CHAPTER VIII

THE TECHNOLOGY DRIVERS

Battelle Labs, which had become the home of TACTEC in the 1960's, now consisted of 3,000 engineers and scientists, and had the capability to assemble teams of specialized people and apply their talents to whatever project was underway. Battelle teams were under contract to various defense contractors, Department of Defense organizations, as well as many other organizations. They also had an extensive Foreign Science Library with numerous Warsaw Pact magazines and newspapers.

The Ordnance Technology Group was involved in studies of antitank weapons; shaped charge warheads, and tank armor to name just a few projects. Since the full nature and scope of the projects were classified, it would be difficult to discuss in detail the methodology that was involved, but by correlating hardware exploitation reports prepared by Technical Intelligence elements with published scientific literature and reports from various sources, Ordnance researchers were able to forecast future trends in weapons. These reports were done for elements of the Defense Intelligence Agency and the Army Material Command who then published periodic reports on these topics.

These reports went to Combat Development Commands and Army Material Command organizations where the contents were incorporated in plans for new tactics, new organizations and new weapons or upgrading of existing weapons. We had long since "given up" on the M1 tank and were working on plans for the next generation of tanks and antitank weapons. As far as we were concerned, the M1 tank was an "antique", and it had not even reached the production stage!

Another major event of 1979 that would have an important impact on future operations was a decision by NATO to deploy Cruise Missiles and Pershing 2A Missiles to counter the growing threat of Soviet deployment of SS20 missiles. Unknown to the free world, an agreement was also reached between the Soviet Union and the tiny caribbean island of Grenada to provide large amounts of military aid. International defense journals were reporting steady advances in Soviet tank production and deployment of the new T72 tank. With a projected numerical superiority, work was needed to develop new or improved antitank weapons, since Soviet tanks were being supplied to many third world nations.

Because of reports of the Soviet use of chemical warfare as well as a review of the design and development of Soviet weapons as described by the Technical Intelligence Bulletins, it was apparent that Soviet equipment was being designed for use in chemically contaminated areas. As a result, the XM1 tank, which had not yet reached production, was again re-examined and Public Law 79-95 was

passed by Congress which required that M1 tanks would have CBR equipment, similar to the Soviets, included. These tanks would be designated the M1E1. Consideration was also given to including a 120-mm. gun of German design in the tank.

In an effort to catch up, the Chemical Systems Laboratory commissioned several studies to be done on the design and development of collective protective systems. This report covered both Soviet development as well as developments in other nations. The 18th Chemical Detachment (TI) was dispatched to Europe for data collection as well as other missions. The end result was a report which pointed out the nature of the threat, Soviet defensive measures as well as the Western world's development of new equipment. (I was the author of the section on the Warsaw Pact Equipment.) Without discussing details, it is sufficient to say that numerous examples of items that could produce a technological surprise were included in the draft copy of the report but were deleted from the final copy. Through unofficial channels, this information was however supplied to the Foreign Science and Technology Center.

A major technological breakthrough occurred in the early 70's, and this was the development of chobham or spaced armor by the British. Samples of this were provided to the West Germans and unfortunately were smuggled to the Soviet Union. In the United States work continued on design and development of a new generation of combat vehicles. These included the XM1 tank, a new air defense gun system and a replacement for the armored personnel carrier. Needless to say, these new vehicles would form the mainstay of America's fighting forces into the year 2000. They would have to counter Soviet designed weapons that might be employed against them.

Just as death and taxation are the only two things that are certain in life, there are only two things that are certain in fielding new military equipment -- they are that as soon as they leave the production line they are obsolete and as soon as the other side finds out about it, a countermeasure will be developed.

Under a separate project, an in-depth study of the design and development of Soviet Armor and anti-armor weapons was continuing at the Battelle Columbus Labs. The preparation of this report required a review of all the available historical data which was primarily the various Technical Intelligence Reports from WW II, Korea, Vietnam and the Mid-East. This combined with a review of published scientific and technical papers by Communist and free world scientists led to the conclusion that the Soviets were ahead in armor research and developments and were on the verge of fielding a new antitank round that could penetrate the armor in our new M1 tank. This report was prepared for the Missile Intelligence Agency, a part of the Missile Command and completed in June 1980. Eventually the basic content of the report was incorporated into periodic scheduled reports on antitank weapon systems and transmitted to the Tank-Automotive Command and the armor centers combat development elements. However, the information was conveyed to responsible people long before the

reports were printed, but the fact that the Army's new M1 tank was vulnerable to a new type of Soviet round was not announced by Clifford Bradley of the Tank-Automotive Command until March 1982 almost a year after production had begun. During the same time frame, the Missile Command announced plans to cancel further procurement of the VIPER missile.

Another major project was to develop a detailed understanding of the Soviet system for the design and development of new tanks. This would encompass all aspects from basic scientific research to observation of fielded equipment. By carefully charting changes in basic research one is able to forecast future developments of a scientific nature. Some of these changes have direct military application. In many cases, especially in the Soviet Union, their engineers and scientists work in government laboratories and any noted change in their pattern of work or general area of research may be indicative of a new system under development or a change in a system already in production. In order to accomplish this analysis it is necessary to have access to scientific and technical literature, air photos of the R&D facilities involved, as well as samples of the materials in use by the laboratories.

In March 1981, the M1 tank began rolling off the production line in some quantity, at the same time work was underway to both upgrade the tank and upgrade our arsenal of antitank weapons. The antitank rocket had progressed from a shaped charge on a rocket to a more sophisticated system. Work was being done on the guidance systems, the delivery systems and the warhead.

Also in March, an inter-office memo at Battelle Labs was generated by Joseph Bachofen which provided a review of shaped charge warhead research in the United States and outlined suggested areas for future research efforts. In quoting from the memorandum, I have made an effort to eliminate specific technical procedures.

Background

> "During two snowstorm periods in January 1978 I reviewed the trends in shaped charges and advanced armors. As a result, I formulated various multiple pulse, multiple liner, multiple material shaped charged designs for bomblets missiles, gun fired shells, and oil well preforators. I estimated that the preliminiary designs in the notes should form the basis for about five years of research.
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> Now, after three years, the U.S. shaped charge community have only pursued a small fraction of the ideas in these notes. However, the little research that has been performed has provided substantial benefits to the U.S. Other organizations have received much more generous funding from the sponsors.

During late February 1980 to March 1980, the 1978 information was used to design potential modifications of the 100-mm. Milan warhead so that I could have a baseline 100-mm. design for use at anticipated meetings during 1980. When these meetings never materialized, we used derivatives of the preliminary design as the warhead concepts for the Ford-aerospace IMMAAWS.

During 1980, the final reports for Missile Intelligence Agency and ARRADCOM were completed. These reports contain the design methodology for multiple effect shaped charges. The latter report also identifies our interest in multi-material heterogeneous liners so that penetration and behind armor effects could be enhanced. However, the mechanisims of advanced armor penetration have not been explained beyond the desireability for multiple pulses.

Recently, interest has again arisen in depleted uranium liners and porous liners. I have been describing the benefits to everyone since about 1975. Joe Dunleavy, Ed Bodine, and Stan Goodard similarly advertised the potential benefits.

None of us has explained how they work, although I have indicated that it has to do with the jet temperature and "superplasticity." There is much more to it than this and I do not intend to "leak" or present it until there is sufficient funding that it can be presented fully and scientifically. Anything less would leave it mostly uncovered and of no use to either Battelle or a sponsor.

Goals

There are three keys to the next generation of shaped charges beyond the use of multiple pulse charges:

- Longer jet length
- Not disturbed by crater - collapse and other methods of side - impacting a jet
- Continues to penetrate at lower dynamic pressure.

Dunleavy, Bodine, Goddard, and I knew that Tantalum jets had these properties. However, the best any of us ever got to do was bootleg research, the results of which were given away to Firestone

Defense Products at the prodding of the Defense Advanced Research Project Agency. Thankfully, Firestone gave us verbal credit for giving them the information. However, Firestone also kept later research on trying to reduce our specifications to themselves. (Their research was not successful which could have been anticipated as we had performed a great deal of personal research over about eight years between 1962 and 1976 in order to generate the specifications.)

Each of these goals was presently beyond the state-of-the-art in the U.S. shaped charge community. In fact very little has been demonstrated in only a few recorded experiments, although there are good solid reasons for stating the key methods should be future goals. As I envision these, each of them could occupy the talents of three to four people for a continuous effort of from three to five years. If the older methods of cut and try research are used, then the efforts could be more than tripled (just as has happened with the present DARPA work on advanced shaped charges).

I hope that we can find funding for research on liner materials. Unfortunately, I believe that it is beyond the comprehension of the U.S. shaped charge community. Furthermore, even though the community knows that its computer codes are not useful, it will probably not respond favorably to words expressing why they are no good. (This is because of the already heavy funding that has been sunk, "invested.") Thus, as much as the research is needed and we could do it, I doubt that there will be a mad rush to fund the research. Funding sources could be ARP, Air Force Office of Scientific Research, Air Force Materials Laboratory, DARPA - Materials Science, BRL, ARRADOM - Dover, or AFATL."

A corollary area of research is what was known as "behind armor effects" in short, what happens inside the tank after the shaped charge hits it? Again, another internal memorandum generated by Battelle's Ordnance Technology Group is quoted.

Background

"We have summarized the methodology and significant reports applicable to modelling behind-armor effects. The Air Force paid for this, however, they did not pay us to create and exercise such a model.

Systems Planning Corp. was chosen by DARPA to do the Tank Breaker behind-armor-modelling. Their

past efforts and approach to future efforts were based on look-up tables of agreed upon damage. This is not really an advance in the state-of-the-art and would serve only to judge candidate designs (i.e., it could not be used as a design tool).

We will be collecting Soviet research on behind-armor effects under a TACTEC QRI. In light of recent (and prior) experience, we can anticipate that this will be provided to SPC, who will recast the information and peddle it throughout Washington. The only thing we can do in this case is spread our information faster and wider. Still we can anticipate that SPC will do the following:

- Prove that U.S. research must be hurried up as the Soviets are ahead
- Extract information useful in look-up tables.

Systems Planning Corp. is aware that we could construct an analytic behind-armor-damage design-oriented model. They have suggested that we should provide them with our ideas; but we pleaded overwork and lack of funding. I suspect that we will be put under some pressure to provide such information once we are signed under Tank Breaker. Unfortunately, there is no funding included in the proposed effort for doing this. Thus I suggest that we stick to the statement of work and further suggest that we ask for an additional contract or a modification if we are to provide modelling services.

Research Goals

Due to the worldwide active interest in behind-armor effects, I suggest that we should seek the following:

- Worldwide state-of-the-art review of technologies, modelling, personalities, and facilities

- Development of an analytic model oriented toward the design of both weapons and armored structures.

The former could be reasonably supported under the charters of the DIA or CIA. Unfortunately, they only respond to items of current interest to the U.S. community which is apparently behind the rest of the world in this area and is not asking for such an effort. The latter could be funded by ARO, BRL, ARRADCOM-Dover, TACOM, or any weapon systems program

managers. Unfortunately, they do not realize that they need and can benefit from such research.

I am not quite sure how to market these research goals. Others have also had obvious problems in this respect for about 30 years. We do have significant credibility in the technologies, applications, etc. Still the question is, "How do we get someone to fund significant research?" We know that unsolicited proposals don't work for us and that at best the research winds up in someone else's hand.

I have thought of a new approach but have no experience with it. Suppose we write a copywrighted "white paper" that presents the following:

- Historical Importance
  - explosive shell versus wooden ships
  - shaped charge research
  - battlefield casualties
- Availability of Modelling Techniques
  - scientific information
  - instrumentation
- Benefits of Research
  - saving lives
  - better weapons

The copywrighted paper could then be distributed to members of Congress and the Department of Defense who actively influence the requirements levied on new systems developments. The objective would be to have a requirement for behind-armor effects documentation on each system to include the blast, flash, etc. that we are aware of and that are not presently modeled."

Had this information and research been done in the 1960's and the results provided to Combat Vehicle Design teams, the U.S. would have been able to field a more survivable tank than the M1.

Soviet developments, both in scientific research and in fielded weapons had progressed more rapidly than in the United States. Fielded weapons were discussed in many books but the most concise history of Soviet weapons appeared in a "Salamander" book of 1981.

"...the first generation of Soviet antitank guided weapons (ATGW) was the AT-1 Snapper. This was much in evidence in the 1967 Middle East War and many examples were captured by Israel. It had four large cruciform wings, single charge solid motor and the 11.5 lb. (5.25kg) hollow-charge warhead could pene-

trate some 13.8 in. (350mm) of armour.

The much more advanced AT-2 Swatter appeared some years later and has also seen action in the Middle East and been captured by the Israelis. The AT-2 is carried on a quad launcher on the BRDM-1, and has four wings also on a cruciform, but rather smaller than in the AT-1. All wings are fitted with control surfaces (elevons) with two carrying tracking flares. An internal solid-fuel motor with oblique nozzles between the wings fires it off a launch rail of surprising size, interestingly, there is no high thrust booster. Behind a rather blunt hemispherical nose are two small fin-like projections.

AT-2 is command-guided by radio, which facilitates deployment from the various versions of the Mi-24 tactical helicopter and, it is believed, the AV-NF (Naval Air Force) Ka-25 ship-borne helicopter. Aerial applications are still thought to be of an interim nature, pending the entry of the AS-8 missile into full-scale service.

The one remaining puzzle is the nose, which suggests IR terminal homing, possibly in conjunction with the two small "foreplanes", an IR seeker head is by no means impossible to combine with a hollow-charge head. The warhead has never been officially described in the West, but is said to penetrate 19.7 in. (500mm). Users include WP countries, Egypt and Syria. This missile was replaced by the AT-3.

During the Middle East War in October 1973 two-man teams of Egyptian infantry opened what looked like small suitcases and inflicted casualties on Israel battle tanks the like of which had seldom been seen on any battlefield. Ever since, the little missile code-named Sagger by NATO has been treated with great respect, though it is still a simple device with no tube launcher or any guidance other than optical sighting and wire command.

Called Malatyuka in the Soviet Union, it was first seen in a Moscow parade in May 1965. Since then it has been seen on BRDM's (six-round retractable launcher topped by armoured roof), BMP and BMD (single reloadable launcher above the main gun) and Czech SKOT (twin reloadable rear launcher). The Mi-24 Hind A helicopter can also carry this missile on its four outboard launchers, presumably firing from the hover or at low forward speeds. The missile is accelerated by a boost motor just behind the warhead with four oblique nozzles, and flies on a solid sustainer with

jetevator TVC for steering. There are no aerodynamic controls, but the small wings can fold for infantry packaging. A tracking flare is attached beside the body, and it is claimed that an operator can steer to 3,281 ft. (1,000m) with unaided eyesight, and to three times that distance with the magnifying optical sight. The Western estimated penetration of 15.75 in. (400mm) for the 6 lb. (7.72kg) warhead is almost certainly a considerable underestimate. Users include the WP armies and Afghanistan, Algeria, Angola, Egypt, Ethiopia, Iraq, Jugoslavia, Libya, Mozambique, Syria, Uganda and Vietnam, and probably at least five further countries."

The AT-3 was rapidly replaced by newer systems which include:

AT-4 Spigot Missile - Code-named "Spigot" by NATO, AT-4 is a high-performance infantry missile fired from a tube, and generally similar to the Euromissile "Milan." The system has been in service with the Soviet and other Warsaw Pact armies for some seven years, but photographs have only recently become available in the West. Total system weight is 87-1 lb. (39-5kb) in the manportable configuration. Control is Semi-Automatic Command Line-of-Sight (SACLOS) and guidance is by the usual means of a wire. Range is estimated at about 2,187 yards (2,000m), but may be as much as 2,735 yards (2,500m), although flight-time at such ranges may be a problem.

AT-5 Spandrel Missile - Allotted the NATO reporting name of Spandrel, this is the tube-launched system first seen on BRDM-2 armoured cars in the Red Square parade of 7 November 1977. Each vehicle has five tubes in a row, on a trainable mount amidships. The tube resembles that of Milan and has a blow-out front closure and flared tail through which passes the efflux from the boost charge. This blows the missile out prior to ignition of its own motor. Folding wings, SACLOS guidance via trailing wires and general similarity to Milan seem more than coincidental. The Group of Soviet Forces in Germany is thought to have replaced all its Swatter and Sagger missiles with Spandrel by 1979-80, a significant increase in its antitank capability.

AT-7 Spiral Missile - This missile, code-named Spiral by NATO, is believed to be a large laser-guided weapon able to demolish any AFV. It is believed to be standard on the Hind-D helicopter and may also be fitted to the laser-equipped Soviet battle tanks. The suggestion that it is based on the SA-8 surface-to-air missile appears unlikely.

Much of the missing information was information that could only be obtained by human efforts and by elimination of the human collection elements of organizations such as the CIA, the U.S. had increased the risk of technological surprise. U.S. efforts to examine satellite photos of tank production facilities could only provide a warning of new production items and their quantity.

Exploitation of captured foreign material would give an excellent analysis of the quality but too late to be of value in designing countermeasures.

Much of the advanced research being done at Battelle in support of DARPA and the missile command was too late to have any impact on systems being fielded to include the VIPER and could have been done by a Technical Intelligence detachment at the missile command, had there been one still in existance. In an article by Frank Greve, of Knight-Ridder newspapers, the history of the VIPER anti-tank rocket was reviewed which appeared in 1982.

It was supposed to be the dream weapon -- a lightweight shoulder-fired rocket that any infantryman could use to stop an enemy tank dead in its tracks. It was called the VIPER, and it was supposed to cost $78 when it was proposed back in 1976 -- so low in price that every soldier could have one. The VIPER project had become an $882 million bog in what Budget Director David A. Stockman, in his celebrated Atlantic Monthly interview, described as the "swamp of $10-20-30 billion of waste" in the Pentagon budget. Its production cost has soared to $787 per unit. The Marines want no part of it. And government experts say it has little chance of knocking out a modern Soviet tank. This is a story of weapons procurement run amok.

The VIPER project illustrates the way even a small weapons-development project can balloon into a nearly billion-dollar baby. And VIPER is not an isolated case: "It's peanuts in terms of the whole $90 billion procurement budget," one official of the Office of Management and Budget said. "We've never paid much attention to it. The VIPER system itself is no more of a turkey than about 15 others.

Those systems include the M-1 tank, the Bradley infantry fighting vehicle and the AH-64A attack helicopter," he said. Like VIPER, each of these multibillion-dollar projects shows dwindling performance and soaring costs. But none is a better example of the problems than VIPER. An investigation reveals that: VIPER was largely ineffective against tens of thousands of Soviet tanks built since the late 1960s with improved armor. Its cost had increased tenfold from original projects -- from $78 to $787 a round, by the most forgiving account. The Army secretly reduced VIPER's performance standards in 1980 when the weapon's shortcomings threatened its production. When the Defense Department's top engineer wanted to kill the VIPER program, Army generals managed to sneak one sentence into his written recommendation to Congress. That sentence, which the signer either didn't notice or considered inconsequential, played a key role in keeping the project alive.

The Army manipulated rules for testing other anti-tank weapons that might have performed better. The effect was to bias or exclude consideration of most of the competing weapons. Internal criticism of the weapon was stifled by transferring or removing knowledgeable

uniformed and civilian critics from the VIPER project. But supports -- even naive supporters -- often won promotions. The Army dismissed a 1981 General Accounting Office report that found VIPER "largely ineffective," even though the report helped persuade the Marine Corps to drop plans to buy it. The Marines want to defeat modern Soviet tanks, said a spokesman, "not just p--- them off." Army brass also beat back three other recommendations to scrap VIPER, made by the Office of Management and Budget, the Defense Resources Board and the Army Select Committee on the 1984 budget.

The Army recently dropped plans to procure VIPERs from two competing manufacturers, a strategy that might have forced prices down. Instead the Army proposes a sole-source contract for VIPER's producer, General Dynamics Corporation of Pomona, California. The Army planned the sole-source contract despite allegations by a Defense Department investigator and others that inattention and engineering errors by General Dynamics had contributed to delays and cost overruns on the project. The version of VIPER developed after 70 months of engineering by General Dynamics flunks some performance standards achieved by a prototype developed by the Army in 1975.

Both General Dynamics and the Army offered misleading public statements about the weapon's effectiveness. Evidence of its shortcomings lie hidden in internal Army documents, safe from public challenge, although knowledge of that evidence is common in the defense community. Neither General Dynamics nor the Army can account for why VIPER costs so much. One top Army official contended that inflation had accounted for 33 percent per year of the cost increases, but the Army cost analyst closest to the project, Ray Summar, confessed, "I can't back (the) figures up. Instead of 33 percent," he said, "inflation would only account for about 12 percent a year."

To find out how and why VIPER went haywire, more than 50 interviews were conducted with former and current VIPER project officers and engineers, Defense Department analysts and producers of competing weapons. Many asked for anonymity because, as one weapons-maker put it, "retribution is a way of life in this business."

The interviews, coupled with the study of scores of documents, show that the most questionable practices occurred late in the procurement process as the Army struggled to keep VIPER alive. A key example of misleading efforts to "sell" the weapon was a current General Dynamics brochure that touts VIPER's "effectiveness for the individual combat soldier in countering attacks by modern tanks." The brochure's photos show the VIPER rocket hurtling toward a tank, then exploding into the side of its turret. The crew compartment, photographed by remote-control camera an instant later, looks like hell's inferno. One problem: The tank pictured was an M-41 Walker Bulldog light reconnaissance tank developed in 1949 and superseded in 1959. The 1 to 1 1/2-inch armor on that American tank is less than one-fifteenth as thick as that of modern Soviet battle tanks.

VIPER will not penetrate the frontal armor of those modern Soviet tanks at all, condeded Col. Aaron J. Larkins, the Army's 1982 VIPER project manager. Soviet tanks built since 1968 are protected, according to Defense Intelligence reports, by a special angled composite steel frontal armor too tough for VIPER to beat. According to Donald R. Kennedy of Los Altos, California, one of America's foremost anti-tank weapon designers, this isn't surprising. Kennedy and other warhead experts explained that the size of any anti-tank rocket warhead -- expressed as its diameter -- determines its penetration. Current engineering, Kennedy and others said, can produce penetration no more than five to seven times the warhead's diameter. Therefore, VIPER, a 70-millimeter (2.8-inch) weapon, could not penetrate more than 19.6 inches of steel. In fact, said Kennedy, VIPER's warhead is "a 1960s-state-of-the-art configuration," which pierces a good deal less.

No matter. More than 24 inches of penetration would be required, according to Kennedy and others, to go through the front armor of modern Soviet tanks and disable them. These newer tanks, T-64, T-72 and T-80 models, can be knocked out by VIPER from the side and rear, if gunners are lucky and daring. They are likely to get only one shot because of the attention they would draw by the weapon's blast. It adds up to risky business, particularly from a range of 250 yards or less. Asked how risky, one VIPER expert replied during a 1981 Marine symposium: "Let's just say that along with its pop-up sight, VIPER shoud come equipped with a pop-up Medal of Honor."

U.S. intelligence experts, in published reports, estimated that by 1985 the Soviet Union would field more than 22,000 T-64, T-72 and T-80 tanks. Most would face off against NATO forces in Western Europe, a theater where Soviet tanks enjoy a 3-to-1 numerical advantage over NATO tanks. Older Soviet tank models vulnerable to VIPER will constitute less than half the Warsaw Pact tank force by 1985, according to congressional testimony. Hyman S. Baras, the General Accounting Office's director of Land Warfare Audits and author of the agency's report critical of VIPER, summed up the situation this way: "I'd have grave doubts about hanging around with my VIPER until the enemy tank is only 250 yards away. For one thing, if I miss, they're going to blast away with machine guns, and I've had it. And," Baras continued, "if I have to attack the tank from the side or rear, what they're really saying is that I have to ambush a tank. I have to surprise a tank. Now that strikes me as a very risky thing, particularly if I have a low probability of killing it. I think I'd want to be out of there. I'd want to be as far away as I could be."

Despite all its shortcomings, the Army proposed to buy 646,100 VIPERS between 1982 and 1987. Total costs: $882 million. That figure included production facilities and research and development costs not figured in the standard $787 unit price. In VIPER's defense, the Army argued that about 60 percent to 80 percent of battlefield Soviet armor will consist of personnel carriers,

reconnaissance vehicles and less-protected older tanks. Also, to counter tanks impenetrable from the front, soldiers are being taught new techniques in using the VIPER to knock out tanks from the flank and rear.

The Army's argument does not impress retired Brig. Gen. Eugene M. Lynch, an infantry commander in three wars and a veteran anti-tank fighter. "They say VIPER is going to perform effectively," snorted Lynch, a former Defense Department adviser on combat weaponry, "but that's only if the Soviets perform as stupidly as we have projected them to perform in order to validate our weapons." Specifically, Lynch challenged the theory that Soviet tanks would be vulnerable from the sides and rear. Soviet tactics call for strong protection of tanks by artillery and infantry, according to Lynch, making it nearly impossible to ambush tanks. Lynch also dismissed any notion that soldiers would be satisfied with a weapon that works against most -- but not all -- enemy armor. "If VIPER encounters (modern Soviet) T-80 tanks and a guy gets a helluva good hit and the tank keeps going, you're out of business with that weapon. Mentally, he no longer trusts it."

Why design an anti-tank weapon that won't knock out modern tanks? The Army didn't intend to. Its 1975 specifications for VIPER demanded only that it defeat then-known tank armor. Not until 1978 and 1979 did U.S. intelligence learn of the enhanced protection on new Soviet tanks, according to officials of the Army Material Systems Analysis Activity, evaluators of the VIPER project. So what did the Army do? In December 1980 it quietly "clarified" -- or reduced -- the 1975 specifications for VIPER, according to Larkins. The changes, confirmed by Larkins and others, make VIPER acceptable to the Army if it can perform against the outmoded T-55 and T-62 tanks. Omitted are performance requirements against newer tanks.

VIPER's cost growth proved even harder to understand than the rationale favoring its use. No one seems able to clearly explain how the $78 weapon became a $787 weapon in six years. In theory, the Army project manager's job is to get the best work out of private-sector contractors for the best price. If the taxpayer has an advocate in the development of a weapon, it is supposed to be the project manager. In fact, when asked to explain the cost growth, both Army project manager Larkins and General Dynamics spokesman Charles Mimbs read the same few figures and the same sparse explanations from a one-page data sheet. Cost-growth rationales, said Larkins, had been "worked out together" between the Army and General Dynamics. Initially, Larkins promised to have his cost expert explain in detail which changes in VIPER's design produced significant cost increases. The expert, Ray Summar, subsequently said Larkins had forbidden him to discuss anything more than the one-page accounting earlier offered jointly by his boss and General Dynamics.

The accounting is so vague that VIPER's biggest single increase -- $170 per unit -- is explained as "revised subcontractor estimates

(labor and material)." Asked whether the revisions included inflation, General Dynamics spokesman Mimbs replied: "It may or may not." Moments earlier he had termed the joint accounting of VIPER's costs "as accurate a description as you can find." In theory, Congress is supposed to curb military appetites if they turn greedy. In fact, Congress' decision to go ahead and pay for VIPER was just one of 819 similar actions that were reached in backstage compromises last year by staff aides to defense-appropriations subcommittees of the House and Senate. The administration also is supposed to restrain Pentagon spending. But its apparent disinterest in VIPER seemed to be summed up in the Office of Management and Budget official's comment that the office "never paid much attention to it."

Indeed, the only way to really explain the cost growth and the Army's appetite for VIPERs is to trace the weapon from its origins. That, it turns out, is more a story of accidents, wrong turns and missed opportunities than a story of progress. Once VIPER did not look like a turkey. Once, in 1974, Lawrence H. O'Neill, chairman of the Army Scientific Advisory Panel, acclaimed the project "the most complete, competent and comprehensible technical program I have ever seen." Army Chief of Staff Creighton Abrams loved it, too. So did General William Westmoreland, who had started the ball rolling.

Late in 1967, Westmoreland had sent back from his command in South Vietnam a Soviet anti-tank weapon called the RPG-7 which had been recovered by the Combined Material Exploitation Center. It worked, said Westmoreland, a lot better than the U.S. equivalent, the LAW (light anti-tank weapon). The LAW, widely cursed in Vietnam, had a 15 percent to 20 percent dud rate, a bad habit of exploding in its launch tube and a range of only about 130 yards. Westmoreland asked the Army's Missile Command, in Huntsville, Alabama, to take the RPG-7 apart and "reverse engineer" it. Find out what made it tick so nicely. Then he wanted the Army to begin work on a new LAW. Research involving fins, propellants, warheads, launching systems, fuses and other weapon elements consumed four years. Finally, the Army, in 1972, was ready to pull its subsystem research together and invent a new weapon.

The challenge of overseeing research on the new weapon fell to Steven C. Walker, a sandy-haired, enthusiastic major from New Orleans, a West Point graduate who had excelled at the Army's graduate courses in rocketry. Walker and others offer great praise for the chief civilian engineer chosen to work with him, Bernie Cobb. In the community of rocket wizards developed by the Army at its Redstone Arsenal in Huntsville, Cobb was considered both a wizard and a workaholic.

Higher-ups at other Army commands set the key ground rules. on weight, for example, the Human Engineering Laboratory at the Army's Aberdeen (Md.) Proving Grounds imposed a limit of 6 to 7 pounds. This was arrived at after adding various weights to the 48.4-pound load of assault gear U.S. infantry normally carry in battle. More than 7 pounds of added weight, the laboratory found in extensive

testing, and a soldier is slowed and his marksmanship deteriorates. A fateful decision. Implicit in the decision on weight was a basic battlefield strategy: Every infantryman was to carry a VIPER. Rather than dedicate a squad member to lug a heavier and perhaps more-potent weapon. VIPERs would be dealt out to everyone, cooks and mechanics included. In a European war, in which Soviet-block tanks stand to outnumber NATO tanks by a more than 3-1 ratio. Army generals wanted a tank-killer behind every haystack and hedgerow.

The VIPER had to cope with another fateful standard: The Army surgeon general had ruled that the blast of noise of new weapons, including VIPER, could not exceed the level applied to other battlefield weapons. That was, and remains, a more than thunderous 180 decibels after penetrating through earplugs. It may seem odd, the notion that a soldier about to be crushed by a tank should worry about his eardrums. But hearing loss is a common military disability. And the surgeon general's office, stung at the time by bad publicity about Army experiments with mind-altering drugs was in no mood to compromise on noise. "We're in peacetime," shrugged VIPER project manager Col. Aaron Larkins, 44, a pipe-smoking engineer from Tennessee.

As Walker and Cobb sought to come up with a more lethal and accurate rocket with a longer range, weight was a crucial factor. Given that the weapon would have three components -- a launching tube, a warhead and a rocket motor to propel the warhead -- the weight constraint limited the warhead to 1 pound. This, in turn, limited VIPER ability to penetrate armor. The noise was troublesome, too. For longer range, Walker and Cobb needed a sharp, tremendously powerful blast. And, to give VIPER a nearly flat trajectory, improving accuracy, the developers needed the rocket's velocity to approach the speed of sound as it left the launch tube. High velocity also promised a flight time for the projectile so fast the target couldn't move before the warhead hit. The surgeon general's standard limiting the noise made these goals more difficult to achieve. What Walker and Cobb came up with was a projectile 27 inches long that looked like a stubby arrow fired from a 44-inch tube. The rocket motor was at the back, connected to the warhead by a short, tapered metal shank. Except for the shank, the current VIPER is basically similar and works exactly the same way.

The warhead consisted of three parts. At the front were two hollow copper cones with their rims joined together and their noses facing in opposite directions. Packed behind the rear cone was a powerful explosive and a fuse. When the warhead, propelled by the rocket, hits its target, the fuse explodes the charge. The explosion collapses the cones and turns the copper into a molten and gaseous plasma, surging forward with tremendous force. The plasma jet, focused by the cone's original shape, eats through the tank's armor like an acetylene torch. When the molten metal penetrates the tank's crew compartment, it cools into hot shrapnel fatal to the tank's crew.

Because of the overall weight limit, and the dynamics, geometry and weight of the warhead cone, Cobb and Walker figured VIPER would have to be about 2.8 inches (70 millimeters) in diameter. This meant a plasma jet a little thicker than an ordinary lead pencil and able to penetrate about 14 to 18 inches of steel. This was sufficient to be deadly -- at least against the Soviet armor being reported by U.S. intelligence at the time.

To give the VIPER's rocket blast a greatly enhanced punch, the Army came up with a complex, exotic propellant additive called carborane. It has two disadvantages infantrymen someday might care about. The blast from firing produces a terrific cloud of smoke, making VIPER gunners easy to spot. Also, prolonged exposure to moisture destabilizes carborane and may cause erratic firing. Past Army VIPER project managers have cared far more about one other carborane trait: The firing blast it produced exceeded, until recent modifications in the weapon, the surgeon general's standard for noise. "We knew we were trading noise (to get) trajectory and better range and time of flight," said Walker, now an executive with a Huntsville defense company. "You discover in the rocket business that everything is interrelated. You trade penetration for weight, fin surface for velocity, always something for something."

"Balancing those trade-offs becomes almost more an art than a science because you can't predict on paper or on a computer exactly what will happen in other systems when you tweak something in a system that seems unrelated." Finally, in 1974, after some 400 test firings, Walker and Cobb had a prototype VIPER everybody liked. It had good accuracy out to 330 yards. It met the weight standard. The warhead worked. Walker considers his work on VIPER "one of the two or three best things I've done in my life." He keeps the praise of O'Neill, the Army's Science Board chairman, in a presentaion album and keeps a model of VIPER, his VIPER, on his living-room bookshelf. Cobb, his old colleague, still works for the Army and would not talk much. "When we put it together," Cobb did say, "it was the best system in the world."

What happened next made their baby nobody's baby.

The Army transferred Walker to Riyadh, Saudi Arabia, to be a procurement officer for the Saudi National Guard. He didn't resist: "It was time in my career for an overseas tour." At the same time, the Army decided to push VIPER into the design-engineering stage, the next necessary step leading to mass production. This meant taking VIPER from the Advanced Systems Concepts Laboratory, where Cobb and Walker had worked, and creating a new, separate VIPER project office. Cobb remained in the Concepts Laboratory, no longer VIPER's chief engineer.

The task of drafting a contract for the weapon's design engineering and eventual production was given to colonels with no significant prior involvement with VIPER. They could not just point to the Walker-Cobb VIPER prototype and say: "Build it." That was

out for an unrelated reason: A blue-ribbon Pentagon study of the Lockheed Corporation's massive cost overruns on the C-5 transport plane had concluded that cost growth was due, in part, to the military's giving instructions that were too detailed to defense contractors. The Army had agreed to mend its picky ways. So, what the VIPER project officers issued in January 1975 was a set of performance specifications for an anti-tank weapon that could do what the VIPER prototype did. But the design was to be up to the manufacturer. By that procedure, the art involved in the prototype VIPER's carefully balanced systems was lost, just as the artists -- Walker and Cobb -- were lost. From that moment on, there was trouble.

General Dynamics Corporation, today the biggest defense contractor in the non-commmunist world, typically makes small quantities of very expensive, very complex weapons. It makes, for example, $1.2 billion Trident submarines, $14.6 million F-16 fighter planes, and since its recent acquisition of Chrysler Corporation's tank subsidiary, $2.6 million M-1 tanks. In General Dynamic's $5 billion a year sales budget, the VIPER anti-tank weapon project was now less than a $100 million-a-year drop. Just as the VIPER was small potatoes to the Department of Defense, so it was also small potatoes to General Dynamics.

Two would-be VIPER subcontractors approached General Dynamics in 1975, proposing that General Dynamics bid for the main VIPER contract. Lacking broad engineering expertise, they could not bid for the prime, supervising contract. But the companies, Brunswick Corporation, whose Skokie, Illinois, plant made VIPER's launch tubes, and Atlantic Research Corporation of Manassas, Virginia, which made its rocket motor, wanted pieces of the action. What kindled General Dynamics' interest was not the VIPER's price tag, but the quantity of the purchase -- then projected at 1.7 million units. Moreover, the Army had nearly three million older, outmoded anti-tank weapons to replace and the shelf life of all of them was set at five years. VIPER, it was figured, could turn into a perpetual contract, a virtual money machine. In 1976, General Dynamics' won the contract over two other companies. Their bid offered relatively low cost and met most of the Army's specifications. The first job, recalled Joseph Alcala, the company's initial VIPER project manager, was to "develop our engineering design and beat it against our cost targets." As it turned out, VIPER, General Dynamics and the Army all took a beating. Everyone involved with the project, then and now, recalls the early days as awful.

One of General Dynamic's first fateful decisons, for example, was that the ingenious pop-out, curved tail fins that Walker and Cobb had designed for VIPER had to go. Even the patented pop-off ring, which kept the fins furled and allowed the VIPER projectile to pass smoothly down the launch tube, had to go. Instead, Alcala wanted a cluster of dagger-type fins, each the size of the large blade of a Boy Scout penknife. The new fins were easier to mass

produce, even though they provided less surface area to stabilize the rocket in flight. The problem was, without Cobb's pop-out ring, the fins dragged in the launch tube and sometimes broke off, disabling the rocket. Also, because the new fins had less surface area, the emerging VIPER proved more wobbly in crosswinds.

Instead of restoring the old Cobb-Walker fins, Alcala and the Army's engineers decided to change the rocket's shape so it would be less vulnerable to aerodynamic forces. First, they filled in with hardened plastic foam the narrow shaft between rocket and warhead. What had looked like a stubby arrow now looked like a bullet. Unfortunately, recalled veteran VIPER engineer James Hughes, the foam sometimes disintegrated under the force of the explosion. Also, for some mysterious reason, the foam reduced the warhead's penetration. Eventually, an aluminum shield was fitted in place of the foam. The interior surface of the launch tube was streamlined so the new fins would not drag or break, and the fins themselves were reshaped. The cost: $2 million to $5 million in design-engineering money, according to Hughes, plus six months of research time.

Industry sources cited another cost eventually important to VIPER gunners: The new version proved as much as 25 percent less accurate than the old in Army tests. In another fateful early decision General Dynamics changed the way the warhead is connected to the rocket. The threaded joint proposed by Walker and Cobb was ruled out. In its place, General Dynamics proposed a stamp-and-crimp process called magneforming. Result: Fuses were damaged by the process, and rockets and warheads sometimes broke apart. Eventually, General Dynamics went back to the threaded joint. Walker and Cobb had chosen it "because the magneformed joints on the old LAW hadn't been strong enough," Walker recalled, smiling at the irony.

The noise problem also proved persistent. To stifle it, engineers moved the rocket motor away from the gunner's ear. They lengthened the launch tube. They shortened it again. They fused with the tube's rear opening. All told, fixing the noise problem cost $5 million to $10 million, according to Army engineer Hughes, and, before it was fixed, consumed research time up until January 1981. That, too, may have been unnecessary. VIPER's sharp blast is very short in duration, unlike the rolling blast of, say, a howitzer cannon. And it is likely to be a one-time exposure, compared to repeated cannon blasts. The surgeon general's office, according to VIPER officials, might revise upward its noise standard for VIPER because of such arguments being made by the weapon's proponents.

Retired Col. Hubert O. Lacquement, the first project manager assigned to VIPER, offered this summation of the early work: "We took a great prototype and screwed it up." For his candor, one pentagon official went so far as to characterize Lacquement as "the only project manager who ever told us the truth." Other sources said he was long on engineering skills and short on management skills. Whatever the case, Lacquement warned his commanding general

as early as August 1977 that trouble lay ahead. "There's going to be a major slip in the production schedule, and its going to carry costs with it," he recalled telling his boss. "You've go to allow this or quit." Lacquement was given a month to fix the problems. He could not, and was removed from his VIPER job a month later. He has retired from the Army and now worked as a metallurgist for a Pittsburgh steel company. His boss on the VIPER project, Maj. Gen. Charles Means, on the job four months, had decided the project needed new blood, top to bottom. Alcala, General Dynamic's first project engineer, was recalled to California just as Lacquement left.

Once again, VIPER had been orphaned, all at once, of its top experts. That turnover problem persists. When Larkins retired in May 1982, VIPER would have had its fifth top Army executive in six years. General Dynamics had fed the problem, too: Robert Ray, Defense Department production engineer who studied the troubled program in April 1980, wrote that General Dynamics by then was on its third program director, a man with two months' experience on the VIPER project. The deputy director position had been open for six months. Five of nine principal deputies each had been on the program 10 months or less.

From the turnover Ray concluded that "until recently at least a portion of the emphasis that the VIPER program would normally receive was diverted (by General Dynamics) toward larger and more visible programs." Turnover also made it impossible for anyone to master costs. Asked where the original $78-a-unit figure had come from, General Dynamics spokesman Charles Mimbs replied: "Corporate memory has forgotten how that number was generated." Asked about the same $78 figure, Larkins shrugged: "Unfortunately, we don't have the institutional memory of 1975-76." That they could not be more precise is not surprising. As one former VIPER engineer put it, "Nobody around the project ever cared about dollars. They print the hell out of 'em in Washington anyway." Said another VIPER analyst: "Nobody gave a damn about price."

One explanation may be that cost growth is bad news, and, as Lacquement explained, "If you want to get promoted, don't bring anybody any bad news." Thus, increased costs tend to get dropped into the laps of new project managers. Larkins, for example, who came to VIPER in August 1980, soon found that a realistic cost estimate should be $458 a unit, not the figure of $254 that had been used by his predecessor and was then being used by everyone else in the Army. "I always had costs in the back of my mind," said the predecessor, P. Church Matthews, Jr., in a recent interviews. But Matthews said he concentrated more on getting the bugs out of VIPER. He also got promoted to general and reassigned before he got around to reporting the heady $204 increase in VIPER's cost.

Actually, the origin of the $78 figure is not mysterious. Walker and Cobb had priced components of their prototype, added an assembly fee, and figured that was about right. Certainly, it was a bad guess. Said General Accounting Office examiner Hyman Baras:

"The Military is not good at estimating. If private business estimated with the imprecision of the military, they'd be out of business pretty soon." Often, however, industry accepts or offers unrealistically low cost estimates to win an initial contract, procurement experts say. As happened with VIPER, estimates are kept down during development-engineering stages, lest Congress or the Pentagon take fright and drop a project. Most increases show up -- as they did on VIPER -- just as a weapons system goes into production. In VIPER's case, $533 per unit has been added to the cost since August 1980, when Larkin came on the job.

Explaining the cost growth is another matter. For example, costs arising out of VIPER's fin changes are termed "safety improvements" in the official Army-General Dynamics account. The increased cost of the threaded joint connecting the warhead to the rocket motor is described as a "reliability improvement." Inflation, as one might imagine, catches much of the blame. On VIPER, it is counted once again as "inflation in excess of Department of Defense indices." In addition, it is counted as "increased labor and material costs." The result: Principal Viper cost analyst Summar thinks that inflation drove the cost up at a rate of about 12 percent per year. However, in a reply to the General Accounting Office's criticism, Amoretta M. Hoeber, deputy assistant secretary of the Army, attributed $335 of VIPER's cost increase to inflation. On a $78 base, Hoeber's reckoning thus would set an inflation rate of 33 percent per year, compounded annually.

Larkins, the current Army project manager, in addition to his money problems, inherited another unenviable chore: Between 1980 and 1981, he had to bring VIPER, already two years behind schedule, through extensive field testing. The testing had to go without significant failures so production could begin. Watching with wolfish skepticism were Defense Department officials who thought VIPER expendable, plus the producers of competing weapons systems, plus a few congressional staff experts in defense overruns. Aware of the growing skepticism, Larkins and a representative of the Army's Training and Doctrine Command met in Huntsville three days before Christmas in 1980. They proceeded to exempt VIPER from standards it couldn't meet -- before it could be judged by those standards.

First, VIPER was exempted from knocking out all tanks and expected to fight only older T-55 and T-62 models. Major General Lawrence F. Skibbie, director of combat support systems for the Army acknowledged the exemption in an interview. Also, he said, the standard for knocking out those tanks, which had been a range of performance, was reduced to a level 14 percent below the old minimum range. General Dynamics had urged both standard-easing changes, according to Larkins, because VIPER could do no better. Officially, the reduction of standards is considered confidential by the Army. Details of those reductions are widely known in the defense community, however. Larkins, with Army consent, also eliminated a requirement that VIPER function after two hours submerged in three

feet of water. It had already been found that VIPERs leak after three to five minutes. When six were submerged for two hours, according to Army reports, four rounds tested proved to be duds, and the remaining two flunked accuracy requirements. Instead of confronting immersion tests, VIPER was to endure a far-less stringent 48-hour "rain test," Larkins and the Army decided.

Finally, they allowed VIPER's weight to go up from its original 7-pound standard to 8.98 pounds. This permitted General Dynamics to fix an embarrassing problem. The back end of a launch tube had blown off in one early test. "Delaminated" is the way the company described it. To fix the problem, General Dynamics proposed to strengthen the tube by winding on eight additional wrappings of Fiberglas. In addition to added weight, this added costs of about $100 per unit. Unconsulted and unimpressed by these changes was the Marine Corps. Particularly dismaying to the Marines, who consider amphibious assault their basic mission, was the reduced immersion requirement. The Marines did not withdraw their support, however, until a General Accounting Office report appeared on July 18, 1981, six days before the Army was to make a final decision on VIPER production. The General Accounting Office report was scathing. It concluded: "VIPER's demonstrated effectiveness barely meets the low end of the Army's requirements and, at that, only against older Soviet tanks. Against the new tanks, which will be the predominant tanks it will be facing, VIPER remains largely ineffective."

The Marines agreed with the General Accounting Office that VIPER should be scrapped and more attention paid to heavier weapons that could defeat the new Soviet threat. Not the Army. On August 3 a panel of generals meeting in Huntsville decided to go ahead with production. Skibbie, in an interview with Knight-Ridder, offered four main reasons: First, VIPER represents a marked improvement over the old LAW (the light anti-tank weapon), more than doubling its range while improving accuracy and safety. Second, the Army's 10-man combat squads of the future would not be able to spare a man to lug a heavier, more potent weapon. Third, even the heavier systems are likely to be impotent against the next generation of Soviet armor. Fourth, troops can be trained to knock out even the new tanks from their flanks and rear.

None of these arguments, said Gen. Eugene Lynch, the crusty retired tank-combat veteran, "justify putting a lousy weapon into the inventory." He continued: "The generals who promote weapons like VIPER tend to be the bravest guys in the world because they know they're never gonna get shot at. But they're not worried about putting some 19-year-old in a position where he's not even gonna be able to fight." What has kept VIPER alive, Lynch asserted, is the Army's tenacious commitment to it, not its virtues. The tenacity arises, he said, "when you get five guys who don't know what they're talking about, but they agree, and they happen to be in positions of influence. So they dominate. Anyone who gets involved has got to agree with them if they want to get ahead. The tragedy of it is that nobody has the guts or freedom to say, 'Hell, let's kill this,

it's dumb.'"

When Congress and VIPER's competitors sensed the weapon's weaknesses, beginning in 1980 and growing in 1981, a classic procurement battle commenced. The Army, naturally, closed ranks to support it. Indeed, Gen. John W. Vessey, Army vice chief of staff, and later to become chairman of the Joint Chiefs, had gone so far as to call VIPER "the sponge that will soak up the enemy's armor." Gen. E. C. "Shy" Meyer, Army chief of staff, was more measured in his support in 1980 congressional testimony. VIPER's effectiveness, Meyer said, "is appreciably greater than any other anti-tank rocket of comparable size available in the same time period."

That is true. VIPER, according to industry analysts, was the only weapon currently available in that size and weight class, except for the weapon it was intended to replace. Most other countries and manufacturers have developed a bigger, heavier anti-tank rocket, weighing something like 20 pounds, which would knock out the new Soviet armor. Producers of these and other competing rockets -- principally French, West German and Norwegian arms companies -- recognized VIPER was in trouble and decided to peddle their weapons anew. They also realized they would be battling the Army in promoting their wares. So they courted and supported influential decision-makers at the Defense Department and in Congress.

Good contacts in Washington are a critical part of this lobbying game. Manurhin of France, for example, which makes a 19-pound tank-killer called APILAS, employs Carl Bernard, a retired Army colonel who specializes in the French arms industry. His brother, Charles, is director for land warfare in the office of the undersecretary of defense for research and engineering. Charles Bernard recommended killing VIPER in 1981, and a deputy of Charles Bernard's, Myron Bruns, has promoted testing of competing weapons. "I've never talked to my brother about VIPER," said Carl Bernard, adding that his opposition to VIPER is personal, not financial. An Army company he led in the Korean War lost 100 of 125 men to North Korean tanks while carrying inadequate anti-tank weapons, he said.

A-F Raufoss of Norway, would-be manufacturers of an improved version of the U.S. LAW employed through a U.S. partner company another retired Army colonel, George Poole. Poole is a close friend of Charles Bernard's specialist in infantry weapons, Col. Charles Garvey. Garvey volunteered in an interview that in December 1980 he had spent a Pentagon-approved week in Norway as a guest of the Export Council of Norway and had toured the Raufoss plant. Garvey, a part-time real estate broker, also confirmed that he had agreed in 1981 to seek an investment property for Poole, a search that did not work out. Garvey had pushed efforts to test U.S. stockpiles of old LAWs and has promoted the A-F Raufoss product as an "insurance policy," he said, if VIPER doesn't come through.

Prior to that, Garvey regarded himself as, in his words, "the

biggest VIPER advocate they had." He also had a business relationship with a General Dynamics executive: In July 1980, General Dynamics representative Mimbs was moving to California from Washington. Mimbs called Garvey "out of the blue." Garvey said, and asked Garvey to sell his house. For the $122,000 sale, Garvey received a lister's fee of $1,800, he said. "I had never met him before nor since," Garvey said of Mimbs. "We had never discussed business or anything else." Of his dealing with Poole and the Norwegian weapon-maker, Garvey said: "I truly didn't -- and don't -- feel I've done anything wrong."

As a former infantry officer, Garvey said he "just wants to be sure the foot soldier has a weapon that works." In neither instance when sought out as a real estate agent, he said, had he solicited the business. "You just get to know everybody, and they know you." Many Pentagon employees are linked to defense-industry representatives by part-time work, and close friendships are common. Indeed, throughout the industry, the Pentagon and Congress, connections such as that of Garvey to General Dynamics and to Raufoss personnel, and between the Bernard brothers, are so common as to be the rule. "You have to understand that we all need each other," said one person involved in the procurement business. "A lobbyist can find out things on the Hill where a Pentagon civilian, by law, can't go. Sometimes a general can lobby better than a company rep. Other times, they're in closed meetings the company rep can't attend. You need all the people you can find who can be eyes and ears for you," he said. "You've go to play the game to win at it."

Another tight relationship involves the West German company of Messerschmitt-Boelkow-Blohm, makers of an anti-tank weapon called Armbrust. In 1981, the company employed Paul Cooksey, son of the former head of the Army Materiel Development and Readiness Command and also one-time defense aide to former Sen. Richard S. Schweiker (R., Pa.). Sen. Warren Rudman (R., N.H.) has been Armbrust's staunchest advocate on Capitol Hill. His defense aide is Jay Behuncik, formerly of Schweiker's staff. Indeed, Behuncik replaced Cooksey as Schweiker's defense expert when Cooksey left to become a lobbyist with his father's company.

With VIPER threatened, General Dynamics also played procurement politics. Through a New Hampshire-based VIPER subcontractor, it urged Rudman, in the senator's words, "to be reasonable. They wanted my understanding that it was a difficult project and that General Dynamics and the government had a lot invested in it." Rudman, who said in an interview he once had the votes to kill VIPER, eventually elected to compromise instead. General Dynamics had also contacted a key critic of defense spending, Rep. Joseph. P. Addabbo (D., N.Y.), Chairman of the House Defense Appropriations Subcommittee. VIPER's fuses are made in Addabbo's district by Bulova Systems and Instruments Corp. of Valley Stream, N.Y.. While critical of VIPER in 1980 and 1981, Addabbo has never moved to kill it.

As part of the rescue operation, General Dynamics and the Army also promised they could bring down VIPER's costs. In an interview, General Dynamics spokesman Mimbs said Bulova's fuses could be reduced in price from $80, to $30, and Brunswick's launch tubes made nearly $100 cheaper. But these are not genuine cost reductions, representatives of those companies said subsequently. Herbert E. Ennis, president of Brunswick's defense division, said the $100 reduction would be the result of a switch from hand-wrapped Fiberglas VIPER launch tubes to machine-wrapped tubes. "We knew from the very beginning we'd never hand-wrap in mass production."

Bulova's vice president for engineering, Roscoe Caruso, meanwhile, could not recall quoting fuse prices at $80 each "unless we're talking about a very low quantity." The $30 figure, he added, "was just a rough, order-of-magnitude guess, not a commitment." Late in 1981, things looked bad for VIPER. The Norwegian manufacturer promised a weapon nearly as good as VIPER at $225 a copy, less than one-third of the General Dynamics price. The French APILAS made by Manurhin, could knock out tanks that VIPER couldn't. Armbrust had enough congressional support to force a shoot-off. Moreover, the Marines' withdrawal threatened to make VIPER's per-unit price even higher because the larger the contract, the lower the unit price, and vice versa.

Then, in November, a shaky compromise was worked out in the House and Senate Defense Appropriations Subcommittees. Total VIPER production, until then set at 1.7 million rounds, would be cut to 889,100, presuming Marine participation; 649,100 without it. Because of the reduced commitments, disappointing to General Dynamics, the Army agreed to drop plans to find a competing VIPER manufacturer. Instead, General Dynamics was to be granted a "sole source" contract, if it could reduce costs to a level acceptable to the Army. Additionally, VIPER's production rate would be slowed to allow evaluation of the weapons of foreign competitors. That was demanded by Rudman, the West German company's supporter.

As one more element of the delicate compromise, Raufoss, the Norwegian company, was to receive $3 million from the Army to improve its light anti-tank weapon prior to the shoot-off demanded by Rudman. Such a shoot-off was tentatively scheduled for July 1983. In return for these concessions, and over the resistance of the Defense Department's Charles Bernard, the Army was allowed by Congress to proceed into production of VIPER at the rate of 60,000 units in fiscal 1982.

Neutralizing the Defense Department's opposition is probably the most cunning Army effort on VIPER's behalf since 1976. Charles Bernard had urged that the Defense Department's Research and Engineering section oppose VIPER's production. His argument had won tentative acceptance in that office. Undersecretary Richard DeLauer, according to several sources involved in the compromise, was ready to sign a rejection letter to Congress to kill the program. However, Army brass, upon learning of this threat, approached an

aide to DeLauer, Richard Hardison, Charles Bernard's boss, was sympathetic to the Army's position. The DeLauer letter was to pass through Hardison's hands.

It did, in a draft that said although DeLauer agreed with the battlefield need for VIPER, it should not be bought if it would cost more than two times the price of the current, unimproved light anti-tank weapon. That was $400 -- far lower than General Dynamics' cost-reduction effort could ever hope to go for VIPER. Thus, under the conditions set in the draft letter that reached Hardison, VIPER was dead. But with one sentence, he restored it to life. The added sentence read: "Perhaps you will be able to find a better solution, but an approach something along the following lines might be considered." That sentence preceded language about doubling the cost of the existing LAW.

Thus, the Army now says that DeLauer merely suggested that VIPER's costs should be no more than double that of LAW. He did not demand that this cost reduction be achieved. But when DeLauer signed the draft, according to several industry sources, he did not intend that sentence to qualify his recommendation. Indeed, some sources add that he might not have noticed the sentence. Whether that is fact could not be determined. Neither DeLauer nor Hardison would return repeated phone calls, deflecting them instead to subordinates absent or ignorant of the matter. As for Hardison, he left the Defense Department's Research and Engineering office in February. Now he heads the Army's Concepts Analysis Agency, a position normally reserved for an Army general.

This was not the end of the procurement battle. Rankled by the congressional demand that the Army combat support systems, and other Army brass have managed to find obstacles and to set conditions that some cannot meet. In his first instructions for the shoot-off, for example, Skibbie wrote that the cut-off weight for weapons tested should be 12 pounds, and the Armbrust, weighs just over 13 pounds and is 31 inches long. Under pressure from Rudman, Skibbie has since relaxed his instructions to allow the West German weapon to compete.

The second key competitor, Norway's improved version of the American LAW, depends for its improvements on $3 million from U.S. Army funds. The Norwegian manufacturer, A-F Raufoss, also must make those improvements within a tight schedule to have them completed by a July 1983 testing deadline. But the Army, which was to have released the $3 million by March 15, now has discovered legal and technical problems that will at least delay the transfer of funds and might kill it. The Army did not plan to test VIPER head-to-head against its foreign competitors, since they and VIPER will be tested under different standards. Nor is it committed to buying the winner.

During my short tenure at Battelle Labs, I was aware of the problems the VIPER was having. In a letter to the editor of Infantry

Magazine, I pointed out a possible solution to knocking out enemy tanks.

Dear Sir,

Thanks for publishing my article on technical intelligence (INFANTRY, May-June 1981, pages 17-18).

I was told several years ago that most technical intelligence people are opinionated and nit-pickers. My observation is that TI people are trained to look for small, seemingly insignficant details while most combat arms officers tend to look at the big picture and leave the small details to others. I spend a lot of time thinking of ways to get the concepts of TI across to combat arms units without getting into classified material.

After reading several of the more recent articles and letters you have publishd about possible new items of equipment, I would like to put forth the following for someone to evaluate.

In World War II the Germans had a mini-tank (the Goliath) that was remote-controlled and contained a demolition charge. Why not consider making a small remote-controlled mini-tank with an antitank missile mounted on it? The gunner could be 10 feet underground and watch the tank's progress on TV and fire the missile when the target was in range. The worst case would result in the loss of the missile and the tank. The best case would be the destruction of the target and the eventual recovery of the mini-tank.

Finally, while Trident submarines and MX missiles seem to get all the attention these days, I maintain that there will always be conventional warfare somewhere. Sooner or later this country or the Army will have to concede that the Infantry is here to stay and they may as well make certain it is as well equipped as possible.

Again, thanks for your help and editorial assistance.

When it was published, I forwarded a copy to Guy Throner of Battelle's Ordnance Technology Group. His reply dated October 1, 1981 was very revealing:

"Dear Bill:

Thanks for the note. I've passed your idea on to Joe

Backofen. I'm not sure the Army is yet ready for such advanced thinking, but at least we can find the 'temperature of the water.'

Best regards,

By September 1983, some two years later an article appeared in DISCOVER magazine entitled, "A Disarming Robot":

> "Resembling an extra from the cast of 'Star Wars', the creepy-crawly object above is actually a small robot that can inspect and disarm bombs without risk to bystanders. Much lighter than the cumbersome bomb disarmers now in use, this one weighs only 165 pounds and can fit easily inside a small station wagon. The robot, called Ro-Veh, comes equipped with both wheels and a set of tracks to help it climb up or down steep stairs. Ro-Veh uses a television camera to allow its human controllers to inspect a suspicious object closely, then -- if it is a bomb -- fires a powerful jet of water on command from a small cannon. The water penetrates the inside of the bomb like a speeding bullet to short-circuit its electrical wiring."

It is too soon after the Soviet invasion of Afghanistan to state what impact it has had on the course of world events, but it served to shock America into action. President Reagan was elected with an apparent mandate to strengthen America's defenses. At the same time that President Reagan took office, the Army began to produce the new M1 main battle tanks with the first models coming off the assembly line in 1980. Quoting from an article in "DISCOVER" magazine of June 1982:

> "The M-1 is the most expensive, heaviest, fastest, hardest hitting, best protected tank the Army has ever owned. No mere evolutionary descendant of earlier models, it is the first really new type of tank America has built since the Korean war. Its special armor, its revolutionary power plant, its crygenic (supercold) night-vision system, its computerized aiming, its laser sensing devices, and its unique crew protection, among other innovations, stretch Army has ever owned. No mere evolutionary descendant of earlier models, it is the first really new type of tank America has built since the Korean War. Its special armor, its hypervelocity main-gun ammunition, its revolutionary power plant, its cryogenic technology to its present limits. The M-1 and its planned variants are expected to remain the bulwarks of America's land forces until the beginning of the 21st century.

Although the Army calls the M-1 the "best tank in the

world," critics believe that too much has been staked on the complex machine, which carries a price tag of nearly $2.2 million. Senator William Proxmire, among others, calls it a costly "clunker" that is subject to frequent breakdowns and unlikely to prove battle-worthy.

Whichever side is right, the M-1, after years of development, problems, and controversy, is now a reality. On March 31, full-scale production began when the first M-1 rolled out of the Detroit Arsenal Tank Plant in Warren, MI. Limited production had begun earlier, in February 1980, at the Lima Army Tank Plant in Lima, OH. Now that both plants (originally operated by the Chrysler Corporation, which sold the operating rights to General Dynamics in March) are in production, M-1's are entering service at the rate of about 60 a month. By the end of April, some 350 of the vehicles had already replaced M-60 tanks in the First Cavalry Division at Fort Hood, TX, and in the Third Infantry Division stationed in West Germany. By 1990, when production is scheduled to end, the Army should have 7,058 of the behemoths.

The M-1 announces itself as something radically new even before it looms into view. While other tanks roar and clank like hugh bulldozers and can be heard for miles, this one emits a howl and is not quite so noisy. Its unusual sound is made by a trail-blazing engine - the Avco-Lycoming AGT-1500 gas turbine, more closely related to the turboprop power plants of large aircraft than to the traditional piston engines of tanks. Although the M-1's turbine gulps 3.8 gallons of diesel fuel every mile - a rather rich diet even for tank engines - it produces 1,500 horsepower, double the output of the engines powering earlier American tanks.

The AGT-1500 has been rsponsible for some of the most serious of the M-1's teething problems. Engineers at the Army Tank Automotive Command in Warren say that many of the M-1's maintenance problems, which are being overcome but which are still excessive, stem from the turbine engine - particularly the bearings that support its rotor."

While the U.S. had been busy developing a new tank to last until the year 2000, the Soviets had also been busy fielding new tanks. Since fielding the T62, the Soviets had fielded the T64 and the T72. As of 1984, no actual hardware had come into the hands of U.S. personnel. Several attempts had been made but none were successful. There were rumors that British Intelligence had recovered a T72 from

Afghanistan but this was unconfirmed.

Several theories on Soviet tank design and development were postulated. Some theories held that the new Soviet tank, the T80, was an upgraded version of the T72 put out on the field to fool Western observers while the Soviets worked on a really radically new tank. Other theories held that the T80 or T72 M1981/3 was the main Soviet tank of the future. Other theories held that the Soviets were working on a new heavy tank. In any event, there must be hard physical evidence to confirm or refute these theories, and this would be the work of Technical Intelligence operations in the future.

Based on past experience, there had been a considerable delay in getting captured material to the rear. Apart from the obvious hazards of combat, there were problems in transportation of the material, pilferage of "war souvenirs" as well as a lack of qualified technical intelligence personnel at the combat unit level. Current organizational changes planned for combat intelligence units contained the same basic plan, to have technical intelligence teams attached to the Corps level unit. There had been no mention of where these people were to come from as it was not a career field within any branch of the Army. In addition, there were no plans for having them at division level where they were really needed.

Realizing that there was virtually no Technical Intelligence operation at either V U.S. Corps or VII U.S. Corps in Europe, I wrote directly to LTG Williams, CG of V U.S. Corps and advised him of some of the problems that existed in "behind armor R&D." LTG Williams, a Vice-President of the Armor Association, forwarded my observations and comments to Major General Wagner at the Armor Center at Fort Knox. I had by then departed from Battelle Labs. I also realized that there would be a problem in the field collection effort of the XVIII Airborne Corps, the Rapid Deployment Force at Fort Bragg. I also expressed my concern to LTG Tackaberry, the CG. Having alerted our front line forces and our strategic reserve, I moved on to other projects while awaiting further developments in the field of tank design.

Within the Army Reserve System, my opposing forces section set up a training area which made extensive use of foreign weapons and equipment. This filled a gap in the training of troop units which occurred when the 11th MI Battalion ceased fielding displays, however, our weapons were plastic replicas of obsolete weapons, and some war relics obtained by private collectors, which added some realism to training..

Realistic training. It's what every military commander strives for, but often has trouble getting. They may be unable to introduce their troops to the combined use of different attack elements, like infantry, tanks, artillery and aircraft. In war games, the opposing force may be smaller than what the soldier can expect to be up against, or insufficiently trained to provide an effective threat. But the major problem is space. After running back and forth over

the same terrain dozens of times, the troops have it memorized. Commanders don't have room to direct a free-flowing mock battle. And safety hazards, not to mention environmental concerns, limit the amount of live firing experience.

As of 1981, the Army's solution to this problem was the National Training Center (NTC). It was being designed to meet the demand for an intensive, wide-open-spaces combat environment. Commanders would be able to mix timely decision making with high-fire-power weapons and force-on-force engagements.

The NTC was being established at Fort Irwin, California, a 643,000-acre sand box (about the size of Rhode Island) in the middle of the Mojave Desert. Although most exercises will be preparing the service people for hostilities in a European setting -- a climate totally different from the Fort Irwin area -- officials figure that other features, namely space, make up for it. It's also handy for close air support from Nellis Air Force Base, Nevada, about 100 miles to the east.

The idea for the NTC got on the drawing boards in 1976. "The Army needed an area where battalion engagement simulation and live-fire exercises could be conducted in a realistic combat situation within CONUS (Continental United States)." said Major Dave Barth, the NTC project officer at FORSCOM headquarters. "Fort Irwin offers the area and facilities to support that kind of training."

As of 1976, Fort Irwin was under control of the California Army National Guard, but they regularly shared the property for Army Reserve and Active military training. Although U.S. Army Forces Command (FORSCOM) would be in charge by 1981, space and time will continue to be set aside for Reserve Component exercises.

When the NTC becomes fully operational, sometime around 1984, every FORSCOM battalion-sized armor and mechanized unit, with its supporting units, will rotate through for two weeks of extensive training at a time. They'll be deploying and redeploying underrealistic mobilization conditions. While at the NTC, they'll spend their "battle" time in the field under simulated combat conditions. This includes sleeping under the stars and eating off tin plates.

Heavy equipment will be supplied. Ultimately, the NTC will have four battalion's worth in stock for use by the rotating units. As new equipment, such as the M-1 tank, is entered into the Army supply system, it will also be available at the NTC.

Plans are to have 42 battalions with their support units -- about 80,000 people -- rotate through the center every 18 months. It's expected commanders can count on at least one field training exercise at the NTC during their command cycle.

The primary type of engagements to be practiced on this almost-

real battlefield would be force-on-force engagements using the opposing forces (OPFOR) concept. The U.S. Army Intelligence Command and School has the task of developing the OPFOR plan. FORSCOM will subsequently station two battalions at Fort Irwin to act as a permanent OPFOR unit.

The force ratios between the OPFOR and the training battalions will be in numbers and types of equipment expected in a European conflict: about three to one. In these exercises, the OPFOR people will become a 1,000-man motorized rifle regiment. They'll be skilled in enemy tactics and serve as a realistic enemy. Dressed in OPFOR uniforms, they'll also be commandeering outdated U.S. vehicles disguised to look like something the threat would use. Right now, discarded M551 Sheridan reconnaissance vehicles are undergoing conversion.

There will be fatalities in these exercises, but of course, they'll be simulated ones. Principal weapons will be equipped with the Army-developed Multiple Integrated Laser Engagement System (MILES). If a MILES laser hits a target, "killed" players are taken out of the battle. Using this system, commanders and their troops get immediate feedback on the effect of battle plans and order.

Fort Irwin also has room for a separate live-fire exercise range. Direct fire, artillery, antitank missiles, attack helicopters and Air Force close air support weapons will be brought together at battalion task force level in a realistic live-fire scenario. And soldiers will be able to observe its effect on a simulated enemy.

Modern electronics systems will be used to monitor all the field activities. Battle actions can be recorded and later played back for review and critique. Leaders can get the whole picture of the battle scene and learn what corrections to make for the next exercise.

"Everything that happens will be stored in the computer to provide quick feedback for the unit on how it fared during the exercises." says Maj. Barth. "We'll be able to provide the unit with a record copy of the entire exercise, to include audiovisual tapes, so they may use it to evaluate and improve their training programs."

Fort Irwin, now the National Training Center, will probably be the biggest classroom in the world. Data collected over time will aid the Army in evaluating and possibly revising tactics, doctrine, organizations, equipment and training techniques. Hopefully, what commanders and their units learn there in the coming years will help the Army meet its goal of combat readiness.

By 1984, the 11th MI BN had been redesigned as the 203rd MI BN and had one company stationed at the National Training Center conducting Foreign Weapons Demonstrations and displays.

As a result of a trip to Charleston, South Carolina, I came in contact with Larry Dring, a former special forces officer and veteran of several tours in Vietnam. Larry had extensive contacts behind the Iron Curtain and supplied me with numerous foreign publications on Warsaw Pact vehicles. Larry also made an extensive tour of Lebanon in 1981 and observed firsthand combat conditions in the area. In mid-summer, he sent me a detailed written report on the subject, knowing of my interest in weapons. I made copies of his report and sent them to Fort Knox and Fort Benning. I received a reply from the Infantry Center stating that the information was appreciated by both the Tactical department and the Weapons department. Since I had departed from Battelle Labs, there was no need to forward them a copy as it related to current operations rather than Science and Technology.

In departing from Battelle Labs, it was my opinion that the M1 tank and planned improvements would be with us for many years, hence, I felt it was important to take action to improve the survivability of our tank crews. It was apparent that the M1 was going to be prone to breakdowns which would make the crews "sitting ducks." Their individual weapons were the .45 caliber pistol, the M3 submachine gun and the M16 rifle. The pistols and submachine guns were becoming obsolete and the M16 was very cumbersome in a tank.

The United States Joint Service Small Arms program let it be known that research contracts would be let to develop a new sub-machine gun for the U.S. Armed Forces. James Leatherwood, inventor and Engineering Vice-President at Military Armaments Company and former member of the Combined Material Exploitation Center in Vietnam, seriously applied himself to the development of a new sub-machine gun.

In mid 1982, I joined the firm as a Special Assistant to the President. Leatherwood's company, Advanced Armament, purchased the original MAC tooling and had the tooling to build the old MAC 10, a submachine gun, and recently developed design technology for a new and improved version to build.

Leatherwood combined this new technology with the advice of Gordon Ingram and Mitchell WerBell, III, two of the more famous early Ingram M10 era characters and soon had efficient working models of the Ingram available for testing. These new M10's were far superior to the old Ingrams and the decision was made to produce the guns for sale.

A new Military Armament Corporation of Stephenville, Texas, was formed and production was begun on the MAC Ingram M10A1. The design, development and production of the famous Ingram M10 submachine gun has had, to use a cliche, a checkered history. The latest model, the MAC 10A1S, was available in 9-mm. and .45 ACP, interchangeable. The complete history of the Ingram series of submachine guns would show that Ingram's original designs were based upon the Thompson submachine guns and the M3 grease gun. In the late 40's Czeck gun

designers came up with a radical change -- the magazine was moved to the pistol grip. This development influenced Major Uziel Gal who designed the now famous UZI. These developments led Ingram to redesign his gun, and the end result was the MAC 10.

Jim Leatherwood had also been the chief of the weapons and munitions section of CMEC in Vietnam and had been the person in charge of in-country testing of the RPG-7 rocket. He had also been sent back to the Foreign Science and Technology Center to assist in the Reverse engineering of the RPG-7. Jim and I were both aware that the intelligence training in the Army was not the best in the world. In the process of developing plant expansion plans, we included a weapons/intelligence museum that could be used as an emergency training facility.

Leatherwood, in addition to manufacture of his ART II Sniper Scope and M10A1, had developed two additional scopes as well as the M12 submachine gun that was a vastly improved version of the Ingram M10. Unfortunately, due to financial problems and the Government's purchase of a West German weapon, personnel cutbacks at Leatherwood Industries were implemented. In addition, Weaver Scopes of El Paso, who made two of the firms three scopes went bankrupt. By 1985, the firm also went bankrupt.

In March 1983, President Reagan made his now famous "Star Wars" speech in which he announced his plan to push forward with his Strategic Defense Initiative, which basically called for placing futuristic weapons in space to defend against missile attack. The Army Reserve contacted me and assigned me to the Defense Intelligence Agency, Vice Directorate for Scientific and Technical Intelligence.

In response to President Reagan's announcement, the Soviets' first reaction, according to a Jack Anderson article in November 1985, was an anguished letter in Pravda signed by a group of Soviet scientists, attacking Reagan's proposal. It was titled: "Appeal to the Scientists of the World." The letter deplored the "strategic defense initiative" and even bemoaned the fact that the purity of scientific research was being sullied by military application. Several of the letter's signers stumped Western Europe to recruit support among the scientific fraternity. One of them, Ye. P. Velikhov, has lectured several times on American college campuses.

Exactly who were these pious protesters? The CIA did some background checking, and we've (Jack Anderson) seen the secret list identifying the signers of the anti-Star Wars appeal by the jobs they actually perform. With ill-concealed sarcasm, the CIA report summarizes its findings this way: "The sincerity of this letter can be judged by the fact that many of its signatories are heavily involved in the Soviet Union's own extensive efforts to develop both offensive and defensive strategic weaponry." Among the more blatant hypocrites who signed the Soviet appeal were:

- P.D. Grushin. He heads the Soviet Union's design bureau for anti-ballistic missiles, including interceptor missiles, including interceptor missiles now deployed around Moscow and another missile in the development stage. (The United States has no comparable weapon deployed.)

- V.S. Semenikhin. The CIA identifies him as "the leading figure in developing command, control and communications systems for anti-aircraft and anti-missile use."

- B.V. Bunkin. He is an important figure in the development of radar and other key components of weapons systems for strategic defense.

- V.S. Aduevsky. Long involved in strategic systems design, he has moved in recent years into the area of space systems. He now has responsibility for a number of military space projects, including a space-based laser gun.

- Velikhov. The darling of anti-Star Wars activists on American campuses has been one of the "driving forces in Soviet laser weapons development for at least 15 years," according to the CIA. For several years Velikhov was director of the Institute of Atomic Energy Laboratories at Troitsk, where military lasers are being developed. Two of the other "driving forces" in laser weapons, N.G. Basov and A.M. Prokhorov, also signed the letter.

If the Soviet Scientists' appeal were to be heeded, of course, and U.S. efforts to develop strategic defense technology were abandoned, it would leave the Russians without competition in the field. The letter's anguish over military corruption of science was equally hypocritical. Among the appeal's signers were a designer of two Soviet intercontinental ballistic missiles and three other missile designers; three designers of military aircraft; two scientists described by the CIA as "the grand old men of the Soviet military nuclear energy program"; the chief designer of Soviet nuclear submarines, and "the leading Soviet expert in the synthesis of nerve agents," like the "yellow rain" that has killed thousands of Southeast Asians since 1975.