ARMY R,D&A

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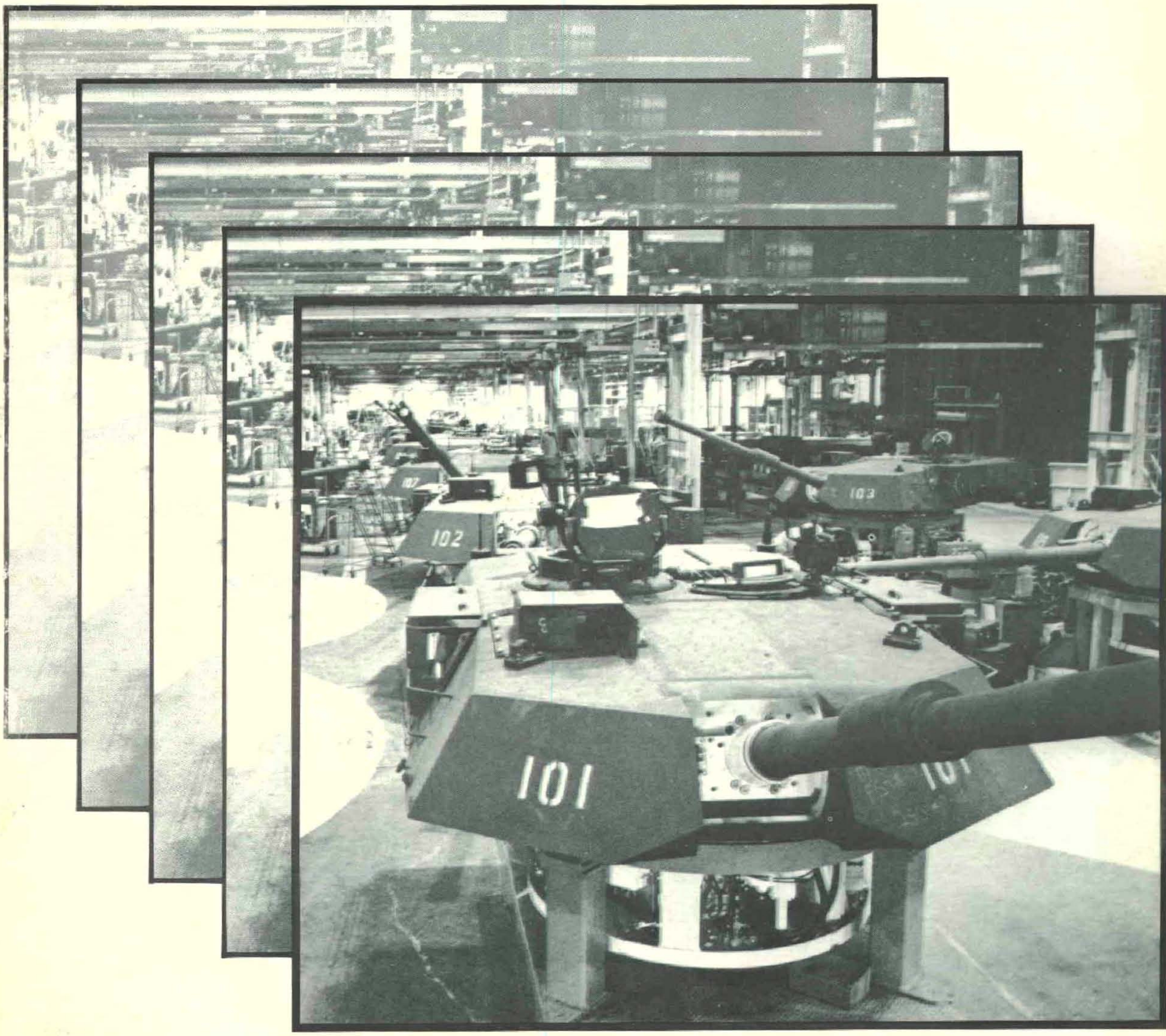
MARCH-APRIL 1984

EXCELLENCE IN PRODUCTION



AIMING FOR SOLDIER SATISFACTION

ARMY R,D&A

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ABOUT THE COVER:

An M1 tank production line is shown on the front cover, setting the tone for a series of articles in this issue devoted to the topic of production. The back cover is related to an article on future trends and their implications for DARCOM during the next two decades. Cover design by Christine Deavers, HQ DARCOM Graphics Branch.

FEATURES

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Problems of Productivity

Late last year Department of Defense and industry executives gathered at a meeting sponsored by the American Defense Preparedness Association, in Pittsburgh, PA, to consider mutual problems and issues related to the productivity of the industrial base. The following discussion, provided here in a condensed version, was presented at that meeting and was devoted to "a search for common goals." An industry perspective is presented by Mr. Thomas J. Murrin, President, Energy and Advanced Technology Group, Westinghouse Corp. Mr. Jack E. Hobbs, Deputy for Management and Programs, Office, Assistant Secretary of the Army, provides a government view.

Opening Remarks by Mr. Hobbs

Tom Murrin and I would like to spend a few moments to establish a framework for the remainder of the conference. As you spend time in the materials, automation and human resources workshops, we feel it is important that you keep in mind some of the overall dimensions that bound the productivity problem.

Opening Remarks by Mr. Murrin

In my view, there is no more crucial issue than improving the productivity and responsiveness of our defense industry, for it is vital to our national security, and to the economic well-being of our Nation. I am hopeful that we can shed some light on the different environmental issues and challenges faced by DOD and industry, differences which have affected our relationships, and have made it difficult for us to focus on common goals.

Let me recognize at the outset that our American aerospace and defense industry has demonstrated outstanding leadership in the areas of quality and productivity. We represent the strongest single concentration of industrial talent and resources in the United States today. We are also, in my opinion, the U.S. industry that is in the best position to lead our Nation out of the industrial and competitive decline. But to do this, we must develop new approaches, and new attitudes that will allow us to focus on our objectives.

DOD and industry have been trying to define a set of common goals for decades. In recent years, we've talked a great deal about improving quality and productivity in the defense industry. And we've heard much "rhetoric" about teamwork—about replacing adversarial relationships, and restrictive regulations with a spirit of trust and with the cooperation that is essential to the pursuit of these common goals.

While we appear to be making progress, there are indications that the net effect of all our "rhetoric" has been quite the reverse and that our relationships are actually deteriorating—largely because some of our goals are not common but, in fact, are conflicting.

We can no longer afford to continue to work in conflict, we must change what has become business as usual. Therefore, I look forward to this opportunity to jointly discuss today's environment, the challenges we face, and our DOD-industry relationships, and to set forth some recommendations. Hopefully, you will find the format we have chosen stimulating. To begin, Jack Hobbs will discuss the environmental issues from a DOD perspective.

Hobbs on the DOD Environment

It would not be news to any of us that the United States is in the process of recovery from an unusually persistent inflationary cycle and a period of record-setting unemployment. It was during this period that we embarked on one of the greatest modernizations of our defense posture in post war history. During this same period there have been record high deficits in the Federal budget.

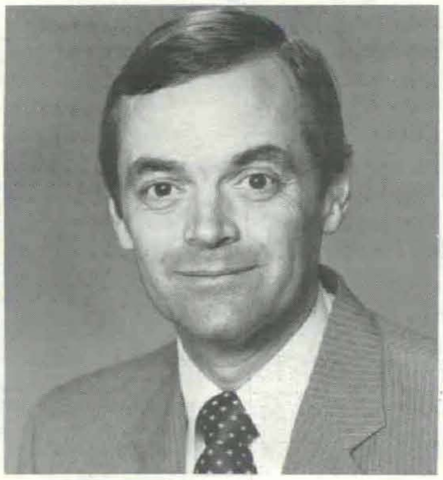
From the public's perception these items are related inasmuch as the economic problems and the defense growth are attributed to haphazard management, high inflation, high interest rates and so on. The pressure on our board of directors, the Congress, is to rearrange budget priorities and debt reduction.

As a result, there are more and more legislative efforts to regulate and scrutinize various aspects of the defense budget. A major focus is the acquisition process. These efforts have expanded well beyond the normal budget issues. Legislation has been enacted to establish a new independent weapon system test agency. There is a great deal of interest in specific acquisition strategies.

Reporting of program status on more and more programs and the inclusion of the six largest contracts on a program for cost growth control are other forms of new congressional controls. Finally, program priorities, the amount of competition, technologies to be pursued, and source selection are receiving greater scrutiny.

In addition, we are concerned with our ability to regain the steady increase in productivity that characterized our industry for so many years. This is very critical if we are going to demonstrate that we have the capability to manage the added resources being given to defense.

At the same time, our industrial base is faced with a technological explosion which has significantly accel-



Jack E. Hobbs, Deputy for Management & Programs, Office, Assistant Secretary of the Army (RDA)

erated the life cycle of our weapon systems. As the rate of change in individual technologies increases, there is a geometric increase at the total systems level. This compounding effect increases the probability of technological surprise, but, at the same time, offers a large payoff for technology insertion. This period of rapidly expanding technology must be a period when productivity is a major focus of our industrial partners.

In summary, we find that defense must operate in an increasingly unpredictable and unstable world, confronted with more and more public scrutiny, and in the midst of a transformation of American industry faced with a technological explosion and at the same time faced with making changes in manager and employee attitudes to regain a level of quality and productivity that was at one time taken for granted. These things shape the environment in which we must purchase hardware from industry.

Murrin on the Industry Environment

I'd have to agree that the environment in which DOD must operate today is indeed perplexing—militarily, politically, and economically. The environment we face as defense contractors is similarly complex and more difficult than ever before.

I'd like to address three issues driving industry today—namely, the scrutiny we face not only from our customers, but from Wall Street and our stockholders—the growing threat from international competition—and the effect of the ongoing technology explosion, as it affects the competitiveness and viability of our defense products.

Relative to scrutiny, we in the defense industry also feel the results of the scrutiny DOD experiences from the Congress and the public. They demand that DOD, through their defense contractors, deliver high quality goods and services, on time, and within budget, a reasonable expectation.

In addition, our financial performance in the defense industry is scrutinized as never before by Wall Street investors, and through them by our stockholders. We are, in fact, competing for investment funds with commercial industries and it is imperative that we return profits competitive with non-defense industries, if we are to receive our "fair share" of the capital so critical to modernization of our offices and factories, and our "fair share" of the research dollars so crucial to our long-term international competitiveness.

Our number one threat to profitability is the rapidly growing force of international competition, particularly from the Japanese. Once-dominant U.S. industries have been driven out of business by the higher quality, and lower prices, offered by international competitors. The situation has caused more concern and rhetoric than any commercial crises in history. Traditionally preeminent American corporations have lost both market share and profits to European and Asian firms and have laid off thousands of workers in the process. Many of our unemployed find themselves "technically obsolete."

Our Nation's balance of trade is showing increasing deficits every year while our international competitors grow stronger, in both technology, and numbers. A number of historically strong "smokestack industries" find the environment one of bleakness, and little promise. Certainly that is the feeling in some companies right here in Pittsburgh.

During the last decade there have been four key factors that led to our Nation's industrial decline. These were:

- Too little attention to the management of quality and productivity.
- Too little investment in applied R&D and capital equipment.
- Inadequate management of human resources.
- Continuous growth of bureaucracy and trade restrictions to the detriment of entrepreneurial innovation.

We must not allow this to repeat itself in the defense industry! But we must recognize and subsequently accept the fact that these same issues face the defense industry and the same foreign competitors are attempting to increase their share of the global defense market. We must establish a course of action that will guarantee our continued preeminence in this defense market.

Let me assert that we in the defense industry, and our DOD partners, must speak out together on this issue of global competitiveness. We can no longer maintain an attitude of indifference toward the industrial policies, technology, and defense products of other nations.

Together, we must face some rather tough and complex geopolitical trade issues, including technology transfer, licensing, coproduction, and financing. We must do a better job of transfusing our defense dollars and defense technology into other industries to insure our Nation's competitiveness in the global commercial marketplace.

Speaking as a single voice on these issues, and on the threat of international competition, might well be our most constructive counter to the scrutiny we both face in supporting defense spending.

Our situation is further complicated by the third environmental factor—a technology explosion, unlike anything yet experienced.

Today, the development to deployment cycle is so long and technology "half life" so short that our new systems face the risk of early technical obsolescence. This dictates prudent life cycle improvement planning and technology insertion budgeting as integral parts of each new defense program.

Corporate America and DOD are speaking out together on the need to protect our IR&D funds and expand dramatically technology modernization and manufacturing technology programs.

Recently, at Westinghouse, we signed a multiyear cooperative investment program with the U.S. Air Force called GET-PRICE. It is a pioneering manufacturing technology program that promises to save DOD almost one billion dollars over the next decade, with Westinghouse modestly sharing in the savings.

Also, we are engaged in the bold and far reaching Very High Speed Integrated Circuits program, cooperating with DOD, and other defense contractors in the development of a new generation of semiconductors.

Hobbs on the DOD Challenge

We clearly face different environments and goals. To effectively manage in these environments, we must identify, articulate and agree on the challenges we face. There are several interrelated factors that must be addressed concurrently to improve the way we do business, increase the mobilization capacity of our industry and maintain a productive and efficient supplier of defense hardware.

The first and most important of these factors is quality. I am not referring to only quality control or quality assurance. Quality must be thought of in a larger context. This implies a different concept that is traditionally associated with our quality efforts. It means the weapon system must be designed to quickly accommodate changes in technology or threat. Additionally, the equipment we purchase must meet functional, reliability, availability, maintainability (RAM), and real world performance objectives at an agreed upon cost. Finally, the support infrastructure must be properly implemented to include the necessary personnel, training, software, parts, and test equipment.

In short, quality must be viewed as a continuum throughout the entire acquisition process. From the requirements document to the manufacturer and on to the support structures, quality must encompass every action and event. Quality needs to become an accepted way of doing business. We need to stop having special programs to emphasize quality.

Closely associated with this concept of quality is life cycle management. In making resource allocation decisions, the DOD and the Congress must have a high degree of confidence in the inputs on which these decisions are based.

We must identify the cost associated with a new system early in the life cycle. This includes the costs of production, operation, maintenance, personnel, common support equipment and other infrastructure costs.

Another challenge is to reduce the time from development to deployment. Rapid advances in electronics, materials, and propulsion technologies, to name a few, have forced us to rethink the entire weapon system time line. We can no longer afford to take 7 to 10 years to field new systems. We must find ways of reducing this time.

A similar, yet somewhat different, situation exists in the production and manufacturing area. Our experience in making the transition from development to production has not been good. The end result of the development process must be a product that can be built by the production organization with at least the same level of performance and RAM as the engineering prototypes. This needs to be a major focus of our development efforts.

Finally, throughout the acquisition process, we must establish ways to make it more flexible. Competition must be used when it makes sense. On most major systems, it is not economical to maintain two prime contractors in production. However, on most systems, 50 to 70 percent of the cost is in items purchased by the prime contractor and this is where competition does make sense.

Thomas J. Murrin, President, Energy & Advanced Technology Group, Westinghouse Corp.

We know that competition will, in many cases, stimulate innovation, lower costs and provide an incentive for contractors to make capital investments in order to become more productive.

In summary, the challenge to the DOD is to establish the operating criteria for total quality in our systems, manage on the basis of life cycle costs, reduce the cycle time and become flexible in our use of competition so that it can be used when and where it makes sense.

Murrin on the Industry Challenge

From an industrial point of view, the environment of rapid change presents us simultaneously with three interdependent challenges: dealing with profitability, quality, and employment.

The first challenge for industry is to remain profitable. This is rule number one in the free enterprise system. We must remember that all of the productivity efforts we speak of are meaningless unless they lead to the profits necessary for us to continue in business. However, to stay in business, we must provide quality products for our customers, training for our workforce, and automation in our factories and offices.

Clearly one way to achieve higher quality is through the modernization and automation of our offices and factories. We must also manage for quality by motivating our people to design and build quality in and to rely on themselves rather than inspectors and quality auditors. This will require a "cultural change."

The term "QC" might yield better results if it meant "quality culture," instead of "quality control." For decades we've been controlling quality by measuring acceptable levels of rejects. We need a quality culture based on the belief that there is no limit to quality and no acceptable level of rejects!

As we move in this direction, we must not overlook our human resources. We have an obligation to provide long-term job stability for our employees in the defense industry. Automation, higher quality, and less rework with full employment must be the call of the day.

We must reach understanding and consensus on the critical "linkage" between a high quality product, full employment during a period of technology explosion and automation, and reasonable profits for industry.

Recognition of that "linkage" may be the key to the investments that will allow us to stay at the leading edge of technology, continually train our people, and upgrade our facilities to provide top quality defense systems.

The linkage between quality, profits and employment may also be the key to needed changes in the acquisition process. Industry is neither efficient nor profitable in an atmosphere which features program instability, year-to-year doubt over follow-on orders, varied and low quality production rates, and bidding for programs with inadequate funds, and unrealistic schedules. Such an atmosphere does not breed high quality, nor job security.

A critical linkage between profits, employment, and quality? A far-fetched idea? Perhaps, but I assert that is precisely the "linkage" made by the Japanese. Haven't they created program stability, multiyear production, and economical production rates by focusing on quality? And haven't high market share, economic growth, full employment, and profits been results?

Also, what of the Congress and the taxpayer? Do they link defense quality and defense profits together? Perhaps not! Perhaps they believe the opposite? And perhaps misunderstanding of this linkage leads to the adversarial relations we will discuss next.

Hobbs on Relationships

During the past two decades it seems clear that the continuing management problems in government programs are not due to the lack of initiatives for change. Today, as in the past, there are many initiatives to address the problems. Our focus must be to discover why these initiatives have not become part of the way we operate.

The initiatives have failed to be implemented because of hesitancies of the institution to change. Improvements in the management of programs and the upgrading of our industrial base require the commitment of both government and industry to make some basic changes in the way we do business. We must replace bureaucratic, top down, centralized planning with consensus-based, results-oriented actions.

We have a discontinuity in the basic goals of the parties involved. The culture of my world is the quick fix. We deal with the current contract or current budget problem. For your part, I would say you have a broader view dealing with market share, return on investment and long-term profits.

We deal with technical excellence but do not enforce design criteria to insure we have designed with a cost goal in mind. I believe you determine an acceptable market price for an idea and build to that price.

Past initiatives did not recognize the basic differences between the goals of government and industry. As we push industry to make greater capital investment to improve productivity and reduce cost, we must recognize that industry needs an opportunity to recover that investment and make a profit on it. This is difficult to accomplish when the next contract is negotiated based on last year's actual cost. This is hardly an incentive for industry.

All too often, the Government's goal becomes one of minimizing the contractor's profit, disallowing costs, and drawing up a contract that passes on to the contractor all developmental risks and, in addition, often includes a multiyear production option which, in effect, punishes the contractor for quality and productivity improvements by reducing price and profit if such improvements are implemented before the options are exercised.

Finally, we have over a period of years created a hostile mode of operation. We have created an atmosphere where the parties are dealing from mutual mistrust and, I submit, it costs to mistrust each other.

Murrin on Relationships

During the past 20 years, we've somehow lost the spirit of trust, and the cooperative relationship that previously existed between the Government and industry. In the process, a traditional trust was replaced with bureaucratic restrictions, and adversary relationships. We talk often about quality and productivity and teamwork but when we try to implement these through an unproductive acquisition process, built around mistrust, our best efforts fall apart.

It is through the acquisition and contract process that our relationship becomes adverse because the current structure forces us to a win-lose attitude and lose-lose negotiations.

We tend to forget that the Soviets are the true adversary and instead become adversaries ourselves.

The rules of the game guide the Government negotiators to focus on disallowed costs, and minimizing the Government risks. Quite naturally, the contractor's goal becomes the opposite as he tries to retain some of the profits that he believes are due him, and retain reserves to cover unforseen downstream risks that he is being asked to face alone.

I agree with Jack's point that when the contracts are multiyear, they often disincentivize quality and productivity improvements. It's little wonder that our spirit of teamwork often disintegrates when we begin the acquisition process.

The solution to this dilemma is for both parties to focus on a set of common goals. Those goals should include the delivery of the highest possible quality product to the field at a fair price and on a reasonable schedule with the end objective of maintaining our national military readiness.

The cooperative technology modernization and Very High Speed Integrated Circuits programs that I mentioned earlier are consistent with this aim and prove that our relationships can be at "arms-length" without becoming antagonistic. Still some will argue that relationships between DOD and industry are inherently adverse since each is motivated by separate and often conflicting aims.

Some also say that common focus is impossible, because the contractor is motivated not by the need to prevent Soviet superiority, but by return to its stockholders, and because the military users and DOD procurement agencies fail to fully comprehend the critical link between industry's profits, and our national security.

Some will argue that only in wartime can DOD and industry become a single team with a common purpose. I for one reject such pessimism! I believe that we can no longer afford adversary relationships. We need to focus our available strengths, resources, and talents on our Nation's adversaries—the military and industrial competitors who threaten our security and economic prosperity. We also need to focus on total quality improvement.

Hobbs on Common Focus

We've talked about the environment, challenges and relationships from our individual perspectives. It should be obvious that we must find a better way to manage in a fast-moving, unpredictable environment which has some deep-seated and counter-productive biases.

The DOD and industry must recognize that productivity is the long-term effect of management decisions and actions. In this context, management must focus attention on the causes of productivity improvements. This means we must concentrate on a wide variety of actions that affect weapon system costs. These include things such as human resource development, asset utilization, cost performance thresholds and tradeoffs, program stability, capital investments and concurrent versus series scheduling.

While internal efforts are critical, major improvements can only be made through joint customer-supplier management actions. We must jointly address areas such as the forward planning process, better communications, different ways of contracting, and changes in the regulatory and administrative process. We must, for example, institutionalize the user community's involvement in the requirements planning process. We must insure that the system developers are focused on solving functional problems and not creating engineering monuments. This information must be communicated to industry in a form that can be used for independent R&D efforts, business base planning and capital investment decisions.

In the contracting, our objective must be to give industry the chance to enhance profits by being innovative. This includes the use of competition where it makes sense, incentivizing capital investments and value engineering efforts. We must recognize the domino costs of regulations and administrative actions so that the true cost is compared to the value added or subtracted by the regulation.

In this final analysis, to make real and permanent improvements, management on both sides must demonstrate their commitment to productivity through specific actions and attitudes. The leadership must focus their organization's resources on opportunities such as technology insertion in existing assets, flexible manufacturing systems, and reducing policing costs.

Murrin on Common Focus

If we are to focus our energies and talents together, we must direct them on the threats we face together and recognize the linkage between the military and industrial competitions in which we are engaged.

Only if our Nation prospers economically, can we successfully face the Soviet threat. Concurrently, advanced technology from our DOD programs can help our Nation's competitiveness on the international commercial battlefront, only if we effectively manage that technology, and transfer it to our commercial industries expeditiously, and with respect to national security regulations.

The key to this common focus on external threats is leadership with effective, open constructive dialogue between the leaders of all facets of our defense team. I include not only DOD and industry but Congress, and the public. We must strive to create a "culture" based on trust and to motivate all of our people to contribute their very best towards the defense of this Nation. I mentioned earlier that inadequate attention to quality was one of the causes of our Nation's industrial decline. Historically, we have placed misguided focus on marginal productivity gains instead of attention to doing things right the first time.

Quality and productivity go hand in hand, but in that order, and for too many years we have had the order reversed, seeking productivity gains, even at the expense of quality.

For many decades, U.S. industry has been productivity focused, trying to push more out by steamlining, cutting, squeezing, and applying the pressure. We've continually pushed to cut the costs, just another 5 to 10 percent. Each time that we squeezed for another marginal saving we risked alienation of the work force, and sacrificed quality.

While we focused on productivity programs aimed at marginal cost reductions, we found ourselves losing in the marketplace to superior product quality, superior reliability, and superior service after sales.

Producing more inefficiently and at the expense of quality is certainly no way to increase productivity. Putting more inspectors on the line, to find the mistakes, is clearly the wrong approach to productivity. Doing something over because it wasn't done right the first time wastes money, and lowers productivity.

Simply stated, improved productivity is the by-product of improved quality. We must focus on both but if we focus first on quality all else will follow. We in the defense community have an extraordinary opportunity, and in fact a pressing responsibility to lead the way toward a national strategy based on quality and productivity improvement. We need to set standards-of-excellence for all of industry to emulate.

We need to improve the quality, reliability, and performance of our defense systems while providing more value for our Nation's defense dollar.

Finally, we need to take specific actions that will allow us to maintain U.S. leadership in the defense and aerospace industry.

Hobbs' Closing Remarks

There are several actions that can be taken to get us started toward achieving our common goals. Neither industry nor government can do this alone. Improved quality and productivity is only possible through a partnership between DOD and industry. Toward this, we'd like to suggest a four point program which we believe should be adopted as a means of stimulating quality and productivity improvements.

We need to outline ways to provide industry with our long-term budget goals for programs so that industry internal budgets can reflect ways to improve productivity. This action would insure that government programs are knitted into the fiber of the contractor's planning cycle.

Secondly, we must make stable operations a way of life. We cannot expect increases in productivity and control of costs if programs constantly change. Thirdly, industrial modernization programs should be supported by top management in DOD and industry. These programs, more than anything on the horizon, can defeat the cost disincentives in our current contracts.

Finally, we must focus on technology insertion and in advancing the state-of-the-art in critical generic technologies like flexible manufacturing, robotics, software and Very High Speed Integrated Circuits.

A long-term joint industry/DOD strategy on quality, productivity and international competitiveness is essential. Let's work together to guarantee our future. Let's replace bureaucracy, adversarial relationships, with sound management, team work and innovation. This will allow us to maintain U.S. preeminence in critical defense technologies. We really have no other reasonable choice.

In summary, we need to find a way to do business in an environment where everybody expects a quality product and is willing to negotiate, test and field with that assumption.

Small Arms Weapons Manufacturing Modernization

By William A. Dittrich

Until recently, the manufacturing methods for small caliber military weapons in the United States had seen little change for the past 40 years. The Army's major mobilization producers are still using machinery designed, for the most part, before World War II.

While private industry has been converting to numerically-controlled machines and more recently, to robotic assembly methods, the government-owned weapons production base still uses primarily manually-operated machines and hand assembly. Manual inspection and material handling techniques dominate the process.

We continue to rely heavily on skilled operators, many of whom are close to retirement age, to assure a quality product. Under full mobilization conditions, reactivation and expansion of the existing base would be a difficult task.

In 1980 however, the Army began a Manufacturing Methods & Technology and Facilitization Program to upgrade and modernize the capability for small arms weapons manufacture, utilizing the latest technology in manufacturing processes and inspection techniques.

The initial phase of the program has centered on the improvement of processes used for gun barrel manufacture, since the gun barrel is the component requiring the most specialized processes and historically is the most difficult to produce. Concurrently with process improvement and equipment development, product improvement programs also have been initiated to introduce material and configuration changes that result from introduction of the new processes for manufacture.

Before describing the new process, it is important to give a brief description of a typical existing facility for manufacture of a small caliber barrel. The Saco Defense Systems Division (SDSD) of Maremont Corp., Saco, ME, provides the major share of the mobilization base for caliber .50 through 30mm barrels, and maintains a government-owned production equipment package including a variety of World War II-vintage specialized machine tools to perform gundrilling, chambering, rifling, and similar operations. This base is supplemented with privately-owned general purpose equipment. A similar situation exists at mobilization producers for other smaller caliber rifles.

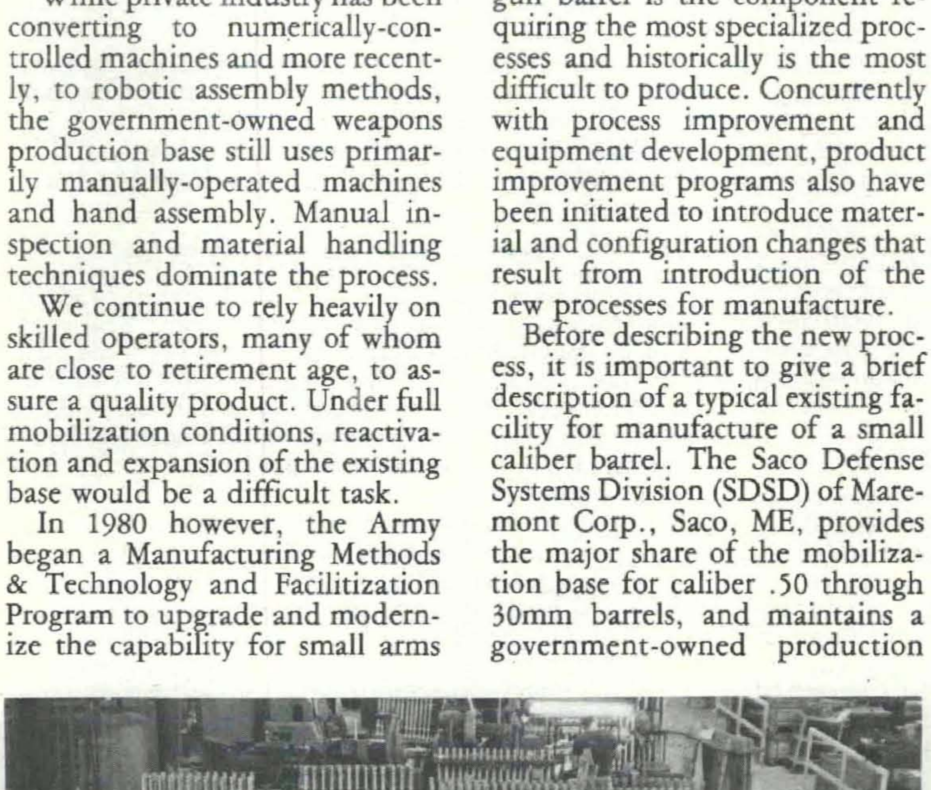


Figure 1 shows a typical existing gun-drilling operation. Carts of gun barrels are seen in the background. Each of the old drilling machines drills two barrels at a time. Forty-five minutes to two hours are required for drill cycle depending on barrel size.

Typically, Saco produces about 2,000 to 20,000 barrels annually of each of several types. Barrels begin as purchased steel bar stock or forgings which are subjected to a series of initial exterior machining operations to provide a configuration suitable for interior machining operations. They are then gundrilled to provide a hollow tube (Figure 1). Subsequently, additional turning operations are done on the exterior. The barrel is rifled by a broaching operation and the chamber is drilled and reamed. The barrel interior is chrome plated.

Throughout the process, a number of separate cleaning operations are performed. The barrel is also straightened several times in the process, an operation requiring a substantial amount of operator skill. In total, between 50 and 100 separate operations are performed on typical caliber .50 through 30mm barrels.

Barrels are manually handled on pushcarts for transport between these operations, and hand gages are used extensively for in-process inspection. For example, the chamber configuration alone is measured by manually inserting over 20 separate go/no-go and dial gages at various stages of the process.

While the process is old, the high degree of skill of the operators continues to produce a qual-

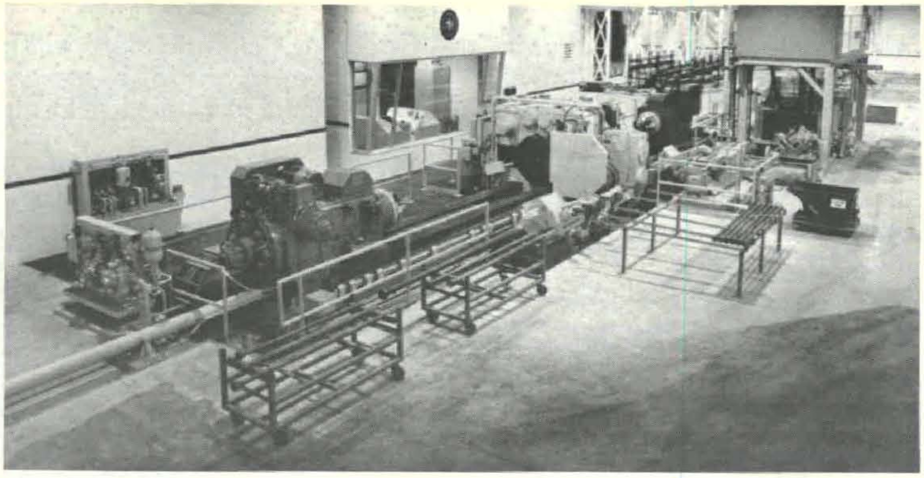


Figure 2. This new hot rotary forge is presently being readied for production at Maremont Corp., Saco, ME. Installation of heat treat and automated material handling to interface with this forge is in progress.

ity product. However, the process is labor intensive. The drilling operation for a 30mm barrel by itself takes over an hour. Broaching requires sequential attachment and manual cycling of over two dozen individual cutters through the bore to obtain the desired progessive twist rifling configuration, a laborious process.

Approximately eight hours of actual machining time is needed for a typical barrel. This does not include time for handling and inspecting them. Manual handling of in-process batches of components, in addition to being time consuming, results in a large in-process inventory. More than 50 percent of the original input material ends up as chips or other waste, adding significantly to the cost of the product.

The new manufacturing technology program to improve the process is executed by the Fire Control and Small Caliber Weapon Systems Laboratory of the U.S. Army Armament R&D Center at Dover, NJ. Projects are managed through the DARCOM Office for Manufacturing Technology and the Industrial Readiness Directorate HQ U.S. Army Armament, Munitions and Chemical Command, Rock Island, IL.

The program initially analyzed existing processes at Saco Defense Systems Division while comparing proposed alternative concepts on the basis of investment cost, operating cost, reactivation time, and other factors. Sample barrels were fabricated using alternate processes for forming the initial blank, drilling, chambering, rifling, and plating the barrel. Processes were closely monitored so that variables were defined, times for each operation were developed, and production efficiency could be predicted.

While some tests were run at Saco, the need for specialized machines often required subcontracts to machinery producers and development laboratories. Other corporations were located which leased time for process evaluations on machines which were used normally for totally different purposes. For example, tests of hot rotary forging of caliber .50, 20mm, and 30mm preforms were conducted under the GFM Corp. supervision on a machine recently installed at a West German steel mill. Gundrilling investigations were performed at drilling machine manufacturers using different types of drill bits supplied by other corporations.

The manufacturing technology efforts performed thus far have resulted in processes much different from those now in use. The initial portion of the process for all caliber .50 through 30mm barrels, the hot forge subsystem, will continuously accept bar stock, automatically cut it to length, heat it to forge temperature, and then rotary forge it to near-net-shape with little material loss (Figure 2).

The key machine in this portion of the process is the $3.5 million model SHP-16 rotary forge machine built by GFM Corp. Four computer-controlled reciprocating hammers in its forging box shape the bar into a barrel configuration as the rotating red-hot bar passes through the machine (Figure 3). Then the barrel preform will be heat treated in a continuous process using fully automated material handling and computerized process control.

The hot forge subsystem has been designed to permit rapid conversion between barrel sizes. Changeover usually requires only

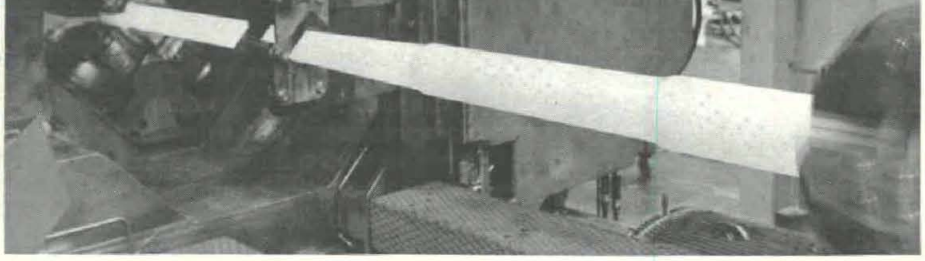


Figure 3. A medium caliber barrel is shown on its final pass through the reciprocating hammers which form it to near net shape.

changes of input material sizes and selection of different computer programs. Hammer tooling must be replaced when changing from 20mm to 40mm size range, but this can still be accomplished in less than 30 minutes.

The overall time required to process a single 20mm barrel preform from input bar stock is less than 15 minutes. Since many steps are being performed concurrently, the line can produce barrel preforms at rates of between 12 and 30 per hour, depending on size.

After passing through the hot forge subsystem, the barrel will follow divergent paths depending on size and the configuration of rifling. Ejector/BTA drills will replace existing gun drills to produce barrel bores at six times the old rate. Caliber .50 and smaller barrels having a constant twist rifling will be finished on a cold rotary forge which shapes the hollow preform over a mandrel.

Larger barrels having a progressively varying twist rifling will be rifled using high speed broaching or electrochemical machining techniques, and computer-controlled specialized turning machines will finish the chamber and exterior surfaces. A rapid-flow plating system proven under the Manufacturing Methods and Technology Program will then apply the plating to the bore of the barrel at over 10 times the rate of existing plating systems.

Facility projects were begun in FY 1981/82 to implement the manufacturing technology projects. The equipment for the hot forge subsystems which forms the barrel preform, has been installed at Saco Defense Systems Division and is in the acceptance/prove-out phase. It will be operational in the third quarter of FY 1984 and then begin to provide payback. Additional equipment for cold forging of rifling is also on order, and future facility projects will complete the line.

Saco Defense Systems is complementing the government investment by purchase of conventional computer numerical control machines and other equipment. While the facility will not be completed for at least another three years, the program has been planned to provide early payback by installing initial portions of the line so that they can interface with latter portions of the existing process until the facility is completed.

Improvements are also being made in process control and inspection. The manual straightening method will be replaced by a computer-controlled machine which will use a laser measurement system to determine straightness, and a computer algorithm to control the force and location of impact required to straighten the barrel. Consequently, the operator will be removed from the loop.

Manufacturing technology efforts are now underway to finalize the designs for this prototype automated barrel straightening and rifling equipment. Future manufacturing technology facility projects will consider automated inspection and assembly operations.

In addition to the immediate cost savings resulting from reduced material usage and labor, many other benefits are envisioned. Quality will be much improved as a result of better process control, i.e., less end product loss. Use of computer numerical control rotary forging, single point numerical control chambering, automated electro-optical inspection and the like will increase line flexibility, permitting changeover and rapid reactivation for a variety of barrels with a lower requirement for specialized tooling.

Operating personnel skills will be reduced in areas such as straightening by use of automated equipment.

Other potential benefits derive from the use of hot rotary forging for the initial barrel preform preparation. Preliminary tests have shown feasibility of recycling worn out 105mm cannon barrels by rotary forging them at Watervliet Arsenal into blanks suitable for small arms weapons. These blanks can, in turn, be further hot forged on equipment at Saco into caliber .50 through 30mm barrel preforms.

The process can be repeated, for example, to convert 30mm worn out barrels into 7.62mm blank stock. In addition to saving over two-thirds of the cost of virgin material, use of critical nickle and cobalt will be reduced by this reclamation process.

Through the cooperation of the Army's weapon producers, machine builders, and inspection equipment developers, the obsolete production base is well on its way to being modernized. Technology now being implemented at Saco Defense Systems will also find its way into other mobilization producers.

Improvements in forging, drilling, plating and the like will have application in other industries as well. Thus far, the program has been most successful in demonstrating new technology. With the start-up of the first part of the line later this year, the real reasons for the program, lower product cost and better availability, will begin to be realized.

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Back to the Basics

Recent Issues and Policies Concerning Quality Assurance

By Harry L. Light

Throughout the Army there is increasing command emphasis on quality and reliability and the role that all scientists and engineers must play so that DARCOM fulfills its goal of providing "Quality Equipment and Support for an Excellent Army." The purpose of this article is to explain the issues behind this increase in command emphasis and the policies recently promulgated which all DARCOM engineers and scientists must follow to achieve the DARCOM goal.

The Issues

In an interview with the *New York Times*, the Army Chief of Staff stated "There are some things that I can get emotional about and quality control is one of them."

More recently, the DARCOM deputy commander for Research, Development and Acquisition conveyed to the Army Chief of Staff the DARCOM approach to quality: "We are stressing that we design for performance, perform producibility engineering and manufacturing methods and technology early to insure repeatability in volume production and adequately test for component qualification, as well as system performance. Quality is not accomplished through inspection. Quality must be designed into the initial system and **we must and will hold scientists and engineers responsible for quality and costs.** Inspections verify conformance to design. Quality is a mindset and must be achieved through active participation by everyone from the corporate management to the worker on the production line. We must motivate and discipline. We shall do that. Our soldiers deserve no less."

This high-level command emphasis on quality stems from what quality assurance is all about—soldier satisfaction. Poor quality control results in a loss of confidence by the soldier in the field, unsatisfactory reliability performance, and increased costs of weapon systems. The credibility of DARCOM depends on the quality and reliability performance of its equipment and support.

Dissatisfaction with the quality, cost and reliability, availability and maintainability performance of several major Army systems and the process by which they evolved have led to the recognition that improvements to the process need to be made immediately.

Because of difficulties experienced with the development and production of certain newer ammunition and other items, the DARCOM commander appointed a Product Assurance and Test Review Board, chaired by GEN Walter T. Kerwin (USA retired), to evaluate the adequacy of the DARCOM Product Assurance and Test Program.

The Board's objectives were to review the adequacy of quality assurance and field procedures, assess whether deficiencies exist in the interface between DARCOM and the Defense Logistics Agency, and determine whether management expertise and the quality of production-line workmanship are declining.

Although the Kerwin Board initially focused on traditional quality problems—contractors' negligence during production, failure of quality assurance personnel in procuring activities to fulfill their responsibilities, and the negligence or incompetence of Defense Contract Administrative Services inspectors—the Board quickly realized that lapses in these areas contributed only in small part to the quality problems of the Army. The real problem the Board realized was errors in the design and development process, prior to production.

After recognizing that improvements in the design and development process afforded the high-leverage needed to improve the quality of DARCOM equipment and support, the Board refocused its efforts. Inquiries were made to examine the DARCOM/TRADOC interface, the technical performance of new items, the extent to which ASARC or DSARC decision points control the development process, the suitability of test procedures, the accuracy and completeness of the technical data package and the role of the project manager.

This refocus resulted in the findings that problems found during design and development stages were not satisfactorily resolved prior to transition into production, that quality assurance is considered only after cost and schedule, and that lack of up-front quality assurance guarantees problems down stream.

Although the Kerwin Board dealt primarily with ammunition, the issues and recommendations have validity for most DARCOM commodities as is evidenced by the findings of Contractor Assessment Reviews. These joint HQ DARCOM and major subordinate command reviews were initiated by the Deputy Commanding General for Research, Development and Acquisition last fall as a result of costs and quality problems of major systems.

The purpose of these reviews is to identify and make recommendations concerning productivity, cost and quality control. Typical problems identified which result in loss of control of costs and quality of systems entering production include:

- Systems entering production with unresolved design issues and test failures.
- Long duration between identification of a problem, completion of failure analysis and implementation design changes and corrective action.
- Quality and producibility considered only after completion of design and redesign efforts.
- Inadequate planning of facilities, equipment and tooling to support large volume production.
- Lack of parts and vendor controls programs.
- Capitulation to schedule demands by accepting waivers and deviations not in the interest of the Army.

• Reliablity requirements not being placed in contracts.

New Policy

Since the credibility of DARCOM depends on the quality and reliability, availability and maintainability performance of materiel at Initial Operational Capability and since equipment must work reliably and be supportable at high readiness levels, the deputy commander for Research, Development and Acquisition has issued new policy on management of reliability and maintainability which recognizes the responsibility of all DARCOM scientists and engineers in this critical area.

This policy emphasizes basic engineering design, growth management and testing through system development and production, and directs that command principles and project managers be rated on their attainment of RAM requirements.

Starting with the development of requirements, the policy insists that quantitative reliability requirements be established for all programs. These requirements must meet user needs and be consistent with the state-of-the-art of technology. These requirements should consider both hardware and operations and recognize that RAM will grow as design changes are implemented and troops gain training and experience. These requirements then become the operational reliability and maintainability requirements expressed in the Required Operational Capability. Before proceeding to the next milestone, these requirements must be met.

The policy next insists on basic reliability, availability, and maintainability engineering and design practices to meet these operational requirements. The reliability and maintainability designed into the hardware must exceed the minimum acceptable value expressed in the ROC. There must be a safety margin in the design to compensate for the degradation commonly experienced during systems integration. As such, development, programs must implement parts control and include reliability parts in accordance with MIL-M-38510, MIL-STD-883 and other established military specifications.

The policy demands that reliability requirements be established during advanced development and implemented at the start of full-scale engineering development.

In addition, reliability and maintainability apportionment, tolerance analyses, failure modes and criticality analyses, and development of manufacturing process controls and inspection equipment are to be accomplished during the engineering design process. The policy also calls for the use of environmental stress screening, which employs thermally cycling and random vibration at all levels of assembly. This screening is accomplished to precipitate failures resulting from poor workmanship and defective parts so that these failures occur during manufacturing rather than in the field.

The applications of environmental stress screening to date have resulted in significant improvements in reliability and reduction of manufacturing costs by reducing rework.

In calling for the development of manufacturing and process controls and acceptance during design, the policy on management of reliability and maintainability reiterates the DARCOM policy on producibility.

Recognizing the strong and potent role that technology affords in controlling costs and quality and improving reliability and producibility, the director of Technology Planning and Management issued instructions that each laboratory identify quality and producibility opportunities and develop programs to address these opportunities.

The policy also requires a planned reliability growth program for use during development, production and initial deployment to achieve operational reliability, availability and maintainability requirements. The program is to be conducted in accordance with MIL-STD-189 and must address the entire system and critical components and subsystems.

An essential part of the growth program is the test-analyze-and fix (TAAF) concept. A test period must be scheduled in conjuncture with each major milestone to identify design, software and manufacturing defects. Test time and resources must also be scheduled to correct deficiencies found during testing. There must be sufficient dedicated people, facilities and test units to identify the "root cause" and eliminate design and manufacturing defects.

In addition to TAAF, achievement of reliability growth results from other processes which identify defects such as environmental stress screening, reliability predictions, failure modes and effect analyses, and component testing.

As a control and check on the acquisition process, the policy insists that approved reliability, availability and maintainability and supportability requirements for each major milestone be met before proceeding to the next phase or Initial Operational Capability.

Recent policies reemphasize that the responsibility for quality and reliability of Army weapon systems include all DARCOM engineers and scientists. It is only through the teamwork of all involved in the weapons acquisition process that we can fulfill the DARCOM goal of "Quality Equipment and Support for an Excellent Army."

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Producibility Engineering Training . . .

A Key for Successful Transitioning to Production

By Gilbert J. Tallar

Today's project manager is well aware of the responsibility for cost, schedule, and technical performance of weapon systems. While R&D engineers are developing new design concepts within the shadow of the state-of-the-art for achieving the functional performance goals, other team members are reviewing development costs and schedules for completing engineering development.

Drawings, describing the details of this new design concept are also released for manufacturing. Also, skilled technicians, using general purpose equipment, produce a handcrafted prototype model. Finally, development and operational tests of the engineering prototype are conducted to validate that functional characteristics match those specified in the engineering design.

The R&D community may honestly believe its task has been successfully completed. However, within a short time after the initial production "go ahead," a rapid rise in procurement cost usually occurs and questions are raised as to whether the Department of Defense can really afford this new system. In this case, further analysis usually indicates that while having form and function, *the product lacks structure for economic production.*

This scenario of the early days of weapon system development is still applicable today. The project manager must not only consider his responsibilities related to cost, schedule, and technical performance in development, but must also strongly support the additional responsibility of planning for producibility if smooth transitioning to economical production is to occur in a timely manner. The process for achieving this economic structure is Producibility Engineering and Planning (PEP).

Absence of a disciplined producibility engineering approach was indicated in a 1981 Selected Acquisition Report (SAR) on procurement cost growth of Army weapon systems. The report stated that for 11 major Army systems, the average change in procurement cost from the original baseline in constant dollars and adjusted for quantity was 35.5 percent. Furthermore, while the cost growth was 23 percent in the development phase, it was a staggering 92 percent in the production phase. Within six months of initial production, major cost adjustments were required.

In the 1970's, several unsuccessful attempts at producibility engineering and planning were tried. Procurement appropriation funds were utilized during the later stages of engineering development after the development and operational tests were completed.

Army items were developed and tests were completed prior to advance production engineering efforts to make the item producible. However, this resulted in the development and testing of items which were not designed for production.

Release of procurement funds to manufacturing was accomplished only after successful completion of the R&D tests which provided the assurance that most of the development risk was reduced to an acceptable level. Furthermore, since full-scale engineering development and advanced production engineering were accomplished in series, the total combined effort resulted in long delays.

In 1973, the two major functions of advanced production engineering were segregated. The initial production facilities, which are hardware oriented (e.g., tooling and production line setup), would continue to be funded with procurement funds. The production engineering measures, which are software oriented (e.g., drawings, manufacturing processes), would be funded with RDT&E funds.

Producibility and planning funds were consolidated with all other RDT&E funds. In essence, funding requirements for producibility and planning efforts had to compete with all other R&D efforts for resources.

When design engineering needed additional resources for resolving design problems, producibility and planning funds were reprogrammed. Thus, the requirement for resolving design engineering problems took precedence over producibility.

Generally, any remaining resources for producibility and planning were too little and too late.

As a result of these difficulties, DARCOM Commanding GEN Donald R. Keith stated emphatically that "there are no activities in the weapon system acquisition process that demand greater attention than those directed toward assuring effective transition of developed hardware into efficient production."

Reaffirming this policy, Darold L. Griffin, DARCOM deputy director for Development, Engineering and Acquisition, concluded at a 1983 PEP Conference, that "Producibility Engineering and Planning is vital and must be included in the Army's acquisition strategy and design criteria."

PEP must be started early in development and must have top management support. One of DARCOM's primary

Some PEP Activities

- **Design for ease of manufacture including the performance of producibility trade-offs.**
- **Develop and validate the technical data package from a producibility point of view.**
- **Design and fabricate prototype of special-purpose production and inspection equipment tooling.**
- **Exploit foreign manufacturing techniques for enhanced producibility.**
- **Perform risk analysis of new manufacturing processes.**
- **Manufacture prototype and item components to validate new or improved techniques.**
- **Computer simulation of manufacturing process.**
- **Develop the plant layout and production plan.**
- **Apply value engineering principles.**
- **Identify any need for manufacturing methods and technology (MMT), and manufacturing technology development (MTD).**

Figure 1.

concerns in the acquisition of Army materiel is controlling production cost while at the same time delivering reliable equipment to the field on schedule.

As a result of less-than-satisfactory experiences, DARCOM conducted an analysis of the PEP management methodology. Shortcomings in previous efforts were identified. A step-by-step review of the acquisition process was made to identify all key interfaces. Alternative solutions were developed and evaluated from "lessons learned." As a result, a new PEP philosophical concept was developed at DARCOM. This concept was implemented and published as DARCOM Regulation 70-6, Producibility Engineering and Planning, 22 June 1983.

This regulation prescribes policy, responsibilities, and general procedures for conducting Producibility Engineering and Planning for Army systems and materiel. The regulation is not a "cookbook," but it identifies those activities that need to be accomplished in an efficient and effective manner.

PEP activities are those producibility and production engineering tasks performed by the materiel developer which: affect economic and timely producibility and completeness of product design; accomplish detailed planning and specification of all items and resources for production in an economic and timely manner; and carry out those actions to try out and prove that components specified will perform optimally during production. Some PEP activities are shown in Figure 1.

DARCOM investigated means to disseminate this policy to the "working" levels as expeditiously as possible. The quickest means was to establish a *short, intensive training course* under sponsorship of the Directorate for Manufacturing Technology, which has PEP mission responsibility. The U.S. Army Management Engineering Training Activity was given the task for course development and presentation.

The Producibility Engineering and Planning course applies to all PEP tasks for major and non-major Army systems, items, and materiel undergoing development, which included product improvement programs.

Considering the specific course scope and the phases of the weapon system life cycle, it became evident that more than design engineers require this training. The course was targeted for personnel who serve as contract officer representatives of R&D efforts; project manager personnel who review, monitor, and manage Army systems and materiels transitioning efforts from design into production; as well as procurement personnel who negotiate and administer development contracts.

A program of instruction was developed to identify the subject matter of the course, along with a brief scope of instruction.

Major subject areas of the course are: initiation, justification and authority for PEP; PEP in the weapon system life cycle; PEP implementation; PEP statements of work; contractor's PEP efforts; managing and monitoring the contractor's PEP efforts; and the PM's role in transitioning to production.

The course syllabus strongly supports the notion that the project manager is responsible for producibility and its essential elements, which includes a vital management commitment, effective contract requirements, and incorporation of producibility requirements in the program management documents.

It is strongly emphasized that if the estimates for PEP expenditures are not warranted, written authorization must be obtained from the Director of Manufacturing Technology in coordination with the Director for Development Engineering and Aquisition, HQ DARCOM, prior to entry into Advanced Development and Full-Scale Engineering Development.

To obtain a better understanding of the various types and sequences of PEP activities, a guest speaker is invited from a DOD contractor to discuss two significant phases of the process. Phase one covers producibility and production facility plans and layout.

In phase two of the course, the speaker presents the design details of machinery and test equipment.

The course illustrates that from the Army's point of view, a contractor, during development, transitions through three distinct phases: design intensive, production planning, and production implementation.

During the design intensive phase, the contractor must place heavy emphasis on producibility analysis using breakeven, sensitivity, value, or Pareto techniques. Producibility analysis on high-value, long-lead, and high-risk items should be accomplished with the objectives of maximizing simplicity of design by use of: economic materials, economical manufacturing technology, standardization of materials and components, process repeatability, product inspectability, minimum procurement lead time, and minimum design changes during production.

During the production planning phase, the contractor performs the classical planning activities for facilities, personnel, skills and materials, especially early buying of long lead time items. Tooling is also identified, fabricated, and proofed and breakdown and identification of required material, parts, and assemblies are identified.

During the production implementation phase, the contractor provides assurance that the system is ready for production. The contractor also establishes a mini production line and produces the number of engineering development prototypes to meet the requirements for development and operational tests. After successful completion of these tests, the Army project manager performs a functional and a physical configuration audit in accordance with the configuration management plan per AR 70–37.

After this portion of the course, attendees are cognizant of PEP activities that a contractor performs during the development phases. An exercise reviewing a competing contractor's response to a Request for Proposal for the Full-Scale Engineering Development PEP effort, is given.

The project manager is responsible for planning, budgeting, contractually specifying, and evaluating the PEP performance and assures that the contractor is responsible for the execution of the producibility efforts. It is the project manager who, with assistance from the supporting laboratories, if necessary, determines the amount of PEP effort that should be contractually specified.

Data that the project manager receives from the contractor should not only satisfy his needs for evaluating performance but should also satisfy the needs of top management to whom he must submit reports.

In a final summary of the course, three types of risks associated with Army materiel system developments are discussed. These are product, production, and external. Figure 2 illustrates that a product, constrained by production resources, must be produced within an external dynamic environment.

The major groups of "product risk" and "production risk" are within the purview of the project manager/contractor, while the group labeled "external risk" is beyond their control. The arrows depict the relationship between these three categories as a continuous two-way flow of information.

Product risk. The ideal situation is when the design has been virtually frozen prior to initial production. In reality, this never occurs due to inherent uncertainties in design stability, producibility, and performance.

If design problems have not been resolved during R&D, the attendant uncertainties will carry over and disrupt initial production.

It is also essential that attention be directed to producibility aspects during R&D, otherwise the result will be severe disruptions and increased cost during initial production.

Problems can also occur with system performance even if the design has stabilized and the item is producible. This risk area includes all the "ilities" (reliability, availability, maintainability, dependability, capability, etc.) required to meet rigid performance specifications. If increasingly sophisticated performance requirements continue to drive weapon designs, performance will remain an area of high uncertainty.

TRANSITIONING RISK CATEGORIES

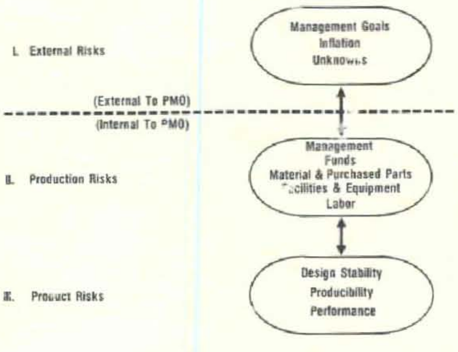

Figure 2.

Production risk. The system requirements of design, producibility, and performance are merely academic unless resources are available to accomplish them. These resources can be succinctly divided into the five fundamental categories of material, facilities, labor, funds, and management. The increasing demands on these finite resources ensure this as a continuing risk group.

The material resource refers to all materials and purchased parts going into the weapon system and its direct support equipment. It includes raw material in addition to specialized vendor items, such as electronic components, engines, transmissions, etc.

The facilities resource includes brick and mortar needs as well as manufacturing and testing equipment and tooling. This risk varies depending on whether existing facilities are modified or new facilities are designed and built. The increasing sophistication of weapon systems brings new and exotic equipment and tooling requirements.

Labor remains a major contributor to weapon system cost. Competition for scarce skills in such critical fields as engineering, software design, welding, machining, heavy equipment use, and maintenance makes this a high-risk category.

Keen competition for limited funds at all levels of government and industry from departmental/corporate level to project level also causes uncertainty. The complicated process by which funds are estimated, requested, appropriated, and obligated adds to the uncertainty.

Management risk includes the sufficiency and experience of management personnel in both the contractor and project management offices and general manageability of the project. In this context, management is just as much a resource as material, facilities, production labor, and funds.

External risk. This group represents uncertainties over which program management and contractor personnel have no control. These uncertainties constitute the dynamic environment in which finite resources are allocated to the production of many systems. The three major categories are management goals, inflation, and unknowns.

The 3-day Management and Control of Producibility Engineering and Planning course is an intensive training program which concentrates on the key issues that DARCOM project personnel must thoroughly understand. The course addresses, in chronological order, the sequence of events that must transpire during the development phases to ensure a smooth, economic transition into production.

The goal of a successful Producibility, Engineering and Planning program is to first know what has to be done—then doing it. To achieve this goal and transition into production successfully, a key ingredient is PEP training.

In conclusion, PEP is not a new concept. The successfully competing manufacturing corporations of today have been performing some producibility activities. They may not have called it PEP. However, if a company wants to remain competitive in the DOD marketplace, *producibility engineering and production planning is an essential ingredient. The road to successful transitioning to production must begin with integrating production engineering with design to ensure producibility.*

The road to successful transitioning to production does not happen by chance. The project manager must plan for it and then make it happen.

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Budgeting to Most Likely Costs—the PM's Dilemma

The problem of cost growth in development programs seems to be endemic to the acquisition process. Recent experience indicates that fully 90 percent of the major development programs have suffered, or will suffer, cost growth. There are many reasons for this phenomenon. Inflation, requirements growth, program stretch-outs, and poor estimates are a few of the more common ones.

A perceived cause of poor estimates is that the project manager is unwilling to recognize his true costs and hence arrives at a cost estimate which is overly optimistic.

The conventional wisdom has it that if the PM were more willing to submit a realistic cost estimate, much cost growth would be avoided. This perception may explain why the PM is frequently charged to budget to most likely costs. Unfortunately the charge is lost on him because our planning, programming, and budgeting system places him in the dilemma of either producing a cost estimate which is almost certainly too low, or of misrepresenting the facts. Let me explain.

First, we must remember that one of the more salient features of the budgeting system is that it involves the allocation of a scarce resource. Consequently, the hunt for money is intense and unceasing—particularly at the higher levels of the system. This means that any estimated costs must be justified in detail.

Costs that are not justified are likely to result in funds being taken away from the program and given to an apparently more deserving program whose costs are better explained.

It is interesting to note that the ruthlessness with which money will be taken away from a program often varies directly with the taker's distance from any responsibility for the program. Cuts can be quite arbitrary. On the other hand, a compensating mechanism is that the capability to study an estimate in detail generally decreases with increasing level of review—creating a temptation we will touch on later.

Another unfortunate aspect of the system is that at no time will the PM know what all of his program costs will be. No one can. If he is smart (or lucky) his unknown costs will not be great, but he can be sure he will have some. Of course, justification of unknown costs is difficult at best.

Thus, knowing these facts of life, and heeding his charge to budget to most likely costs, the PM is faced with two distasteful alternatives. He can either hide unjustified money in the more obscure areas of his estimate (hoping that the "pad" is large enough and that the reviews of his estimate will not find it), or he can submit an estimate which includes only costs that can be justified under current rules of the game, and which is very likely to be an underestimation of the true program costs.

The end result of this dilemma somewhat resembles the forward pass in football. Three possible outcomes may occur—two of which are bad. If the PM pads his estimate and the pad is discovered, then the program will lose some funds, probably be underfunded, and the PM will gain a shifty reputation.

On the other hand, if he submits a justifiable estimate then the program will likely suffer cost growth and the PM will be considered a poor manager, and he may even be thought guilty of a "buy-in."

The third possibility, of course, is that the estimate, padded or otherwise, turns out to be accurate, and everyone is happy. This has certainly happened once or twice.

There is no totally satisfactory solution to the PM's dilemma because the budgeting system is not likely to change soon. Fortunately, the current system has one advantage. By making the PM and the contractor attempt to achieve optimistic cost goals, costs tend to be kept down.

It seems clear if all programs were budgeted for large cost growth, then all the programs would experience at least that amount of cost growth. We can do better than that.

But where does this leave the PM? There should be a reasonable compromise between the current funding process and giving the PM license to steal. The possibility for compromise does exist, but it derives more from attitudinal changes than from changes in the system.

At the outset, the PM's problems would be alleviated if his leaders were more concerned about the causes of cost growth and less about the cost growth itself. To use a medical analogy, the cost growth is only the symptom of a disease. Treating the symptom will provide only temporary relief. We may find a permanent cure by attacking the disease.

Meanwhile, until a cure is discovered, two related changes in the way we deal with programs would help a great deal. The first is a willingness at all levels to accept management reserve. The growing acceptance of the Total Resource Allocation Cost Estimating (TRACE) in RDTE funding indicates that such a change is possible. (It is amazing that TRACE exists in an environment where it occasionally happens that an unwary PM identifies his management reserve—only to have it promptly taken away.)

The establishment of procurement TRACE for individual programs or a procurement TRACE pool is the next step in the right direction.

The complement to this general acceptance of management reserve is the provision of rewards for PMs who control program costs. At present there seems to be little correlation between successful cost control and professional rewards. A stronger correlation would encourage the PM to minimize the use of his reserve.

These suggested changes in the way we deal with program costs are clearly not a panacea. However, they would allow the PM to budget to what he feels are his most likely costs (justifiable or not) and relieve him of his present dilemma when he submits his cost estimate.

The preceding article was authored by a student at the Defense Systems Management College, Fort Belvoir, VA.

Trends and Their Implications for DARCOM During the Next 2 Decades

Decisions can only be made in the current timeframe—there is no such thing as a "future decision." The decisions made today, however, will determine the reality of our tomorrow. To enhance the decision-making process throughout the command, the U.S. Army Materiel Development and Readiness Command (DARCOM) initiated a major thrust to the development of a Strategic Long-Range Plan.

As a preliminary step in preparing for plan development, the Strategic Long-Range Planning Team of the Program Analysis and Evaluation Directorate of DARCOM researched economic, demographic, sociological, technological and political trends from the global and National perspective and their probable implications for DARCOM during the next two decades. This article, which begins with this issue of the *Army RD&A Magazine* and concludes with the next issue, contains many salient points from that research. While aimed primarily at DARCOM, the trends have implications for other commands as well as the Army as a whole.

Use of trends information for strategic decision-making is still an art, and experts often differ widely on what they perceive as a trend. For this article, we have selected predominant trends. Several decades ago, planners looked inside their organizations for 80 percent of the information necessary to anticipate their future and to the external environment for the remaining 20 percent. Today that percentage has been essentially reversed.

Economic Trends

According to most economists, the predominant economic trends for our global future will consist of shortages of critical minerals, rising influence of transnational banks and corporations, a continued high worldwide oil demand and a widening gap between rich and poor nations.

Because the U.S. is largely dependent on foreign sources for critical minerals, projected trends indicate that the U.S. involvement in the third world will continue to grow. The U.S. is currently the leading consumer of raw materials and minerals such as cobalt, titanium, chromium and mercury. Many scarce raw materials, minerals and energy sources are critical to supporting defense activities and limitations on their availability have far reaching implications for U.S. national security interests.

The U.S. will continue to exercise considerable economic influence internationally in trade, investment, monetary affairs, information and in the development of new economic alignments.

Many U.S. corporations will have joint ventures with foreign organizations and there will be other cooperative agreements. These cooperative agreements have a potential for significant impact on national security considerations and international support agreements. When the Army mobilizes, it must be with an industrial base structure it understands, and currently we do not have a totally clear picture of where our secondary items are manufactured.

The world economy will continue to rely on oil for a major share of its energy. According to an independent study conducted by a leading oil company, more than four-fifths of the increase in oil demand is expected in the developing nations where economic growth is the greatest and the alternatives to oil are often expensive. Results of this study agree with the *Global 2000 Report* to the President by the Council on Environmental Quality and Department of State. Oil consumption in these countries should grow 3 percent per year to almost 19 million barrels per day by the year 2000. U.S. demand will hover closely around its current level of about 15 million barrels per day. Power generation and supply is our achilles heel in preparation for the future battlefield.

Although DARCOM efforts, such as development of an adiabatic engine have a high potential to address one critical facet of the Army's energy problem, we must strive to assure that concepts such as Army 21 (formerly AirLand Battle 2000) be developed with simultaneous creative efforts in materiel and logistics.

World population and gross national product per capita projections between developed and less developed nations continue to show a widening gap. The U.S. and Western Europe will get richer by the year 2000. For the next two decades, the international community is certain to be besieged with demands from the less developed nations for readjustments in the distribution of wealth. Implications for the Department of Defense include a world of increasing civil unrest and terrorism as the rising economic expectations of third world nations are not met. It also implies that total Army logistics must now, more than ever, be planned on a global rather than theater or single-country level.

U.S. Economic Trends

U.S. long-term economic trends include an increased rate of GNP growth, an increased rate of economic growth, and a decline in inflation and unemployment rates.

According to the late Herman Kahn of Hudson Institute, during the next 20 years the U.S. GNP will grow 100 percent. Per capita income in the U.S. will double during that same period, and the U.S. population will grow from 232 million to 282 million people. In contrast, Data Resources Inc. forecasters indicate that U.S. GNP will grow between 58 and 87 percent during that period.

Today, 25 percent of all Federal outlays go to fund programs for the aged. During the next two decades the U.S. Government will spend approximately 32 percent of the budget on social and medical programs for the aged population. This demand will likely have an adverse impact on the percentage of the Federal budget available for defense.

Leading economic forecasters predict that the U.S. inflation rate will decline from an average of 5.8 percent in the 1980's down to 3.4 percent or less in the 2000's. The average unemployment rate in the U.S. is expected by many to decline from 8.5 percent in the 1980's to 5.3 percent in the 2000's. With a lower inflation rate and stronger economy, Federal Government personnel and payroll policies will require extensive revision if the Army is to recruit and retain skilled personnel.

Department of Defense Economic Trends

Key defense long-term economic trends indicate that defense outlays are likely to decrease as a percent of the U.S. GNP; security assistance through Foreign Military Sales will continue to fluctuate; weapon system support requirements will increase; and the number of commercial activities will continue to increase, along with an increase in the annual rate of DARCOM capital investment.

During 1984–2000, the percentage of the DOD budget allocated to Army is expected to decrease moderately in favor of Navy and Air Force programs due to the high-dollar item costs of their major equipment.

The Army's Foreign Military Sales levels will continue to fluctuate through the next two decades. Most of the Foreign Military Sales will be to the third world nations in support of national policy. As time goes on, sales competition from France, West Germany, South Korea and possibly Japan will challenge the U.S. Foreign Military Sales market share.

Currently, the U.S. relies heavily upon foreign sales to keep its production base warm for military materiel. Loss of the U.S. market share could significantly increase the future bottom-line costs of maintaining our industrial base. The U.S. share of the market will be directly proportional to the amount of innovative technology and the national policy employed.

Increasing weapon system capabilities that emphasize mobility and increased rates of fire put a further burden on logistics. One of the major burdens is that sophisticated weapon systems require more skilled maintenance people who are well trained in electronic technology. This will be an area of major concern to DARCOM in its manpower and personnel programs.

According to present Office of Management and Budget estimates, the percentage of in-house commercial activities converted to contracts out will increase in the Federal Government during the next two decades. Contracting in DOD, DA and DARCOM will increase. Contracting of some programs, projects and services will result in a change to the way we view the business we are in and the types of skills DARCOM will require in its future employees. Contract management skills will also be in great demand.

DARCOM capital investment projections by the Directorate for Manufacturing Technology reflect an upward trend as it includes installation's plans to use the tools of computer integrated manufacturing (CIM). DARCOM plans now reflect partial implementation of the CIM concept with some planning underway to implement more complete systems. As the plans mature there will be an increased investment requirement for DARCOM. Anticipated productivity increases are in the range of 25 to 40 percent upon project completion.

The estimate of $700 million shown in figure 1 for the year 2000 was provided by DARCOM's Directorate of Manufacturing Technology. The upper and lower bounds define the feasible range of expenditures.

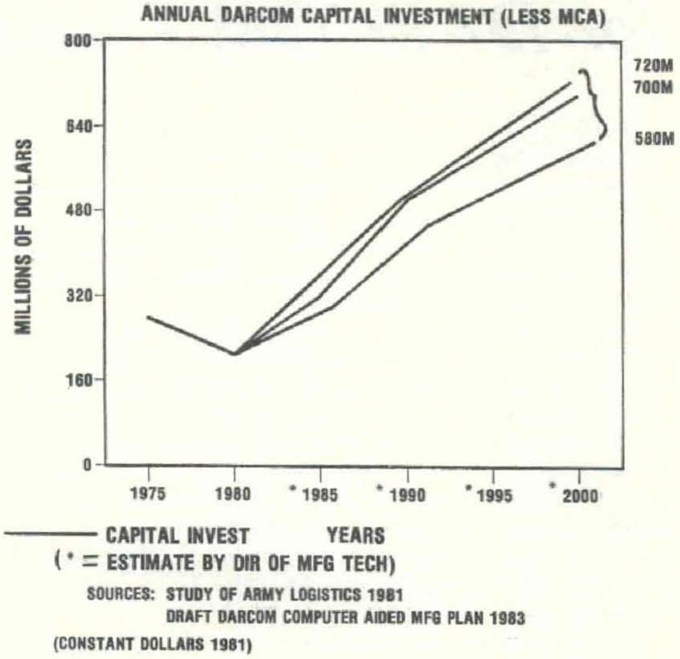


Figure 1.

Demographic Trends

Demography, the statistical study of human population, focuses on population size, groupings and the underlying social perception that covers these shifts. Primary global demographic trends include: very rapid population growth in third world countries, slower rate of growth for developed countries, and increased urbanization. The bottom line is that there will be a smaller piece of the pie for many since we are dealing with a limited supply of resources. Most demographers agree that there will be considerable growth in the earth's population over the next two decades and that the increase will be the greatest in the less developed countries where per capita productivity is already lowest.

According to the *Global 2000 Report* to the President, currently industrialized nations populations will expand 16 percent while third world countries will expand by 76 percent between 1975 and 2000. In 1975 there were 2.75 people in third world countries for every one in industrialized nations. If that prediction holds true, it will increase to 4.16 people in 2000 in third world countries (non-English speaking, non-European heritage) for each person in the industrialized nations. This means there will be an additional 2.5 billion people on this earth, a total increase of more than 50 percent in less than 25 years.

Many of the world's cities will be growing rapidly during the next two decades. Urban densities and urban sprawl have definite warfare implications as population and social advancement/expectation pressures often increase the likelihood of revolution. One need only contrast the maps of the Fulda Gap area in Germany 20 years ago to the maps of the same area today to realize that extensive urban sprawl may make urban warfare a prevalent characteristic of future conflict.

U.S. Demographic Trends

Among the important national trends during the next decade are a decline in the draft-age population, an older U.S. population, a dramatic change in the ethnic mix of the U.S., especially in the Southern and Western States, and a geographic migration from the Northeast to the sunbelt.

According to the AirLand Battle 2000 report, the draft pool will decline from 10 million in 1970 to 7 million in 1989. All of the soldiers of the year 2000 have already been born.

Spanish speaking persons now constitute the largest linguistic minority group in the U.S. and a significant percentage of enlistments. By 2000, the minority portion of the U.S. will increase from 19 to 25 percent and Hispanics will continue to be heavily concentrated in the Southwest and southern Florida.

During the past decade, 90 percent of the U.S. population increase was in the Southern and Western states. This movement is largely due to the cost of energy, taxes, and land as well as a preferable climate. Implications for DARCOM include having an older, more ethnically diverse workforce and becoming "the employer of preference" in the Northeast as many businesses move to the sunbelt.

Figures 2 and 3 show overall DARCOM employment trends for the past two decades (curves have been smoothed to eliminate Vietnam era, etc., fluctuation) and projected workforce strengths for the next two decades. The current mission workload has been assumed. Figure 3, Civilian Workforce estimates, includes an upper bound of 144.5K (a ramp-up to meet the 1982 Manpower Baseline study requirement). The lower bound of 106.8K represents a 6 percent decrease in workforce. The middle line, which is considered most likely, represents a 4 percent decrease in civilian manpower. This anticipated decrease is largely due to national policies as reflected in the Commercial Activities Program and reduction of manpower requirements in depot operations as a result of the Capital Investment Program.

Figure 4, Military Workforce estimates, includes an upper bound of 12.0K, representing a "get well" target for today's mission workload. The lower bound represents a 15 percent decline over the next two decades. This projected loss is largely due to additional light divisions in the out-years without an accompanying increase in end strength to accommodate the change. The middle line, which is considered most likely, shows only a 10 percent decrease as DARCOM strives to make an effective case to show the slow erosion of our military personnel strength.

Sociological Trends

Accomplishing work in the future will still require getting things done with and through other people. Sociology, the science of human society, therefore provides additional clues to the future.

During the next two decades, occupations will change, the educational system will be even more hard pressed to keep pace with job requirements, health will be of increased importance, management will be changed by new information flows, and the media will take on increased importance.

Training for a lifetime is no longer a one-time event. Skilled workers can expect to be retrained four times in their lives. New occupations on the horizon will include such jobs as robot production technician, energy technician, laser process technician, computer-assisted design, graphics and manufacturing technicians and software writers. Decreasing occupations will include assembly line production jobs, jobs requiring unskilled labor, and manufacturing.

For DARCOM, it is apparent that as technology increases,

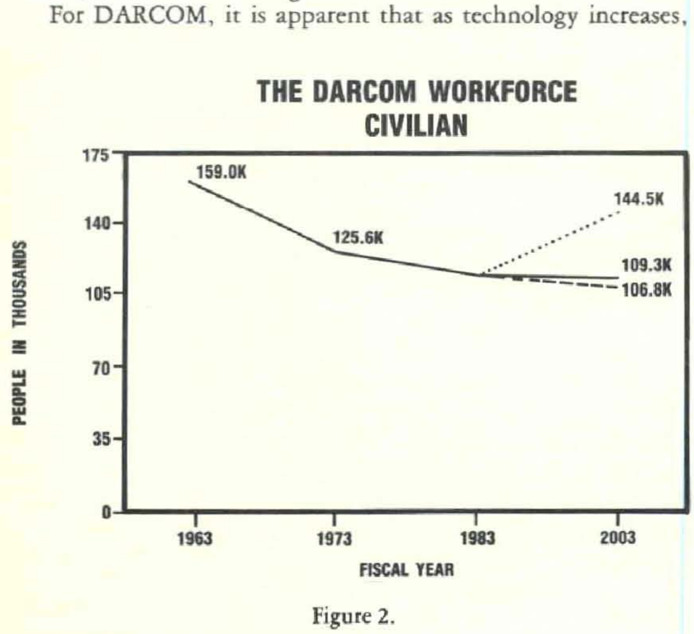


Figure 2.

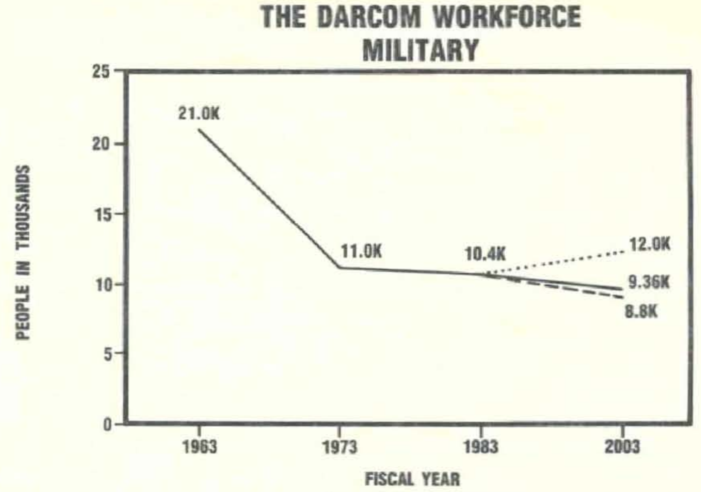


Figure 3.

training demands will increase. In addition, the entire Department of Defense will continue to have a vested interest in assuring adequate skills will be available in both the private and public sector. Another important consideration is the development of skills (e.g., ballistic welding) which are unique to the military. Technology will not solve these skill shortages in the foreseeable future.

The National Commission on Excellence in Education recently released its report, entitled *A Nation at Risk.* Key findings include startling statistics about the decline over the past 25 years in the quality of U.S. education. Recommendations included more stringent admission and graduation requirements, spending more time on "basics," and improvements in teachers and the teaching profession. The commission stated it was confident that America can meet its educational goals if we all work together.

During 1982, a DOD study was done to take a closer look at education and its implications for DOD. The resultant report, entitled *Study of Scientists and Engineers in DOD Laboratories,* made the following key points. U.S. student performance is declining; education above the bachelor level for science and engineering subjects goes in large measure to foreign students, and mathematics and hard science courses are taken by a much smaller percentage of U.S. students than Soviet students.

To DARCOM, Soviet emphasis on mathematics and science means that the technological edge we rely so heavily upon may disappear. DARCOM must also continue to pursue weaponry that is simpler for the soldier to use and maintain. Despite the recent influx of better educated soldiers, we must expect future soldiers to be, on the average, no better educated than our current force. An increased burden of training will therefore be required as a function of both the lower academic achievements of today's graduates and the half-life of technological information.

According to Secretary of the Army James O. Marsh Jr., "An Institution that promotes the health of its employees will be rewarded with increased productivity." The future will bring with it an increase in stress and pollution. DARCOM must recognize the strong relationship between health and productivity and consider promotion of health for its employees.

This article, including the portion which appears in the next issue of the Army RD&A Magazine, was authored by the following personnel during their service as members of the DARCOM Strategic Long Range Planning Team: Joyce L. Brunsell, team leader, Dr. Jarugula S. Rao, John Kato, and William J. Greer.

Training With Industry for Research and Development

By Kay A. Black

Try a little word association: industry, employee, Army officer, industrial management, defense contractor, research and development. One logical response to these words might be Training With Industry—a unique opportunity for professional development available for Army officers.

Training With Industry is a major focus of the Specialty Code 51 (Research & Development) Proponent Office at HQ U.S. Army Materiel Development and Readiness Command (DARCOM). Designed to monitor the health of the specialty, the Specialty Code 51 Proponent Office attends to the overall professional development of designated R&D officers. It establishes policy related to the R&D specialty, and proponent personnel examine the position inventory throughout the U.S. Army and compare it against the personnel inventory. Training With Industry fits into this spectrum as one training effort to develop R&D officers.

In Fiscal Year 1983, management for two areas related to acquisition—procurement (specialty code 97) and R&D—was transferred from the Office of the Deputy Chief of Staff for Research, Development and Acquisition (ODCSRDA) to HQ DARCOM.

The proponent office for the R&D specialty was established in the Directorate for Development, Engineering and Acquisition, while actions for the procurement specialty were assigned to the Directorate for Procurement and Production.

The coordinator for Training With Industry maintains communication with the program's participants throughout their year with industry—reviewing their progress reports and discussing their activities. Other coordinator functions include recommending utilization assignments for participants and identifying companies which qualify for the program and wish to sponsor an R&D officer.

The coordinator also visits the officers at their assigned companies, discussing the tasks and training opportunities offered. The relationship of the company with the officer is evaluated, as well as the quality of supervision regarding the training program within the company.

Multiple objectives support the Training With Industry Program. Generally, the U.S. Army seeks to train a nucleus of officers in high level managerial techniques and industrial procedures and practices not available through the military service school system. The program provides an arena for officers to learn how major defense contractors and other firms do business, and it offers an opportunity for cooperation between the U.S. Army and industry.

Program participants remain under administrative control of the Army while assigned to an industry. However, for all other practical purposes, each is considered an employee of the company. Training With Industry participants do not merely observe, they actively pursue tasks in a manner acceptable to the industry. In the process, the Training With Industry officer studies industrial management and acquisition from the "other side of the fence."

Utilization assignments "drive" the selection process for the R&D Training With Industry Program. Army commands are requested to identify positions which require knowledge of industrial procedures and the DOD/Army acquisition process. Selection is made for these assignments, and the officer serves one year with the company before reporting for the 3-year Specialty Code 51 job.

Selection for the program is competitive and based upon a comparative evaluation of academic and military records. Selected officers are those who have expressed interest in working with private industry. They will usually be captains or majors with 8–13 years of service in various U.S. Army assignments.

Selectees must have a bachelor's degree. Some will also have completed graduate courses or a graduate degree program. When an officer is nominated to a specific company, a resume is forwarded so the company can determine where that individual could best be used. Although not required, completion of the Program Management Course, offered by the Defense Systems Management College at Fort Belvoir, VA, is desirable.

Program participants possess experience in various career fields in addition to research and development. These may include any of 38 specialty areas for U.S. Army officers, including armor, aviation logistics, communications-electronics engineering, munitions materiel management, or missile materiel management. Applications may be made by submitting DA Form 1618R, with a resume, to the appropriate career management division at the U.S. Army Military Personnel Center. The governing regulation is AR 621–1, *Training of Military Personnel at Civilian Institutions*. There are 10 utilization assignments for the 1984 cycle now being filled by the Military Personnel Center.

A variety of companies voluntarily affiliate with the Training With Industry Program. Eight firms have agreed to participate during 1984–85. They are General Electric, Hughes Helicopter, Litton Data Systems, Martin Marietta Aerospace, Olin Corp., Sikorsky Helicopter, TRW, and Vought. Additional companies, generally considered leaders in their fields, are selected from time to time, depending on the availability of R&D activities to which the R&D officer may be profitably assigned—profitable for the U.S. Army as well as the company.

Each industry varies in its method of providing training. Some firms have established courses for their apprentice executives and some have programs involving over-the-road operations, maintenance shops, and terminals.

Research and development participants may encounter a variety of experiences within a company. This includes integrated logistics support, systems engineering, configuration management, manned/systems integration, testing, evaluation, quality assurance, data management, financial management, personnel management, procurement, production, distribution, and security assistance for developmental weapons systems.

Each company also develops a program of instruction based on the assigned officer's experiences and previous training/education plus the unique needs of the company. For example, an officer might spend several days reviewing reports to identify how a project which was completed at a $50,000 cost to the company could be managed for reduced production savings. A program participant, at another company, could spend a week assisting in the testing of a computerized tactical communication center. There is no single program for all Training With Industry participants. This is a major strength since flexibility is necessary to develop useable systems to meet changing national needs.

Programs of instruction are rotational, including assignments requiring officer interaction with program managers, the Defense Contract Administration Services, production planning and operations, in-process and acceptance testing, quality control actions, or engineering management procedures and techniques. The trainee may also be involved in activities such as master scheduling, reliability and maintainability engineering, or spares provisioning.

The program participant may then shift to several weeks of study and involvement into the various aspects of contract management, including the preparation of solicitations for subcontracts, evaluation of subcontract proposals, analysis of the price/cost of proposals, and the execution of contracts, subcontracts, and modifications to these.

In addition to working with the company, a program participant enters or continues a rigorous program of self-study. The objective is to obtain additional background and professional knowledge of the industry to which the officer is assigned. The intensity of effort expected is that of graduate level college assignments.

The civilian industry advisor prepares a letter evaluation covering the performance of duty of the officer. Key topics for coverage in this academic efficiency report include a brief description of the training plus comments evaluating the officer's performance, initiative, technical expertise, and ability to work with civilian personnel in assigned duties.

The acquisition process may produce "hardware" but it does so by effectively utilizing people. These individuals are civilians as well as military personnel, and the ability of an R&D officer to persuade and motivate others in accomplishing the task at hand cannot be overemphasized.

It is truly incumbent upon the Training With Industry participant to foster good working relationships within their assigned company. Generally, the fact that the assignee is an Army officer is kept low-key, but the issue of conflict of interest cannot be emphasized too frequently. A very narrow line exists between what a participant may and may not do, even though, for all practical purposes, the Army wishes the officer to be considered as an employee of the company.

For the protection of all concerned, training participants are limited to the role of observer in any work assignments involving Army projects. In particular, the officer avoids providing advice or guidance regarding contract performance and standards which could be interpreted as official Army policy.

In summary, research, development and acquisition for the U.S. Army involves many organizations within and outside the Army. The Training With Industry Program for R&D focuses on learning which prepares officers to implement the policies for Army RD&A. Participants gain insight into aspects of the technology base supporting materiel systems development and manufacture and their awareness of industry research and development is increased.

A valuable increase in the potential contribution to the Army RD&A process is achieved by a relatively modest investment of a few officers each year in Training With Industry assignments. The program performs a valuable role in the Army's efforts to achieve its goals in research, development and acquisition.

Additional information about the Training With Industry Program can be obtained from program coordinator Jo L. Green. Her address is Commander, U.S. Army Materiel Development and Readiness Command, ATTN: DRCDE-OO (Mrs. Green), 5001 Eisenhower Avenue, Alexandria, VA, 22333. The AUTOVON telephone is 284-8437 and the commercial number is (202) 274-8437.

KAY A. BLACK is employed in DARCOM's Development, Engineering and Acquisition Directorate. She was instrumental in establishing coordination for the Training With Industry in the SC51 Proponent Office. She holds a BS degree from Ball State University and has done graduate work in business administration and psychology. Her memberships include the National Association of Female Executives.

New Army Manual Describes Procedures for M1 Battle Damage Repairs

If the Army's Abrams M1 tank suffered a leak in its fuel line while in battle, could it be temporarily fixed by plugging the leak with adhesive tape? This may not seem as far fetched as it sounds.

For the first time in Army history, a complete, one-of-a-kind Battle Damage Assessment and Repair manual has been completed to tell the soldier in the field how to make emergency, temporary repairs if his tank is damaged or breaks down while in battle.

Always faced with the problem of a combat unit suffering loss of fighting power because of damaged or broken-down fighting vehicles, the Army urgently needed a manual for soldiers to use on the battlefield to make temporary on-site emergency repairs.

The manual is authorized for use only in combat at the discretion of the commander, with the proviso that any temporary fix must be repaired by a standard maintenance procedure as soon as practicable after the mission is completed.

In September 1982, at the direction of MG James Welch, director of the U.S. Army Materiel Development and Readiness Command's (DARCOM) Supply, Maintenance and Transportation Directorate, the Army Battle Damage Repair Program was initiated to develop technical manuals for the M1 Abrams tank, the M48/M60 series tank, the M109 family of self-propelled howitzer, and the M113 family of armored personnel carriers. Also, there will be a common subsystems manual for general combat vehicles.

The lead activity for developing the manuals is the Army Materiel Systems Analysis Activity at Aberdeen Proving Ground, MD.

Other principal participants in the M1 manual development include the Materiel Readiness Support Activity, the Tank-Automotive Command, the Armament, Munitions and Chemical Command, the Communications and Electronics Command, the Training and Doctrine Command's Logistics Center, the Ordnance Center and School and General Dynamics, the prime contractor for the M1.

The M1 manual is the first one to be completed and was presented to Welch in a ceremony at DARCOM headquarters. TACOM will release the M1 manual to the field during the second quarter of 1984. It will contain an evaluation sheet upon which users can make comments for possible inclusion in future revisions of the manual. The remaining manuals are expected to be released in the third quarter 1984.

The 680 page manual contains 373 illustrations and 198 fixes, which the Ordnance School at APG, assisted by the Armor School, the Infantry School, the Field Artillery School and the Signal School, has verified.

Interview With Dr. Bill Richardson

Deputy Director of the U.S. Army Chemical R&D Center

Q. Prior to joining the Army's Chemical R&D Center you managed the U.S. Air Force continuous long-term project in advanced biomedical studies related to aircrew and ground personnel. You are also credited with organizing the program office that initiated the first Air Force exploratory development program on chemical defense. How would you compare the Air Force CB R&D process with that of the Army's?

A. I think the key thing is that these efforts are really both part of the same process. The Army and Air Force, at all levels, are trying to make this a joint program. We have joint Service requirements that we have worked on together and there is currently a substantial effort at creating a joint Services plan relative to what is needed and how we can achieve it.

One example of this team approach is the commitment of the Air Force to put a liaison officer here at the Chemical R&D Center to improve coordination efforts between the two Services. The Navy is also considering placement of an officer here for the same purpose. I think this joint approach is very important in the chemical area.

One of the primary differences between the Army and the Air Force program is size. In the Army's role as executive agent for chemical R&D we provide much of the technology base for all Services.

The Army's program is larger and somewhat more diverse because we must operate in almost every type of environment. The Army's requirements process is also much more rigorous and specific. It is not unusual, for example, for the Army to take two years to develop a requirement for a detector or a decontamination technique. The Air Force, however, tends to use what is sometimes referred to as a "generic" requirements document. The approach is general in nature rather than specifically oriented at an individual item. Our testing is much more rigorous than that of the Air Force, and schedules for developmental and operational testing tend to be tougher.

In general, I would say that the Air Force system can be expedited to a greater degree than the Army's. There seems to be more willingness to accept risk on the part of the Air Force user and a willingness to initiate programs with general requirements and work out details as things progress. The key thing is that when the Army considers advanced development and engineering development, it doesn't receive funding until a requirements document is developed such as a Letter of Agreement or a Required Operational Capability. This is changing to some degree. A regulation is currently being written that will change the starting document from being the requirements statement to a concept of operation. It should be stressed that when we now go through all the steps in developing a piece of equipment it normally takes an average of about 10 years to field it, and that is simply too long.

Q. A university scientist in an Army-sponsored program has reportedly discovered that a certain sea creature produces an enzyme that "eats" enemy CB agents. Can you amplify this?

A. The university scientist you are referring to is Dr. Frank Hoskins who is with the Illinois Institute of Technology. That particular work was sponsored by the Army Research Office and we provided coordination. One of our scientists also worked with Dr. Hoskins in Massachusetts this past summer.

"Biotechnology definitely shows promise for many applications."

Actually, this is not the first finding of an organism or enzyme that can destroy chemical agents. There are several enzymes that will hydrolize nerve agents. The important aspect of this is that it points to an area that we are trying to build up—biotechnology. Biotechnology is a procedure that has undergone very rapid development in the U.S. during the past several years. It was even referred to in President Reagan's State-of-the-Union Address in 1983. Biotechnology has the potential of being applied to the areas of decontamination, detection, and even to self-decontaminating protective garments.

I would like to provide a brief example of how biotechnology works. There are certain enzymes in squid that can break down nerve agents. Similar enzymes are also present in mammals. In some organisms these enzymes are fairly active and destroy a lot of the agent but they are unstable and cannot be removed from the organism and stored in an operational environment. In another instance, an enzyme might be very stable but not very effective. What we hope to do with biotechnology is take a good stable enzyme that works well, produce a lot of it, stabilize it, and then use it for decontamination.

The work this past summer was done in connection with the in-house laboratory independent research program, which provides modest amounts of discretionary funding for high risk, high payoff ideas. This effort showed that a microorganism called Tetrahymena produces a useful enzyme.

Using genetic engineering techniques, it may be possible to take an enzyme from a creature like the squid and put it in a microorganism that could be produced in great quantities and thus create a lot of useable enzymes. If we can achieve that we may have a good enzyme in quantities needed to decontaminate armored vehicles and other Army equipment.

The growing importance of biotechnology is evidenced by the fact that it is a major Army thrust, sponsored under the leadership of Under Secretary of the Army James Ambrose. He reviewed our program and asked that it be accelerated and enhanced. We are in the process of elevating our current Biotechnology Section to branch status and we plan to hire five genetic engineers to expand our program.

Biotechnology definitely shows promise for many applications. For example, there is a company that is planning to market a non-corrosive enzymatic drain cleaner. A similar type of product would be of great value to the Army because the decontaminant solutions we now use are corrosive: they not only destroy the undesirable agent, but they also degrade paint, rubber parts, and other parts of equipment. If we could tailor enzymes to only destroy chemical agents we would have a very useful product.

I would like to cite one other important application in this area. Using a techinque called monoclonal antibodies, we have produced a simple "dipstick" that changes color when exposed to chemical agents. The one we have produced thus far is for a specific nerve agent.

However, we hope to do similar work with regard to various toxins, mustard agents and other substances. We have also begun an academic research program, working with the Defense Advanced Research Projects Agency, on receptor site technology. This effort relates to detection of toxins which, as a group, have some common effects on the body's physiological systems.

Q. How costly is the enzyme process?

A. The largest monetary investment is being made by industry. One chemical products corporation, for example, is putting about $200 million into biotechnology. This pattern seems to be occurring among various other industries. We will make use of some of their technology base. We simply can't afford to, and don't need to, match commercial investments.

Q. Robotic technology has been discussed as a potential asset in decontaminating vehicles. Can you expand on this and provide some information on other potential applications of robotics relative to CB defense?

A. If we were to confront the need for decontamination in a chemical war today, it would be very labor intensive. In fact, it would require the shifting of personnel from other areas to perform it. Decontamination today is basically a washing or cleaning process done with solutions and scrub brushes. Robotics would provide the Army with the capability of putting an individual in a protected environment within a vehicle and directing a hot air stream or hot or cold liquids at a contaminated surface. This would speed the decontamination process. We have been examining this in our exploratory development program and we recently received approval for a project line for advanced development.

CRDC THRUSTS

Provide Armed Forces With Responsive CBD/CW Systems

- **Exploit the worldwide technology base to achieve significant materiel advances.**
- **Adopt a materiel acquisition strategy which features early planning and analysis and field integrated famililies of materiel which are readily adaptable to improvement as technology improves.**
- **Implement a coherent long range plan to achieve and maintain materiel superiority.**
- **Maximize workforce and organizational effectiveness.**
- **Be and be perceived as the center of excellence in CBD/CW science, technology and materiel.**

I can imagine a decontamination process similar to a self-contained car wash where a vehicle would pass through it and be washed by a recirculating solution. Robotics might also have application in the area of reconnaissance, where we might be able to identify a chemically contaminated area in terms of the extent of contamination and when the area might be safe.

In the near term, we are looking at the fielding of manned reconnaissance vehicles. Our long-term sights are set on fielding unmanned vehicles, both ground vehicles and remotely piloted aircraft.

Q. Some people contend that the Soviets have a distinct advantage over the U.S. relative to the state-of-the-art of their CB decontamination equipment. Could you comment on this?

A. Let me preface my response to this question by pointing out that the Soviets had 500,000 casualties due to chemical warfare in World War I and they are never going to forget that. I think it is obvious that the Soviets have made a large commitment to chemical warfare capabilities. The fielded Warsaw Pact materiel for chemical defense does not appear to be significantly advanced over ours or our allies. However, what is apparent is an immense investment in a large number of decontamination vehicles and other equipment. Estimates of troops committed to the Soviet Union's chemical program range from 80,000 to 120,000. The Soviets have a significant chemical R&D effort and a large part of that seems to be devoted to offensive capabilities.

Q. What do you believe is the most important short-term challenge and the most important long-term challenge facing the Chemical R&D Center?

A. The biggest short-term challenge we face is fielding equipment as quickly as possible. We need a better detection capability in the field and we need to be able to retaliate and fight in a chemical warfare environment if needed. I should stress that it is national policy that we will not employ biological weapons. We therefore have no offensive biological program, but we must address defense against biological agents, including toxins, as well as chemicals.

During the 1970's the chemical R&D program went through some fallow years. The technology base was low. Events in Afghanistan and Southeast Asia resulted in a new awareness of the chemical threat and the Army increased its investment in the technology base. Our key objective is to take this investment and transfer it into fielded equipment.

Relative to the long-term challenge facing the Chemical R&D Center, I want to emphasize the need to continue chemical defense preparedness. Everyone would like to see an end to the production, stockpiling, and use of chemical weapons. We want to achieve a verifiable treaty. However, the potential for the diversity of weapons that could confront us is going to increase. The point I am trying to make is that we must be able to cope not only with the current threat but also with any future threat. In essence, we must develop new equipment and techniques based on an unknown threat that we may face in the future. These systems must be adaptable and flexable and still be logistically efficient for the soldier. A real technical challenge in all of this is to insure that we don't overburden the soldier with the equipment.

It is especially important for the Chemical R&D Center to insure that our efforts are credible and quality conscious so that those in higher level management know that they have invested wisely.

Q. Is public acceptance a problem relative to the work performed by the Chemical R&D Center?

A. There is a general horror about the prospect of chemical and biological warfare on the part of the public and to some extent by those in the military itself. Unfortunately, because of this horror there is a tendency by some people to ignore the need to be prepared for a chemical or biological war.

In general, the Congress has been very supportive of defense measures related to chemical warfare. Until we get a good verifiable treaty, however, I believe we are going to have to continue to work on both defensive and retaliatory capabilities. Defense alone is unfortunately not a deterrent.

It is very important that people realize that a chemical is not just one additional weapon system for our arsenal. It is a new level of warfare that changes the way we fight.

Q. Development of equipment for detecting and identifying enemy CB agents is a key mission of the Chemical R&D Center. How would you compare detection equipment of 10 years ago with that which exists today?

A. Equipment that we were deploying 10 years ago was based on wet chemistry technology. It was slow, labor intensive and awkward to use. Equipment we are now fielding is still based somewhat on wet chemistry but it is faster and easier to use than earlier equipment. For example, the primary alarm device we previously had in the field—the M8 Chemical Agent Detector—was purely a wet chemical system. This system had detector solutions which had to be replaced every 12 hours. Its response time was also 1 or 2 minutes. The equipment we are now fielding, the M8A1 detector kit, has a response time of 3 to 5 seconds.

There are several other interesting technologies and devices we are looking at. For instance, we are giving some attention to a United Kingdom device, based on technology developed here, known as the Chemical Agent Monitor, or CAM. This is a hand-held system which weighs about five pounds and provides the capability to scan surfaces and tell if a nerve or mustard agent is present.

We are also developing the XM22 Automatic Chemical Agent Detecting Alarm. This is a little bit heavier than the Chemical Agent Monitor but it incorporates a heater which actually heats surfaces and vaporizes liquid agents so they can be detected. This system can identify a broader range of agents.

Another important system under development is the XM21 remote sensor which will be fielded before the end of this decade. This device gives the field commander the first standoff capability for detection. It will allow him to look out at a cloud and detect chemical agents at a distance of 3 to 5 kilometers. We are also developing an automatic liquid agent detector, the XM85, which will detect droplets of agents from missiles or aircraft.

Overall, I think the real differences in detection equipment from 10 years ago will be more evident when many of the items I just discussed are fielded during the next 3 to 5 years. I should point out that many of the things which are now in our technology base and consume a large percentage of our investment are also very exciting. These include items such as miniature detectors that could be placed in ground vehicles, aircraft cockpits, and on the individual soldier.

Q. How does the future of Army Chemical R&D look to you?

A. It looks very challenging. The problems we face are technically complex. As I stated earlier, we must work on both a known threat and an unknown future threat. Even if we do get a verifiable ban on chemical testing, we must still continue our chemical defense preparedness efforts.

In addition to the technical challenge, we must produce materiel which is a limited burden to our troops and is useable in all environments. I also hope we can continue the momentum we began a few years ago relative to our personnel and equipment. For example, we have doubled the number of people on our staff who have PhDs and we have improved the state-of-the-art of much of our laboratory equipment. The number of visiting scientists working with us has also substantially increased. In fact, this past summer we had 37 people from academia and other institutions across the country working in our labs.

I believe we have made good progress in improving our modeling capability which helps us predict what chemical war will be like. We must also make greater use of systems analysis to predict the best technical approaches to problems and we need to improve the Chemical R&D Center's work environment to retain the excellent people we have on board.

DARCOM Hosts Briefings for New Army Brigadier Generals

What story does DARCOM tell to the Army's new brigadier generals? Sixty-eight of them recently learned, not surprisingly, that command emphasis today is heavy on cost discipline, program stability, and resource management.

Briefings and discussions by the command's top management were conducted at HQ DARCOM as part of the Army Chief of Staff's annual conference for newly designated and appointed active duty Army brigadier generals. Attendees received briefings from representatives of major Army commands, organizations, and agencies to acquaint them with current Army plans, policies, objectives, and practices applicable to installation and financial management.

The day-long session included presentations on the command's mission, organization, functions, and programs, plus unresolved issues that the attendees can influence as brigadier generals.

GEN Donald R. Keith, DARCOM commander, made the first presentation, prefacing his remarks with an outline of the thrusts and challenges that DARCOM faces. He underscored lessons learned during the 1970's as they relate to the command's role in the 1980's in such areas as force modernization, acquisition, and logistics.

Keith cited the challenge of force modernization as "the big one" that confronts both the Army and its contractors, and stated that, along with the Army's efforts to modernize, the need to sustain day-to-day readiness is just as vital.

Keith discussed DARCOM acquisition improvement initiatives designed to smooth the way for modernization and develop better cost discipline. He noted ongoing efforts to shorten the acquisition process and to formulate, early-on, a complete strategy for each system that is translatable into an understandable contract that enables industry to bid and produce with confidence.

Relative to cost control, he noted that DARCOM's Program Management Control System (PMCS) "institutionalizes all of our acquisition initiatives." He said that once fully implemented, the PMCS will record every management action taken on a system, as well as the cost consequences of each action, thereby precluding much of the "outside tinkering" that has tended to destabilize some Army systems in the past.

Although the Army has had to play catch-up in producibility engineering and planning and the smooth transitioning of systems from development to production, said Keith, "we have taken a major effort to assure producibility of our items in R&D." He stated that production engineers and the command's contractors are being brought into the acquisition process early. Under the PMCS, he added, "we will fence the producibility engineering and planning and MANTECH dollars needed to do the job right."

The General reaffirmed the command's commitment to product quality, and discussed implementation of recommendations of the Kerwin Board review of DARCOM's product assurance program.

Citing professional development as a key element in DARCOM's efforts to enhance the acquisition process, he discussed details of the new Materiel Acquisition Management (MAM) Programs for development of military and civilian acquisition managers.

Keith said that the initial version of DARCOM's Strategic Long-Range Plan is scheduled for publication this spring. It will address all major command functions, identify future economic, social-demographic, technological, and political trends and their potential impact, and present a strategy for defining and meeting long-range goals and objectives. The plan is designed to bridge the planning and programming gap and to influence the FY 1987–91 POM.

Keith also discussed the two-part DARCOM Long-Range RDA Plan, citing the science and technology portion as a key source of guidance for the Army's technology base during program formulation. The Development and Acquisition Plan is a primary roadmap for RDA programs, including funding and key milestones.

The commander closed with a discussion of logistics initiatives, including increased emphasis on ILS, and new programs for Total System Fielding and Logistics R&D, plus support of the High Technology Light Division (HTLD).

MG John B. Oblinger, Jr., DARCOM director for Development, Engineering and Acquisition (DEA) followed General Keith with a presentation on DARCOM support for the High Technology Light Division and the new 10K Light Division. He said that the Army established the Quick Reaction Program (QRP) process to rapidly develop and staff abbreviated requirements documents in order to preclude front-end delays in materiel acquisition.

He next presented a summary of the QRP process including initiation of a document by the Army Development and Employment Agency, Fort Lewis, WA, validated by the Combined Arms Combat Development Agency, cost, schedule, and technical assessment by DARCOM, and review by TRADOC and approval or disapproval by DA.

The audience was shown examples of approved and funded QRP's for the HTLD, including the mobile heavy mortar, indirect sighting system, and AWACS interface. Additional QRP's which were discussed included an initial requirement for 485 Fast Attack Vehicles (FAVS), the new HMMWV Infantry Squad Carrier; Towed Chaparral; and the Airborne Radar Jammer System.

"DARCOM is totally committed to supporting TRADOC in fielding the new Light Division in FY 1986 and upgrading the division equipment from FY 1986 to FY 1989," said Oblinger. "In conducting our initial reviews of TRADOC proposals," he added, "our goal has been to respond with a consensus of what is doable, with a prompt and accurate recommendation of what resources are required."

The DEA director concluded by stressing the DARCOM-TRADOC team effort, including TRADOC's role in developing TOE requirements; DARCOM's development of acquisition strategies; and combined efforts to expedite DA TOE approval, reprogramming and redistribution, and documentation. "We make the best use of our resources," he said, "exploit matrix management to the fullest, and focus on the users' needs."

MG Robert J. Sunell, PM Tank Systems, spoke on "Program Management," and recounted the background of the M1 Abrams Tank System as a prime example of how the Army successfully manages a system from approval of mission need through fielding.

He traced the entire spectrum of management responsibilities of three PM's—including their challenges, milestones, stumbling blocks, and successes.

Sunnell also discussed the numerous and complex steps necessary to complete fielding of a system such as the Abrams. "In order to field a system," he said, "the program manager must interface with most of the Army community."

MG Henry H. Harper, commander, U.S. Army Depot Systems Command, addressed "DESCOM's Support To The Total Army." His remarks included an overview of DESCOM's missions, plus programs supporting the Army in the field and the materiel developer, and details of the command's modernization program.

DESCOM, Harper stated, plays a major role in force modernization through coordination of Total Package Unit Materiel Fielding with the program manager, consolidation of the support package, staging for shipment, and release of support items with the end item.

Harper underscored DESCOM's support role in citing the command's efforts in Operation Urgent Fury in Grenada. According to Harper, DESCOM furnished, within a 24-hour period, more than 312 tons of subsistence, munitions, major end items, and repair parts to U.S. forces.

The final briefing was "Resource Management Challenges" by Marie Acton, DARCOM assistant deputy for Resources and Management. She began by describing today's management environment, including challenges of new technology, management initiatives, mandated programs, and changes in the scope and complexity of the Army mission.

Acton focused her remarks on initiatives for improving the system acquisition process, including reducing operation and support (O&S) costs, and maximizing productivity through available manpower.

What can commanders and managers do to help offset O&S cost growth? Acton responded by offering the following:

- Insist upon discipline in the acquisition process during establishment of requirements, design, logistics, support concepts, and operating and training plans.
- Identify assumptions and factors that are cost drivers, subject them to scrutiny, and challenge them if they fail the common sense test.
- Consider O&S cost implications in every management decision.
- Look for opportunities to drive down O&S costs.

Acton called on the attendees to make the most of the work force available at their respective duty stations, and stress RESHAPE-proven initiatives, such as judicious use of overtime and overhire, productivity improvement, capital investment, and organizational streamlining.

The session concluded with a question and answer period conducted by GEN Keith, MG Jere Sharp, DARCOM deputy commander for Resources and Management, MG David W. Stallings, DARCOM director for Procurement and Production, and MG Oblinger.

The preceding article was authored by Kenneth S. Spalding, writer-editor, Task Group, DARCOM Office of the Deputy Command General for Materiel Readiness.

WSMR Develops Special System for Mortar Burst Scoring

Instrumentation scientists and technicians at White Sands Missile Range, NM, have developed a highly-specialized system for "scoring" (measuring the height of) mortar bursts at another test range 1,400 miles away.

The Mortar Burst Height Scoring System, which costs about $410,000, was conceived and developed by the WSMR Instrumental Directorate for use at Jefferson Proving Ground, IN. Jefferson is one of the Army's major munition test sites.

Mortars are designed to explode at specified heights above the ground, depending on their intended use. Height-of-burst tests are conducted to see if the fuses on these mortars meet government requirements. The new scoring system is designed to measure accurately the height of a mortar burst. The system is composed of a data collection van and a data reader station.

Mortar height burst testing is conducted in an open rectangular field. The new system features eight permanently-fixed video cameras which overlook the 600 by 1,000-foot field. Reference target poles are positioned along the edge of the field at regular intervals.

After the information is recorded on videotape, it is taken to the reader station. With eight recordings, chances are that the event will occur within the field of view of at least two of the cameras. The taped information is fed into the reader, where the height of the burst is determined.

The idea for this new approach was conceived three years ago when the Army's Cold Regions Test Center, Fort Greeley, AK, needed an effective height scoring system for testing of mortar bursts. Determining burst height the old way involved employing an observer with limited equipment, who estimated the height of a burst as it occurred.

In order to improve upon the former method, White Sands developed a small-scale, two camera, real-time video system which achieved satisfactory results. The success of the prototype prompted Jefferson Proving Ground officials to ask the missile range to build another, much larger system.

WSMR's Instrumentation Directorate presented a formal proposal for the system and the Army's Test and Evaluation Command, Aberdeen Proving Ground, MD., and Jefferson Proving Ground gave approval to begin the project.

Two divisions developed the scoring system. Responsibility for the data van was assigned to the Data Systems Division, while the reader development was left to the Optics Division.

The van contains four equipment racks arranged in a semicircle. These house eight video recording units, eight TV monitors, switching gear, an analysis and trouble-shooting station, a control unit for all cameras and a titling system for mortar rounds fired. A work bench and storage compartments are also included. Although space is limited, the operation and collecting of the data during a mortar firing is essentially a one-man operation, according to WSMR electronics engineer Henry Newton. All hook-ups for the TV cameras are on the outside of the van.

The second portion of the scoring system is the video data reader. Amory Hale, Instrumentation Directorate senior physicist, was in charge of this portion of the project.

Because of its size, the reader is separated from the van. It uses the data recorded on videocassettes. Selected portions of videotape from the cameras which captured the image of the burst are transferred to a videodisc unit. Up to 30 seconds of information can be recorded on this disc, which provides a high-quality picture in addition to a number of special effects, such as the burst, which appears as a flash on the screen.

A special computer program is applied to the test information and the result is a precise measurement of the burst, displayed on the TV screen. Officials say the machine can then compute burst heights and plot them to show where and how they landed.

Unit Cost Reporting

By Ronald G. Linthicum

The increase in costs associated with the development and acquisition of military weapons and equipment is a continuing concern of the Department of Defense and the Congress. The inflationary spiral in all corners of the U.S. economy from the mid 1970's through fiscal year 1981 further added to these concerns as the projected total costs of a number of major weapon systems continued to grow.

The search for improved methods in estimating the total cost of new systems, and the curtailment of cost growth during the development and acquisition cycle of each new weapon system, remain the central management issues to be addressed. Consequently, all levels of management perceive that more information on the overall status of each program must be available if proper decisions are to be applied at each phase in the acquisition cycle. This perception has led to a number of reports developed by the program manager (PM) and provided, through the chain of command, to managers at various levels in the hierarchy of decision makers.

This article will address only two such reports—the Selected Acquisition Report (SAR) and the more recently instituted Unit Cost Report (UCR). These reports are prepared by the PMs of programs designated by the Congress as major acquisition systems. The major focus of this article will be on Congressional actions that established these reports and how these reports have affected the Army.

Selected Acquisition Report

The Selected Acquisition Report (SAR) was in use by OSD and the Services as an internal management report prior to 1976 when Congress directed that it be submitted to Congress. Section 811 of the 1976 Defense Authorization Act made the SAR the Services' primary reporting document, in conjunction with the Congressional Data Sheets, for transmitting the status of major defense acquisition programs to the Congress and the public.

The SAR is a standard, comprehensive status report on selected major defense acquisition programs managed within the DOD. Included is the quarterly status of each system's operational and technical characteristics (performance), the schedule of actions completed or to be accomplished in the program, and the system cost estimates keyed to the Five Year Defense Plan (FYDP) in the President's budget.

SARS are considered historical in nature in that the cost schedule and performance values reported in the initial SAR for a system are baselined on the President's budget for that fiscal year and all subsequent program changes are predicated on documented changes to the "approved program."

Unit Cost Reporting— The Nunn Amendment

Congressional concern with cost growth in major defense acquisition systems generated Congressional action that lead to the Nunn Amendment. It provided the Services with an introduction to unit cost reporting.

Using the SAR as the base reporting document, the Nunn Amendment required the program manager to prepare a Unit Cost Report derived from information reported in the SAR and to submit the report to the Secretary of the Army. The additional report became known as a Unit Cost Report because its primary purpose was to measure changes in Program Acquisition Unit Cost and Procurement Unit Cost on a quarterly basis.

The Unit Cost Report was provided by the program manager to the Secretary of the Army to achieve the stated purpose of the Nunn Amendment, which was to direct increased management attention to cost growth in major programs.

The Nunn Amendment became effective on 31 December 1981 and applied only to the major defense acquisition systems reported in the 31 March 1981 SARs. The 14 Army major acquisition programs in the 31 March 1981 SARs were:

Advanced Attack Helicopter (APACHE), Abrams Tank, M-1, Bradley Fighting Vehicle System, Black Hawk Helicopter, CH-47 Helicopter Modernization, Copperhead Cannon-Launched Guided Projectile, Hellfire Missile System, Multiple-Launch Rocket System, M198 Self-Propelled Howitzer, PATRIOT Air Defense Missile System, Pershing II Missile System, Roland Missile System, Sergeant York (DIVAD) Gun System, and the Stand-Off Target Acquisition System (SOTAS).

A significant provision of the Nunn Amendment was the requirement for the Army and the other Services to "look back" in time to the program information reported in the 31 March 1981 SARs and develop from that information a baseline value for Program Acquisition Unit Cost and Current Procurement Unit Cost for fiscal year 1981.

The value for Program Acquisition Unit Cost was developed from the total RDTE (Development), procurement and military construction cost estimates for the acquisition program divided by the number of fully-configured end items to be procured for the acquisition program.

The value for Current Procurement Unit Cost was developed from the total of all procurement funds appropriated for the program for fiscal year 1981 divided by the number of fully-configured end items to be procured during fiscal year 1981.

Once developed, these baseline values for unit costs became the measuring point for comparison with the fiscal year 1982 unit cost values reported in the "as of" 31 December 1981 annual comprehensive SAR and all subsequent quarterly SARs through 30 September 1982. The comparison of baseline and current estimate values for unit costs, including the percentage variance in those values since the baseline SAR of 31 March 1981 were to be reported in the program manager's quarterly Unit Cost Report to the Secretary of the Army "within seven days after the end of each quarter of fiscal year 1982."

Additional information required to be reported by the program manager in his Unit Cost Report included the known, expected or anticipated changes in schedule milestones or system performance since the baseline SAR of 31 March 1981.

Once received from the program manager, the Secretary of the Army was charged under the Nunn Amendment to review the Unit Cost Report and make a determination in regard to the reported unit cost values. If the Secretary determined that one or more of the unit cost values had increased by more than 15 percent, or by more than 25 percent, the Secretary could have determined that a "breach" of unit cost had occurred. The date such a determination was made by the Secretary would start the calendar for a Secretary of the Army written report due at Congress within 30 days of the determination date.

If the Secretary of the Army determined that one or more of the unit cost values had exceeded by 25 percent or more the unit cost values reported in the 31 March 1981 SAR, the Nunn Amendment provided 60 days from the date of the Secretary's determination as the due date for submission to Congress by the Secretary of Defense a written certification in support of the acquisition program.

The Secretary of Defense 60-day certification, like the Secretary of the Army 30-day report, was provided in the Nunn Amendment as an alternative to the withdrawal of Service authority to obligate additional funds for the acquisition program.

If the reports were not received at Congress within the specified due dates, no further obligation of funds in support of the "breaching" program was authorized under the law.

The Nunn Amendment achieved its purpose of involving the responsible agencies and individuals of the Army's cost management structure in the monitoring of unit costs in major acquisition programs. The SARs and Unit Cost Reports were prepared by the program manager and reviewed at each major subordinate command and DARCOM. Unit Cost Reports were then provided to the Secretary of the Army in accordance with the law.

Development and processing of the 31 December 1981 Unit Cost Reports were hampered by circumstances not foreseen by the authors of the Nunn Amendment.

The Nunn Amendment tied unit cost reporting to the program information reported in the SAR. However, the amendment required the program manager to submit the first quarter Unit Cost Report to the Secretary of the Army no later than 7 January 1982. This placed the program manager in the position of submitting a Unit Cost Report to the Secretary of the Army approximately 30 days prior to submitting his SAR for the same reporting period. Thus, the first Unit Cost Reports had to be revised and re-submitted after the President's budget was sent to Congress.

Two programs (U.S. Roland and SOTAS) had been terminated by the effective date of the Nunn Amendment. The 31 March 1981 SAR for the M–198 Howitzer was the last SAR submitted on that program. There was no provision in the Nunn Amendment to omit Unit Cost Reports for programs that have been terminated or relieved from reporting in SARs.

In strict compliance with the law, Unit Cost Reports for the three programs were prepared and forwarded to the Secretary of the Army. The comparison of unit costs for these programs was unrealistic in view of the status of the programs.

The Nunn Amendment required all reporting programs to develop fiscal year 1981 and 1982 Procurement Unit Cost values based on the procurement funds authorized for expenditure by the programs during each of the two fiscal years. There was no offsetting provisions for advance procurement (procurement dollars spent for end items to be delivered in a subsequent year) or for the amount of procurement dollars actually spent for equipment items other than the fully-configured end items reported as the unit of measure in the SAR.

The requirement to track unit costs on fully-configured end items did not take into consideration that some programs were procuring both firing units and missiles. In such cases, firing units were used as the unit of measure in determining Program Acquisition Unit Cost and Current Procurement Unit Cost was developed using missiles as the unit of measure.

Programs reporting Current Procurement Unit Cost based on missiles may have actually spent 1981 procurement dollars for support equipment and/or firing unit components. This presented an unrealistic picture of the unit cost for missiles. This also applied to programs that had experienced a reduction in fiscal year 1982 missile procurement quantities to "free up" funds for the procurement of firing unit components. The reduction in missile quantities caused an increase in missile procurement unit cost for fiscal year 1982.

Even as the Services were wrestling with the interpretation of the Nunn Amendment and attempting to prepare the first Unit Cost Reports, House-Senate Conference action was underway to develop a joint amendment to supplant the temporary provisions of the expiring Nunn Amendment.

Selected Acquisition Reports— The Nunn-McCurdy Amendment

Effective 1 January 1983, the Nunn-McCurdy Amendment repealed Section 811 of the Defense Authorization Act of 1976 by revising SAR procedures and placing new SAR reporting requirements on the Services. It also tied unit cost reporting to the SAR's, requiring that both reports track to the President's budget. Other aspects of reporting program status in SARs were also included in the Nunn-McCurdy Amendment. They are:

- A comprehensive annual SAR for the first quarter of each fiscal year is due at Congress by the 30th day after the President's budget for the following fiscal year (budget year) has been provided to Congress. The comprehensive annual SAR includes performance, cost and schedule information, and any additional information the Secretary of Defense may wish to provide.

- The SARs for the second through fourth quarters of a fiscal year are required only if there has been a change in program cost, schedule or performance since the most recent SAR. Quarterly SARs are due at Congress within 30 days after the end of the reporting quarter. It is possible that a program experiencing no changes since the first quarter annual comprehensive SAR may submit no quarterly SARs for the remainder of the fiscal year.
- The measuring point for unit cost and contract performance reporting is the baseline SAR; the SAR in which information on a program is first reported or the comprehensive annual SAR for the fiscal year immediately prior to the current fiscal year, whichever is later. Once established, the baseline SAR shifts forward on 31 December of each year to the as of 31 December SAR for the prior fiscal year. This effectively ties the Unit Cost Reports to the SARs and the approved program reflected in the President's budget.
- The 1982 Nunn Amendment did not require the reporting of contract information in Unit Cost Reports. The Nunn-McCurdy Amendment introduced the definition of major contracts under a program and requires the six largest contracts under the program to be reported.

A major contract is defined as each active prime, associate prime, or government-furnished equipment contract that is one of the six largest contracts under the program in dollar amount. The values for the six major contracts must be reported in the SAR, including cost and schedule performance information applicable to the contracts.

The Secretary of the Army must submit annually, with the Army Program Objective Memorandum (POM), a report to OSD identifying all Army acquisition programs that meet a $200 million RDTE or a $1 billion procurement cost threshold criteria that are not currently submitting in SARs.

Once identified, such programs must commence SAR and Unit Cost Report reporting unless waiver approval is granted by the Senate and House Committees on Armed Services. A program may also be designated a SAR program at the request of an individual Senator or Congressman, or when the program is selected for reporting by the Secretary of Defense.

Unit Cost Reporting—The Nunn-McCurdy Amendment

The Nunn-McCurdy Amendment has changed the unit cost reporting procedures required under the Nunn Amendment. The most significant change is the requirement to provide performance information on the six major contracts under each of the reporting programs. This expanded the scope of Unit Cost Reports and imposed on the Army another measuring point for determining management performance within programs.

The amendment also redefined the baseline SAR for unit cost reporting purposes. The baseline SAR for all Unit Cost Reports submitted on a program during fiscal year 1983 was the as of 31 December 1981 SAR. The baseline SAR for Unit Cost Reports submitted during fiscal year 1984 will be the 31 December 1982 SAR, and so on for each succeeding fiscal year.

If a program commenced SAR reporting during the second through fourth quarter of a fiscal year, and cannot "look back" to a December SAR, the initial SAR for the program will be the baseline SAR. The concept of a baseline SAR is important because it is the point from which all program cost and contract performance values are measured.

Under Nunn-McCurdy, the Unit Cost Report must include:

- The current Program Acquisition Unit Cost.
- If the program is a procurement program, the current fiscal year Procurement Unit Cost.
- The cumulative cost variances and schedule variances in the six largest contracts under the program since the baseline SAR.
- Any known, expected or anticipated changes in operational/technical characteristics (performance) or schedule milestones reported in the baseline SAR.

The Nunn-McCurdy Amendment retained the definition of Program Acquisition Unit Cost provided in the old Nunn Amendment, but revised the definition of Current Procurement Unit Cost. Current Procurement Unit Cost is now reduced by the amount of current fiscal year procurement funds appropriated for advanced procurement of end items to be delivered in subsequent fiscal years.

Although the new definition of Current Procurement Unit Cost is more complicated, the offsetting values for advanced procurement have brought this measurement of unit cost more in line with the actual expenditure of procurement funds within a program.

The Nunn-McCurdy requirement to report cost and schedule variances in the six largest contracts under the program is keyed to the contract cost tracking provisions of the Amendment. However, the purpose of reporting cost and schedule variances in contracts is not clear. Cost and schedule variances are contract performance indicators that are measured against similar values in the baseline SAR.

An increase in contract cost or schedule variances above that reported in the baseline SAR, in most instances, will not indicate a corresponding increase in the total cost of the contract.

The Nunn-McCurdy Amendment requires the program manager to submit a Unit Cost Exception Report at any time during the fiscal year that he has reasonable cause to believe that:

- The Program Acquisition Unit Cost, or in the case of a procurement program, the Current Procurement Unit Cost, has increased by more than 15 percent above the corresponding unit cost values reported in the baseline SAR.
- Cost or schedule variances in a major contract have resulted in an increase in the cost of the contract of at least 15 percent over the cost of the contract at the time the contract was made.

The criteria for reporting breaches in contract cost have been a particular problem. Tracking the cost of major contracts in existence for some years at the time Nunn-McCurdy came into being proved to be virtually impossible.

It was decided at OSD that the cost of a major contract in existence on the effective date of the Nunn-McCurdy Amendment would be the cost of the contract as of 31 December 1982. This eliminated the problem of having to search back over the years to determine the cost of existing contracts at their start date.

For contracts that came into being after 31 December 1982, contract costs would be measured from those first reported in the Supplemental Contractor Cost Report and the SAR. Because there were no guidelines in the Nunn-McCurdy Amendment as to what contract values constitute the total cost of a major contract, OSD also developed the concept of contract cost baselines. This procedure requires the program manager to develop and maintain on file a record of the contract cost baseline for each major contract under the program. The composite values that make up the contract cost baseline are composed of:

- The program manager's estimated price of the contract at its completion, as reported in the 31 December 1982 SAR, or the SAR in which the contract is reported for the first time;
- The value of any known or anticipated future effort under the contract;
- The value of any portion of the program manager's management reserve funds that he may choose to allocate to the contract.

Once established under this allocation process, the contract cost baseline for a major contract remains in effect for the life of the contract.

If a major contract reported in the SAR is subsequently displaced by a new contract of higher value, the program manager must develop the contract cost baseline for the new contract and commence reporting the contract in the SAR and UCR. He must also retain on file the contract cost baseline for the major contract being displaced in the SAR. This is required in the event that the displaced contract may later requalify as a major contract.

The procedure for reporting increases in unit cost that exceed the 15 percent or 25 percent cost breach threshold remain essentially the same under the Nunn-McCurdy Amendment as they were under the Nunn Amendment. The only significant difference is the requirement for the program manager to submit a Unit Cost Report each time unit cost or the cost of a major contract exceeds by five percent the cost breach initially reported in a previous Unit Cost Exception Report submitted to the Secretary of the Army. There is no limit on the number of five percent incremental Unit Cost Exception Reports that may be submitted to the Secretary of the Army by a program manager.

Unit Cost Reporting—Future Outlook

This article provides an overview of unit cost reporting, including its stated purpose and scope. It was the intent of Congress in implementing Nunn-McCurdy to cause the highest levels of management within the Services and OSD to focus more attention on cost growth in major defense acquisition programs. This purpose has been accomplished by:

- requiring the Service Secretaries to review a quarterly report that reflects changes in unit cost and contract performance within a program and;
- inhibiting management decisions that may place a program in the position of having to report to Congress increases in unit cost that breach the 15 to 25 percent cost thresholds.

On the other hand, unit cost reporting has placed an additional report burden on affected program managers. Already saddled with the SAR, Supplemental Contractor Cost Report, Program Management Control System, and others, the program manager has had to absorb unit cost reporting without any increase in the number of personnel to prepare and track reports. To a lesser degree, intermediate headquarters have been similarly affected.

The Unit Cost Report is not lengthy or overly complicated. Once prepared, however, it is subject to review at each level in the chain of command. At the staff level the burden is verification and staffing of the report within the limited time available to accomplish a satisfactory audit of the report.

The Nunn-McCurdy Amendment requires the Unit Cost Report to arrive at the Office of the Secretary of the Army within seven calendar days after the last day of each fiscal quarter. The Unit Cost Report must agree with the SAR and the SAR for the first quarter must reflect the approved program in the President's budget.

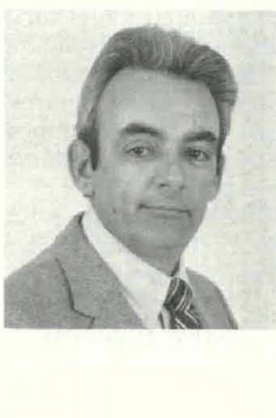
The problem during the first quarter is that the President's budget is not approved and submitted to Congress until the last week in January or the first week in February.

Correspondingly, the 31 December SAR is not prepared until the President's budget goes to Congress. This places the program manager in the position of having to prepare two Unit Cost Reports for the first quarter; the first report to meet the statutory requirement to submit a Unit Cost Report to the Service Secretary within seven days after the end of the first quarter, and a revised report after the President's budget has gone to Congress and the SAR reflecting the approved program has been prepared.

During the past two years, virtually all reports covering major defense acquisition programs have expanded in scope and/or the level of detail to be reported. This growth in reporting has not been offset by the needed manpower and automation of resources needed to meet the increased workload at the program management level.

During critical periods in the program and budget cycle the program manager may have to assign his subordinate management personnel the task of preparing reports in lieu of coordinating and developing management actions. Thus, reports created to detect management oversights may, in fact, create management oversights.

This paradox in the reporting scheme dictates that higher level management must weigh the need for additional reports against other workload requirements if no additional resources are available to the developer of the reports.



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Army Tests Unique Danish Machine Gun Mount

Representatives of the U.S. Army Training and Doctrine Command joined members of the Army's R&D community last year to witness reliability testing of a unique Danish machine gun mount at Aberdeen Proving Ground, MD.

The Danish 7.62mm Machine Gun Mount is made by Dansk Industri Syndikat A/S (DISA) of Slangerup. It is being evaluated specifically for use on the Armored Forward Area Reconnaisance Vehicle, but it has application for other Army vehicles. These include the Bradley Fighting Vehicle and the High-Mobility, Multi-Purpose Wheeled Vehicle, according to Robert Bloom of the International Materiel Evaluation Program (IMEP).

The program is the Army element of the Department of Defense Foreign Weapons Evaluation Program. The U.S. Army Test and Evaluation Command (TECOM) at Aberdeen Proving Ground manages the IMEP. Bloom said that representatives of other Army agencies were invited to witness the gun mount testing to give them an idea of its capabilities and possible applications for other systems.

Although it is being tested with the U.S. M60 machine gun, the Danish mount is designed for light machine guns of all types. The mount rests in a pivot bearing, which can be installed on the roof of almost any vehicle, Bloom said.

The mount consists of two lever arms. Together, they allow the gunner to fire the machine gun in any direction and at elevations from minus 10 to plus 80 degrees. The gunner stands in the "manhole" of the vehicle's roof. Using the mount, he can rotate, raise, and lower the machine gun. As a result, he can quickly change direction and elevation of fire while standing. The mount eliminates the need for the gunner to twist, stoop or stand on his toes in order to acquire a target.

Once the pivot is installed, the mount can be placed into the pivot in seconds. Also, the weapon can be installed or removed from the mount quickly. A buffer spring reduces firing recoil.

Bloom said the Danish mount provides more flexibility than other mounts developed for use on vehicles.

APG testing has focused on reliability, endurance, human factors, tracking, and accuracy. The mount has been exposed to cold and hot temperature testing in APG environmental test chambers.

Bloom said the purpose of the APG testing is to determine if sustained firing, vibration and rough handling adversely affect the mount's performance. It was put on an M113 Armored Personnel Carrier and driven over TECOM test courses.

From the Field . . .

Belvoir R&D Center Tests New Electrolyte Battery

A new low maintenance, lead-acid battery, under test at the Army's Belvoir Research and Development Center, Fort Belvoir, VA, may be a major step in the development of a practical power system for electric vehicles. This gelled electrolyte battery differs from standard wet cell batteries because its sulfuric acid electrolyte is suspended in a gel of fumed silica and phosphoric acid. This feature eliminates the need to add water and increases the life of the battery.

"In an electric vehicle, water has to be added to conventional batteries once every one or two weeks," according to Edward J. Dowgiallo, Jr., of the Center's Engineer Service Support Laboratory. "This accounts for 90 percent of the vehicle's maintenance time. The wet cell batteries we had been working with also had a limited life of about 180 recharge cycles. We think the gelled electrolyte battery will endure 290 or more cycles and still give us the same driving range for each cycle," said Dowgiallo.

In addition to low maintenance and longer life, the new battery requires less time to recharge. "It takes 10 hours to recharge a wet cell system. On the other hand, gelled electrolyte batteries start to reach their peak already after five hours. That's within, what we call, the utility load leveling window, the time late in the evening when the requirement for electricity is lowest and vehicles can be recharged without overburdening the power distribution system," added Dowgiallo.

Evaluation of the new batteries is carried out under an agreement with the Department of Energy. So far, the Center has completed a microstructural analysis of the batteries and is currently conducting life cycle tests of a complete power system. Future plans include studying the possibility of using regenerative braking to increase the range of the battery. Results of these tests should be available next spring.

Environmental Facility Provides Critical Tests

Because communication is critical in combat, the U.S. Army strives to ensure its radios and other communications equipment are sturdy and dependable.

This is achieved by exposing the equipment to a variety of environmental conditions such as temperature and altitude extremes; solar radiation; tropical humidity; high winds; powder-like dust; structural shock and vibration; and several species of fungus.

The Army does much of this testing at the Electronic Proving Ground (EPG), Fort Huachuca, AZ. EPG's Environmental Test Facility (ETF) creates environmental conditions in the laboratory to measure their effects on equipment. These laboratory conditions simulate field conditions that the equipment can be expected to encounter.

EPG is one of the nine U.S. Army Test and Evaluation Command installations and activities in the United States and Republic of Panama where the Army tests proposed weapons and equipment. EPG concentrates on communication and electro-optical equipment testing.

In addition to climatic test capabilities, the Environmental Test Facility conducts structural tests, including shock and vibration testing, according to Abraham Mohammed, chief of the Environmental Test Facility.

Vibration data from military standard tables are fed into a computer. The computer controls the input functions to a vibrator that simulates the random vibration spectrum for a particular vehicle, such as the high frequency vibrations of a jet aircraft or a truck traveling cross country. Rough transporting is an inherent consequence of rapid deployment, Mohammed explained.

The environmental facility also exposes electronic equipment to fungus growth.

Nine climatic chambers provide the ETF with great testing flexibility, according to Henry Sylvia, an electronic technician at the environmental facility. The chambers range in size up to 10 feet by 10 feet by 16 feet. Some can expose the test item to a combination of environmental factors at the same time. One chamber can produce rapid temperature drops from 200 degrees to minus 80 degrees in 13 minutes.

Another chamber provides simulated conditions of steady rain or sunshine. It can expose the equipment to rainfall of up to nine inches per hour. The chamber produces solar radiation with a combination of sunlamps and ultraviolet lamps at a rate of from 100 to 140 watts per square foot.

One chamber produces a dry, fine sand and dust-laden atmosphere stirred by air blowing at speeds from 100 to 2,000 feet per minute.

ETF personnel use an explosion chamber to verify the capability of test equipment to operate in an explosive atmosphere, such as might exist in an aircraft, without igniting an explosion. ETF personnel introduce gasoline into the chamber to produce a 13-to-one air-to-fuel ratio, the optimum explosive mixture for the chamber, Sylvia said.

Two shock machines allow Environmental Test Facility technicians to gauge the effects on electronic equipment of being dropped from vaious heights. The machines, which resemble and operate like guillotines, have the capacity to load up to 600 pounds of test equipment and can create impacts up to 500 g's. The equipment is attached to a cross bar, elevated and dropped. By varying the height of the drop, the technicians can gauge the impact and its effect on the test item.

Other tests duplicate the effects of transportation by truck, severe shocks and immersion in water.

A test course ribbed with four-by-eight timbers is used to conduct military truck transport tests on large pieces of equipment, such as truck shelters. Two transportation simulators can be used for similar testing in the laboratory. The ETF also conducts rail transport tests at a railroad yard in Tucson, 75 miles north of Fort Huachuca.

Some testing is designed specifically for the truck shelters which house electronic and communication equipment in the field. A fording tank determines a shelter's ability to resist water penetration. A 5-ton boom hoist is used to perform shelter drop tests, usually from the height of 18 inches.

A wind and rain facility consists of a 60 horsepower fan and spraying nozzles that can be controlled to produce various rainfall quantities. The facility can simulate rain in excess of 20 inches per hour with winds from 10 to 60 miles per hour.

The microbiology laboratory occupies a germ-free section of the ETF. Microbiologist Emelda Colanto prepares her own fungus cultures and she has grown fungus on test items ranging from radios to truck shelters.

Equipment is placed in a warm, humid chamber and innoculated with five different fungus spore cultures. The susceptibility of the equipment is determined after 28 days.

Some general effects from the micro-organisms are digestion of the organic materials, etching of glass and metals by enzymes and acids produced during fungus growth, and the physical presence of micro-organisms that produce living bridges across electrical components.

The environmental extremes produced at the Electronic Proving Ground may never be imposed on the Army's communications and electronic equipment in combat. Should they be needed in battle, however, the Environmental Test Facility strives to insure that these systems will not fail due to weather conditions or rough handling.

New Concept May Ease Ammunition Handling Tasks

A concept that may substantially ease the battlefield labor associated with ammunition handling has been under evaluation at the U.S. Army Human Engineering Laboratory (HEL), Aberdeen, Proving Ground, MD.

Identified as the unit configured load, the concept is being examined in a series of tests known as the HEL Forward Area Supply and Transfer II (HELFAST). Basically, a truck is packed with ammunition according to the needs of a company-sized fighting unit.

Standard ammunition supply points in-theater normally require company trucks to wander through acres of ammunition, sometimes accompanied by a fork lift. Stops are then made at the stacks to get a load of ammunition. Each truck carries one, or at most, two types of ammunition of the six or so types being issued.

Under the concept of a unit configured load, material handlers pre-position pallets of ammunition for a company sized unit inside the ammunition supply point, ready for a company truck to pick up and take back to the fighting unit at the front, enabling the truck to have a faster turn-around time.

"This concept makes the supply point a one-stop shopping center," said John D. Waugh, HELFAST team leader. This is a first attempt to conduct ammunition supply operations in a unit configured load mode of operations, said Waugh.

"We're moving a labor-intensive task from the forward area back to the combat support area," said LTC Donald A. Nemetz, the research and development coordinator for the Combat Service Support Directorate, which includes the HELFAST team.

The unit configured load concept would save the time that it would take for battalion trucks, each loaded with a single type of ammunition, to go to each company in that battalion, dropping off ammunition at each one. The concept would also save time in the alternate delivery method, which is the reconfiguration of truck loads of mixed ammunition at battalion level prior to delivery to the company.

Handling ammunition in unit configured loads is a component of an advanced concept for the future involving the use of robots to repackage ammunition in-theater for issue forward to the battlefield.

"This is one of the first steps in the Battlefield Robotic Ammunition Supply System concept, in doing business faster and more efficiently," Waugh said. He adds that the concept of unit configured loads originated at HEL, and the U.S. Army Missile and Munitions Center and School at Redstone Arsenal, Huntsville, AL, quickly endorsed the idea.

SFC Matthew D. Frazier brought 12 graduates of the Ammunition Handling Course at the Missile and Munitions Center and School to HEL this past summer to participate in the evaluation. They spent six weeks moving boxes of ammunition, manually and using forklifts; creating mixed pallets of ammunition according to the needs of the fighting unit; and loading trucks with them as though they were leaving an ammunition supply point to go forward. Each activity was controlled and timed to check the efficiency of the operation.

For the purpose of the evaluation, the soldiers made up a unit configured load representative of one that would go to a tank company. The load consisted of six pallets: three of Armor Piercing Fin Stabilized Discarding Sabot; two of High Explosive Antitank ammunition; and one pallet of mixed ammunition, with 32 small arms boxes of four ammunition types on one pallet.

The boxes were loaded with sand and steel shavings to approximate the weight of boxes of live ammunition.

"In order to get accurate data, we wanted dummy ammunition loads that would look like, handle like, and have the same center of gravity as the real thing," said LTC Nemetz.

The boxes, resembling small arms ammunition, weighed approximately 70 pounds. By the time a team of two or three soldiers had assembled three pallets of 32 boxes each for a specific trial, they had manually lifted, transferred, and reconfigured 6,720 pounds. Most days, the HELFAST team was able to schedule six trials, for 40,320 pounds, a whopping 20 short tons manually handled by a two or three member team per day. Despite the intense heat, high humidity and potentially hazardous environment, no serious injuries occurred.

Three major mixed pallet assembly techniques were tested during this HELFAST II test. One involved having a forklift transfer pallets of small arms ammunition from stacks to a central point where the soldiers broke down the pallets and reassembled them in the required mix for inclusion in the unit configured loads.

A second technique required the soldiers to retrieve ammunition boxes from stacks normally separated by approximately 75 feet (for safety reasons) by walking that distance to get the necessary ammunition and then walking back to the point where a pallet was being assembled. This technique assumes a scenario where no forklift is available.

The third involved a forklift, starting with an empty pallet, moving from one ammunition stack to another, where soldiers would load the required ammunition onto the pallet.

Teams of two and three soldiers were used, plus a forklift operator in the trials where a forklift was used. Teams tried each technique a total of nine times, with a third of the testing conducted at night to see what impact assembling ammunition in the dark had on the three techniques.

SFC Frazier reports that the soldiers under his command became more proficient over the six weeks of HELFAST testing. The course for ammunition handling at Redstone lasts just over five weeks, he said. In that time, soldiers must learn ammunition sizes and markings and about handling and storage.

During one trial in HELFAST II testing, he said, three company trucks arrived and were all on their way with their unit configured loads in a significantly reduced amount of time. Advantages of the unit configured load concept, he said, are the elimination of truck traffic in the ammunition supply point and the time saved. The trucks tear up the ground in a supply point, he noted, creating additional logistics problems.

Another advantage is that a unit configured load could be changed to a different ammunition mix if the nature of the battle changed.

Capsules . . .

ETDL Plans 38th Frequency Control Symposium

The 38th Annual Frequency Control Symposium, cosponsored by the U.S. Army Electronics Technology and Devices Laboratory and the Institute of Electrical and Electronics Engineers, Inc., will be held from 30 May through 1 June 1984 in Philadelphia, PA.

This unclassified symposium, which has served as the leading international conference on all aspects of frequency control and precision timekeeping, will feature technical papers dealing with topics such as fundamental properties of piezoelectric crystals, theory and design of piezoelectric resonators, filters, and surface acoustic wave devices. Symposium general chairman is Dr. J. R. Vig, U.S. Army Electronics R&D Command.

Dr. Sculley Presents Army Laboratory Awards

Outstanding scientific, technical and managerial achievements by Army laboratories were recognized recently during presentations of the 1983 Department of the Army awards for Best Laboratory, Most Improved Laboratory, and for Excellence.

Nominations for the Best Laboratory and the Most Improved Laboratory were evaluated by a special awards committee and forwarded for final selection to Assistant Secretary of the Army for Research, Development and Acquisition Dr. Jay R. Sculley.

The U.S. Army Electronics R&D Command's Electronics Technology and Devices Laboratory (ETDL), Fort Monmouth, NJ, was chosen as Best Laboratory, based on technical accomplishments in areas such as surveillance and targeting acquisition, communications, air defense, and munitions. Other achievements were in program responsiveness and managerial initiatives.

Dr. Clarence G. Thornton, Jr., director of the Electronics Technology and Devices Laboratory accepted the award from Dr. Sculley during ceremonies at Fort Monmouth. ETDL, which is the lead Army laboratory for the Department of Defense Very High Speed Integrated Circuits Program, won the same honor in 1980.

The U.S. Army Natick R&D Laboratories, Natick, MA, earned top honors as Most Improved Laboratory. Selection of Natick was based on outstanding work in microclimate conditioning of combat uniforms and significant progress in R&D laser/ballistic eye protection, new camouflage clothing and chemical protective overgarments.

During Natick ceremonies, at which Dr. Sculley presented the award, it was noted that Natick had revamped its overall management objectives, reorganized its internal structure, and updated mission responsibilities, all of which contributed to dramatic advances by dedicated employees.

Army laboratories which received 1983 awards for Excellence were the U.S. Army Missile Command; Walter Reed Army Institute of Research; the U.S. Army Night Vision and Electro-Optics Laboratory; the U.S. Army Engineer Waterways Experiment Station; and the U.S. Army Ballastic Research Laboratory.

COL Brisker Terms Smoke Week VI 'Huge Success'

COL Morton S. Brisker, project manager for Smoke/Obscurants, has announced successful completion of Smoke Week VI, held from 9–20 January 1984 at Camp Grayling, MI. The objective was to address the interaction among electro-optical systems, smoke/obscurants, and the natural cold and snow environment. More than 51 trials of various standard, developmental and foreign smokes were conducted.

Managed by the Countermeasures and Test Division of the Office of the PM Smoke/Obscurants, Smoke Week VI was held concurrently with the Scenario Normalized Operations in Winter field experiment which is being conducted by the Corps of Engineers Cold Regions Research and Engineering Laboratory.

Smoke Week VI was a cooperative effort between the U.S. Army Materiel Development and Readiness Command and other Department of the Army and DOD organizations concerned with conditions of the realistic battlefield. Cost sharing/multi-organization participation is considered a key ingredient in these field tests, which were initiated in 1977 and have resulted in improvements in major systems such as TOW 2 and Copperhead.

U.S. Army, Navy, Air Force, contractor, and foreign government agencies participated in these exercises, which COL Brisker termed a "huge success." His sentiments were echoed by the 40 DOD officials and contractors who took part in a 1-day tour of test facilities and observed actual smoke trials.

The Office of the PM Smoke/Obscurants will assess the large volume of data from Smoke Week VI and issue a final report early this summer.

CERL Employees Receive Patents for New Devices

Improved techniques for predicting potential dam breaks and monitoring the quality of welds during construction activities may soon become available using devices developed by researchers at the U.S. Army Construction Engineering Research Laboratory (CERL) Champaign, IL.

Letters of patents were recently awarded to Ray McCormack and Frank Kearney, employees in CERL's Engineering and Materials Division. McCormack received his patent for a distance measuring system intended for use in measuring minute shifts in dams to provide advance warning of potential dam breaks. The system consists of a modulated light source which transmits a light through optical fibers to a detection device. The optical fibers limit the likelihood of the light beam from being diffracted by fog or temperature changes—a problem with current light based measuring systems.

Kearney received a patent on his Opto-Electronic Speed Sensor System. The system monitors the speed of the manual welding process and is part of CERL's real-time weld quality control system. CERL's weld quality control system is a computer-based approach for identifying the strength of a weld as it's being placed during construction activities.

Battelle Forecasts $94 Billion For 1984 U.S. R&D Expenditures

Expenditures in calendar year 1984 for research and development in the United States are expected to reach $94.2 billion, according to the annual forecast of Battelle Memorial Institute's Columbus Division. This represents an increase of $7.7 billion (8.9 percent) over the $86.5 billion that the National Science Foundation estimates was to be actually spent for R&D in 1983.

While much of the increase will be absorbed by continued inflation (estimated at 5.0 percent for R&D in 1984), Battelle forecasts a real increase in R&D expenditures of 3.7 percent. This is slightly higher than the 10-year average rate of 3.3 percent in real R&D effort that has been experienced since 1973.

Industrial funding for R&D, projected to increase more significantly than government support, will account for 51.8 percent of the total R&D funding. Industrial support is forecast to be $48.8 billion, up 10.3 percent from 1983.

Battelle sees an increase of 7.8 percent in Federal support for R&D, with funding expected to be $42.7 billion. This is 45.3 percent of the total R&D expenditures for 1984.

Funding by academic institutions in 1984 is expected to be $1.7 billion (1.8 percent of the total), and other nonprofit organizations will provide slightly less than $1 billion (1.1 percent).

The report notes that during the past decade industrial support of R&D has increased at an average compounded rate of 5.2 percent per year, while Federal support has increased at 2.9 percent on average. The trend toward increased industrial support has especially been developing in recent years, since until 1979 government supported more R&D than did industry.

Industry will remain as the dominant performer of R&D, according to the Battelle report. In 1984, performance of R&D by industry is expected to rise to $70.8 billion, or 75.2 percent of all research performed.

This compares with $10.3 billion (10.9 percent) for the Federal Government, $10.5 billion (11.1 percent) for academic institutions, and $2.6 billion (2.8 percent) for other nonprofit organizations.

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

Four government agencies dominate Federal R&D and are expected to account for 90.9 percent of total Federal R&D funding in 1984, compared to 89.8 percent of funding in 1983. The makeup of this funding, however, will change significantly in 1984. Comparisons between the 1984 and 1983 projections include:

	1984 Estimated Percent of Federal Funds	1983 Estimated Percent of Federal Funds
DoD	64.5	58.9
NASA	7.0	8.2
DOE	9.9	11.7
HHS	9.5	11.0

The forecast notes that increases in defense spending primarily are directed toward the acquisition of major weapons systems and the R&D that will be necessary to support them.

Continued success of the space shuttle program and the potential use of the shuttle as an instrument for more economical insertion and repair of satellites is seen as justifying continued support of the program for both civilian and defense purposes. However, a decline will result in NASA R&D funds from the transferring of much of the space shuttle support from research to operational programs and a redefinition of NASA expenditures.

R&D will be heavily self-funded in the manufacturing industries, where on the average, less than 32 percent of the total will be supported by the Federal Government. The non-manufacturing industries do relatively little R&D, yet 43 percent of the support for this activity will be provided by the Federal Government.

As part of the forecast, Battelle estimated the industrial versus Federal support for R&D performed by several broad industrial sectors. In 1984, Battelle expects the aerospace industry to regain leadership in total R&D, with funding of more than $15.8 billion. Of that, 72.9 percent will be industrially funded.

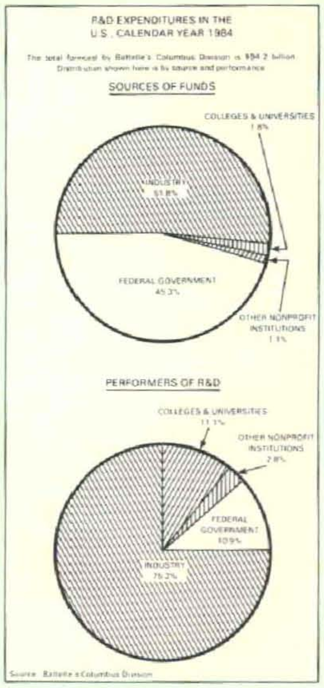
Last year's leader, the electrical machinery and communications industry, is forecast to have the second largest total R&D support with $14.5 billion. Of that, 39.3 percent will be industrially funded.

Other industrial sectors Battelle estimates will receive more than $1 billion in R&D funds include:

Machinery ($9.1), autos, trucks and parts, and other transportation equipment ($6.2), chemicals ($8.2), professional and scientific instruments ($5.8), petroleum products ($2.9), and food and beverage products ($1.0).

The Battelle forecast indicates that industry is taking over short-term R&D projects and is reacting to the growing pressure from foreign technological competition.

Much of the significant increases in industrial support is linked to three factors.



First, the general economic climate appears to be improving and industry is responding to new opportunities foreseen in both the short and long-term. "As greater emphasis is being placed on industrial productivity, revitalization, the growth of the 'information society,' and the expansion of the consumer and industrial markets, it is anticipated that sales and profits—both early indicators of R&D fund availability—will be increasing in the near term," the report concludes.

Second, there has been a relaxation of selected real and perceived barriers to cooperative research programs, creating multi-company supported R&D programs at universities and nonprofit organizations, as well as dedicated research centers supported by groups of companies. Finally, the report says that R&D tax incentives enacted in 1981 may be starting to impact industrial support for R&D.

The Batelle forecast also compares the four performing sectors in terms of their relative costs of R&D.

During 1984, the overall cost increase for all R&D is estimated to be 5.0 percent. By sectors, the increases are estimated as government, 5.3 percent; industry, 5.3 percent; colleges and universities, 3.7 percent; and other nonprofits, 2.7 percent.

The preceding forecast was prepared by Dr. Jules J. Duga, with assistance from Dr. W. Halder Fisher. Both are with the Department of Applied and Technical Economics at Battelle's Columbus Division. Parts of the data were drawn from many sources, including the National Science Foundation reports, the McGraw-Hill Annual Survey of Business Plans for R&D Expenditures, and other similar sources.

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