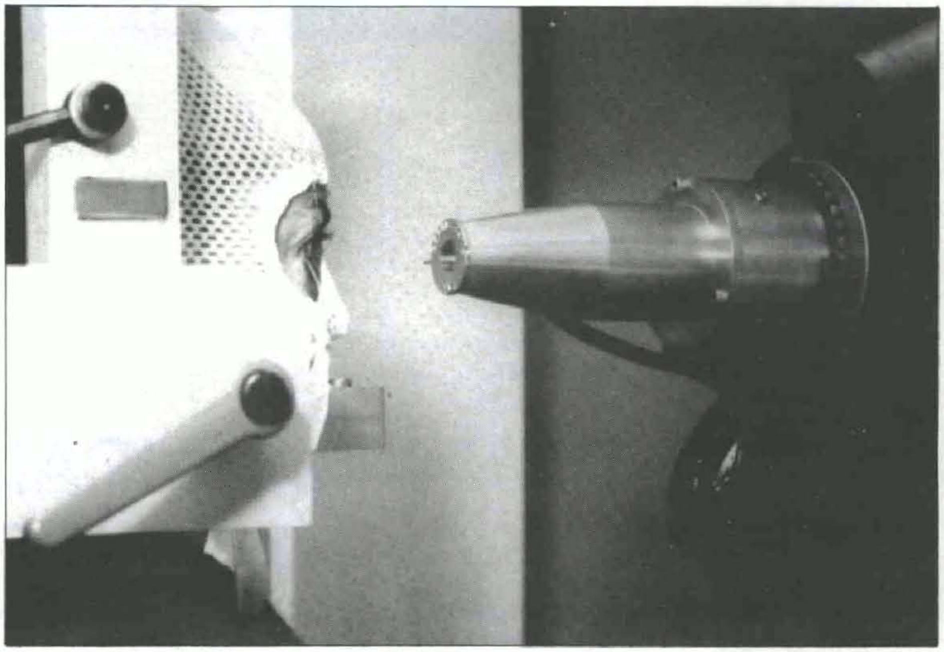
at USASSDC has developed an ion beam texturing process to texture surface materials for optical sensors as an alternative approach to stray light rejection. The ion beam texturing process has applications where increased surface area is desired without significantly changing the size or shape. Medical implants which adhere to human tissue may benefit from this technology by increasing stability while decreasing resistance.

Near Net Shaped Molding of Composite Materials. Resin matrix composite materials are typically difficult and time-consuming to fabricate when complex shapes are required. A technology effort developed by USASSDC uses a near net multi-segmented shaped mold to produce complex shapes for resin matrix composite materials. If the mold is properly designed, no finishing operations are needed to produce holes, reinforcement points, or curvatures and the cured part is dimensionally correct. This technology should result in lower costs associated with the production of composite materials. This fabrication process should be of interest to any industry which currently uses complex shaped, resin matrix composite materials.

Advanced Technology

Acousto-Optic Tunable Filters. Acousto-optic tunable filter (AOTF) technology is being developed for use by USASSDC in target interrogation sensors for the detection and use of target discriminants defined by intensity, contrast, and polarization. The AOTF uses the principle of acousto-optic interaction to provide a capability for measuring both the polarimetric and spectral properties of incoming light in a single instrument. This capability provides quantum-jump enhancement of the discrimination decision credibility. Because of its greater versatility when compared to traditional filtering devices, the AOTF has many applications outside the military arena as well. For instance, the AOTF is being used in devices which measure and record fluorescence spectra, called spectrofluorometers, for identification of cell culture characteristics for medical applications. In the chemical and food processing industries, the AOTF could be used to enhance on- line controllers for the detection of chemicals, and to detect mold on citrus fruit. Additional applications in environmental monitoring and waste management are being investigated.

Laser Communications. Laser communications offer a number of advantages over conventional radio frequency (RF) satellite communications. The shorter wavelength available using lasers provides higher data rates at less power and smaller apertures, both resulting in lower weight requirements. Further technical advantages for laser communications are high resistance to jamming, higher information bandwidth, lower probability of intercept, and 50 times current communication capability. Although there are some technology challenges yet to be overcome before intersatellite laser communications can reliably outperform RF communications, future advancements in laser satellite communications may lead to their incorporation into many commercial communication systems which desire the above characteristics.



NPB technology can be used in proton treatment of cancer.

Targets, Test and Evaluation

Global Positioning System Integration. The USASSDC is sponsoring a development effort to fully integrate a Global Positioning System (GPS) receiver into a target missile system. This capability will become an integral part of the on-board navigation, guidance, and control system of these missiles. One of the major benefits of this endeavor is that the GPS can provide independent measurement of the vehicle's position and velocity to the navigation, guidance, and control system. Potential applications to the commercial aircraft industry may result in a GPS which is fully integrated into the "autopilot" systems which would make these systems more accurate and effective.

Conclusion

Many of the technologies being developed by the USASSDC to support missile defense have applications other than those for which they were intended. Selected examples from these technologies were described earlier in this article. In order to identify these alternate applications, one must be able to remove any preconceptions about the limited scope of the technology, as well as be able to separate the underlying technology from its existing application. Also, it should be noted that few technologies are readily transferred from one application to another without requiring some modification. Therefore, it takes dedicated personnel and other resources from both the technology developer and the technology recipient in order to successfully insert an existing technology into a new application.

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MEDICAL DUAL-USE TECHNOLOGIES

By Chuck Dasey

Introduction

Military medical research is unique in a discussion of dual-use technologies because nearly all medical research intended to protect military personnel from battlefield hazards or to treat combat casualties can be applied to civilian health and medicine.

Military medical researchers deal in the cellular and molecular responses of the body; these biological, chemical and physiological processes are common to all human beings. Methods of preventing illness and injury which are derived from medical research can be applied to both military and civilian scenarios. Whether people are injured in highway accidents or on battlefields, the challenge of treating their wounds through surgical and pharmaceutical intervention is fairly constant.

Military medical researchers address a broad spectrum of health hazards associated with military operations and training. Some civilian mass casualty situations and occupational and public health hazards resemble those encountered in military environments. In many cases, military medical products for prevention or treatment can be successfully applied to civilian needs.

Historically, military medical products and procedures have benefitted civilian medicine and public health. Significant examples from the history of the Walter Reed Army Institute of Research include development of the technique for using chlorine to purify drinking water, determining the modes of transmission of yellow and typhoid fevers, developing the first standard test for syphilis, and developing the first large-scale blood banking system.

More recent examples include drug and vaccine development for tropical and third world diseases, development of new surgical techniques and treatment products for burns, preservatives for stored blood, longer lasting and more effective insect repellents, and laser safety standards and protective eyewear.

Medical Doctrine

Army medical doctrine is focused on prevention of illness and injury. A comprehensive effort is in place, encompassing research intended to reduce the vulnerability of deploying soldiers to infectious diseases, chemical and biological attack, combat stress, and performance-reducing environmental effects such as heat, cold, high altitude, loss of sleep due to sustained and continuous operations, and the potential health hazards of operating Army systems.

Specific examples of products developed by the military that will aid in the prevention of diseases include Japanese Encephalitis Vaccine, Hepatitis A Vaccine, and Argentine Hemorrhagic Fever Vaccine. Two new drugs, Mefloquine and Halofantrine, are FDA-approved for the treatment of malaria. Progress is being made to develop additional products for preventing malaria, traveller's diarrhea, dengue fever and HIV/AIDS, diseases that can affect service members in most regions of the world.

Chemical Defense

In the chemical defense arena, basic research to develop therapy for nerve agent poisoning has led to advancements in therapy for other neuromuscular and central nervous system disorders. The study of the response of pulmonary (lung) endothelial cells following exposure to chemical agents has increased the understanding of mechanisms for pulmonary edema.

The development of a cyanide pretreatment, a barrier skin protectant, and improved decontamination and chemical casualty management procedures are achievements that benefit workers in the chemical industry and in civilian laboratories and other workplaces where hazardous chemicals are used.

Investigators in the medical biological defense research program provide an institutional diagnostic capability for anthrax and several types of viruses and toxins in human and animal medicine. This capability is frequently accessed by civilian health authorities in the United States and abroad when mysterious outbreaks of illness occur. Special methods to isolate, transport, and treat patients with hazardous, communicable diseases are included in this capability.

In addition to the diagnostic capability, the medical biological defense research program has produced vaccines, antisera and antitoxins for prevention and treatment of illness caused by biological warfare agents. These products are occasionally used to aid civilians victimized by natural occurrences of disease. An antitoxin for botulinum toxin, which causes a very severe form of food poisoning, was used recently to treat victims of an outbreak of botulism in Egypt.

Environmental Medicine

Army environmental medicine experts have developed comprehensive data bases on health hazards related to military deployments. From this data base they have developed standards and recommended practices for avoiding heat and cold injury, dehydration, and altitude sickness; work-rest cycles to allow workers to adapt to adverse climatic conditions, and physical fitness regimens designed to reduce musculoskeletal injury. They have also explored the nutritional requirements of military deployments and developed guidelines for adequately nourishing soldiers. This knowledge base and resulting standards can be applied to civilian occupational settings in which environmental extremes affect work performance.

Combat Casualty Care

The Army Medical Department takes great pride in its combat casualty care system. The research and development base that supports that system seeks to extend the AMEDD's cutting edge medical technological capability to the front lines. During the Vietnam War, Army Medevac helicopters flew casualties direct from the front line to field hospitals. This system of direct transport of patients to definitive care, with medical support available on the transport vehicle, helped develop emergency medicine or trauma medicine as a specialty which is now practiced in hospitals throughout the world.

Dual-Use Products

Currently, many new dual-use products and technologies for treatment of injuries are in development. After Army-sponsored basic research eliminated numerous roadblocks, a civilian pharmaceutical company recently announced it will begin human trials of a blood substitute. The oxygen-carrying blood substitute could be applied in an emergency to keep a casualty alive until whole blood is available. This product will be useful on remote battlefields and at the scene of civilian mass casualties and disasters. It will be used without regard to blood type, and will be manufactured from blood which will be screened to insure the blood substitute is free of disease-causing contaminants.

Army researchers have also developed a blood preservative which extends the shelf-life of stored whole blood. The preservative is used in civilian blood-banking institutions worldwide. They have developed another product for preserving blood that has been stored frozen (for any interval up to 20 years) and then thawed for use.

Another developmental product which will be useful in surgical repair of wounds is a biodegradable polymer used to stem bleeding from bone. It is superior to the currently used product, bone wax, which is not biodegradable and which can increase the chance of infection. The new material is also thought to be antibacterial.

Similarly, prototypes of a biodegradable bone screw have been developed to simplify internal fixation of jaw fractures sustained during combat. Fixation screws which biodegrade while the bone heals will result in stronger healed bone fractures as screw holes fill with new bone, and would eliminate the need for screw removal due to failure, irritation, and possible infection. The new screws will offer significant improvements over current technology that uses metallic screws, stainless steel wire, and various dental splinting devices for fracture fixation.

Army medical researchers have excelled in developing new hardware systems for medical imaging. New developments in imaging technology range from a portable, high performance X-ray system for medical and dental use in the field, to a Medical Digital Imaging Support (MDIS) System, which captures and stores diagnostic images from X-ray systems and CT scanners in computer memory. The system centrally stores images produced at scores of sites throughout a major medical center, and allows them to be called up on any terminal in the hospital at any time. This system eliminates the need to use, store, and share X-ray films, which are frequently lost or misfiled in a busy hospital. Images stored in the system can also be communicated anywhere in the world for consultative or educational purposes, through wire, fiber optic cable or satellite communication systems.

In the field, Army medicine is advancing applications of teleradiology and telemedicine, in which satellite communication of medical data and imagery are used for remote consultations between the field and experts back at home.

Another imaging system, invented and patented by Army investigators, is a method for rapid, three-dimensional numerical mapping of objects from one inch away to hundreds of yards away. This device can map features of human anatomy, such as a tooth, with resolution of 20 microns, or a whole head, with one-half millimeter resolution. Possible non-medical applications of this technology include internal inspection of pipelines or airplane and ship hulls; robotic manufacturing and assembly; rapid, on-line inspection for manufacturing; computer-aided design, and inspection of microcircuitry.

Additional dual-use projects in development for trauma medicine and surgery include methods for surgical repair of laser eye injuries, the use of fibrin tissue adhesives for control of hemorrhage, microencapsulated antibiotics for single-dose, sustained prevention of wound infection, a mathematical model of the cardiovascular system, and improved surgical procedures and treatment products for burn wounds.

Conclusion

Military medical researchers have achieved great progress in prevention and treatment in the past. However, significant challenges remain ahead. The proliferation of sophisticated conventional weaponry, and the capability to deploy nuclear, chemical and biological weapons, is growing. There is compelling evidence that regional battlefields of the future will be at least as dangerous as any in the past, or any that were war-gamed during the Cold War. The drawn-down Army will need to be sustained and preserved on the battlefield through an effective preventive medicine program.

Military medical researchers will need to stay abreast of new trends and discoveries in the life sciences, and initiate new applications of medical knowledge and technology to battlefield medicine. They will perform their critical mission in consolidated, streamlined, tri-service laboratories. They will work closely with contractors and collaborators from academia and civilian industry. The applicability of their work to civilian health and science challenges, as well as to military needs, will be an important standard for evaluation by the Defense Department and the Congress. Their success as military medical researchers and technological innovators will benefit not only the military, but medicine and mankind in general.

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DUAL-USE FOOD TECHNOLOGIES

By Philip Brandler and Gerald L. Schulz

Introduction

Although "dual-use technology" is now getting formal attention and recognition, this approach has a long history in the area of food processing technology. The first example of military-sponsored dual- use technology related to food was the development of food preservation by the use of heat and hermetically sealed containers by Nicholas Appert in the early 1800s. This process, known today as "canning," was developed in response to a need for shelf-stable foods to feed Napoleon's armies. The benefits of this early development and application of dual-use technology to the entire world are obvious.

The formal establishment in the United States of a military research and development organization, prior to World War II, dedicated to feeding resulted in extensive cooperative work between the Army and the food industry. As a result of these efforts, numerous dual-use technologies were developed jointly to meet military needs as well as offering potential for civilian applications. Dehydrated coffee, prepared dry bakery mixes, and dried milk are a few of the more familiar cooperative developments of that era that found widespread use throughout the world.

Current Dual-Use Technology Initiatives

The U.S. Army Natick Research, Development and Engineering Center (Natick) has a number of ongoing dual-use technology efforts in the areas of food processing as well as food safety. Several of these are summarized in this article. These cooperative efforts with academia and industry provide an ideal vehicle for leveraging commercial research and development to help meet military needs at significantly lower costs while fulfilling President Clinton's policy of assisting the private sector to promote business growth.

Dehydration

Natural drying of foods by the sun is the oldest preservation technique used by man. Modern drying techniques include the use of hot air in various types of air driers, use of hot surfaces as in roller drying, and sublimation of ice from frozen foods (freeze drying).

Removal of the water required by all microorganisms for growth not only prevents deterioration and spoilage of the food but also significantly reduces its weight, making this an ideal preservation method for many military applications such as the Long Range Patrol Ration. Dehydration of foods is widely used today for both civilian (soups, coffee, juice powder, fruits, backpack meals, etc.) and military applications (see Figure 1). Freeze drying is the dehydration method generally recognized as producing the highest quality product; however, this process is relatively costly and energy intensive.

Natick, in conjunction with academia and industry, is exploring various methods of reducing the overall cost of food dehydration. We are pursuing methods such as microwave-assisted freeze drying and utilization of less costly methods to remove much of the initial moisture, followed by freeze drying for the final moisture removal. Significant reduction in costs and energy requirements, without sacrificing quality, could result in greater use of dehydrated foods both for commercial and military applications.

Cold Pasteurization

New, non-thermal processing technologies for the production of fresh and fresh-like prepared foods are being investigated at Natick and in the commercial and academic sectors. These technologies include pulsed electric fields, pulsed light, oscillating magnetic fields, hyperbaric pressure treatment, and combinations of preservation methods , such as combining natural preservations with moderate thermal treatment.

These technologies have the potential to produce foods that are shelf stable but possess the flavor and textural characteristics of fresh foods by greatly reducing the structural changes in comparison to conventional processing methods. Currently, various processes are being evaluated, and those with the greatest potential will be further developed under joint programs with academia and industry. These non- thermal processes can be applied to meats, dairy products, fruit preserves, vegetables, etc.

Successful development of cold pasteurization technology will result in both extended shelf life of fresh foods as well as higher quality shelf-stable foods. Obvious advantages for military feeding include extended operational use of fresh, highly acceptable A Rations (e.g., fresh foods) and improved quality and variety of combat rations (e.g., shelf-stable foods).

For the commercial sector, extended shelf life of both fresh and shelf-stable foods could result in new markets, particularly in Third World countries where refrigeration is not widely available. Additionally, humanitarian aid and emergency feeding systems could benefit significantly from food products that can be stored for extended periods under uncontrolled storage conditions.

Dental Liquid Meals

The development of a ration system designed for patients who cannot eat solid food due to maxillofacial injuries, such as broken jaws and dental injuries, was requested by the Office of The Surgeon General. Liquid diets previously used in hospital feeding required substantial preparation time and equipment and were not always acceptable to patients.

The Dental Liquid Ration developed by Natick consists of dehydrated powders that, when reconstituted with water, are sippable through a straw and taste like normal components of a meal (see Figure 2). Thirty-six products were developed to support a three-day menu cycle. These items include chicken barbecue, lyonnaise potatoes, green bean casserole, and chocolate mocha cake.

In FY92, the Dental Liquid Ration was accepted by the Surgeon General and it is now being procured for hospital use. A Cooperative Research and Development Agreement was initiated with Land O' Lakes, Procor Technologies (now Advanced Food Science, Incorporated) to apply the developed technologies to industrial processes for commercialization of the ration. These products have broad application not only to soldiers with jaw injuries, but also for civilians with jaw injuries, swallowing disorders, geriatric feeding, feeding of Altzheimer patients and cancer patients, etc.

Shelf Stable Bread Products

Successful development of shelf stable pouch bread products required extensive studies on the mechanisms of the complex chemical reactions that limit the storage stability of bakery products. Natick and several commercial baking firms conducted extensive studies to define the quality deficiencies of stored bakery products and to develop new formulations and processes that retard or inhibit the degradation processes, such as staling and the growth of molds.

A bread product packed in flexible pouches, either individually or bulk, has been developed and accepted for use in operational rations and field feeding systems. This product is stabilized by water activity control, pH, and modified atmosphere packaging to ensure quality and safety. This unique technology has now been applied to the development of novel shelf-stable products such as burritos, pizza and deli sandwiches, in addition to a new line of shelf-stable pound cakes. Several companies are currently producing shelf-stable bakery products. One unusual application of this technology is to the diet food industry when shelf stable meals are part of the diet program.

Restructured Meats

Development of restructured meats was pioneered through research efforts at Natick to reduce the impact of rising meat costs on the military feeding systems. Utilizing novel processing techniques, a variety of restructured products were developed and implemented in various feeding systems (e.g., the Meal, Ready-to-Eat, the Tray Ration and frozen meats used in both Garrison Feeding and A Ration field feeding). These restructured, portion-controlled meats resemble whole meat muscle products, such as steaks and chops, but at a cost savings of up to 40 percent.

Restructuring techniques make possible the control of fat content and allow for nutritional optimization of the products. For military rations, restructuring has been successfully applied to beef, pork, chicken, veal, and lamb products. It has multifunctional use in the freeze dehydrated rations, as well as the retort pouch meat entrees. Many major meat processors now use restructuring techniques for some of their product line. Restaurants and fast food operations have adopted the veal and chicken patties in particular on a widespread basis. New restructuring techniques are now being studied under a cooperative research program with the U.S. Department of Agriculture, Agricultural Research Service, and Colorado State University.

Food Irradiation

As part of the "Atoms for Peace" program sponsored by the Atomic Energy Commission, the DOD initiated an extensive research program for the development of food processed by irradiation for use in military feeding systems. The DOD conducted this effort at Natick until the program transitioned to the USDA in 1981; in 1991, the Army rejoined the food irradiation arena as an active member with USDA.

To date, the food irradiation process has been approved for potatoes (sprout inhibition), fresh vegetables (shelf life extension) (see Figure 3), fresh fruit (shelf life

Figure 1. Dehydration of foods is widely used today for both civilian and military applications.

Figure 2.
Dental liquid rations are sippable through a straw and taste like normal meal components.

extension), fresh poultry (elimination of food pathogens), spices (microbial destruction and inhibition), and pork (control of *Trichinella).* Thirty-nine countries currently use irradiation processed food.

Commercially processed irradiated fruits and vegetables are now being introduced by commercial suppliers in the U.S., and the volume and types of products available are expanding as companies are establishing their market base. Potential uses for irradiated foods by the DOD include shelf life extension of fruits and vegetables, pasteurization of chicken, and spice deinfestation, particularly for use in field feeding situations to permit the maximum use of A Rations.

As approvals for high-dose irradiation processes are obtained, irradiated products will be considered for use in operational rations, since this process permits the sterilization of the product after cooking. This means we can grill a steak and then package and sterilize it in the package without the use of high heat treatment for long shelf life. In the commercial sector this process will permit the production of shelf-stable high-quality whole muscle meat items that are currently available only in frozen form.

Retort Pouched Foods

Natick initiated research efforts on the potential for use of flexible retortable pouches as a replacement for the tin plated metal cans used in the Individual Combat Ration ("C" Ration) in the early 1960s. Extensive cooperative studies by Natick, academia and the packaging industry on composition of the trilaminate material, extractives from the pouch, insect penetration, and pouch integrity during shipment and storage demonstrated the feasibility of replacing metal cans with flexible pouches.

The new Meal, Ready-to-Eat (MRE), based on the retort pouch concept, was type classified in 1975. Industrial procurements have been ongoing since 1980, with many commercial firms supplying components for the MRE. Research leading to this commercialization of the pouch merited many Army and national awards, including the Packaging Institute's Special Award and the Institute of Food Technologists' Food Technology Industrial Achievement Award. Currently, retort pouched foods are used commercially, primarily in the diet and specialty food areas, such as microwaveable meals for children (see Figure 4).

Improved Sulfite Detection Method

Sulfite is a multifunctional food additive that, although safe for a majority of the population, is known to cause hypersensitivity reaction in some people, especially among asthmatics. In order to protect sulfite-allergic individuals from exposure to sulfite, the FDA requires that all food products declare the presence of sulfite on the label if it exists at or above 10 ppm. The conventional method for sulfite detection, the Monier-Williams (MW) method, is subject to a false positive. Therefore, the results are uncertain at the detection limit of 10 ppm. Since sulfite is used as a stabilizer in dehydrated foods used in operational rations and for shipboard feeding, a more accurate, efficient detection method was needed.

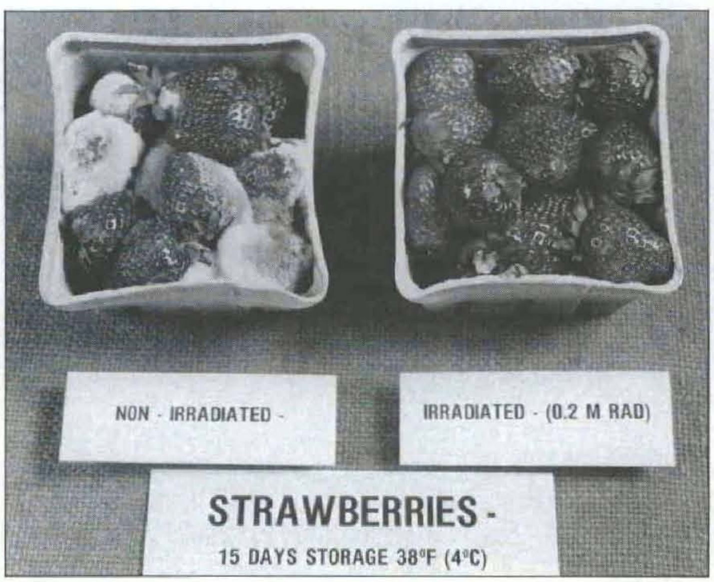
An alternative method developed at Natick overcomes many deficiencies of the MW method. The MW method required 150 minutes for acid distillation and depends on a non-specific alkali titration for determination. The Natick method is based on ion exclusion chromatographic separation with an extremely specific electrochemical detection. As a result, interference-free sulfite detection with one ppm detection limit is achieved in 20 minutes.

The method has been tested by a nationwide collaborative study and approved by the Association of Official Analytical Chemists. It can be used by food industries and regulatory agencies to ensure compliance with the FDA sulfite labeling regulation without the complications due to false positives by the MW method.

Rapid *Listeria* Detection Method

The need for rapid and convenient procedures for detection of *Listeria* is recognized in the food industry as well as in government agencies (USDA, FDA, and Centers for Disease Control). Natick embarked on the development of a rapid method for detection of cold-tolerant, foodborne pathogenic *Listeria* for two reasons: (a) interest in the military for lightly processed and ready-to-eat, chilled foods or rations; and (b) the recognition of risk of foodborne illness from pathogenic *Listeria* with these types of rations. The Navy, in particular, makes extensive use of products preserved in

Figure 3.
Thirty-nine countries currently use irradiated foods.



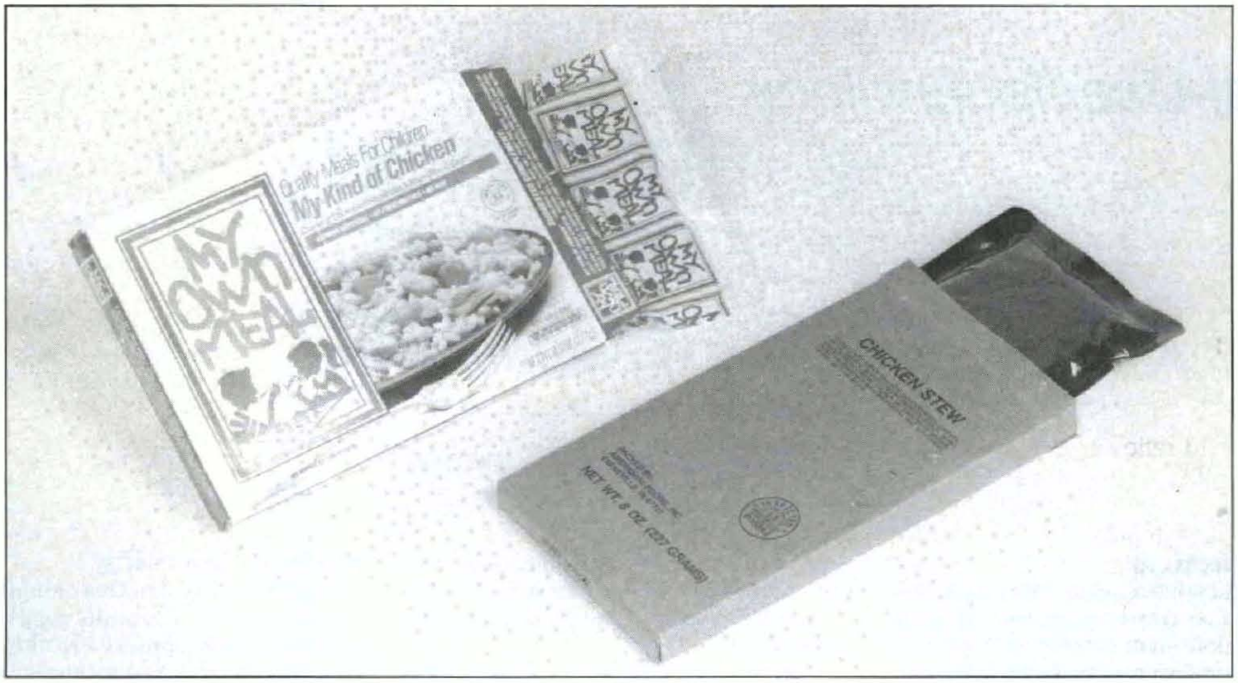


Figure 4.
Retort pouched foods are used commercially in diet and specialty food areas.

chilled and frozen state onboard ship.

Natick has developed the most rapid procedures to date for the detection and identification of pathogenic *Listeria monocytogenes* (LM) in foods. At least two firms have adapted the recovery phase of the Natick procedure in their respective food safety assay kits. The recovery phase involves providing growth conditions that selectively encourage the formation of LM colonies of agar plats. Subsequent to the recovery phase, the agar plates are screened for *Listeria* colonies using the Spectral Pattern-Oblique Transillumination (SPOT) test. This rapid test involves the specific recognition of *Listeria* colonies that are obliquely illuminated by transmitted visible light by appearing bluish at an angle of 135 degrees and reddish at 110 degrees.

Conclusion

Dual-use technology has a long and proud history in the military subsistence area. While significant contributions to the commercial sector have been made by military ration developments, the current emphasis is on mutual leveraging between military, other government agencies, industry and academia through Memorandums of Understanding (MOU) and Cooperative R&D Agreements. Natick currently has seven Cooperative R&D Agreements approved and eight additional being finalized. MOUs are in place with USDA and NASA, and Natick has joined with industry and academia in consortia such as the Center for Advanced Food Technology.

In addition to the obvious development cost savings to the military through the pursuit of cooperative programs, the application of dual-use technology reduces the cost of subsistence items as compared to military unique foods. The expanded industrial base enhances the readiness posture, reduces the ramp-up time to meet mobilization requirements and, therefore, reduces the prepositioned war reserve requirements with consequent cost savings as well.

From a commercial viewpoint, the expedited development of shelf- stable food technologies for military rations not only expands the American market for value-added, high-quality packaged foods, but these technologies provide a broader range of exportable food items for foreign countries where refrigeration is not as prevalent as well as for disaster and humanitarian relief feeding.

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Dual-Use Technology... THE PRECISION LIGHTWEIGHT GPS RECEIVER

By COL Bruce D. Sweeney

Introduction

In August 1990, Global Positioning System (GPS) receivers—each costing more than $40,000—had been in development since 1976 and were again failing user reliability, availability and maintainability (RAM) testing. The U.S. Army was deploying to the trackless desert to confront the armored and entrenched hordes of Saddam Hussein while the Army deputy chief of staff for operations was demanding thousands of GPS receivers immediately. To compound this situation, the assistant secretary of defense (command, control, communications and intelligence) would only permit us to buy "military accuracy" GPS receivers for combat and combat support applications.

This was the situation in August 1990 as I assumed duties as the new GPS project manager. GPS Army User Equipment is part of the NAVSTAR GPS system, a joint acquisition program with the U.S. Air Force as the lead service. My challenge was to get a GPS capability to the field quickly, at low cost, and to accomplish this task through the GPS Joint Program Office (JPO).

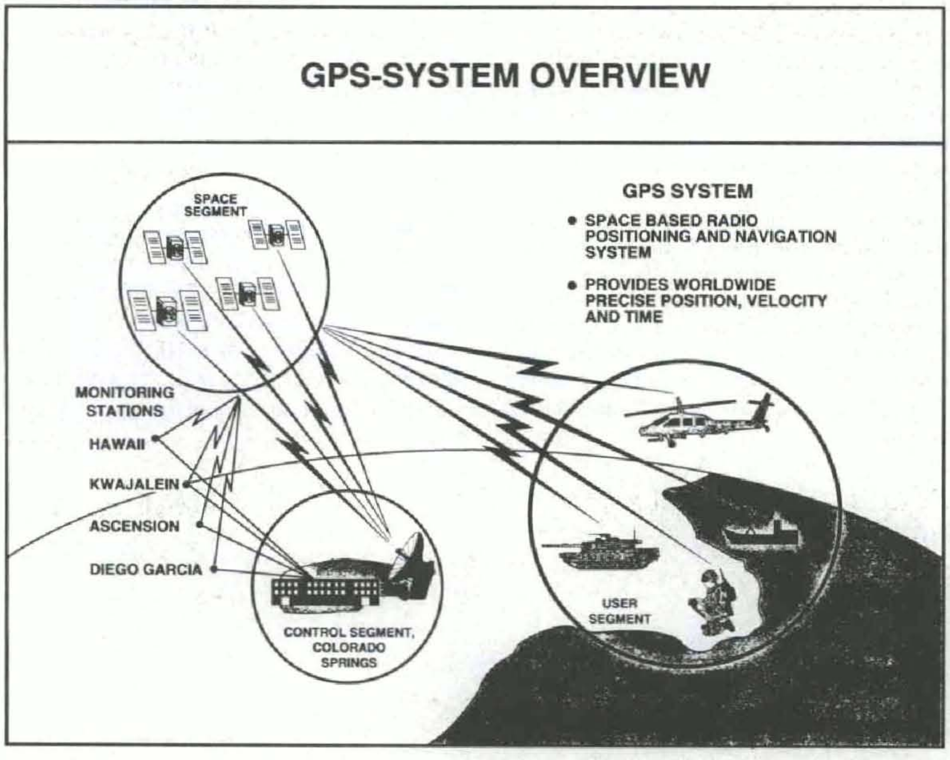

Figure 1.

System Overview

The NAVSTAR Global Positioning System is a space based radio positioning and navigation system that provides worldwide precise position, velocity and time information to users (see Figure 1). It is composed of three segments (space, ground control and user), all in varying stages of operational readiness. The focus of this article is the user equipment segment (or receivers).

GPS is a dual, military and civilian, use system. It provides standard positioning service (SPS) for civilian users who gain access to the system using commercially available receivers. For U.S. military and selected allies, Precise Positioning Service (PPS) is available via the incorporation of embedded encryption algorithms which perform the functions of selective availability (SA) and anti-spoofing.

Selective availability is used by the U.S. Department of Defense to deny full system accuracy to potential adversaries. The current, or "peacetime," SA level provides civilian users three dimensional position accuracy, i.e., the system provides position information which is within 76 meters of truth, 50 percent of the time (we call this Spherical Error Probable, or SEP). The PPS (otherwise known as military accuracy) receiver automatically corrects for these intentional SA errors and provides the "authorized" user three-dimensional position accuracy of 16 meters SEP.

DOD policy refrains the services from using SPS receivers and directs us to the exclusive use of PPS receivers for combat/combat support purposes. However, commercially designed receivers had, by 1990, become so much lighter, easier to use and less expensive than military receivers that they became a viable alternative for field application in contingency situations. The specific challenge has been to apply the concept of dual-use technology to GPS

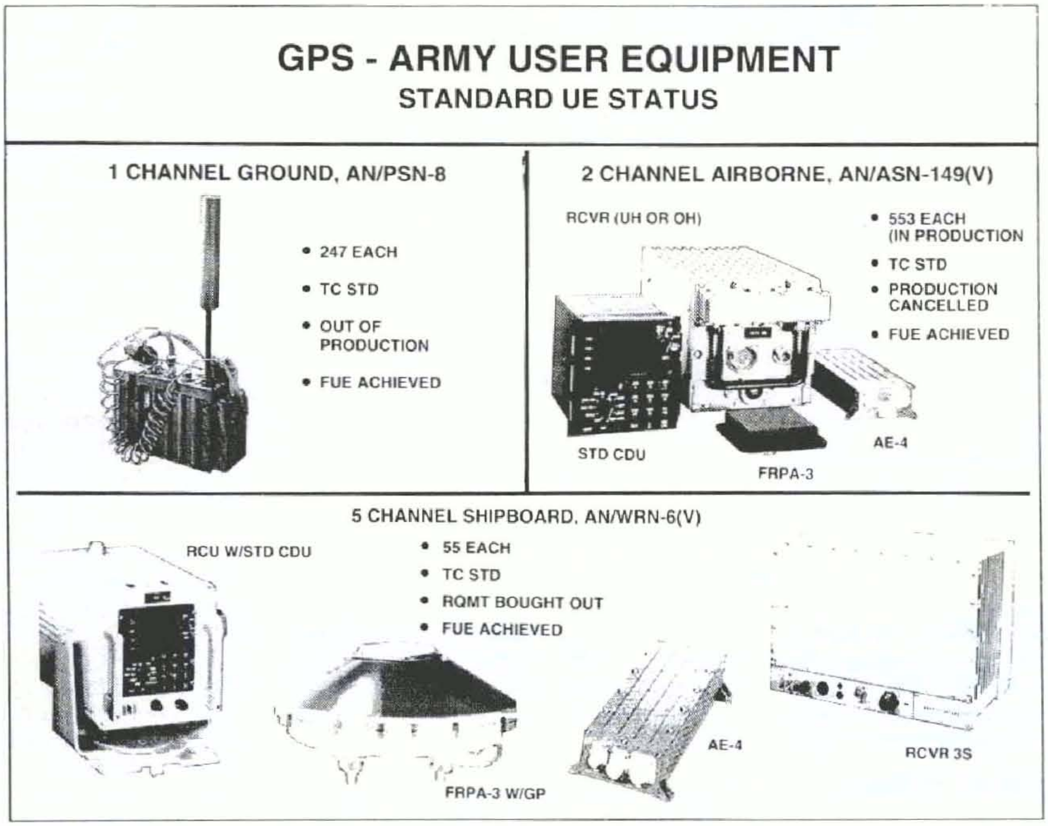

Figure 2.

receivers in order to make PPS receivers affordable and desirable for use by Army ground forces. This article describes how this was achieved within 2½ years of the approval of an Army formal requirement (April 1991) via the use of an aggressive nondevelopmental item strategy.

User Equipment Development Phase

Through 1992, the user equipment segment of GPS lagged far behind the control and space segments in terms of DOD investment and utility, especially for ground mobile operations. The JPO had pursued the development of a family of full military specification receivers beginning in 1976. Figure 2 depicts user equipment being acquired by the Army as of 1990.

While the Army has a need for GPS receivers which are integrated into aircraft and ocean-going watercraft, the focus of this article is on the NDI replacement for the AN/PSN-8 one channel ground set—the AN/PSN-11, Precision Lightweight GPS Receiver (PLGR).

The AN/PSN-8 is a 17-pound man-transportable, or vehicle mounted GPS receiver, with a unit price tag of more than $40,000 in 1990. This set successfully completed formal Initial Operational Test and Evaluation during Operation Desert Storm and met envisioned performance and electronic warfare requirements. However, it remained too heavy and complex to gain favor for use by dismounted soldiers. Additionally, to acquire about 60,000 AN/PSN-8 sets for ground Army users would have required more than $2 billion. It was to have been the Army's objective system until our experiences with a commercial-off-the-shelf receiver during Operation Desert Storm (ODS).

Operation Desert Storm

ODS deployments in 1990 called for an interim emergency buy of about 8,000 Small Lightweight GPS Receivers (SLGR) which weighed 4.1 pounds and cost about $4,000 each. It was a ruggedized commercial receiver which was easy to use but did not provide the Precise Positioning Service accuracy required for objective military operations.

During ODS, the National Command Authority removed the intentional errors of SA, thus giving any user of SPS receivers full system accuracy, a prudent move at the time because only the U.S. and its allies had meaningful quantities of GPS receivers of any description. In future combat situations, this will not be the case. GPS producers are selling thousands of civilian SPS receivers to foreign customers each month. Following ODS, the problem became how to get PPS capable receivers to U.S. forces quickly.

The Requirement

The Army, as the predominant ground user of GPS, was also experiencing a dramatic increase in demand. In 1986, the Army foresaw only a nominal demand for about 900 ground receivers, but with feedback from ODS, requirements poured in from the Army combat developers and peaked at 76,785 for the 28 division force in 1990/91. Figure 3 shows this increased demand. Even with the downsized 20 division force in 1991-92, demand continued to grow.

In 1990, the Army halted production buys of the AN/PSN-8. Market surveillance revealed that commercial vendors were offering several GPS products to the public that were lighter in weight and lower in cost.

The Market Survey

In November 1990, the Army, through the JPO, began to assess whether commercial GPS receivers could be adapted for military use. My biggest challenge during the market survey period was reaching consensus within the JPO that a non-developmental item strategy for a lightweight PPS receiver was feasible. In parallel with the initial phase of the market survey to find an off-the-shelf ground receiver, the Army amended its 1979 Required Operational Capability (ROC) to take advantage of commercial GPS technology.

By switching to a commercial-off-the-shelf (COTS)/NDI strategy for PLGR, the Army had to perform tradeoffs in its requirements since anticipated COTS receivers were not expected to match the performance of the AN/PSN-8. Definition of PLGR was directed to meet minimum essential

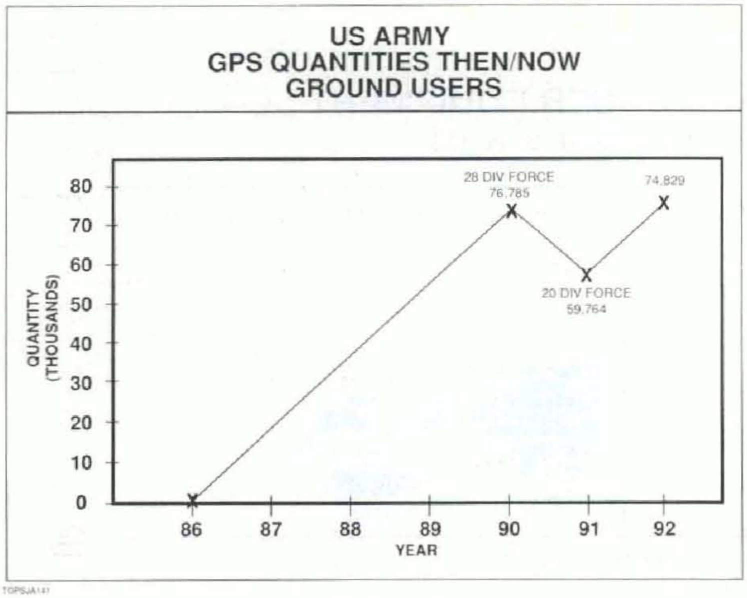

Figure 3.

requirements, to be affordable, available in the near term and easy to operate. The challenge during tradeoff analysis was to control the appetites of government design engineers seeking to optimize performance.

Competition and Industry's Challenge

Several GPS manufacturers appeared ready to participate in a COTS acquisition of PLGR because PLGR was sufficiently like what their commercial products were evolving to in response to demands in the commercial sector (e.g., recreation market) and foreign market. Some GPS manufacturers objected to this strategy because they were unwilling or unable to bring their commercial products up to the PLGR specification without a government R&D contract. The government project team eventually concluded that sufficient commercial manufacturers would participate in a COTS-style procurement. This decision was hotly contested within the government and by some commercial suppliers right up to production award.

During the solicitation phase, those vendors who objected to our strategy used available legal channels to challenge our COTS NDI strategy. We sustained two Government Accounting Office (GAO) protests, two Court of Claims cases, and ligation at the Court of Appeals. The thrust of industry's discontent was that their existing commercial SPS receivers required a whole range of minor to major modifications to become PPS compliant and, thus, they charged, should not meet the Federal Acquisition Regulation definition of NDI.

The government team expended a lot of energy during this lengthy litigation process but successfully held to our procurement inchstone schedule until the Court of Appeal imposed an injunction to any contract award on the day that bids were to be opened in January 1993. This injunction caused a 43-day delay in award which has rippled through the rest of the planned events. Otherwise, the original NDI acquisition schedule was adhered to in all respects.

PLGR Acquisition Strategy

The Army and OSD placed several constraints on the PLGR acquisition which drove the entire strategy. These were:

- Lowest possible unit and life cycle costs (Army). Our PLGR goal was to meet or improve upon SLGR's approximately $4,000.00 unit cost and four year manufacturer's warranty.
- Production delivery must commence in CY93, sooner if possible (Army). Programmed funding was at risk.
- PLGR capability must approximate the AN/PSN-8 SA and anti-spoofing performance in a package smaller than SLGR, with human factors as good as, or better than, SLGR (Army and OSD).

A government "form/fit/function" (F/F/F) specification was extensively coordinated with industry (November 90–June 91) and their response provided strong evidence that several commercial manufacturers of SLGR-like products could provide a PLGR compliant product by September 92. The acquisition strategy was then coordinated with industry during June 91–April 92. It planned a winner-take-all single production contract consisting of a basic award plus four option years, each with flexible quantity pricing. The Army accepted the specification and acquisition strategy in a PEO Communications In Process Review production decision in December 1991.

The NDI acquisition strategy set legal precedent during GAO hearings and was upheld by the courts. The precedent was that the government, under an NDI acquisition, can properly acquire a system which may not exist at the time of project initiation. The courts stipulated that government use of an NDI strategy was permissible if the system was to be otherwise in production at the time of government contract award.

Solicitation and Evaluation

The procurement was conducted as a two step sealed bid with bid sample testing (see Figure 4). Step 1, Request for Technical Proposals and Bid Samples, required each offerer to submit a technical proposal and fully compliant bid samples in September 1992. Three industry proposals, with bid samples, were received. Two vendors successfully passed the bid sample testing which consisted of technical performance, environmental, SA and anti-spoofing, and human factors and were invited to participate in Step 2, Invitation For Bid via Sealed Bids, issued in January 1993. Bid opening and contract award occurred in March 1993. Rockwell International, Cedar Rapids, IA won the life cycle cost based production contract.

The Contract

The contract is a five-year, firm-fixed-priced, requirements type contract. The base year required the purchase of a minimum 4,200 units and maximum of 13,999. The four option years require a minimum 2,000 units and maximum 20,000 purchase. Production leadtime is six months during which an abbreviated first article test is conducted to verify specification compliance not previously covered during bid sample testing.

The PLGR comes with a six-year performance and reliability warranty. There are minimal data items (less than 30 scheduled data deliveries). The government controls only the form/fit/function of the PLGR and its accessory items. Rockwell is free to evolve the production baseline to achieve production efficiencies anywhere in the box except for the embedded government approved security device. This aspect of the acquisition strategy was critical to a commercial type buy in that it encourages the manufacturer to maintain current technology as parts suppliers change and as manufacturing processes evolve.

Rockwell priced their PLGR at $1,300.00 per set in the base and first option years, then decreased unit cost to $772 per set in the last option year. Their PLGR weighs 2.7 pounds and the six year warranty is included in the unit hardware cost. With such attractive pricing, the Army was able to acquire 11,000 sets with available FY93 OPA funding formally estimated to support a purchase of only 2,700 sets. The favorable pricing allows the Army to buy out all known requirements of approximately 60,000 PLGRs within the option years and within programed funding.

Follow-On Testing

Pre-production Operational Test (OT) was waived by the deputy under secretary of the Army for operations research, and supported by the DOD director of operational test and evaluation, due to prior successful completion of operational tests for the AN/PSN-8, the experience of SLGR during ODS, and the plan for a substantial bid sample test prior to initial purchase. A formal operational test was concluded on Nov. 12 by the U.S. Army Operational Test and Evaluation Command to establish the adequacy of the logistics concept and support package.

Deployment

Production deliveries began in September 1993 and fielding of the initial 11,000 PLGR will commence on an accelerated schedule beginning with CONUS based contingency forces in early FY94. Worldwide fielding to active component units will be completed by FY97. This is seven years earlier than what could have been achieved with ODS vintage SLGRs at ODS vintage prices!

Keys to Success

We conducted a comprehensive market survey. This allowed the government to know what was coming in commercial technology and to capture it. It also allowed industry to complete their commercial product development with efficient hooks to accommodate military unique features. The government team, armed with industry feedback, traded cost, schedule and technical performance to maximize the potential for open competition. This proved difficult but achievable.

User participation in the trade-off process was ultimately critical in encouraging the project manager to eliminate most military specifications and standards.

We established the performance specification baseline and then froze it through solicitation, testing and production. In other words, we "shot the engineers." This gave industry confidence in our need, schedule and process. Industry was treated as a full partner in the planning process and their comments and suggestions were listened to and acted upon.

We structured a sensible test program to "fly before you buy" but didn't over test the product. The tester/evaluator bought in to concise, focused tests to ensure controllable risks, versus a killer, risk elimination test program. We used a combination of manufacturer and government technical tests and government operational tests to gate key decisions and events.

We solved problems through open team discussions and kept the dialogue going until each problem was solved. We didn't let an individual team member keep us from resolving roadblocks because of an individual interpretation of the "rules."

Lastly, the biggest reason for success was establishing a practical schedule and sticking to it. HQ, U.S. Army informal urgency statements were needed from time to time to keep the heat on timely problem resolution.

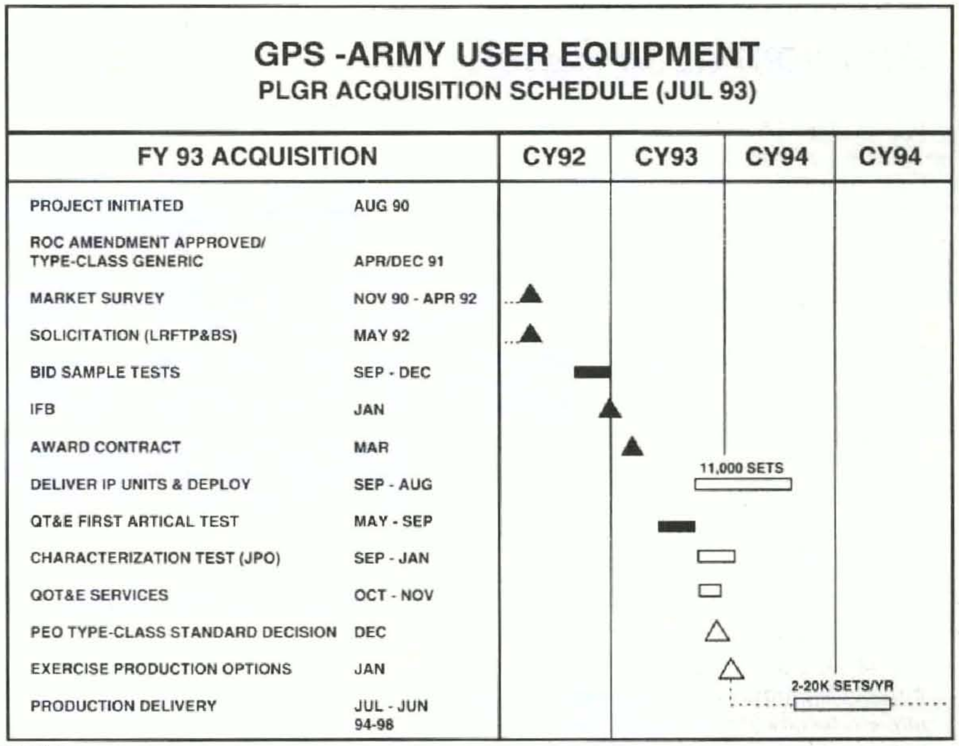

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Figure 4.

The Result

PLGR is the best performing military accuracy receiver yet acquired by the GPS Joint Program Office. It costs three percent of the 1990 price for the AN/PSN-8 manpack receiver. This provided more than $2 billion in cost avoidance to acquire PLGR for the total force. It is easy to use and lighter than even SLGR. Overall, just a few hard won concessions in the acquisition strategy facilitated deployment of a receiver that meets or exceeds all goals for the project and provides the soldier the best that U.S. technology can build today. He can again overmatch his adversary in the next war.

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An Information Paper...

THE ARMY ACQUISITION CERTIFICATION PROGRAM

By Dr. James Edgar

Editor's Note: The following information paper is being published in an effort to provide information regarding the Army's Acquisition Certification Program. Additional information papers on key issues related to the Army Acquisition Corps and the acquisition work force are planned for publication in future issues of Army RD&A Bulletin.

1. DEFINITION: Certification is a *management* process which determines that an individual meets all the mandatory standards established for a career level in an acquisition career field.

2. PURPOSE: The purpose of certification is to assure that acquisition personnel are qualified in terms of education, experience and training to perform the duties of their assigned acquisition position.

3. CAREER FIELD: A career field is one or more occupations or functional areas that require similar knowledges and skills. There are 12 acquisition career fields, 11 of which apply to the Army: Program Management; Contracting (including construction); Industrial Property Management; Purchasing; Manufacturing and Production; Quality Assurance; Business, Cost Estimating and Financial Management; Acquisition Logistics; Communications-Computer Systems; Systems Planning, Research, Development, and Engineering; and Test and Evaluation Engineering. Auditing is a DOD career field, but the Army has no acquisition positions in Auditing. Each acquisition career field has specific mandatory education, training and experience standards, which are found in DOD 5000.52-M.

4. CAREER LEVELS: A career level is a grouping of education, training and experience standards that provide the framework for progression within an acquisition career field. There are three career levels: Level I/Basic (0-1/0-3 and GS-5/7); Level II/Intermediate (0-3/0-4 and GS-9/12); and Level III/Senior (0-4 and above and GS/GM-13 and above). (Note that the levels are less for GS-1105 positions/personnel in the purchasing career field.)

5. CERTIFICATION STANDARD: Each acquisition position has a certification standard. A certification standard is a combination of three elements: (1) the career level (I, II or III) of the position; (2) the acquisition position category and corresponding acquisition career field; and (3) the education, training, and experience standards for the career level and career field as stated in DOD 5000.52-M. (Note: There are 14 acquisition position categories but only 12 acquisition career fields. The two non-specific position categories are: Program Management Oversight; and, Education, Training and Career Development. Supervisors/managers must decide what acquisition career field or fields are most closely associated with the duties of the position.

6. MULTIPLE CERTIFICATION: An individual may be certified in more than one acquisition career field; however, they must be certified to the standard identified in their acquisition position category.

7. CERTIFICATION LEVELS: The Army intends for certifying officials to be at the appropriate level commensurate with their responsibilities in the acquisition system and the proximity of the individual's official personnel file.

a. The following criteria apply to certification of civilians. Level I certifications may be accomplished by second-level supervisors. Level II certification will be accomplished by the PEO, Installation Commander, Major Subordinate Command or Major Command depending on the location of the position. For individuals assigned to Department of Army, Level II certification is approved by the Functional Chief/Functional Chief Representative (FC/FCR). All Level III certifications will be approved no lower than the Functional Chief/Functional Chief Representative. The Director, Acquisition Career Management (DACM) and/or Army Acquisition Executive (AAE) may certify Functional Chiefs/Functional Chief Representatives and other senior-employee positions.

b. Level I and Level II certification of military officers will be accomplished by PERSCOM, Chief Acquisition Corps Management Office. Level III certification will be accomplished by the DACM and/or AAE as appropriate.

c. The various certification levels and appropriate certifying officials are shown in Table 1.

8. WAIVERS: Generally, individuals assigned to acquisition positions who do not meet the applicable education, training and experience standards required for certification have 18 months in which to achieve the standards. If an individual is not certified within the prescribed time limits, then a waiver must

TABLE 1
CERTIFICATION AUTHORITY LEVELS

CAREER LEVEL AUTHORITY CIVILIAN	MILITARY	CERTIFICATION LEVEL
AAE	AAE	III
DACM	DACM	III
FC/FCR		III/II
MACOM	PERSCOM	II
PEO		II
INSTALLATION		II
2ND LEVEL SUPERVISOR	PERSCOM	I

TABLE 2 CERTIFICATION WAIVER AUTHORITY		
CERTIFICATION CAREER LEVEL	WAIVER AUTHORITY CIVILIAN	MILITARY
III	AAE	AAE
III	DACM	DACM
II	DACM	DACM
II	FC/FCR	
II	MACOM	
I	FC/FCR	DACM
I	MACOM	
I	MSC	
I	PEO	
I	INSTALLATION	

TABLE 3 CERTIFICATION/WAIVER AUTHORITY LEVELS			
CERTIFICATION LEVEL	LOCATION OF EMPLOYEE	CERTIFICATION LEVEL AUTHORITY	WAIVER LEVEL AUTHORITY
I	INSTALLATION	2ND LEVEL SUPERVISOR	INSTALLATION
I	MSC	2ND LEVEL SUPERVISOR	MSC
I	PEO	2ND LEVEL SUPERVISOR	PEO
I	MACOM	2ND LEVEL SUPERVISOR	MACOM
I	HQDA	2ND LEVEL SUPERVISOR	FC/FCR
II	INSTALLATION	INSTALLATION	MACOM
II	MSC	MSC	MACOM
II	PEO	PEO	FC/FCR
II	MACOM	MACOM	FC/FCR
II	HQDA	FC/FCR	DDACM
III	INSTALLATION	FC/FCR	DACM
III	MSC	FC/FCR	DACM
III	MACOM	FC/FCR	DACM
III	PEO	FC/FCR	DACM
III	HQDA	FC/FCR/DACM/AAE	DACM/AAE

be approved to allow the individual to remain in that position until certification has been completed. In addition, individuals who do not meet the education, training and experience required for critical acquisition positions may not carry out the duties or exercise the authorities of such positions, except for a period of six months, unless waivers of those requirements are granted. Waivers are authorized when in the best interest of the Government and individual. Waiving authorities are comparable to certifying officials but at one level higher than certifying officials. Table 2 indicates the various waiver levels.

9. CONCLUSION: Certification is an important management process to insure that individual members of the acquisition work force/acquisition corps are qualified relative to the mandatory standards for their position, level, and career field. It is also an evaluation tool that individuals may use to measure their progress against their career progression goals. Table 3 indicates both the certifying levels and waiver levels for the three career levels for civilian employees.

Military officer certification is underway using the criteria and standards in the October 1991 edition of DOD 5000.52-M. Civilian certification will rely on automated procedures being established in Field ACPERS. This will simplify certification for functional managers, civilian personnel offices, and individual employees, and is similar to Air Force procedures for civilians. Necessary changes to Field ACPERS are awaiting the new standards in a revision to DOD 5000.52-M. The current edition will remain in effect until October 1994 for military. Civilian certification will not begin before May 1994. A reasonable period for implementation will be allowed. The certification provisions of DOD policy will not go into effect until after a reasonable phase-in period. In the meantime, no one will be harmed because they have not been certified. However, individuals should be scheduled to attend all mandatory training for their career field.

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FORCE PROVIDER

By COL David H. Wayne
and MAJ C.G. Gault Jr.

During Operations Desert Shield and Desert Storm the Army was not prepared to provide soldiers with high quality field services. Soldiers were typically provided with 1940's vintage General Purpose billeting tents, which paled in comparison to the newer air conditioned Tent Extendable Modular Personnel that the Air Force used. For showers and latrines, the Army relied upon makeshift, locally fabricated facilities, while other services had modern sanitary systems. Often, the Army and Air Force base camps were located next to each other, to further contrast their respective capabilities. This contrast stirred the Army leadership to initiate actions to improve our soldiers' quality of life. The result is called Force Provider.

The Army staff directed the Army Materiel Command (AMC) and the Training and Doctrine Command (TRADOC) to develop the Force Provider Program. The guidance from the Department of the Army was to design, integrate and evaluate a packaged materiel capability to provide food, billeting, and hygiene services. Consequently, Force Provider began to take shape as an air transportable turn-key system which contains, in one package, everything necessary to provide quality food, billeting and hygiene services for up to a brigade.

These tent and hard wall shelter-based packages consist of air conditioned/heated billeting, kitchens, dining areas, latrines, showers, laundries, water distribution, power generation and morale, welfare and recreation capabilities. Each package is being configured in 550 soldier modules that can be combined to support a force of 3,300 soldiers. Ultimately, six of these brigade size packages will be procured.

> The primary mission for the Force Provider is to give rest and relief facilities to soldiers who have suffered the stress of combat duties.

The Air Force's Harvest Eagle system provides a capability similar to what the Army wants. The Army will capitalize on Air Force experience by adopting the best of their fielded equipment as part of the Force Provider sets. Mission differences between the two services will, however, require some variation in the equipment selected for Force Provider. The Air Force usually sets up their equipment semi-permanently in support of airfield operations and they have the luxury of using their own aircraft to deliver their assets. On the other hand, the Army plans to tailor their equipment for greater ground mobility and for movement into a theater of operations primarily by sea.

The primary mission for the Force Provider is to give rest and relief facilities to soldiers who have suffered the stress of combat duties. Based on the tactical situation, soldiers will be rotated away from forward locations to a Force Provider complex for up to one week. When soldiers arrive, the Force Provider unit personnel will assign billeting to include cots, personal foot lockers, and chairs. Soldiers will then be free to take advantage of numerous available services. A private hot shower will likely be most soldiers' first priority. Then they may turn their soiled clothing in to the field laundry service. State-of-the-art field latrine facilities will be a welcomed improvement for soldiers accustomed to outdated "diesel burners" and even lesser field expedient accommodations.

After taking care of hygiene essentials, soldiers can head for a modern field kitchen where cook-prepared hot meals will be

Any way you look at it, whether used in peacetime or wartime, Force Provider spells comfort.

standard fare. Diners will eat in the comfort of environmentally controlled dining tents. Following the meal, a variety of morale, welfare, and recreation services is only a short walk. In some cases, soldiers will have the opportunity to shop at a tactical field exchange, grab a cold beverage and go next door to watch a video movie. The outdoor recreational area will undoubtedly be a popular spot for team sports. If personnel services are needed, teams from nearby personnel, finance, and postal units can set up in the space set aside for them. In addition, separate areas are designed for a barber shop and religious service support.

Another mission for which Force Provider is ideally suited is an intermediate staging base support for the Contingency Corps during force projection. For example, in XVIII Airborne Corps, the 1st Corps Support Command may be tasked to operate a reception area in a strategically forward location in support of troop deployments into a theater of operations.

Other missions include support of humanitarian aid and disaster relief operations in which the Department of Defense is becoming more actively involved. During the Hurricane Andrew disaster relief operations in South Florida, the Army was faced with setting up tent cities for homeless victims. Although eventually successful, the task of pulling engineer and logistics resources from multiple supply sources to erect and operate the tent cities was challenging, to say the least. Because Force Provider is a self-contained package, it will save critical time and effort in meeting similar situations.

The U.S. Army Natick Research, Development and Engineering Center (Natick) has teamed with the U.S. Army Quartermaster Center and School (QMC&S) to assume program leadership responsibilities for Force Provider. Since much of the component hardware has already been fielded by the Army, Navy, or Air Force, there is no need to go through a time consuming developmental process for new equipment. Using an approach called "Team Force Provider," a highly streamlined acquisition strategy will enable this system to be procured and fielded by 1995. This acquisition strategy calls for maximizing use of existing equipment to meet near term requirements while simultaneously evaluating items to enhance the system later. The main effort will be to integrate the right equipment in the right quantities and to package Force Provider to meet the Army's requirements.

This non-traditional acquisition strategy is characterized by concurrent efforts in the areas of engineering, production and testing, rather than the conventional "A before B before C" process. Since many of the component subsystems selected for Force Provider have already been type classified, technical and operational test data are now available. This situation has afforded program managers an opportunity to accelerate the schedule by making an immediate limited procurement decision. A limited procurement decision permits production to begin at once and proceed concurrently with the test effort. Production contracts for low risk and long lead time equipment will be awarded first. This allows test data to come in before obligating funds on higher risk equipment, especially when quantities are uncertain.

While procurement contracts begin to be awarded, a limited focus user test will be conducted to validate system functionality. Critical test issues include verification of training requirements, equipment quantities, system technical manuals and transportation data. Test scheduling is difficult to influence because test equipment has to be acquired and test dates are locked-in months in advance. However, since the major subsystems of Force Provider are now known, there is no need to delay production. Once the test and evaluation effort is completed, final type classification can be made for production of all six brigade-size Force Provider sets.

In addition to the primary program management effort, DA had AMC and TRADOC initiate a pre-planned product improvement program. This will run parallel with the Force Provider main program management effort described above. Natick and QMC&S will team-up with Belvoir Research, Development and Engineering Center and industry to enhance selected subsystems over time. Since the initial procurement will be exclusively for existing DOD equipment, commercial equipment will be type classified and substituted later. Many defense contractors have viable nondevelopmental item solutions which could prove to meet the Army's requirements.

Equipment containerization is a key issue being examined. Strategically, the equipment must be capable of movement by ship and by C-141 aircraft. Within theater, tactical movement will be via rail, truck, helicopter or C-130. The mobility challenge is to pack Force Provider equipment in a container which will optimize air, ground, and particularly sealift compatibility.

Another question concerns a determination of who is going to operate the Force Provider complexes. Field Service Companies were initially thought to be best suited to staff them. However, Force Provider is intended to provide support above organic capability and Field Service Companies already have dedicated missions. As a result, the combat developers are now building a Force Provider table of organization and equipment. This unit will likely be staffed by a small cadre during peacetime and fully manned during war.

Any way you look at it, whether used in peacetime or wartime, Force Provider spells comfort.

COL DAVID H. WAYNE is the commander of the U.S. Army Natick RD&E Center. He has held numerous command and logistics staff positions including battalion commander and G-4, 7th Infantry Division (Light). Wayne is a graduate of the Army War College and holds an M.B.A. degree from Marymount University.

MAJ CLOVIS G. GAULT, JR. is the deputy force provider manager at U.S. Army Natick RD&E Center. He is a distinguished military graduate of the University of Houston and has an M.S. degree in logisitics management from the Florida Institute of Technology. Gault is a member of the Army Acquisition Corps and a resident graduate of the Command and General Staff College.

"How Will Dual-Use Technologies Benefit the Army?"

MG Otto J. Guenther
Commanding General
U.S. Army Communications-Electronics Command
Fort Monmouth, NJ

Let me first present the argument why there is such a strong emphasis on the promotion of dual-use technologies out of the Congress, the Administration, and the Department of Defense (DOD), dating back in fact to the Bush Administration's "Peace Dividend" during the disintegration of the Warsaw Pact and Soviet Union. President Clinton and Vice President Gore, in their "Technology for America's Economic Growth, A New Direction to Build Economic Strength" initiative dated Feb. 22, 1993, present the argument for promoting dual-use technology development and application. Briefly synopsized, the initiative states that since World War II, the federal government's de facto technology policy has consisted of support for basic science and mission-oriented research and development which for the most part has been defense oriented. Compared to Japan and our other competitors, government support for commercial technology has been minimal with the government relying chiefly on its investments in defense and space to trickle down to civilian industry. It is stated that while this support to commercial technology may have made sense in an earlier era when U.S. firms dominated world markets, it no longer reflects the reality of today's world market economy. Simply stated, the Administration argues that if our nation is to remain competitive in today's global economy that provides for long term economic growth and the creation of jobs for our nation's work force, then new strategies are required to shift emphases to the commercial sector of our economy. One of the strategies being advanced by the Administration and within DOD is the reorienting of our research and development from the development of solely defense-oriented technologies and applications to technologies and applications having both defense and commercial application, i.e., dual-use. The incentive for both DOD and defense industry, which reflects the attitude of the Congress and the Administration, is the reduction in the defense budget. As stated by Deputy Secretary of Defense William Perry, by FY96 "defense industry will have lost 65 percent of its market" as measured from FY86 levels. The DOD acquisition budget is declining rapidly, reflecting a need for downsizing within DOD and a need for downsizing and diversifying into commercial markets for private industry.

To help the services and industry transition into a dual-use environment, the Administration and DOD have begun several initiatives. Among these are DOD's proposal to maintain the technology base budget at a constant level, as opposed to other budget elements that will decline while emphasizing the shift into dual-use technologies. Another initiative has made Independent Research and Development applicable for defense and commercial applications, and DOD has further proposed that future DOD contracts be focused on a combination of defense and commercial efforts. The DOD Small Business program topics have also been reviewed for dual-use. The most significant initiative is the White House Technology Reinvestment Project (TRP). The TRP is a fully collaborative government-wide effort designed to stimulate the evolution of a national industrial base that can provide both the most advanced, affordable, military systems and the most competitive commercial products. This is to be accomplished primarily through government funding of dual-use technology development efforts proposed by various industrial partnerships.

Of the eleven major dual-use technologies identified, the key technologies concerning the Army are the following: Information Infrastructure, e.g., network architecture, wireless communications, software development, etc.; Electronics Design and Manufacturing, Mechanical Design and Manufacturing, Materials/Structures Manufacturing, e.g., advanced composites; Environment Technology; Aeronautical Technologies; Vehicle Technology; and Advanced Battery Technology. These dual-use technologies are very broad and cover a wide range of Army applications. Dual-use is, as the term implies, a two-way street. Through closer cooperation and leveraging of technology with industry, academia, and the numerous consortia, technology can be steered and applied to meet Army requirements without the need for the country to support two separate industrial bases. The services will continue to pursue service-unique technology for specific applications, but the economics of today and the projected defense reductions simply do not allow us the luxury to support separate commercial and military industrial bases. These must be woven together where possible so as to meet the requirements of both the military and commercial market without jeopardizing DOD service missions.

Dr. Richard Chait
Principal Deputy for Technology/ Chief Scientist
Headquarters, U.S. Army Materiel Command
Alexandria, VA

A front page *New York Times* article in August 1993 talks to monitoring eruptions on the ocean floor and headlines "a scientific first as military shares with civilian research." This is just one example that, given today's realities, the dual-use concept of technology generation and application makes a great deal of sense not only for the Army Materiel Command but for the Army, DOD and our nation as a whole.

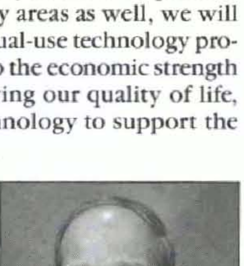
While the concept of partnering is not new, certainly there is a greater realization of the benefits of the dual-use concept than ever before. So it is not a surprise to me that we are devoting a great deal toward making this approach succeed.

It is interesting to note that the Army has successfully been using the Military Adaptation of Commercial Items Program where validated military requirements are fulfilled by procuring items such as trucks from the private sector. Today, we are going much beyond this. A case in point is the Army's National Automotive Center which stresses collaboration and technology transfer in key areas of ground vehicle R&D. Efforts to date are right on track. Possibilities include an active suspension system for military vehicles to improve off-road performance (see "National Automotive Center Emphasizes Dual Use Technology" article in this issue for other examples).

In another exciting area, that of electro-optics, I can point to night vision technology proposals that have emanated from ARPA's Technology Reinvestment Project. In the initial proposal phase just concluded, some very interesting proposals have emerged as follows: ultra low cost night vision devices for law enforcement officials, and improved night and adverse weather driving and flying capability employing uncooled and cooled Forward Looking Infrared (FLIR) technology. Here, the "spin-on" benefit is amortizing the cost over a significantly larger production base which will have a positive impact on the cost of future FLIR systems for the Army.

Equally impressive is the Army's efforts in food technology. In conjunction with academia and industry, advanced techniques are being explored to improve quality and reduce the overall cost of processing shelf-stable foods, e.g. food dehydration. This will provide the military with extended shelf-life war reserve food stocks, and the commercial sector with packaged heat and serve foods, camper back-pack meals and emergency food supplies. (See "Dual Use Food Technologies" article in this issue for more details.)

If we can achieve these objectives not only in the examples cited above but in other key Army technology areas as well, we will have achieved a meaningful and dynamic dual-use technology program with all of its benefits—contributing to the economic strength of the nation by creating jobs and improving our quality of life, while at the same time providing the technology to support the power projection strategy of our Army.



Dr. Robert B. Oswald
Director of R&D
U.S. Army Corps of Engineers
Washington, DC

The dual-use technology initiative represents a way of doing business that will become an integral part of the Army research effort. The dual-use initiative attempts to expand the use of this nation's investment in federal research to benefit industry and spur economic growth. On the surface, it appears the benefits accrue largely to the private sector. But the Army itself has much to gain for several reasons.

The dual-use technology initiative will raise the visibility of the contribution and capabilities of our Army research effort and its professionals. This initiative will encourage Army laboratories to become more actively involved in transitioning the results of its research through partnerships with industry. As we do this, the nation will come to see the excellence of our work, our people, and our facilities.

The dual-use technology initiative is the latest iteration in a series of executive and congressional technology transfer activities. It refocuses the attention of Army researchers on the possible commercialization of their work. The Army has made great strides under Stevenson-Wydler in drawing on available federal technology for civilian benefit. These successes will be enhanced under the dual-use initiative.

The dual-use initiative also expands upon the idea of federal-private sector partnering for future technology initiated under the technology transfer legislation. More effective partnerships with Army and industry will optimize the resources available to both parties. Obtaining the involvement and input of our private sector partners early in the research will ensure the outcome provides maximum value to both Army and public users.

The Army also will benefit from the modifications to the technology added by the private sector company that continues the development under a commercialization agreement. As our partners continue the research and development work, they will do so with a solid understanding of both Army and public needs for the technology.

Matching interests, needs, talents, and facilities is a winning combination in this new era of dual-use partnerships. The Army, its research community, its soldiers, and the nation benefit through improved technology and by optimizing resources through this initiative. The dual-use initiative will enable the Army to meet its military research objectives and support the nation in doing so.

Dr. Kenneth J. Oscar
Deputy Commander for Research,
Development and Engineering
U.S. Army Tank-Automotive Command
Warren, MI

Dual-use technology can dramatically reduce the cost of developing and acquiring Army equipment. First, if the Army can find one or more commercial industries who already have similar research and development programs, both the Army and industry will benefit by a partnership where we can pool our resources to jointly develop a similar product. Next, if the Army and industry can use common specifications, the acquisition costs will be reduced. Finally, production costs and sustainment costs of spares will be greatly reduced by the increased production quantities to satisfy the military and commercial markets. There is an additional benefit which is hard to quantify and that is the increased creativity and quality that comes from a multi-government industry team effort.

Rather than leave this important effort to chance and have to rely on each individual engineer and scientist to seek out and negotiate teaming arrangements with industry personnel, TARDEC has formed the National Automotive Center (NAC) to structure the effort. The NAC concentrates on three industry sectors; autos, heavy trucking, and construction equipment. The NAC reviews the Army's programs, plans and capabilities in the ground vehicle area. The NAC then works with the automobile companies to go over their plans and capabilities to find good matches. The NAC then brings both parties together to develop Cooperative Research and Development Agreements or CRDAs. To make this process easier, the NAC is developing blanket CRDAs with the Big Three auto companies and their suppliers. With the blanket CRDAs in place, individual teaming projects can be agreed to in days instead of months, completely at the local level. The NAC is making dual-use technology work for the Army.

MAJ(P) John E. Peeler
Manager, Small Business Innovation Research (SBIR) Program
Manager, Advanced Concepts and Technology II (ACT II) Program
Office of the Deputy Assistant Secretary of the Army (Research and Technology), Pentagon

The term dual-use technologies refers to those technologies having both military and commercial applications. Current and projected economic trends and reductions in defense spending prohibit maintaining separate military and commercial

SPEAKING OUT

industrial bases. Dual-use technologies allow closer cooperation and leveraging of technologies between the Army, industry and academia.

For the public and private sectors, DOD emphasis on dual-use technologies has created jobs, expanded business opportunities, stimulated the development of new products and services, and improved the competitiveness of the nation's high technology industries. But what has the Army gained?

The Army's technology base program, at slightly more than $1 billion, represents less than one percent of the nation's annual R&D expenditures. Thus the Army depends heavily on external R&D efforts for its technology base investment. Any non-Army resources that can be applied to meet Army R&D needs will reduce the Army's financial burden accordingly.

By providing seed money to industry and/or academia to develop and demonstrate critical technologies in specific areas of interest, the Army has an opportunity to evaluate a broad range of advanced technologies through simulations, demonstrations and advanced warfighting experiments. The Army bears most of the cost and risk and often provides facilities, equipment and expertise during early development and evaluation of new technologies. Sponsorships from larger corporations, institutions and agencies then provide the bulk of funding needed to mature those technologies that show promise for dual-use applications. Because of this, the Army's cost and acquisition cycle to field those technologies can be greatly reduced. Further, lessons learned from one project, whether successful or not, can often be applied to future R&D efforts resulting in additional savings.

In the past, the Army had numerous success stories in applying dual-use technologies in the Small Business Innovation Research (SBIR) Program and the Advanced Concepts and Technology (ACT) Program. Congress approved FY94 funding for the Technology Reinvestment Project (TRP) sponsored by the Advanced Research Projects Agency (ARPA) as well as increased funding for SBIR. The Army renewed its commitment to dual-use technologies through increased funding for the ACT II Program. These programs and others provide the stimulus for a joint military/commercial industrial base capable of producing timely, affordable advanced technology military systems as well as commercial products that can compete internationally on the basis of quality and cost.

Public Law 102-564 requires that federal agencies evaluate proposals from small businesses for scientific and technical merit as well as commercial potential (dual-use). Dual-use potential and non-DOD sponsorship are critical for follow-on funding in the ACT II Program. Application of dual-use technology programs, in addition to being mandated by public law, is clearly a win-win situation for everyone involved.

AWARDS

Army R&D Organizations Recognized

Three Army organizations were recognized for outstanding achievements during fiscal year 1992.

The U.S. Army Natick Research, Development and Engineering Center (NRDEC), Natick, MA, was named the Army Research and Development Organization of the Year. NRDEC was selected from several Army research organizations nationwide.

The award cited NRDEC for the overall merit of its mission performance to provide the Army with maximum survivability, sustainability, mobility, combat effectiveness, and quality of life for individual soldiers and crews under worldwide environmental extremes and hazardous conditions.

The Army R&D Organization of the Year Award is based upon organizational effectiveness and mission impact; program, personnel, and resource management initiatives; and special accomplishments.

Recipients of R&D Excellence Awards were:

- The U.S. Army Missile Command Research, Development, and Engineering Center (MRDEC), a leader in technologies associated with missile propulsion, guidance and control/terminal homing, high power-high energy lasers, and short range unmanned aerial and ground vehicle systems. Other MRDEC achievements were related to the Army Combined Arms Weapon System, a cooperative, award-winning program with Penn State University that resulted in hardware demonstrations of optical neural networks made of simple components.
- The U.S. Army Cold Regions Research and Engineering Laboratory (CRREL), the only DOD or national laboratory with a special focus on cold issues. For instance, the CRREL executes the Cold Regions Hydrology research program, developing methods to accurately predict snowmelt and snow hydrology in watersheds for water control and flood forecasting operations.

The R&D Excellence Awards are presented to research and development organizations whose achievements are considered the best within the Army R&D community.

IMPORTANT NOTICE

Army RDA Bulletin has a new mailing address. All correspondence should now be addressed to:

DEPARTMENT OF THE ARMY
ARMY RDA BULLETIN
9900 BELVOIR RD SUITE 101
FT BELVOIR VA 22060-5567

Please Note: DO NOT use the ampersand (&) in any correspondence addressed to Army RDA Bulletin.

Program Managers Course Slated for Restructuring

As this issue of *Army RD&A Bulletin* went to press, the bulletin editorial office was informed that the Army Program Managers Course (PMC) is being restructured. Although final details are still pending, the course will reportedly be redesigned into two parts, with part I not to exceed 14 weeks, and part II not to exceed four weeks. Both parts will meet statutory requirements and be mandatory only for ACAT I and II PMs, deputy PMs, and PEOs. Part I will still be available for those being designated by the components. PMC part II attendance is intended for ACAT I and II PMs/DPMs selectees prior to assignment.

A more detailed article on the PM Course restructuring will be published in the January–February issue of *Army RD&A Bulletin*.

Guest Editorials

ACQUISITION REFORM AND DUAL-USE TECHNOLOGY

John Deutch
Under Secretary of Defense (Acquisition)

Secretary Les Aspin points to the "new dangers" this nation must be prepared to confront, after the collapse of the former Soviet Union. These dangers are: proliferation of weapons of mass destruction, major regional conflicts, threats to democracy, and economic security. Priority will be given to maintaining readiness of our fighting forces and avoiding a "hollow force." With declining budgets and a greater emphasis on readiness, the inevitable consequence is that the "Investment" accounts (R&D plus Procurement) will bear a greater than proportionate share of the budget reduction.

Deputy Secretary Bill Perry addresses this problem head on. He points to the urgent need for acquisition reform that will enable the DOD to acquire needed equipment, systems, and services much more economically than in the past. The central change needed is to shift the Department's practice of relying on a largely defense unique industrial base through military specifications for goods and services to relying on the commercial sector for goods and services employing commercial business practices.

Such a shift will not occur overnight and can include only a portion of the goods and services that the Department needs. For example, we cannot buy tanks or nuclear submarines in the commercial market place. But, a large fraction of the technology and systems of importance to the DOD is available in the commercial sector, frequently with more advanced technology and lower cost than the "milspec" items to which we are accustomed. For example, the private sector has capability that exceeds what "milspecs" provide in microelectronics, software, advanced materials, and manufacturing technology.

We, in the acquisition community, as a matter of sheer economic necessity, must take advantage of the opportunity to meet more efficiently our defense needs through greater reliance on the commercial sector. Moreover, as procurement budgets and the size of buys decline, unit prices will inevitably increase; even if we would like to retain past practice, at today's budget levels, it is simply unaffordable to rely on defense unique items, unless absolutely necessary.

Once the need to rely on commercial goods and services for the majority of the requirements of the Department of Defense is established, it follows that we have an interest and responsibility to invest in those "dual-use" technologies that are of greatest significance to the Department. The recent, highly successful "Technology Reinvestment Project," managed by the Advanced Research Projects Agency (ARPA), competitively awards cost-shared technology development contracts to industry for "dual-use" projects that range from flat panel displays to nanotechnology—initiatives that directly contribute to the Department's mission.

But there are important indirect benefits of the Department's "dual-use" technology initiative as well. Secretary Aspin's new "economic security" danger highlights the importance of domestic prosperity to our national security. Without economic growth and jobs, there will be neither public support for defense or the ability to devote resources needed to maintain the peace. Defense Department support for "dual-use" technologies strengthen the commercial sector in technologies that are key for creating high quality jobs and competing more effectively in international markets. In addition, the defense market will open new opportunities, encourage greater innovation, and increase production volume for U.S. commercial firms, thus improving productivity.

Not surprisingly, President Clinton has shown keen interest and great support for the "dual-use" technology initiatives of the Department. In his March visit to the Westinghouse Defense Group plant in Baltimore, he spoke of the importance he places on the "dual-use" technology of the Defense Department and other agencies for achieving agency missions more efficiently and for encouraging greater economic performance. This is clearly a "win-win" situation—"dual-use" technology efforts contribute both to the defense mission and to the strength of the U.S. economy.

Up to the present, the Department's "dual-use" initiative has been largely limited to ARPA. It is high time for the Army to mount its own "dual-use" technology program and link it to acquisition reform initiatives appropriate to the Army. Such initiatives will certainly have the strongest support from the Secretary of Defense, the Deputy Secretary of Defense, and the Under Secretary of Defense for Acquisition.

AAC Highlights . . .

I-GRAD IS HERE!

What is I-GRAD? It is the hottest new educational opportunity available to Army Acquisition Corps officers! It is a challenging, graduate degree program which combines resident graduate study with the unique and practical experience of Training With Industry (TWI).

It is divided into two phases (resident graduate study and TWI). The total length of time for program completion is approximately 24 months. Phase I consists of graduate study at a participating university. This phase of the program lasts approximately one year or three consecutive terms. During the resident phase, the officer completes core courses required for an M.B.A. degree.

Phase II begins when the officer transitions to the TWI phase which is 10 months in duration. While in this phase, the officer is familiarized with a broad spectrum of industrial operations and management practices through participating as part of the corporate management team in a "hands on" environment.

Near completion of TWI/phase II of the program, the officer submits a research project to the university which encompasses his TWI experience. Upon successful completion of the research project requirement, the university will award sufficient constructive credit for graduation from the school of business with an M.B.A. degree.

The selected universities are in close proximity to the TWI locations, therefore, no PCS is required between program phases.

Officers will apply for I-GRAD using DA Form 1618-R. Further coordinating instructions will be forwarded to officers selected for the program. A six-year service obligation will be incurred.

The target implementation date for I-GRAD is FY 1994. For further information, contact CPT Kel Wood, TWI program manager and staff officer in the FA 97 Proponency Office, U.S. Army Contracting Support Agency, Falls Church, VA. He can be reached at DSN 289-2796, or commercial (703)756-2796.

Acquisition Positions

With the Defense Acquisition Workforce Improvement Act (DAWIA) now law, the Military Acquisition Management Branch (MAMB) at the U.S. Total Army Personnel Command (PERSCOM) again wants to emphasize the importance of Acquisition Corps officers serving in approved acquisition positions. The intent of the DAWIA is to assign AAC officers to approved acquisition positions filled by non-AAC officers.

Assignment officers and others at MAMB have talked to a great deal of people about Program, Education, Other and Total acquisition time (PEOT). Because of the experience requirements at the lieutenant colonel and colonel level, it is critical for an acquisition officer to serve in a position that adds to the officer's PEOT.

Each officer should know if they are assigned to an approved acquisition position. Approved acquisition positions come from the Military Acquisition Position List (MAPL). These are the only positions that PERSCOM assigns acquisition officers to. The MAPL positions are reviewed yearly by a council of acquisition colonels. The purpose of the review is to keep the MAPL current with the changing acquisition needs of the Army. Because the MAPL is a dynamic document, MAPL positions occasionally change.

If you are not sure if you are assigned to a MAPL position, contact your local personnel office or your PERSCOM assignment officer.

Award Recipients Named

The following Army Acquisition Corps and acquisition support personnel are recent recipients of key awards. **Army Acquisition Executive Support Agency (AAESA):** LTC Alan Bacon, Program Executive Office—Aviation (PEO-AVN), Army Commendation Medal (ARCOM); CW3 Santiago Gonzales, PEO-AVN, Meritorious Service Medal (MSM); LTC Rickie D. Hancock, PEO-AVN, MSM; SFC Gerold Smith, PEO-AVN, MSM; MAJ Donnie C. Turner, PEO-AVN, MSM; LTC William T. Capps Jr., Program Executive Office—Missile Defense (PEO-MD), Legion of Merit (LOM); CPT Richard O. Henrick, PEO-MD, MSM; MAJ Dan A. Johnson, PEO-MD, MSM; COL Roy D. Millar, PEO-MD, LOM; LTC Keith F. Snider, PEO-MD, MSM; CPT Patti D. Daye, Program Executive Office—Tactical Missiles (PEO-TM), MSM; LTC Albert T. Hamilton, PEO-TM, LOM; LTC Dennis J. Loeffelholz, PEO-TM, LOM; LTC William I. Nichols, PEO-TM, MSM; LTC James A. Wells, PEO-TM, MSM; LTC Donald E. Wilbourn, PEO-TM, MSM; CPT Fred J. Wilson, PEO-TM, MSM; MAJ Donald J. Burnett, Program Executive Office—Armored Systems Modernization (PEO-ASM), MSM; MSG Daniel J. Dillon, PEO-ASM, LOM; LTC Noble T. Johnson, PEO-ASM, MSM; CPT Kenneth G. Juergens, PEO-ASM, MSM; MSG(P) Kenneth M. Thompson, PEO-ASM, MSM; SSG(P) Maritza Alomar, HQ AAESA, Army Achievement Medal and ARCOM; MAJ Steven J. Cox, HQ AAESA, MSM; and SPC Tabatha S. Underwood, HQ AAESA, ARCOM.

Lieutenant Colonel Promotions

Congratulations to the following Army Acquisition Corps officers who were recently selected for promotion to lieutenant colonel:

NAME	UNIT
Agosta, Paul Peter Jr.	USASPSA
Alderson, Frederick King Jr.	DEF PERS SPT CENTER
Althouse, James Merritt III	USA BMDO
Barnes, Robert Stuart	PEO-MISSILE DEFENSE
Bennett, David Benjamin	PEO-STAMIS
Bilodeau, Denis Paul	PEO-CCS
Blakney, Peter James	USACGSC
Brito, Joseph Martin	PEO-CCS
Brooks, Jeffrey Carlton	PEO TAC MSL
Brooks, John Randall	USACGSC
Broughall, Stephen Edward Jr.	ODISC4
Brown, Robert Mark	HQ DA, DCSPER
Burgess, Thomas Anthony	517TH MAINT BN
Burton, Donald James	HQ TACOM
Busby, Thomas Edwin	PM ITTS
Cassi, Louis John	STRICOM
Cogossi, Bruce Richard	USAG FT CARSON
Costas, James Peter	CMD SYS INTEGRATION AGENCY
Curtis, Timothy Conrad	ODISC4
Daniel, Clement II	USADSMA
Davis, Michael Emmett Paige	HQ DA, DCSOPS
Davison, Alan David	USA SAFETY CTR & SCH
Dorman, David McCoach Jr.	FT MEYER, VA
Downey, David Allan	TEST PILOT EXCHANGE PROG
Downs, Wallace Terrell	SSDC
Durso, Joseph Anthony	HQ DA DCSOPS
Ecklin, Donald Charles	PEO-MISSILE DEFENSE

NAME	UNIT
Fahlsing, George Allen	CBDA
Fair, Matthew Joseph	HQ TACOM
Faulkner, David Fielding	USACGSC
Flomer, Terre Lee	HQ EUCOM
Forsyth, Robert Alan	USA GARRISON VINT HILL FARMS
Frahm, Karen Kay	USA CAC FT LEAVENWORTH
Freeman, Robert David	HQ MICOM
Fuller, Mary	CMD SYS INTEGRATION AGCY
Gage, Bruce Edmond	USA TAPO
Garcia, Alberto Laureano	USAD SYS SPT ORG
Garrison, Leslie Dean	USAD SYS SPT ORG
Gerasimas, Bernard Francis	HQ ARDEC
Gozdur, Edward Ernest	WSMR, NM
Gregory, Royce Alan	OASA (RDA)
Grobmeier, John Raymond	HQ CECOM
Gross, John Levere	TARDEC
Grunkemeyer, Robert Charles	PEO-COMM
Hallagan, Robert Edward	USAIC, FT HUACHUCA, AZ
Harper, Debra Kay	USAE, AIR FORCE ACTIVITIES
Haugh, William Robert Jr.	INFO SYS DEV CTR, FT LEE, VA
Henry, Michael Burnell	BMY RESIDENCE, YORK, PA
Heuler, Ronald Raymond	CMD SYS INTEGRATION AGENCY
Hipple, William Freder	USASPSA
Hoover, Robert Shannon	HQ TACOM
House, Kevin Addison	USA BMDO
Howard, Charles Craig	USAE, AIR FORCE ACTIVITIES
Howell, Mitchell Anthony	HQ DA DCSPER
Hudnall, Richard Mark	USAE HQ DISA
Huskins, James M.	PEO-STAMIS
Hussey, Michael Duane	USA CONTRACTING CMD, EUR
Jancek, Jeffrey Michael	HQ CECOM
Johnson, Pamela Vinyard	HQ AMC
Jones, Claude Andrew	HQ AMC
Justice, Nickolas Grey	HQ PERSCOM
Kaura, Mary Ann	PEO-MISSILE DEFENSE
Keeling, Jesse Craig	SSDC KWAJALEIN ATOLL
Keith, Michael Thomas	PEO-MISSILE DEFENSE
Kessinger, Stephen Howard	STRICOM
Kickbusch, Consuelo Castillo	USA INFO SYS SOFTWARE AGENCY
Kindel, Thomas James	PEO-COMM SYS
Kuespert, Karl Henry	HQ TACOM
Kummerer John Henry Jr.	USAD SYS SPT ORG
Lawless, John Noel Jr.	USA STU DET CT
Leahy, James Buckley Jr.	STRICOM
Lees, Robert Burns Jr.	PEO-COMBAT SUPPORT
Leonard, Alvin Jerome	DCMD MID ATLANTIC
Leonard, Steven Richard	HQ PERSCOM
Linehan, Patrick Daniel	DACM OFFICE
Lovett, Gregory Alan	DPRO MCDONNELL DOUGLAS
Lundeen, Jon Gregory	PEO-COMM SYS
Mallette, Timothy Richard	INFO SYS DEV CTR, FT LEE, VA
Manning, John Albert	USA AMCCOM
Mathews, Randolph Arthur	USA STU DET RI
McChesney, Michael Kevin	USA SPSA
McKaig, Tim Roberts	SSDC
McKenney, Michael Allen	OFC OF THE CSA
McMaster, Charles Frederick	USAE JOINT ELECT WARFARE CTR
Meade, Kevin John	ACS INTEL
Merkwan, John Anthony	DPRO RAYTHEON
Modlin, James Michael	PEO-MISSILE DEFENSE
Moran, James Ross	OASA (RDA)
Moran, Richard James	DPRO MARTIN MARIETTA
Naegle, Brad Raymond	USA STU DET CA
Naudain, James Craig	PEO-TACTICAL MISSILES
Nelson, Ronald Jeffrey	HQ CECOM
Newberry, Tommie Edward	SSDC
Nielsen, Harold Kriss	PEO-AVN
Noble, Jenna Lee	USA OPTEC
O'Reilly, Patrick James	USA BMDO
Owens, Carl Douglass	HQ PERSCOM
Parker, Gary Walter	HQ CECOM
Patten, George Benjamin	TARDEC
Peeler, John Elmer	OASA (RDA)
Perry, David Edgar	HHB 6TH AD BDE, FT BLISS, TX
Phillips, Lee Andrew III	PEO-TACTICAL MISSILES
Ponting, Kurt Patterson	DEF PERS SPT CTR
Porto, Justin Edward	INSCOM
Puchon, Charles Anthony Jr.	SSDC KWAJALEIN ATOLL
Quinn, Harry Michael	CBDA
Robinson, James Olen	USA OPTEC
Ross, Allan Gerald	USA AMCCOM
Rouse, John Edward	DEF CONSTR SUP CTR
Russ, Doris Jean	USA ELE DEF COM AGCY
Sawyer, Maryelizabeth Walsh	ISSAA
Shelley, Neal Andrew	USA ELE OJCS
Shemwell, Arthur Luther III	USSOCOM
Short, Patrick, Charles	PEO-COMM SYS
Simpson, Michael Gray	PEO-CBT SPT
Sobey, Robert Leland	AVN AUGMENTATION, FT CAMPBELL
Stautz, Thomas Richard	USSOCOM
Stevens, Charles Rucker	USSOCOM
Sutton, Earl II	PEO-MISSILE DEFENSE
Sweatman, John Cooper	SSDC
Tensfeldt, Jeffrey Edward	PEO-MISSILE DEFENSE
Treece, Charles Frank	WSMR, NM
Urban, Stephen Anthony	ACS INTEL
Wall, James Allen	USA STU DET TX
Walters, Wesley Frank	SSDC
Wargo, James David	USA RSCH ASSOC GROUP
Weinzettle, John Paul	USA ELM OSD
Wiley, Mark Charles	HQ MICOM
Witten, Bernard Jerome	ALMC
Woznick, John Cornelius	USAARMC, FT KNOX, KY
Yawn, Barbara Ann	USAD SYS SPT ORG
Zellmer, John George	PEO-COMM SYS

Officer Selection Board Schedule

The following is the FY94 officer selection board schedule approved by the Army deputy chief of staff for personnel.

First Quarter:

- LTC/MAJ SERB: Oct. 26–Nov. 24 93
- COL SERB: Nov. 2–24 93
- Warrant Officer SERB: Nov. 2–24 93
- Special Branch SERB: Nov. 9–19 93
- LTC, Army Medical Department Command: Nov. 30–Dec 10 93
- LTC, Combat Arms Command: Nov. 30–Dec. 23 93
- LTC, Combat Service Support Command: Dec. 7–23 93
- LTC, Combat Support Arms: Dec. 7–23 93
- General Officer, Army Nat Guard, Fed Recognition: Dec. 14–17 93

CAREER DEVELOPMENT UPDATE

Second Quarter:
- LTC, Army: Jan. 4–Feb. 4 94
- COL, Combat Service Support Command: Jan. 4–14 94
- Senior Service College (Civ): Jan. 11–14 94
- COL, Combat Support Arms Command: Jan. 11–21 94
- COL, Combat Arms Command: Jan. 18–28 94
- General Officer, USAR Assignments: Jan. 25–28 94
- MAJ, AMEDD: Jan. 25–Feb. 4 94
- Special Branch RIF: Jan. 25–Feb. 4 94
- Company Grade RIF: Feb. 1–18 94
- Warrant Officer RIF: Feb. 8–25 94
- COL, Project Manager: Feb. 8–18 94
- COL, Army Medical Department Command: Feb. 8–25 94
- MG, Army: Feb. 15–17 94
- LTC, Army Medical Department: Feb. 15–25 94
- AMSC/LEDC (Civ): Feb. 22–25 94
- Senior Service College, Army: March 1–25 94
- LTC, Product Manager: March 15–25 94
- Joint Specialty Officer, Credit: March 15–25 94
- LTC, Medical Corps/Dental Corps: March 15–25 94

Third Quarter:
- MAJ, Army: April 5–May 6 94
- MAJ, Med Corps/Dental Corps, Voluntary Indefinite: April 5–15 94
- Senior Service College, AMEDD, and CH, and CPT/CH: May 10–27 94
- CPT, Army Medical (RA, VI): May 17–27 94
- General Officer, Fed Recognition (ARNG): May 24–26 94
- Chief Warrant Officer 3,4,5: May 31–June 17 94
- Army Mgt Staff College (Civ): June 20–24 94
- BG, Army, Army Med Dept, JAG: June 14– July 1 94

Fourth Quarter:
- Command and Staff College, Army: July 5–Aug. 9 94
- COL, Army Medical Department: July 12–22 94
- General Officer, USAR Assignments: July 22 94
- COL, Army: Aug. 16–Sept. 9 94
- Command and Staff College, AMEDD Sept. 13–23 94

CONFERENCES

36th Power Sources Conference

The 36th Power Sources Conference will be held June 6–9, 1994, in Cherry Hill, NJ. Sponsored by the Army Research Laboratory in conjunction with the U.S. Air Force, U.S. Navy, Advanced Research Projects Agency, Department of Energy, and NASA, the meeting will focus on energy generation and storage technology (largely, but not exclusively electrochemical) which is of interest to the DOD, other government agencies, and the civilian marketplace.

Call For Papers: The orientation of the meeting will be toward devices, but relevant submissions on materials, mechanisms and phenomena are very welcome, in addition to contributions on prototype development, manufacturing technology, device and system engineering, and economic and environmental considerations.

Abstracts should be submitted by Nov. 19, 1993, to *Palisades Institute for Research Services Inc., ATTN: Ralph Nadell (PSC), 201 Varick Street, New York, NY 10014; (212) 620-3341; fax (212) 620-3379.* Abstracts should be reproducible. They also must not exceed one page, but one additional page of figures may be added. Title, author, affiliation, complete mailing address, and telephone number should be included. The abstract should clearly state the purpose of the work, the manner and degree to which it advances the state-of-the-art, and specific results that have been obtained and their significance.

Authors of papers selected for presentation will be notified by Jan. 21, 1994. Accepted authors will be required to prepare an approximately 2,000-word (4 pages including figures), camera-ready text for inclusion in the *Conference Proceedings,* which will be distributed at the conference. The deadline for papers is April 18, 1994. It is the author's responsibility to obtain all required clearances.

General information is available from Ralph Nadell at the address or telephone number listed above.

Dr. K.C. Emerson Dies

Dr. K.C. Emerson, a former deputy assistant secretary of the Army for research and development and a retired Army colonel with 27 years of active military service, died earlier this year in Sanibel, FL. He had served during World War II in the Philippines, had walked the Bataan Death March and was a prisoner of war in Japan. Listed in *Who's Who in the World* for several years, Dr. Emerson had published more than 140 books and papers on medical and veterinary entomology.

Army Research Lab Produces Heavy Composite Hull

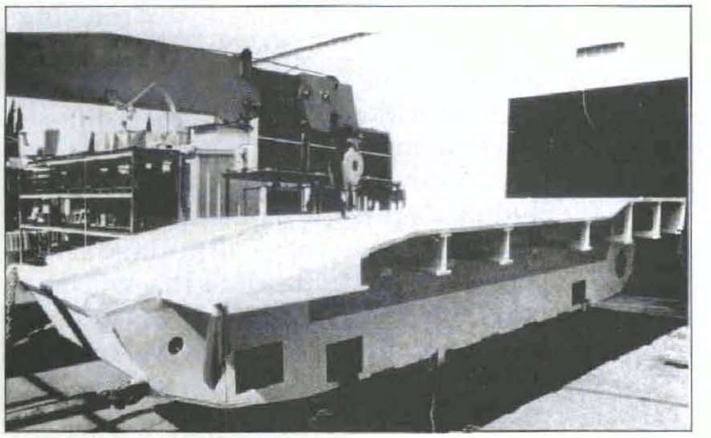
There was a time when metal served as the primary material for various tank structures. Lately, however, scientists and engineers have focused upon composite materials to reduce the weight of future armored vehicle systems. Following up on the successful 30-ton Composite Infantry Fighting Vehicle (CIFV), engineers at the Army Research Lab (ARL) in Watertown, MA, have produced the 50-ton Heavy Composite Hull (HCH).

Project Manager Bill Haskell feels that the HCH (not actually 50 tons itself, but made for a vehicle of that weight) will meet the structural loading imposed by terrain operation, gun firing and payload integration. In addition, the structure can accept existing or emerging mobility system components.

The real challenge will be outfitting (putting in transmission, engine, suspension, etc.) and field testing. However, this has been delayed due to funding constraints. Haskell is frustrated by this situation. "We've come this far and can't get to the real test to see how successful this technology will be. But I am hopeful, because of the favorable response we have received throughout the Army and industry," he said.

Haskell also remarked that concerns such as composite hull manufacturing costs still need to be addressed. ARL composite processing programs will tackle these issues. Haskell added that there's a cultural bias that metallurgists have to overcome because many think that everything has to be metal.

When designed properly, composites can be durable and, unlike metals, resistant to corrosion. With the smaller hull effort, scientists and engineers demonstrated that thick composite structures could survive in the combat vehicle environment.



The completed Heavy Composite Hull.

Haskell coordinates flammability resistance, ballistic testing and nondestructive evaluation with his staff, the main contractor—FMC Corporation, of San Jose, CA—and several other contractors. By working in such diverse areas, he interacts with various ARL divisions and their branches, which includes ceramics, polymers and armor.

Said Haskell, "This is a healthy exercise for our organization, as various internal departments and other ARL directorates have come together to chip in with the project. It is actually a very difficult thing coordinating several areas to work on a particular project."

As mentioned before, the first vehicle was a tremendous success. The fiberglass-reinforced, composite-hulled vehicle proved its worth when completing a 6,000-mile field test at Camp Roberts located near Paso Robles, CA. Haskell said that the test proved that the CIFV performs as well as a similar vehicle with a hull at reduced weight and offers additional benefits such as enhanced crew survivability, reduced interior noise and possible reductions in some manufacturing and life-cycle costs.

ARL-Watertown has a close working relationship with the Tank-Automotive Command, which should foster a transition of the technology into their future armored vehicle development programs.

"This is one of ARL's contributions to the future main tank development," said Haskell. "Field testing would demonstrate durability of the technology while helping to reduce vehicle weight."

The construction of the heavyweight vehicle is a tremendous technological step. "Most people look at this program and see a tank. I see this as just proof of a new materials technology," Haskell concluded.

The preceding article was written by Eric Hurwitz, a public affairs specialist at the U.S. Army Research Laboratory in Watertown, MA.

Aviation Applied Technology Directorate Awards Contract

The Aviation Applied Technology Directorate (AATD), U.S. Army Aviation and Troop Command, Fort Eustis, VA, recently awarded a 58-month, $70,464,616 contract to McDonnell Douglas Helicopter Company, Mesa, AZ, for the Rotorcraft Pilot's Associate (RPA) program.

Bruce Tenney, RPA manager, stated, "The RPA program seeks to provide revolutionary improvements in combat helicopter mission effectiveness through this application of knowledge-based systems for cognitive decision aiding and the integration of advanced technologies in areas of pilotage, target acquisition, armament and fire control, communication, controls and displays, navigation, survivability and flight controls. This effort is currently the preeminent science and technology program in the Army, and one of the largest contracts ever awarded by AATD."

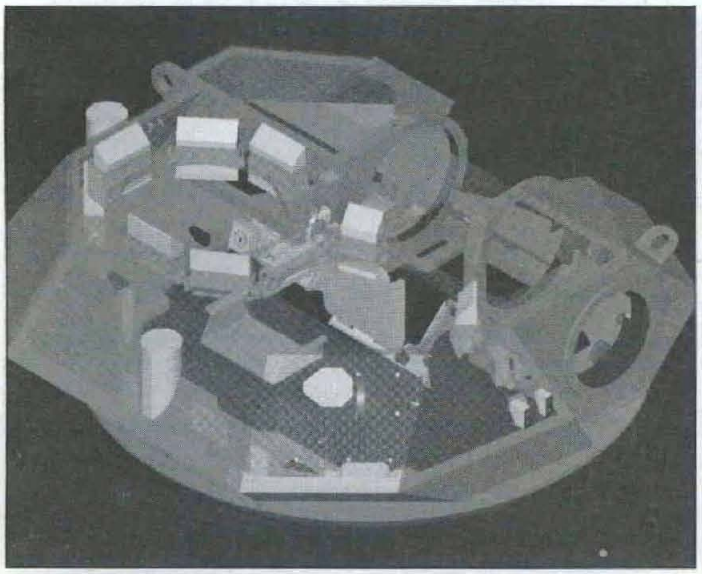
Virtual Prototyping at TARDEC

An advanced computer-aided design, or CAD, technique known as virtual prototyping is dramatically changing the way in which engineers at the U.S. Army Tank-Automotive Research, Development and Engineering Center (TARDEC) design new vehicles for the Army.

In virtual prototyping, computers are used to generate three-dimensional solid models of vehicle concepts in a simulated real-world battlefield environment. Then, by viewing the scene through special three-dimensional stereo goggles, a soldier can see the images the way they would appear from inside the vehicle and aid engineers in correcting design deficiencies prior to building and testing expensive hardware prototypes.

"A soldier can observe the relationships of vehicle displays and other components with each other and how suitable they would be for the user in a working environment," explained design engineer Demetrio Lacap of TARDEC's Design and Manufacturing Technology Directorate. "And if he sees something he doesn't like in a vehicle design, such as the position of display panels and controls, we can keep changing the design in the computer until he is satisfied."

CAD is not new to TARDEC. Two systems were installed during the early 1980s, one in Building 200 and the other in Building 215. They dramatically reduced the time required to complete design projects. Engineers were able to perform tasks that once took days or weeks with a standard drawing board in a matter of hours by combining human skills with computer technology and computer graphics.



TARDEC's engineers and scientists are leading the Army in the use of virtual prototyping.

But as good as these systems were, their modeling capability was limited to producing what are called wire-frame models, which include views of only the distinct edges of objects.

"With the equipment we have now," said Lacap, it is much easier to do design analyses and produce finished drawings, because we are working with solid surfaces instead of only the edges. Solid modeling also makes it easier to verify the way newly designed parts fit together before they are actually produced and fabricated.

According to Lacap, the first Army vehicle designs to be created by virtual prototyping will be upgraded versions of the Bradley Vehicles—the M2A2 Infantry Fighting Vehicle and the M3A2 Cavalry Fighting Vehicle—slated for introduction in the late 1990s.

Designated the M2A3 and M3A3, they will include a new electronics system that will provide digital communications with air and ground combat vehicles as a supplement to voice communication. This system will improve combat effectiveness by dramatically reducing the time needed to send and receive information. Also, the short duration of the radio signal—usually no more than a second—will make it more difficult for the enemy to use it to locate a vehicle's position.

Other features will include an improved infrared target-acquisition system, the capability of tracking two targets simultaneously, and separate day-night battlefield viewers for the commander, gunner and squad leader. There will also be an improved position navigation system.

Lacap said efforts are now under way to enter the M2/M3A2 Bradley engineering drawings into the TARDEC CAD system, where they will become a permanent common solid-model data base that will help engineers to develop the upgraded Bradley design. He added that Bradley virtual prototyping is expected to start early in FY94.

The preceding article was written by George Taylor, a technical writer in the Marketing Office of the U.S. Army Tank-Automotive Research, Development and Engineering Center.

RD&A NEWS BRIEFS

DOD Selects Small Business Research Proposals

DOD recently announced the results of the technical evaluation phase of proposals submitted under the DOD Small Business Innovation Research Program (DOD-SBIR). At the time *RD&A Bulletin* went to press, more than 900 of the 6,470 proposals received had been identified as offering the greatest potential in their field for meeting the research and development needs of DOD. They will be subjected to further evaluation and negotiations leading to contract awards.

The proposals were selected from those received by the Army, Navy, Air Force, Advanced Research Projects Agency, Defense Nuclear Agency, and Ballistic Missile Defense Organization. They were in response to the FY 93 Phase I Solicitation which was the first of two solicitations issued by the DOD in that fiscal year.

The purpose of the DOD-SBIR Program is to stimulate small businesses to conduct high-quality innovative research and development to meet important defense-related scientific or engineering needs. The goals of the national program include increasing the use of small businesses in federal research and development.

Consisting of three phases, the SBIR Program was enacted by Congress in July 1982 by Public Law 97-219, and re-enacted in October 1992 by Public Law 102-564.

Under the statute, Phase I is intended to permit the determination of the scientific or technical merit and feasibility of a proposed research or development effort. Phase II awards will be made to firms based on the feasibility demonstrated in their first phase efforts and the quality of a Phase II proposal. Under Phase III, it is expected that non-federal capital would be used by the small businesses to pursue private sector applications, or that federal non-SBIR funds might be used for DOD mission oriented contracts for products or processes.

The first FY 94 DOD-SBIR solicitation opened in the fall of this year. Copies of the solicitation are available from the Defense Technical Information Center, Attn: DTIC-SBIR, Alexandria, VA 22304-6145; or telephone (800) 225-DTIC.

LETTERS

Dear Sir:

It's typical to write letters to the editor to expand upon or take issue with a published view. Instead, I'm writing to call attention to an overlooked topic: Serving customers.

A glance at the 1983 and the 1993 Fortune 500 lists shows that many long-standing "industry giants have ratcheted down. Times have changed. Most say it's the economy and they are probably correct, but there is more to the story. Economic decline is a catalyst that accelerates degeneration in organizations that did not pay attention to business basics. One business basic is: customer satisfaction.

Two quotes summarize extreme views. "They can have any color they want—as long as it's black." "The customer is always right." The first view works if the product is in demand. It's wise to embrace the second view if the line of customers at the door is shrinking.

Past demand for their product may cause some organizations and individuals to overlook customer service. Being one of the few games in town lulls us into a false sense of security. When resources (such as money) decline, competition forces those who have lost touch with their customers out of business. It's time to give serious thought to customers and what one can do to get more of them. We can't wait for customers to show up. We must actively find customers and work harder to keep them through customer service. A customer-oriented approach serves two purposes: It tells them you care and it aids your understanding of their reality.

Most engineers and scientists are sensitive to customer service, but the heavy workload we experienced in the recent past may have eroded our marketing skills. Not that long ago, engineers and scientists were in demand. They were hard to hire and harder to keep. Now, engineers and scientists who wish to stay employed should rethink how they relate to customers and what they can do to improve customer contact and service.

Many engineers and scientists leave marketing to others. That's fine if your marketeers are thoroughly conversant with what you have to offer and can plug that into customer needs. On the other hand, marketing of science and technology usually demands involvement of those who are doing it. Few non-scientists and non-technologists understand those fields well enough to answer questions accurately; so, I advocate a do-it-yourself approach.

You are probably thinking—OK, now what should I do? Well . . . there is a lot to marketing. Start by defining who your customers are, how you have served them, and what you can do to serve them better. Loyal customers got that way because you served them. Service means satisfying customer needs, wants and desires. Serve the customer and keep serving the customer.

Open new areas of customer service by helping them redefine their product line. Show them how new ideas or concepts can fit their purposes. Find out how you can satisfy their needs, wants, and desires for new products or product improvement. Cause them to think beyond what was, to what can be. Most of all, express your ideas in ways the customer understands: Talk their talk.

Beyond job security lies job satisfaction. I'll bet you have some really good ideas you set aside due to the press of business. What about test-marketing those ideas for fun and profit? But that's another topic. In summary, you can count on having customers if you give them reason to count on you.

Sincerely,
Paul J. School, Ph.D.,
Chief, Fort Belvoir Field Element of the Human Research and Engineering Directorate, Army Research Lab

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ARMY

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BULLETIN

Professional Bulletin of the RD&A Community

WRITER'S GUIDELINES

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SUBJECT MATTER: Subjects of articles may include, but may not be necessarily limited to, policy guidance, program accomplishments, state-of-the-art technology/systems developments, career management information, and management philosophy/techniques. Acronyms should be kept to an absolute minimum and when used, must be written out and explained. Articles with footnotes will not be accepted.

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