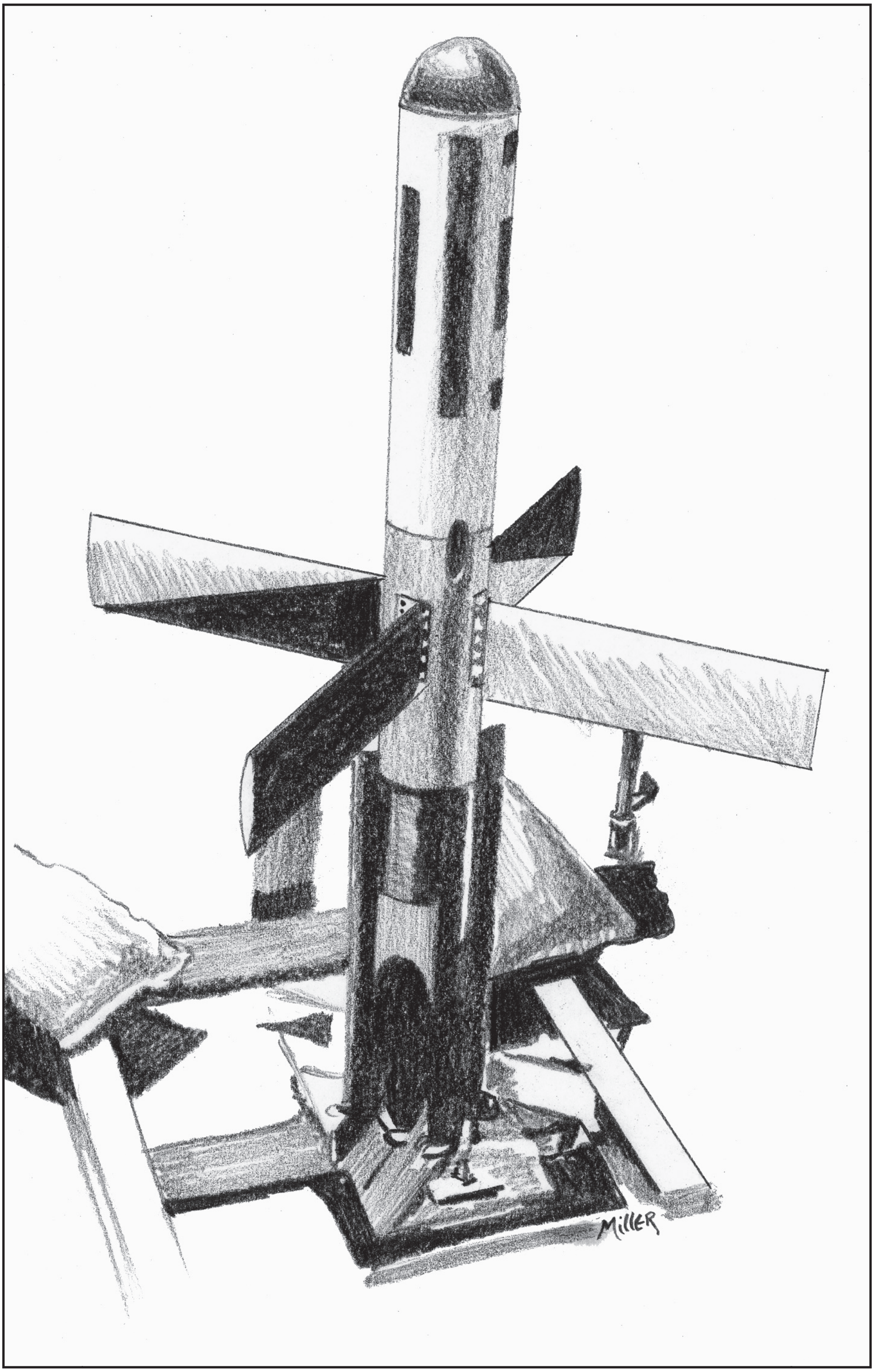

Illustration provided by TSgt Scott A. Miller, USAF

LESSONS LEARNED FROM THE DEVELOPMENT OF THE FIBER OPTIC GUIDED MISSILE (FOG-M)

J. Daniel Sherman

This study examines the development of the Fiber Optic Guided Missile (FOG-M), and explores the role of the *product champion* during development. FOG-M illustrates the types of problems encountered in defense contracting when contracts lack sufficient controls or incentives, which include problems associated with strategic alliances between two defense contractors. This investigation also illustrates how inter-organizational design can be modified so that the role of a laboratory organization can be more effectively integrated with the defense contractor. Finally, the research results demonstrate how the history of FOG-M may have been radically different if the policies and principles of *DoD 5000* had been enacted earlier and an evolutionary acquisition strategy been employed.

During the early 1970s a young physicist, William McCorkle, with the Army Missile Cmmand's Research, Development, and Engineering Center (RDEC) developed a radically innovative concept for a new anti-tank weapon. McCorkle, who was already an accomplished physicist, had been experimenting with new technologies associated with remote piloted vehicles. These pilotless drone aircraft, which were equipped with miniature television cameras and transmitters, could be used for reconnaissance and other military applications. McCorkle believed that systems could be developed which were equipped with warheads that could be used as anti-tank weapons. He called his concept the Fiber Optic Guided Missile, or FOG-M, because of its utilization of emerging fiber optic technology for guidance and control.

McCorkle seemed to possess all the traits of a classic *product champion*. He was technically brilliant, persistent, unafraid of setbacks or temporary failures, and exhibited a level of dedication and focus that is necessary for any radical innovation to succeed given the many obstacles that inevitably must be overcome. His initial work on this concept not only included creatively managing his time at work in the RDEC laboratory, but countless hours in his workshop at home. By the late 1970s he began his quest to obtain the necessary support from the Army and Congress for the development of this radical new weapon system.

A WEAPON SYSTEM WITH UNIQUE CAPABILITIES

The missile that McCorkle envisioned would be designed to engage tanks, other armored vehicles, high-value ground targets (such as command and control centers), and possibly helicopters beyond the line of sight of the operator. The range was unknown at the time of concept inception, but he hoped to achieve a range between 10 and 20 kilometers. This range would be well beyond the maximum range of tank main guns or direct fire anti-tank missiles. The system would consist of a gunner's station with between 6 and 16 missiles mounted on a Multi-Utility Tactical Truck (MUTT). The missiles would be launched toward a target area based on forward intelligence information. After missile launch, the operator would be able to intervene at any time to lock on and engage detected targets. The operator would view the flight path and the target via a small TV camera equipped with a zoom lens mounted in the nose of the missile. Data would be transmitted to the operator's console by fiber optic cable that would unspool from the missile itself. Simultaneously, guidance commands would be transmitted to the missile on the same optical fiber from the ground computer located in the gunner station. After being vertically launched, the missile would cruise at low altitude below cloud ceilings.

Most of the costly hardware needed for guidance and image processing was designed for the ground station rather than the missile itself.

This missile had a number of potential advantages. Most of the costly hardware needed for guidance and image processing was designed for the ground station rather than the missile itself. The FOG-M could be operated from a concealed position, protecting the operators from direct fire. Because it had non-line-of-sight capability, the operators could locate and destroy targets behind hills and other barriers that other missiles or artillery could not detect and destroy. This was perhaps the most critical unique capability of the system.

There were other potential advantages. Because the guidance data was transmitted through the fiber optic wire, enemy electronic countermeasures would be ineffective. Furthermore, the issue of available space on the radio frequency spectrum would never be problematic since the FOG-M had its own self-contained propagation medium. The

FOG-M's lethality was enhanced by the fact that it would not attack the frontal armor of a tank. Rather, it would be launched vertically, flatten out to a level flight path, and then dive at a steep angle toward the top of the tank, where the armor is weakest. In addition, because of FOG-M's ability to recognize targets, the probability of fratricide would be significantly reduced. Finally, this recognition ability also allowed for the simultaneous capability to perform reconnaissance.

THE PRODUCT CHAMPION ENCOUNTERS RESISTANCE

In his classic study of product champions, Donald Schon of the Massachusetts Institute of Technology cites numerous examples of successful radical innovations where the product champion encounters continuous, and often relentless, resistance to a concept (Schon, 1963). There are many reasons for resistance to radical new ideas and William McCorkle found this to be true with FOG-M. He first sought the support of the U.S. Army Armor center at Fort Knox, KY. He was met with a general lack of support, however, and discovered that the Armor Center was committed to allocating research and development funds to acquiring a more lethal tank cannon, and any other efforts would be seen as diverting resources from that priority.

Next, McCorkle attempted to solicit the support of the U.S. Army Field Artillery School at Fort Sill, OK. The School, however, saw FOG-M as a weapon that was somewhat foreign to traditional artillery. To make matters worse, the artillerists thought FOG-M should be an anti-aircraft weapon, while air defenders thought it should be an anti-armor weapon, and the Infantry believed FOG-M should belong in the Artillery. This was a weapon with tremendous tactical potential, but it did not fit neatly into one of the Army branches. The result was that it was believed to have potential, but could not get the full support of any single Army branch (William McCorkle, personal communication, May 21, 2001).

THE PRODUCT CHAMPION OBTAINS EXECUTIVE SPONSORSHIP

In Schon's research on new product development, he found that invariably, in large scale product development efforts, if the product champion was not able to obtain a high level executive sponsorship, the product died. In 1982, FOG-M's fate was influenced in a very positive way. That year, James Ambrose, Undersecretary of the Army, became convinced that FOG-M had significant potential as an anti-tank weapon. During this same time, Congressman Anthony Battista, the senior member on the House Armed Services Committee's research and development subcommittee, also realized the weapon's potential. This high-level sponsorship was instrumental in securing the necessary funds to begin serious development in the RDEC laboratories.

Dr. Paul Jacobs of the Guidance and Control Directorate assumed the role of program manager and worked closely with McCorkle on the development effort. Jacobs created what can only be described as a classic *skunkworks* in the laboratory. He put together a team that consisted of individuals from all of the RDEC labs in order to develop a FOG-M prototype. With no prime contractor, but numerous contractors with limited tasks collocated with RDEC engineers in the lab, and minimal administrative overhead and control, work progressed at an accelerated pace. In 1982 alone, the team completed the detailed investigations and systems analysis required to define the FOG-M concept that would be developed and tested in the following two years (Paul Jacobs, personal communication, May 7, 2001).

THE LABORATORY ACHIEVES A HUGE SUCCESS

With increased funding support, by 1983 the FOG-M program achieved the status of a 6.3A Technology Demonstration Program. To make the skunkworks operate with maximum efficiency and flexibility in terms of personnel assignments, Jacobs employed a matrix structure. Various individuals were assigned responsibility for specific components with flexible staffing arrangements, whereby proportions of individuals' time were assigned from the various laboratory directorates. Jacobs informally acquired support from administrative personnel within RDEC directorates such as Guidance and Control, Structures, Software Engineering, Systems Simulation, and Propulsion.

By mid-1985, multiple man-in-the-loop flight tests had been conducted. These tests demonstrated automatic fire control and launch, vertical launch from a canister, automatic cruise at low altitude, control by the operator to maneuver the missile trajectory manually during the cruise mode, operator detection of the target, lock-on and terminal engagement of a moving tank target, and the utility of the digital multimode target tracker. Then on June 1, 1985, the FOG-M prototype achieved its first successful hit on a moving target. In an incredibly brief 2-year period, the skunkworks operation of the RDEC labs had achieved a stunning success. The extraordinarily effective process of systems development at this point in the history of FOG-M, under the leadership of William McCorkle and Paul Jacobs, read like a chapter out of Peters' and Waterman's best seller, *In Search of Excellence*.

THE NON-LINE OF SIGHT PROJECT OFFICE IS CREATED

An unexpected event occurred in 1985 that had important implications for FOG-M. Defense Secretary Casper Weinberger made the decision to cancel the Army Air Defense Center's Division Air Defense (DIVAD) anti-helicopter gun system, also known as the Sgt. York. The program had been over budget, behind schedule, and had experienced performance problems. This created an opportunity for FOG-M, not as an anti-tank weapon, but as an anti-helicopter weapon.

As a result of the successful prototype testing, FOG-M was repositioned from being an anti-tank weapon to being an anti-helicopter weapon, and the decision was made to accelerate FOG-M development and to conduct the Initial Operational Evaluation. In December 1986, the Under Secretary of the Army for Acquisition designated FOG-M as the Non-Line-of-Sight (NLOS) system for Forward Area Air Defense.

The full scale development contract was awarded to Boeing and Hughes in December 1988. On paper, Boeing and Hughes were to split the work equally. Boeing was responsible for the ground equipment and Hughes was responsible for the missile. The Boeing Hughes bid was $131 million and this low-cost bid resulted in the contract award. However, a project office Cost and Operational Effectiveness Analysis (COEA) conducted that same year estimated over double the cost for the full scale development phase. This would represent the seeds of trouble to come.

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While Hughes made more effective use of the RDEC data, Boeing preferred to take an approach whereby they would, in the estimation of Jerry Dooley (Deputy Project Manager, NLOS project office) and William McCorkle, invent their own version of FOG-M. Hughes' engineers were noticeably upset with Boeing's approach. Jacobs hypothesized that this was not only motivated by patent advantages, but was also a case of the NIH, or "Not Invented Here," syndrome. Boeing's view of the situation, however, was different. Robert Foss, Boeing Marketing Manager for Tactical Missiles, observed that the Boeing team felt they were taking an appropriate approach and that Hughes was being uncooperative by attempting to position their company advantageously for the forthcoming production contract (personal communication, July 23, 2001). Jim Daniel, Boeing FOG-M chief engineer, maintained that the military specifications imposed by the NLOS project office were excessive and required the significant design changes (personal communication, July 24, 2001). In any case, the failure to take full advantage of the development accomplished by engineers in the RDEC labs was also a seed of serious trouble soon to come.

By the end of 1989, Boeing's progress on the ground equipment was beginning to slip seriously behind schedule. In 1990, the full-scale development contract experienced significant cost overruns. These overruns were attributed largely to Boeing and Hughes unrealistically low bid for the full-scale development contract. At this point, cost containment measures were formulated by the NLOS project office in conjunction with the contractors. Thus, by September 1990, an In-Process Review approved the restructured $630.8 million baseline for the NLOS program. In addition, by the end of 1990, the Initial Operational Evaluation (IOE) and the Extended User Evaluation (EUE) testing programs produced a 58 percent success rate with the IOE-type missiles. In operational testing, military personnel engaged moving and hovering helicopters and moving and stationary tanks that were out of the line of sight of the firing unit. These tests extended to distances of 10 kilometers.

THE BOEING HUGHES CONTRACT IS CANCELLED

Despite the IOE success and the significant progress that had been made, by late 1990 the cost overrun issue was receiving high-level Pentagon attention. A disastrous turn of events for the program occurred in January 1991, when Army Acquisition Executive Stephen Conver made the decision to terminate the Boeing Hughes contract. During this time period, the Department of Defense (DoD) had been under increasing pressure from Congress and the public to reduce cost overruns in weapons acquisition. Mike Kelly, a former Hughes engineering manager, hypothesized that Conver wanted to make an example (personal communication, May 29, 2001). The perspective of the NLOS project office was similar. Jerry Dooley observed, "It turned out that FOG-M was sitting in the wrong place at the wrong time, because he was looking for an example, and there we were, with our estimates showing us way over [budget]" (personal communication, May 3, 2001). Conver explicitly stated that the reason for the cancellation was excessive cost growth. However, Dooley, McCorkle, and Jacobs posited that this was actually a secondary reason. The primary reason may have been the prioritization of other systems over FOG-M. In any case, whether or not this decision was optimal has been the subject of some controversy.

LESSON 1: A FLAW IN THE ACQUISITION STRATEGY CAN HAVE SERIOUS CONSEQUENCES

The acquisition strategy of the NLOS project office was very similar to that of many other systems in development during the late 1980s. The full scale development effort was a cost plus incentive fee contract awarded to the Boeing Hughes team. The contract was to extend for 43 months. The design to unit cost provisions carried an award fee based on an evaluation that was to be conducted after limited production buy 1 (LP1). This would be followed later by a second evaluation of LP2 and LP3. The limited production buys would be sole source contracts to the full scale development team. Both of the contractor team members would be required to produce the system under a firm fixed price follow-on limited production contract. Furthermore, both team members would be required to be qualified for full scale production (FSP) prior to any FSP award. Following the completion of full scale development, the two team members (Boeing and Hughes) would then compete for the full scale production contract. This contract was to be a firm fixed price contract.

A cost plus incentive fee contract can work well in a number of contexts. However, in the case of FOG-M, the incentives were problematic. First, the incentive in the contract was not significant compared to the income that could be generated by the systems development. Jacobs observed that the main reason Boeing was not making full use of the engineering development that had been completed in the lab was because the incentives were inadvertently structured otherwise. There was insufficient incentive to fully utilize the technology developed by RDEC engineers. The financial incentives favored, in essence, reinventing FOG-M. Furthermore, cost overruns had become common in many large defense contracts in the late 1980s, and neither Boeing management nor the NLOS project office may have believed that the government would actually cancel the contract (Thomas Jarrell, Boeing Deputy Project Manager, personal communication, July 24, 2001).

A fundamental error occurred during the Boeing Hughes selection process. The Boeing Hughes team bid $131 million for the full scale development contract. Their strategy was, ostensibly, to come in low with the full understanding that some cost overrun would be inevitable later. The NLOS project office had conducted its own cost estimates including detailed risk analyses. Their own estimates were well over double the Boeing Hughes bid, in the range of $343 million. What appeared to be the rational decision at the time was made. The contract was awarded to the low cost bidder. Unfortunately, this decision had serious implications later. By signing the contract at $131 million, cost overruns were inevitable. In a high-visibility program like NLOS, the magnitude of the overruns which began to materialize two years into the full-scale development program were simply too large to avoid the scrutiny of Congress, the Government Accountability Office (GAO), and high-level Pentagon officials. The resulting cancellation was a devastating setback to the program.

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Jacobs observed that another potential issue with the acquisition strategy was the fact that Boeing and Hughes were teamed for the full-scale engineering development phase. However, at the conclusion of this phase they were to compete for the production contract. This arrangement would not create conditions conducive to full cooperation and collaborative sharing of technical knowledge. Rather, there would be a significant incentive to be cautious regarding the sharing of any unessential information in order to create an advantage for the forthcoming production competition. From Jacobs' vantage point, the level of cooperation between Boeing and Hughes was weak during the full scale development. Both Ken Matkovich from Hughes and Bob Foss from Boeing agreed that cooperation was less than ideal (Kenneth Matkovich, personal communication, July 2, 2001).

LESSON 2: INTEGRATION AND CONTROL COULD HAVE BEEN IMPROVED THROUGH MODES OF ORGANIZATIONAL DESIGN

It has been established that the integration of the engineering development completed in the RDEC labs and the work of the contractors was less than optimal. As noted previously, the contract itself did not facilitate integration between the contractors and the lab. The effort on the part of the NLOS project office to initiate the Technology Risk Reduction program and the creation of the Technology Transfer Steering Committee were very useful devices. However, even though they were necessary, they were not sufficient to achieve the required level of integration or technology transfer from the lab to the contractors. A more profound organizational design solution was needed.

In the research literature on organizational design, this type of problem is commonly addressed with the creation of cross-organizational teams. These teams exist under many different labels, such as design-build teams, platform teams, integrated product development teams, etc. In the case of FOG-M, the full-scale development contract itself would have needed to specify in detail the structure of these teams which would consist of contractor engineers, RDEC laboratory engineers who participated in the early development, and project office personnel. The RDEC laboratory personnel would not perform management functions, but would either be collocated with contractor personnel to perform the actual technical work or be allocated specific tasks. Detailed specification of how funding would be allocated among the various participants would be a necessary part of the contract. This approach has worked effectively in other programs, such as the Advanced Amphibious Assault Vehicle. What cannot be overemphasized, however, is that the financial model articulated in the contract must *promote* collaboration rather than create a profit incentive to not collaborate.

However, it is important to note, as Jim Daniel observed, that the performance of such teams is always a function of the quality of the participants in terms of their technical skills and their willingness to cooperate.

The concept of integrated product development teams (IPTs) emerged in the 1990s. Jim Daniel, Boeing's chief engineer on FOG-M, believed that in the 1988-90 timeframe the coordination between Boeing and the government could have benefited significantly from such teams. In the subsequent work on the Enhanced Fiber Optic Guided Missile (EFOG-M), between 1994 and 1999, with Raytheon as the prime contractor, IPTs were utilized. This was actually one of the first major Army contracts in which IPTs were employed. In this application, teams were created that consisted of both government and contractor personnel. For the fire unit platoon leader's vehicle, for example, there were teams for the equipment bay, the vehicle launcher, the cab equipment, and the system software. For the missile, there were teams for the seeker section, propulsion, the warhead section, the missile airframe and canister, the aft section, and the data link. For systems engineering, integration and testing, there were teams for system design, system simulation, system integration/test, and command, control, communications, computers, intelligence, surveillance, and reconnaissance (C4ISR), (J. P. Ballenger, Raytheon Missile Systems, personal communication, May 29, 2001). Had such a concept been implemented during the Boeing Hughes contract, technology transfer between the lab and the contractors would have been greater. However, it is important to note, as Jim Daniel observed, that the performance of such teams is always a function of the quality of the participants in terms of their technical skills and their willingness to cooperate. Hence, the optimal form of organizational design is only a necessary, but not sufficient, condition for high levels of cross-organizational integration.

LESSON 3: THE CENTRAL PROBLEM IN FOG-M DEVELOPMENT WAS UNSUSTAINED USER SUPPORT DUE TO SUBOPTIMIZATION, RESULTING IN FUNDING DIFFICULTIES

From the very beginning FOG-M encountered problems with user support. This was troubling to William McCorkle, the project managers, and the deputy project managers, both government and contractor. This was a weapon that by all indications could have effectively served the Infantry, Artillery, or Air Defense. This was due to an uncommon degree of versatility in potential military applications. McCorkle hypothesized, however, that the Infantry had a very traditional viewpoint, thinking in terms of direct contact with the enemy within a range of roughly 4 kilometers. FOG-M was to be deployed at greater distances and destroy enemy targets remotely. Thus, while the system could have been potentially very useful to the Infantry, their military tradition or culture may have caused them to view FOG-M as something foreign to their mission.

In a similar way, the Artillery viewed FOG-M as a weapon that would be deployed in ways that did not fit with their traditional mission. Furthermore, they had prioritized other systems and were committed to those development and production programs. Consequently, the artillery viewed FOG-M as a weapon that belonged in Air Defense. In the late 1980s, following the cancellation of the DIVAD program, Air Defense did give a high level of support to the FOG-M program. However, this support was limited to a period of time in the late 1980s and early 1990s. With the cancellation of the full-scale development contract with Boeing and Hughes, a multiyear window of opportunity was lost.

One reason FOG-M had difficulty attracting support from one of the Army branches was that it is not a basic upgrade or replacement for an existing system that was becoming obsolete. Therefore, it had no established constituency. One might conclude that a major contributing factor to the support problem was that the Army occasionally suffers from an organizational structure deficiency sometimes referred to as *stovepipes*. Here the stovepipes are the Infantry, Armor, Air Defense, Field Artillery, and so on. The FOG-M was a radical new innovation that simply did not fit neatly into one of those stovepipes. However, this weapon had such potential lethality and versatility that in the wider sphere of battle planning it could have tremendous utility. Thus, it appears that this is an example of what management literature refers to as suboptimization. Each branch is individually maximizing based on their decision criteria, but the combined outcome is suboptimal. Under *DoD 5000* this problem has been addressed through the strategic planning process, which focuses on the identification of capabilities (particularly joint capabilities integration) in response to threats. This development represents a significant improvement in DoD acquisition planning.

It should also be noted that since FOG-M was competing against other systems for resources, it may have been beneficial earlier in the program to utilize cost effectiveness data more extensively to make the case for FOG-M development funding. Such analyses would be subject to greater error at early stages because the data would be incomplete. However, while the cost per missile was expensive, the accuracy in testing was so high that the number of missiles utilized in combat, when compared to other weapons, would be predictably low. Thus, overall cost effectiveness was a major potential benefit of FOG-M. The absence of data, however, made it more difficult to convince decision makers of the merits of this system based on cost and operational effectiveness criteria.

A joint venture or strategic partnership with one or more of our allies would have increased both the potential base of financial resources and the political support for the system.

During the 1990s, several U.S. allies developed and fielded systems based on the FOG-M concept, including Japan, Israel, Sweden, and a combined French/German/Italian program. This in and of itself is evidence of the system's viability. It also suggested another avenue by which FOG-M may have acquired resource and political support during the 1980s and early 1990s. A joint venture or strategic partnership with one or more of our allies would have increased both the potential base of financial resources and the political support for the system. Examples of where this strategy worked very well were the development of the Multiple Launch Rocket System during the early 1980s with Great Britain, West Germany, and France, and the Patriot PAC-2 with the Germans just prior to the Gulf War. Given the ostensible international interest in a missile system with FOG-M's capabilities, a well timed strategic partnership may have succeeded in providing the necessary resources to accelerate development.

LESSON 4: CHANGING REQUIREMENTS HAS ADVERSE CONSEQUENCES FOR THE DEVELOPMENT SCHEDULE AND COSTS

By the mid 1980s, the work in the RDEC labs had been so successful that FOG-M was well on its way toward the completion of engineering development. However, a combination of factors in the years following, with the creation of the NLOS project office, the cancellation of the contract, and the subsequent restart of the program, resulted in escalating costs and schedule delays. Decisions were implemented to give the system both TV and imaging infrared seekers, changing the propulsion system from a solid propellant rocket to a variable speed mini-turbine engine, increasing the range requirements to 20 kilometers, increasing the weight of the warhead which changed the specifications for the missile, developing two versions (light and heavy) for the HMMWV and the M993 tracked vehicle, developing the capability of guiding two missiles simultaneously, and approving the later combined arms version that would be capable of destroying both tanks and rotary wing aircraft. The combined effects of these and other requirements changes had very real consequences for costs and schedule. When the RDEC lab prototype was completed, the technology maturity level was comparatively high on most components. However, with the increased requirements specified in the NLOS Required Operational Capabilities document, the technology readiness level was significantly reduced.

Paul Jacobs attributed the problem of "requirements creep" to the shifting of support bases over time and the comparatively short position tenures of high-level military decision-makers. According to Jacobs, the proclivity of decision-makers to institute requirements changes is always based on good intentions, but the net effects on schedule and cost are often underestimated. The problem is compounded by the fact that proposed requirements changes are often accompanied by funding uncertainties, and a failure to accept the proposed requirement change may result in loss of funding. This continuous threat to funding influences technical decision making in a way that increases technological risk.

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Clearly, what was needed was an Operational Requirements Document that specified requirements at a high level of technology readiness and saved upgraded capabilities that involved less mature technologies for future preplanned product improvements. Currently, under *DoD 5000.2* and the *DoD Acquisition Guidebook*, the preferred approach to systems development is evolutionary, based on a time-phased plan to develop a new system in increments with shorter acquisition cycle times. This approach parallels best practices in commercial product development and results in achieving the performance objectives through a phased process where a graduated sequence of systems are fielded so that the warfighter is not kept waiting for a single step to full capability.

There are two basic processes of evolutionary acquisition. The first process is incremental development. The desired capability is identified, end-state requirements are established, and development occurs in incremental phases or blocks of preplanned product improvements with technology insertion based on technological maturity. The second basic process of evolutionary acquisition is generally referred to as spiral development. In spiral development the end-state requirement is not known and each incremental upgrade of the system is based on direct feedback from the warfighter.

If either incremental development or spiral development had been employed as the acquisition strategy, the history of FOG-M would have been very different. According to Jerry Dooley, such an approach would have actually been preferred by the NLOS project office. However, evolutionary acquisition was not becoming central to acquisition strategy until *DoD 5000*. Hence, in the case of NLOS the need to secure funding served as an irresistible impetus to increase technological risk. This resulted in the inevitable prolonged development schedules and escalated costs.

THE ENHANCED FIBER OPTIC GUIDED MISSILE (EFOG-M)

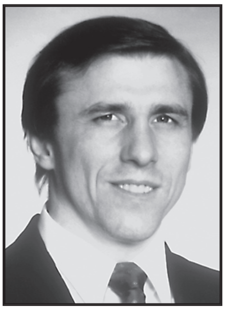
Following the cancellation of the Boeing Hughes contract, an NLOS Task Force was commissioned to review the Army's requirements for a non-line of sight capability. In March 1991, the NLOS Task Force, TRADOC representatives, and the Army Acquisition Executives (AAEs) agreed on a basic set of NLOS capabilities. These included both an anti-tank (Infantry) and anti-helicopter (Air Defense) requirement. In July 1991, an Army System Acquisition Review Council (ASARC) meeting resulted in the approval of the NLOS Combined Arms (NLOS-CA) program. At this time, Colonel Louis Kronenberger was chosen to assume the position of project manager to transition the program from the terminated full scale development program into a pre-demonstration/validation program.

The EFOG-M demonstration program request for proposals was released in March 1994 and amended in May and June 1994. Following the RFP, proposals were received from four contractors. The Source Selection Evaluation Board awarded the contract to Raytheon in October 1994. However, because of protests from the three unsuccessful offerers, a review by GAO delayed the official awarding of the contract to Raytheon until May 1995.

Subsequently, the EFOG-M program remained essentially on schedule, and all of the major technological challenges had been resolved by 1998. The enhanced system had day/night capability with the infrared seeker. It was also capable of *hot launch* (as opposed to the use of an erection device for launch) and it had extended range. The engineering development was completed, and all that remained was the final stage of man-rating safety testing before production could begin. From the beginning, support from the Infantry had not been exceptionally strong. They had prioritized other systems (such as Javelin, TOW, and LOSAT) above EFOG-M. There were substantive tradeoffs. If the Infantry was to acquire quantities of EFOG-M missiles, reductions would occur in the acquisition of other weapons. The cost per missile was relatively high, but this had to be considered in light of the small production numbers. Raytheon argued that the cost would decline with increases in production over time, as was typically the case with other systems. Nonetheless, the Army Chief of Staff and the Assistant Secretary of the Army for Research and Development made the decision that the Infantry would have to choose between EFOG-M and LOSAT. The rationale was that the acquisition of both systems would be too costly in light of overall budgetary constraints. The Infantry chose LOSAT. In 1998, the EFOG-M program was cancelled by Congress.

CONCLUSION

The cancellation of the production program appeared, at least on the surface, to be the end of EFOG-M. However, this may not be the end at all for one important reason. No other system in the Army's inventory has the unique capabilities of EFOG-M. Nothing else has the combination of non-line of sight capability, large bandwidths to transmit exceptionally detailed images, the freedom from electronic countermeasures, high velocity reconnaissance capability, the ability to destroy both tanks and helicopters, and a 20 kilometer or greater range with extraordinary accuracy. This unique combination of capabilities suggests that it may be only a matter of time before an Enhanced Fiber Optic Guided Missile reemerges.



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