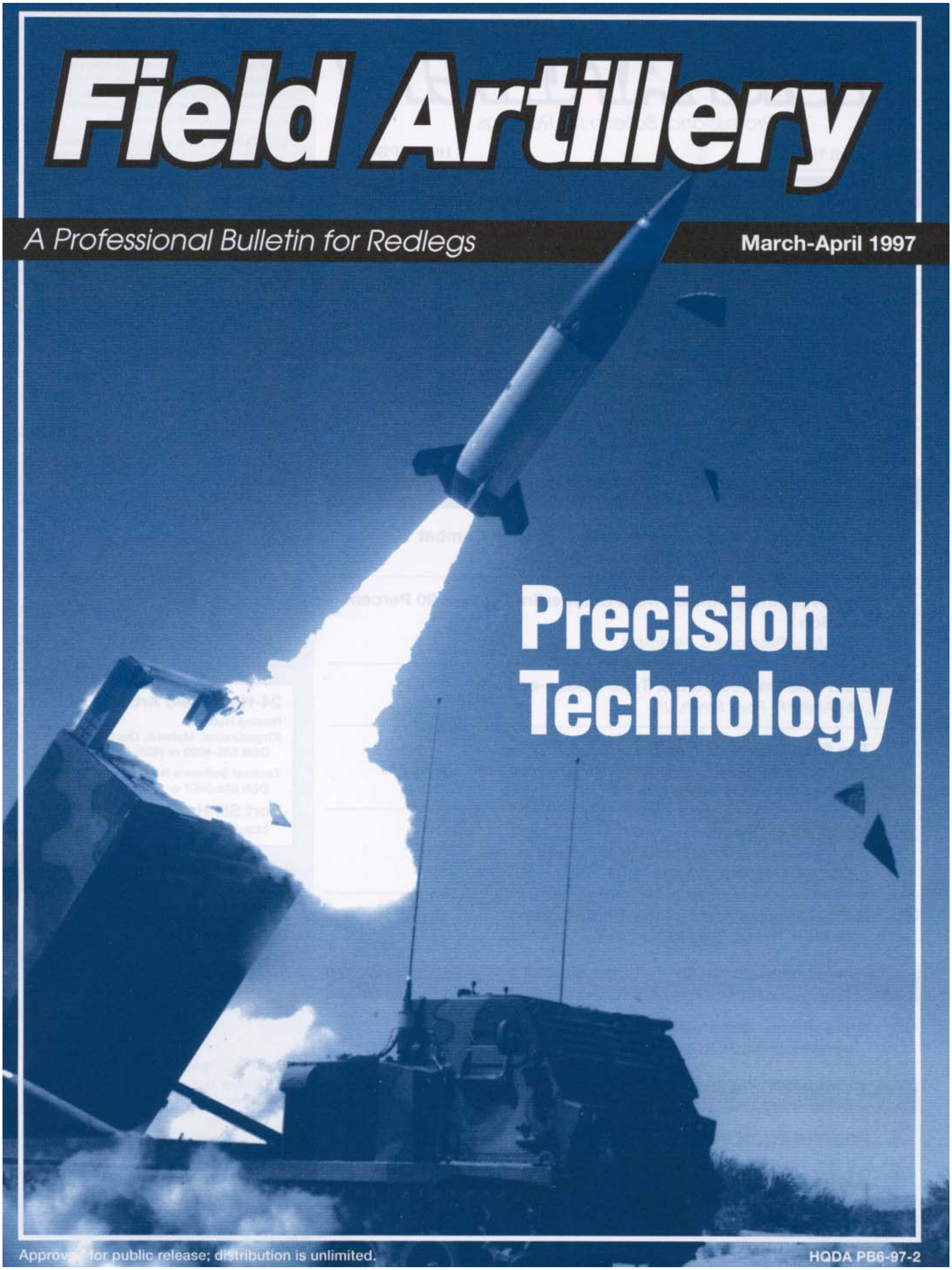
Field Artillery

A Professional Bulletin for Redlegs

March-April 1997



Precision Technology

HQDA PB6-97-2

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Front Cover: *ATACMS Block IA being fired at White Sands Missile Range, NM, by 2-18 FA, 212th FA Bde.*

PURPOSE (as stated in the first ***Field Artillery Journal*** in 1911): *To publish a journal for disseminating professional knowledge and furnishing information as to the Field Artillery's progress, development and best use in campaign; to cultivate, with the other arms, a common understanding of the power and limitations of each; to foster a feeling of interdependence among the different arms and of hearty cooperation by all; and to promote understanding between the regular and militia forces by a closer bond; all of which objects are worthy and contribute to the good of our country.*

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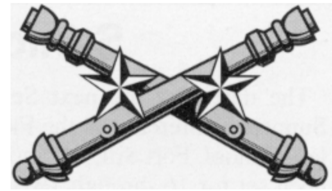
MAJOR GENERAL RANDALL L. RIGBY
Chief of Field Artillery

Precision Weapons— Not for *"All Seasons"*



Military history proves that successful armies anticipate future needs, determine requirements that meet those needs and then take advantage of the latest technology to fill those requirements. Although the nature of warfare evolves over time, this formula for success remains essentially the same. Developing the needs, requirements and solutions for 21st-century warfare demands we take a critical look at precision weapon technology.

Hi-Tech Cautions. One of the constants of warfare is that any advantage achieved through technology is a temporary gain. Sooner or later, rivals either develop effective countermeasures against the technology or acquire the same technology and employ it themselves. In the Middle Ages, highly skilled archers equipped themselves with the newly developed longbow and ended the effectiveness of armored knights mounted on horseback. Leaping forward to the 20th century, we've countered radar capabilities with stealth weaponry. It's imperative that as we design the Army After Next, we don't forget these lessons in military history.

Every armed conflict gives us a glimpse of future warfighting. We get insights about the weapons and tactics that warrant further research, development and refinement—the beginnings of a vision for the future. Operation Desert Storm was no different. It was the first battlefield test of weapons enhanced by precision technology.

But as capable and devastating as these weapons proved themselves, we must remember two important points. First, potential enemies are aware of our precision weapon capabilities. During Desert Storm, a global television audience watched just how precise our weapons could be as news networks broadcast images of a missile launcher's destruction through the eyes of gun-camera footage. We saw entire buildings reduced to rubble with little collateral damage.

Americans quickly became enamored with these weapons and marveled at the possibilities they offered. So did the rest of the world. Our coalition partners and adversaries alike learned the lessons precision technology had to teach. "Proof" of the effectiveness of these weapons was strewn across the desert.

Acquiring this type of weapons technology suddenly became an urgent goal of both friends and foes—a process made easier for them as a result of the research and development groundwork laid by the United States. The reduced overall cost of such weapons now allows other armies to buy them faster.

Ironically, it is because the rest of the world embraced our hi-tech approach that we must continue to fund and further refine our weapons technology. Clearly, we can ill afford to lag behind in improving, developing and, now, countering hi-tech weapons.

The second point is that we can't employ such capabilities in *all* battlefield situations. As glamorous as precision weapons are, we haven't used them in military operations since Desert Storm. Beginning with Operation Provide Comfort for the Kurds in northern Iraq in 1991 and extending through a string of other humanitarian and peacekeeping missions in Somalia, Haiti, Rwanda, Bosnia and Macedonia, our forces deployed to either deter or quell hostilities—not engage in them.

This presents yet another paradox: we must continue to develop our precision weapon technology capabilities and, at the same time, maintain a force that's not dependent on those capabilities. How, then, do we meet the challenges these stability operations at the opposite end of the spectrum present?

Forces on the Ground. Although precision weapons may create favorable conditions on the battlefield, they have limited value in deterring terrorists, warlords and guerrillas. In each of the deployments since Desert Storm, sizable ground forces capable of separating combatants and easing tensions were precisely what was needed. Only by maintaining a structure that allows us to physically mass forces on the ground can we serve conventional combat requirements—as illustrated by Desert Storm—and the range of other military operations we're likely to continue to be engaged in well into the next millennium.

Ground forces have both the flexibility, the stability and, most importantly, the staying power required for long-term stability operations. The images of highly trained soldiers deploying to trouble spots around the world sends a powerful message. After all, history also shows that the quality of the forces—not their weapons—very often determines victory.

Conclusion. Precision weapons technology will continue to be a dominant theme in the evolution of warfare. As our competitors acquire technology or asymmetrically modernize to counter our capabilities, we will lose the edge we've had and American forces will face greater risks.

But precision weaponry alone is not the answer to 21st century warfighting. As T.R. Fehrenbach wrote in *This Kind of War,* "you may fly over a land forever; you may bomb it, atomize it, pulverize it and wipe it clean of life—but if you desire to defend it, protect it, and keep it for civilization, you must do this on the ground, the way the Roman legions did, by putting your young men into the mud."

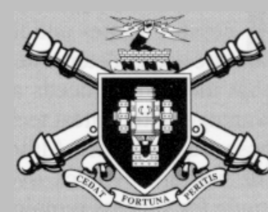
High-quality, highly trained combined arms forces capable of physically massing rapidly on the ground is required for all future threats.

Senior Fire Support Conference Dates Set

The dates for the next Senior Fire Support Conference at the Field Artillery School, Fort Sill, Oklahoma, have been set for 16 through 19 September 1997. The 97 Senior Fire Support Conference will focus on the theme "Training," as we proceed with Force XXI and the Army of the 21st century, to include fire support issues in doctrine, materiel development and joint operations.

Invitations to the conference will be sent to all Army corps and Marine Expeditionary Force (MEF) commanders, Reserve Component (RC) Army and Marine division commanders; selected retired general officers; Training and Doctrine Command school commandants; AC and RC corps artillery and Field Artillery brigade, division artillery and Marine regimental artillery commanders and their command sergeants major; and US Field Artillery Association corporate members. Corporate members and other companies also may have displays at the conference.

If units need more information, they should contact the G3, Training Command at Fort Sill: DSN 639-5460/4203 or commercial (405) 442-5460/4203. The Fax number is 7494 and works with both prefixes.



"Competence is Your Watchword"—FA NCOs, Embrace Your Hi-Tech Systems

The US Army is rapidly taking advantage of new technologies, and the Field Artillery is the undisputed pacesetter. The FA NCO faces unique challenges in his roles as subject matter expert and trainer for new systems being fielded today. Being computer literate is no longer an option for FA NCOs, it's a requirement—simply a matter of competence. Those who wish to advance must jump aboard this fast-moving technological train or risk being left behind.

I would remind my fellow NCOs of two profound statements in the "Creed of the NCO:" "Competence is my watchword" and "I will strive to remain tactically and technically proficient." We, as NCOs, must take the Creed seriously and be proactive in the rapidly changing face of the Field Artillery. It is our inherent responsibility to keep abreast of the giant leaps in technology the Field Artillery is taking and will continue to take as we approach the 21st century.

General William W. Hartzog [Commanding General of the Training and Doctrine Command, or TRADOC] wrote: "There are, in gross terms, two approaches. The first approach is characterized by standing on today's intellectual mountain top with an understanding of the present and seeing as far as one can see—or as one can afford—and then conservatively moving forward into the future a step at a time. The second approach is a bold one in which we intellectually go on a staff ride to a mountain top in the 21st century, look around and see what we can, and then articulate that as a vision for the future. That vision then becomes a starter set of ideas and thoughts to lead us forward into the future. We've taken this second approach."

The vision mentioned by the TRADOC Commanding General is now being molded and formed into that which will lead the Army into the future. At the forefront of this inevitable journey is the Field Artillery.

Hi-Tech History. The Field Artillery has been in the business of tactical and technical automation for more than 20 years with the Field Artillery tactical data system (FATDS). FATDS evolved around the tactical fire direction system (TACFIRE) complemented by peripheral devices, such as the battery computer system (BCS) used for technical fire direction at the battery level and the digital message device (DMD) used by forward observers (FOs) and fire support teams (FISTs) to initiate fire missions, send artillery target intelligence or limited free text messages. Additionally, the variable format message entry device (VFMED) was used at the brigade and task force (battalion) fire support elements (FSEs) to construct and implement artillery fire planning.

All the TACFIRE systems were large and cumbersome and rapidly became outdated due to technological breakthroughs made in the civilian sector.

Next, light TACFIRE (LTACFIRE) came. It used the same terminology and same basic software as the heavier TACFIRE but was small enough (large briefcase size) to be used by fire support personnel in light infantry divisions.

Then came the lightweight computer unit (LCU) with a removable hard disk drive. The LCU can be loaded with various software applications ranging from the initial fire support automation system (IFSAS) to BCS to the fire direction system (FDS) used by the multiple-launch rocket system (MLRS). Additionally, the forward entry device (FED) was introduced to FOs and FISTs for fire mission initiation.

Although the LCU and the lighter, more capable FED is a big step forward for the Field Artillery and its overall mission of providing fire support for maneuver forces, they are not user friendly. The LCU and FED require extensive training.

Additionally, IFSAS does not provide all the functions required for fire support command, control and communications (C^3). Thus, IFSAS is being replaced by the advanced Field Artillery tactical data system (AFATDS).

New C^3 System. AFATDS is a multiservice (Army and USMC with potential systems for direct connection with the Navy and Air Force) automated command and control system for fire support operations. AFATDS provides the C^3 solution to integrating responsive and reliable fire support.

Additionally, AFATDS will be a major component in the Army battle command system (ABCS). The other components of ABCS are the maneuver control system (MCS), forward area air defense command and control ($FAADC^2$), combat service support control system (CSSCS) and all-source analysis system (ASAS).

AFATDS supports the five fire support functional areas: planning, execution, movement control, FA mission support and FA fire direction operations. Its software operates on common hardware that consists of the tactical computer unit that has a removable magnetic disk cartridge with a two-gigabyte memory capability and 125 megahertz of speed. Additionally, there is a 650-megabyte optical disk drive, a 1.44-megabyte 3.5-inch disk drive and a 600-megabyte CD-ROM drive.

AFATDS software will be used at various levels throughout the battlefield, from fire direction centers (FDCs) to fire support elements (FSEs) to command posts (CPs). AFATDS provides distributed processing and ensures commonality and interoperability.

The LCU will continue to be used at various levels. The most notable of these is the introduction of the LCU to the company-level FIST. In this case the LCU will have a new color monitor, a 90-megahertz Pentium processor, 128-megabyte RAM and a one-gigabyte removable hard drive.

AFATDS is being fielded with the hand-held terminal unit (HTU) to be used by FOs and dismounted FISTs (replacing the FED) and also by commanders, fire support officers, scouts and reconnaissance elements. The HTU is lightweight (three and one-half pounds) and is about half the size of the FED.

Roll Up Your Sleeves. These tactical data systems will change the way we accomplish our mission. The Field Artillery of the 21st century will present new challenges.

Old systems are being replaced by high-tech, innovative tactical data systems that will require new training and present wartime challenges to all leaders, especially FA NCOs. Redleg NCOs need to roll up their sleeves and dive head first into all of the new equipment and technology being developed and fielded today and in the years to come. Only then will we be fully prepared to utilize these new systems, accomplish our mission and train our soldiers to fight and win on the battlefield of the future.

I would remind my fellow Field Artillery NCOs of the last sentence in the Creed: "I will not forget, nor will I allow my comrades to forget that we are professionals, Noncommissioned Officers, leaders!"

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HHB, 2-3 FA, 1st AD
Operation Joint Endeavor
Bosnia-Herzegovina, 1996

Through the Eyes of a 1SG: Battery (Light) Defense

A light battery in a defensive position needs the eyes of the first sergeant (1SG). He gathers up doctrine and graphical depictions of what a static battery position should look like and evaluates his unit's defense. He goes through his battery's tactical operational procedure handbook to ensure his unit meets all the parameters. He constantly asks himself, "Are we prepared?"

The good 1SG looks around the battery and notices when soldiers are sleeping during beginning morning nautical twilight (BMNT) or crew-served weapons are unmanned and corrects the situations. Furthermore, he checks listening post/observation post (LP/OP) guards to see if they're sleeping.

And when he finds too many problems, he asks the age-old question, "Are these discipline or training problems?" All battery soldiers must be thoroughly trained in essential basic soldiering skills (11B). Defensive skills through the eyes of a 1SG go beyond just his tactically evacuating casualties and logistical support (minus Class V considerations). He first ensures his soldiers have the basic skills, those skills that prepare them for wartime requirements. First sergeants should ask, "When is the last time my soldiers threw a live hand grenade, fired the AT-4, detonated a claymore mine and, most of all, qualified with their individual and crew-served weapons?" These skills should be at the top of every 1SG's priority list.

FM 6-50 Tactics, Techniques and Procedures for the Field Artillery Cannon Battery gives no guidance useful to a 1SG in those field crafts necessary for the battery's survival. Camouflage, reaction force techniques, placing crew-served weapons and active patrolling are just a few examples. They are left up to the 1SG.

Camouflage goes beyond placing nets over howitzers to hide them from enemy forces. Camouflage starts at the individual soldier with his proper use of face camouflage and his uniform.

The battery's reaction force must know those basic maneuvering skills required to close with an enemy, as outlined in *FM 7-8 The Infantry Rifle Platoon and Squad* and the Ranger Handbook SH 21-76. The 1SG must see that Redlegs routinely emplace crew-served weapons so they support the overall battery defense. He must see that survivability positions are constructed and concertina wire, mine fields or other obstacles are emplaced for his battery to survive.

One defense weakness in many artillery batteries is a lack of training on active patrolling. If we reviewed lessons learned at the Joint Readiness Training Center (JRTC), Fort Polk, Louisiana, we'd probably find most artillery units are infiltrated by not having an active defense. A Pre-Ranger Course should be required for section chiefs and above in light artillery units to gain some of these skills.

Survival starts with every soldier's contributing to the overall battery defense. In war, soldiers may find themselves performing a number of duties, as necessary. That's why the 1SG cross-trains his Redlegs as if their lives depend on it—because they do.

The eyes of a 1SG are very important for the commander, who's involved in many events. The 1SG must take the time to ensure battery procedures are rehearsed to standards and soldiers know the basics—taking nothing for granted.

FA units make delivering timely, accurate rounds down range their priority—and rightfully so. But it's up to 1SGs to ensure batteries survive to put those rounds down range. If as a 1SG of a battery in a defensive position, you have done all the things listed here, then at night you can close your eyes and rest comfortably, knowing your unit is secure.

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Commo: IFSAS Over MSE TPN

The 3d Infantry Division (Mechanized) Artillery, Fort Stewart, Georgia, some time ago experimented with connecting the initial fire support automation system (IFSAS) to the mobile subscriber equipment's (MSE's) tactical packet network (TPN), resulting in faster data transfer, increased transmission distance and improved accuracy throughout the battlefield framework. The IFSAS software can run on the MSE TPN while simultaneously connected to digital FM nets. The connection uses the X.25 protocol for data instead of the 802.3 local area network (LAN) port.

For those National Guard and other units that won't have the advanced FA tactical data system for some time, this alternative commo means could be very helpful. The connection allows greater distance separations from the division artillery headquarters to the division fire support element (FSE) at the division main command post (DMAIN) and division tactical command post (DTAC), maneuver and aviation brigade FSEs and supporting Field Artillery brigades. Additionally, the MSE TPN provides a direct data/digital link to the corps FSE, regardless of the FSE's location. The MSE TPN gives the fire supporter a reliable means of communications that has greater accuracy and speed.

The mechanics of the IFSAS-MSE TPN connection are rather simple. A wire is connected from the MSE small extension node (SEN) to IFSAS' lightweight computer unit (LCU). At the IFSAS LCU, WF-16 telephone wire is connected to a four binding post wire-line adapter. The other end of the wire is connected to a J-1077 junction box that's attached to the X.25 connection port on the SEN. Only quads 1 through 5 on the J-box are active because they're for packet switch connectivity.

Once the wire connection has been made, the IFSAS operator must power up the LCU. As the IFSAS software initializes, it registers with the tactical name server (TNS) in the MSE node center switch and receives an internet protocol (IP) address that goes along with its logical or subscriber name. The IP address uniquely identifies the LCU and allows it to transmit and receive data over the TPN.

This is a great medium for transmitting data over long distances; however, with every system there are shortcomings. For example, when the LCU deregisters with the TNS, the software must be restarted. This process takes anywhere from 5 to 10 minutes and can seem like an eternity if you are in the middle of a fire mission. Another disadvantage is that if you do not have dual-homed SENs and your packet switch goes down, you go out of contact with some of your subscribers until it is fixed and the software is restarted.

All-in-all, IFSAS over MSE TPN gives the fire suppoter the ability to execute real-time fire mission planning from any MSE TPN-supported FA battalion to the corps FSE.

MAJ Thomas E. Jenkins, SC
3d IN Div (Mech) Arty Signal Officer
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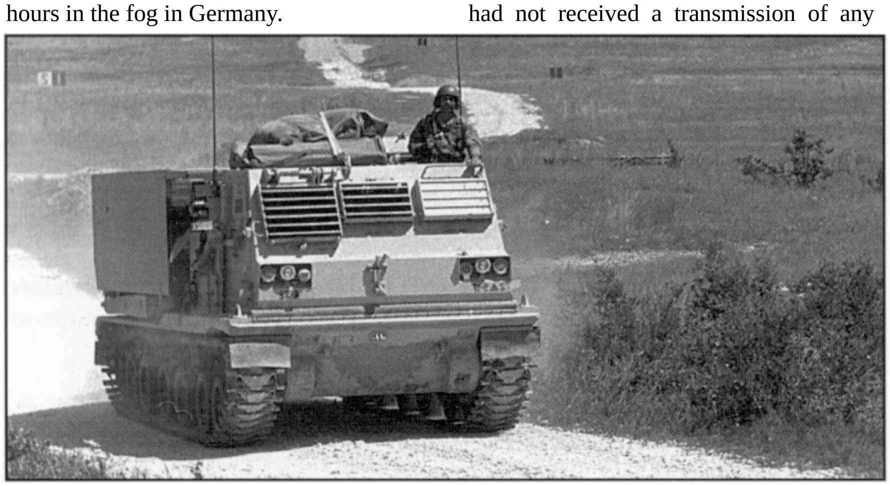
Commo for Dispersed MLRS

I read the article "The Problem with the OPAREA" by Lieutenant Colonel John M. House (September-October 1995) with some interest. In it he mentions on Page 3 that "dispersion in the nine grid squares inhibits command and control," especially when radios fail, reestablishing command and control may require personal visits and that it's possible to lose a self-propelled launcher-loader (SPLL) for hours in the fog in Germany.

As a platoon leader in C Battery, 1st Battalion, 92d Field Artillery at Fort Hood, Texas, with the 2d Armored Division, a similar problem existed. When contact with a SPLL was lost, the platoon leader treked out to locate it and reestablish contact.

After the first episode of this, we changed the platoon SOP [standing operating procedure]. When the SPLL had not received a transmission of any kind in 20 minutes (during normal operations and, therefore, due to radio failure), the SPLL section chief was to report to the platoon operations center (POC) on the 30th minute to reestablish communications.



A/92 FA (MLRS), 2d Armored Drvision

With this method, SPLLs were never again lost for hours, radio maintenance became a matter of pride and the leadership was able to concern itself with other matters. This system worked well during our 1986 NTC [National Training Center, Fort Irwin, California] rotation.

Concerns about SPLLs giving away their positions with unnecessary movement faded as having SPLLs located and available for firing far outweighed their being "lost" due to communications. Not once during a transit to the POC was a SPLL detected by the OPFOR [opposing force]. Sometimes, simply having the SPLL move from its hide position caused radio communications to be reestablished.

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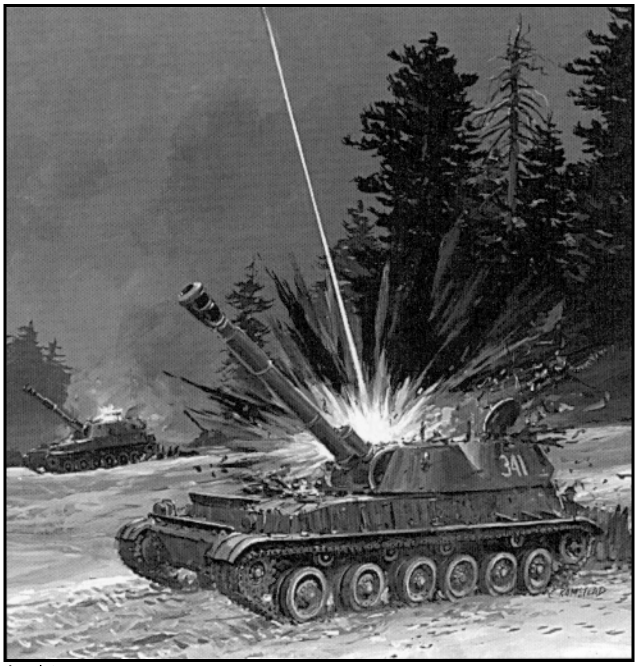
Improving the Effects of Fires with Precision Munitions

by John K. Yager and Jeffrey L. Froysland

The idea of a first-round target hit has long been the goal of the US Field Artillery. This would greatly reduce the number of rounds required to achieve the desired effects, thus reducing the logistics burden. A first-round hit also would minimize collateral damage and civilian casualties, allowing us to engage more targets on the battlefield—to include those in built-up or populated areas.



Aerojet

Toward this end, the Field Artillery has followed several paths more or less simultaneously: improving observer and target location accuracy using laser rangefinders, more accurate radars, vehicular-mounted gyroscopes, inertial guidance and the global positioning system (GPS); improving the howitzer's or launcher's ability to precisely aim toward a target; and developing steerable munitions and submunitions. Meeting the goal of a first-round hit also dictates we develop self-guided and "smart" munitions.

Today, three categories of cannon and rocket munitions are emerging as developmental trends: externally guided, self-directing and (or) inertially guided, and target-locating smart munitions. This article discusses the development of precision munitions in these trend categories for cannons and the multiple-launch rocket system (MLRS).

Cannons Munitions

Our first smart artillery projectile was the venerable Copperhead. First fielded in 1981, it has achieved mixed results. The concept was simple: illuminate the target with a coded laser that bounces off the target, which the projectile detects and uses to home in on the target. The concept sounds simple but, in practice, is more complex.

The National Training Center (NTC), Fort Irwin, California, has reported the Copperhead target-hit success rate is only approximately 70 percent; some units achieve no hits. Human errors are cited in most of the unsuccessful firings: failure to set the proper laser code on the projectile, failure to switch the observer's laser from rangefinding to designating, failure to properly designate the target and an inability to smoothly track moving targets.

In addition, the success of Copperhead hinges on an observer being able to see the target. At approximately $35,000 per round, cost is a drawback. Technical improvements for Copperhead are possible, but a complete set of hardware (projectile, designator and an interface so the two can communicate directly) is required to preclude most of today's problems. Although the Air Force Special Operations Command is building a laser-guided 105-mm projectile for use in AC-130 gunships, cost and waning Army interest in laser guidance has limited Field Artillery efforts in this area.

The second category of precision munition trends is self-directing, self-locating projectiles. The joint Army and Navy low-cost competent munition (LCCM) is a projectile that determines the difference between its desired point of impact and its actual point of impact and corrects its trajectory accordingly.

The LCCM will be developed in three phases. First is the LCCM "self-registering" munition, which uses a miniaturized GPS receiver and radio transmitter inside a standard-sized, fully functioning fuze. Interchangeable with any projectile, the fuze will gather ballistic data in flight and transmit the data back to the firing element. A three-round volley would provide enough data to determine registration corrections that would apply to all firing units in the area.

The Phase IILCCM is a "dragster" munition with small canards added to the Phase I design. The canards will deploy to slow the projectile after firing, correcting the projectile's range. As with Phase I, the fuze will use GPS to gather ballistic data in flight, but instead of transmitting this data back to the firing element, the fuze will calculate the corrections and deploy the canards to achieve the desired trajectory. Because slowing the projectile decreases range, the firing data would have to be for a point at a greater range on the gun-target line.

Phase III LCCM will have steerable canards to allow for deflection correction. As with the Phase II fuze, the Phase III LCCM would gather in-flight trajectory data, calculate corrections and actuate the canards. Instead of simply slowing the projectile to correct for a range error, the canards will rotate to guide the projectile either right or left to correct for a deflection error.

Work on the Phase I design is well underway; fielding is possible as early as FY 2001 if funding becomes available and development continues. Phase II work also is proceeding rapidly; it may be mature about the same time. The Phase III design still has challenges to overcome.

The LCCM fuze will be built to the dimensions of NATO standard fuzes, allowing its use on almost all artillery and mortar projectiles, not just a specific caliber.

Like the Copperhead, the LCCM offers some advantages, but it doesn't ensure first-round hit. For example, because LCCM-guided projectiles are guided to a specified grid location, target location error becomes a greater concern. Also, because probable error is not totally eliminated, the projectile won't provide point-target capabilities or be very useful against targets in built-up or populated areas.

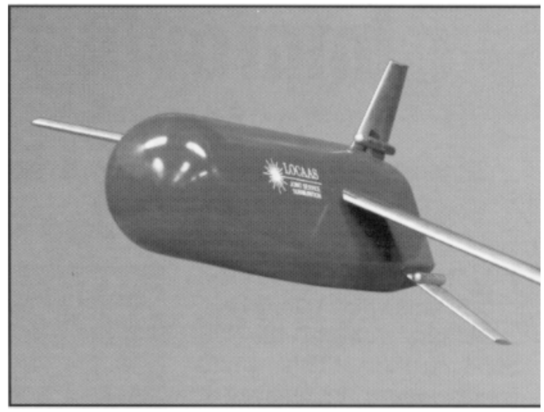
The third munition trend is target-locating smart munitions. The cannon "star" of this arena is the soon-to-be-fielded M898 search and destroy armor projectile, better know as SADARM. A 155-mm carrier projectile ejects two submunitions over the target area, and the submunitions pinpoint armored targets using three different target locating systems: active millimeter wave (MMW), passive MMW and infrared (IR). Each submunition then fires an explosively formed penetrator (EFP) to defeat the target from above.

Recent SADARM testing was very successful, even against target arrays employing countermeasures. Coupled with relatively accurate target location and a LCCM fuze, SADARM will take a major precision step forward. There is even some field interest in a 105-mm version.

Again, SADARM doesn't solve all our first-round hit challenges. Because the projectile is designed for use against armored targets, we can't use it against other point targets, such as bunkers and buildings. Also, the round isn't smart enough—it can't discriminate amongst different types of armored vehicles in the same area, making it just as likely to attack a self-propelled howitzer, as a tank, BMP, command and control vehicle, or even a large civilian vehicle like a bus or heavy truck.

Another version of SADARM, called SADARM PI (product improvement), is also under development. It will feature a larger search "footprint" and multiple EFPs to improve lethality and effectiveness against lightly armored targets (i.e., trucks) and towed artillery.

One interesting hybrid being discussed is a combination of the Air Force Special Operations 105-mm laser-guided projectile and a SADARM-type target-locating suite. The laser guidance package would allow us to engage point targets while the target-locating systems could be preselected for either independent operations or as a backup to the laser guidance. However, this hybrid is only a concept. What becomes of it remains to be seen.



LOCAAS has a laser and radar sensor package to detect, range and recognize targets.

Aerojet

MLRS Munitions

MLRS originally was envisioned as an area weapon—not a precision weapon in the sense that one rocket would destroy one target. MLRS was developed to be the counterfire weapon of the future, to place an enormous amount of submunitions onto the enemy's fire support systems and halt his ability to shape the battlefield through his use of artillery.

Today's need to shape the battlefield early, at depth and with precision resulted in the expansion of the MLRS family of munitions (MFOM) to contain both rockets and missiles.

Rocket Family. This family has evol-ved from the basic M26 rocket. We're looking at adding three rockets to this family: the extended-range MLRS (ER-MLRS), guided MLRS (G-MLRS) and MLRS smart tactical rocket (MSTAR) Each builds upon the improvements of its predecessor.

• *ER-MLRS.* To increase our range and reduce the dud rate (needs demonstrated in Operation Desert Storm), we're developing ER-MLRS. Although the rocket won't meet the goal of a first-round target hit, it will extend our rocket range to 45 kilometers. This range will increase a commander's ability to influence his battlefield at depth and fire across boundaries while also increasing the survivability of his launcher crews.

Additionally, ER-MLRS will reduce the number of duds, ensuring our forces are safer when they cross an area engaged with rockets and helping to safeguard noncombatants. The improved M85 dual-purpose improved conventional munition (DPICM) grenade in the ER-MLRS will be just as effective as the current M77 grenade but with fewer than one percent duds on the battlefield.

The ER-MLRS is now in low-rate initial production and scheduled for operational testing in FY 1998. Fielding will be in FY 1999.

• *G-MLRS.* This guided rocket is based upon the ER-MLRS, employing its rocket motor and M85 DPICM submunition. The addition of a guidance package to the warhead will provide the first MLRS munition that can attack both area and point targets. However, the use of DPICM submunitions restricts the target set to soft, lightly armored and stationary targets (BMPs, radars, trucks, etc.). The restriction on firing MLRS "danger close" remains, although the guidance package will reduce the minimum safe distance (MSD) from friendly forces.

The range of the G-MLRS is expected to be 60-plus kilometers with its accuracy three mils or less. The G-MLRS rocket will enter into the engineering, manufacturing and development stage after the ER-MLRS completes it operational assessment in FY 1998. Fielding is projected for FY 2002.

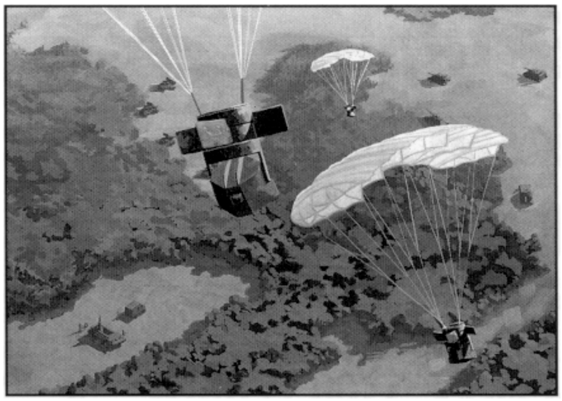
• *MSTAR.* This will be the first MLRS rocket to carry smart or brilliant sub-munitions. As the G-MLRS is based on its predecessor, so is MSTAR based on G-MLRS. MSTAR most likely will use the same motor and guidance package as G-MLRS; however, the warhead will carry smart or brilliant submunitions, providing a first-round hit against a more universal target set, including hot or cold, stationary or moving, and hard or soft targets. This capability, combined with a range of more than 60 kilometers, will allow the commander to shape his battlefield early, with fewer rounds and more effectively.

There are four submunition candidates for MSTAR: SADARM P1: low-cost autonomous attack submunition (LOCAAS); Damocles; and the improved anti-armor, brilliant munition (BAT), called the preplanned product improvement (P^3I) BAT. SADARM P1, as discussed earlier, is a smart munition with a large footprint that searches out armored targets and fires EFPs into the target from above.

LOCAAS uses a laser and radar sensor package for target detection, target ranging and target recognition. Its airframe design provides a large search pattern capability over the target area, and its multi-mode warhead allows it to attack hard or soft targets.

Damocles combines high-resolution infrared and millimeter wave sensors with a sophisticated high-speed processing unit for target recognition. The Damocles submunition uses a steerable parafoil, providing it a large search area, and a multi-functional warhead that can either fire an EFP or 27 individual slugs.

P^3I BAT uses a tri-sensor package combining acoustic, infrared and millimeter wave systems. It autonomously seeks targets with freedom-of-flight, enabling the P^3I BAT to locate targets within a large radius from the dispense point. It can attack hot or cold, stationary or moving, and soft or hard vehicles. The P^3I BAT also increases the munition's performance in adverse weather and against countermeasures and has an improved warhead that's more lethal.

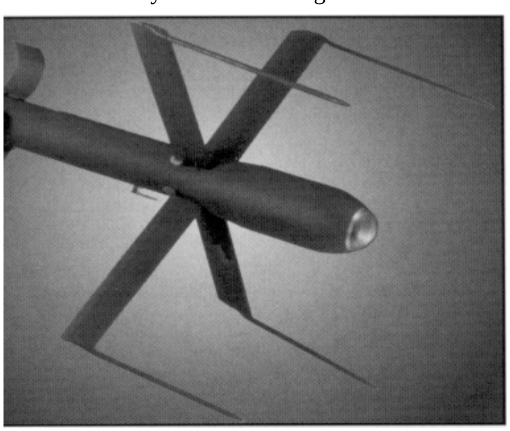


Damocles' steerable parafoil provides a large search area.
Courtesy of Textron

During the next several years, a series of evaluations and analyses will lead to the selection of MSTAR's submunition. The MSTAR engineering, manufacturing and development phase is scheduled to start in FY 2002.

Missile Family

What started out as a single missile program has evolved into the Army tactical missile system (ATACMS) family composed of five variants: Blocks I, IA, IB, II and IIA. Blocks I, IA and IB carry the M74 anti-personnel, anti-materiel bomblet with ranges from 25 to 499 kilometers, depending on block type. These three variants are primarily area weapons used for attacking soft, stationary targets, such as command and control, air defense artillery and logistical sites. Block I is fielded, Blocks IA and IB are scheduled for fielding in FY 1998 and FY 2004, respectively.



P^3I BAT autonomously seeks hot/cold, stationary/moving and soft/hard targets.

The ATACMS Blocks II and IIA are the precision engagement munitions of choice for armored targets in the ATACMS family of missiles. ATACMS Block II will carry 13 BATs or P^3I BATs to ranges of 35 to 140 kilometers. BAT is a dual-sensor (acoustic and infrared) submunition sometimes referred to as "brilliant" because, once dispensed, it autonomously seeks targets with freedom-of-flight direction, enabling BAT to locate targets within a large radius of the dispense point. Its primary target set will be moving armored formations.

The Block IIA missile extends the capability to attack at depths of 100 to 300 kilometers with six P^3I BATs that also can attack fleeting targets, such as transporter-erector launchers. The P^3I BAT is the same munition being considered for MSTAR.

Blocks II and IIA missiles are scheduled for fielding in FY 2001 and FY 2004, respectively.

The Chief of Field Artillery has stated clearly the goal for the artillery of the next century: "First-round target hit at ranges of 40 kilometers or more—or don't expect to be on the battlefield." Because weapons platforms may have reached their maximum potential in terms of ensuring first-round hits, precision munitions will make this vision a reality.

Fifty years ago, capabilities such as those of Copperhead, SADARM and BAT were "the stuff" of science fiction. Today they are science fact. The continuing sophistication and miniaturization of electronics may very well allow tomorrow's artillery to meet the goal of "one submunition, one kill" at deep targets unseen by our eyes.

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Jeffrey L. Froysland is an Assistant TRADOC System Manager for Rockets and Missiles (TSM-RAMS) working on rocket system and submunitions development at the Field Artillery School. He served in the Field Artillery in Germany and Korea, leaving the Army in 1989 as a Captain to work for the Directorate of Combat Developments (DCD) at the Field Artillery School. In DCD, he served in TSM-Target Acquisition before moving to TSM-RAMS. Mr. Froysland is a graduate of the Field Artillery Officer Basic and Advanced Courses and the Materiel Acquisition Managers Course at Fort Lee, Virginia, and is a Lieutenant Colonel in the Army Reserve Acquisition Corps.

Risk Estimate Distances for Indirect Fires in Combat

by Major Gerard Pokorski and Lonnie R. Minton

> **"Take calculated risks. That is quite different from being rash."**
>
> *General George Smith Patton, Jr. in a letter to Cadet George S. Patton IV, 6 June 1944*

Risk is inherent in war. At times, a commander must put his soldiers in harm's way to accomplish the mission. A combatant who is unwilling to put himself and his soldiers at necessary risk is doomed to defeat—regardless of other advantages.

The current climate in the armed forces has made us averse to risk, and rightfully so in a peacetime environment. But even in peacetime, most maneuver commanders realize that, in combat, they won't use the same measures they employ in live-fire training exercises to ensure the complete safety of the force. This is especially true for indirect fires.

Each new generation of infantry commanders asks its fire supporters the same question: "If I'm assaulting an objective, how close can my troops get before I have to turn off the mortars and artillery?" Good question.

This article discusses the difference between risk estimate distances and minimum safe distances (MSDs) and presents a table of the former to help the commander determine the level of risk he'll accept for covering his assaulting soldiers with indirect fires.

Current Sources of Safety Data

Using the guidelines in "Army Regulation 385-63 Policies and Procedures for Firing Ammunition for Training, Practice and Combat" or the MSD table in the recently rescinded manual *FM 6-141-1 Field Artillery Target Analysis and Weapons Employment: Nonnuclear* (U), we derive an MSD of approximately 350 meters for 105-mm rounds and 300 meters for 60-mm rounds with a 99 percent assurance that the damage radius will not extend to friendly positions. However, no dismounted soldier wants to assault the last 300 meters without indirect fires providing at least suppression on the objective.

History gives us many examples of soldiers intentionally calling in artillery less than 50 meters from their positions and surviving. The Battle of the Ia Drang Valley in Vietnam quickly comes to mind. Such examples lead fire supporters and infantrymen alike to be skeptical of MSDs' delineation of how close soldiers can come to friendly indirect fire.

Although the title of AR 385-63 includes the word "combat," the regulation clearly applies to training. Paragraph 1-1, "Purpose," states, "This regulation prescribes general safety precautions necessary to minimize the possibility of accidents in the firing and other uses of ammunition and explosives by troops in training...and *as much as possible* [emphasis added], combat and range operations, including range clearance." No other guidance is given in the manual for combat conditions.

An example of the training focus of the regulation is in Paragraph 10-1 that states firing mortars over unprotected troops is prohibited, except for troops in tanks located 100 meters or more from the line of fire. No caveat is given for combat. (An updated AR 385-63 soon will replace the AR but will be titled more accurately "Range Safety.")

Thus, many infantrymen and fire supporters see our MSDs as a peacetime training safety standard or, at least, a distance in combat in which there is virtually no risk to friendly casualties. A common refrain from the infantryman after the MSD is cited is, "If I'm willing to accept some risk, how close can I *really* get?"

For years, the Army has been publishing risk estimate distance tables (sometimes misnamed as MSD tables) for aerial-delivered munitions in its 6, 7 and 71-series field manuals. Figure 1 shows that the risk estimate distance for a MK 82 high-drag 500-pound bomb with personnel in prone position is 375 meters for a one-in-one-thousand probability of incapacitation (PI). However, the danger area in AR 385-63 for an 81-mm mortar is 350 to 400 meters. Comparing the two, it stands to reason that, in combat, we should be able to get closer than 350 meters from an 81-mm mortar round with acceptable risk.

Risk Estimate Distances for Indirect Fires

At the request of a live-fire observer/controller at the Joint Readiness Training Center, (JRTC), Fort Polk, Louisiana, we developed a table for indirect fire assets in the close fight (see Figure 2 on Page 10). We used the models and programs used to compute the aerial ordnance data in Figure 1.

The intent of the risk estimate distances table is not to be a safety guide that accounts for all possible variations in indirect fire weapons. The intent is to enable the combat commander to make informed decisions on the risk from friendly fire support when his troops assault an enemy position. Each commander can determine the amount of risk he's willing to accept based on the cover available, experience and posture of his troops, and accuracy and proficiency of the firing units. In essence, the table tells him that if the rounds land where they're supposed to, "this" is the risk based on the conditions outlined. He then analyzes his combat situation and acts accordingly.

The risk estimate table should not be seen as a restrictive document whereby the distances become new standards that commanders must not violate in combat. If the mission dictates, commanders

WEAPON	DESCRIPTION	MINIMUM SAFE DISTANCE	
		(10% PI)	(0.1% PI)
MK 82 LD	500-pound bomb	250m	425m
MK 82 HD	500-pound bomb	100m	375m
MK 82 LGB	500-pound bomb (GBU-12)	*	*
MK 83 HD	1,000-pound bomb	275m	500m
MK 83 LD	1,000-pound bomb	275m	500m
MK 83 LGB	1,000-pound bomb (GBU-16)	275m	500m
MK 84 LD	2,000-pound bomb	225m	500m
MK 84 LGB	2,000-pound bomb (GBU 10-22)	*	*
MK20 **	ROCKEYE CBU (antiarmor	*	*
2.75 FFAR	Rockets (various warheads)	100m	175m
SUU-11	7.62mm mini-gun	*	*
M-4/M-12/SUU-23/M-61	20mm Gatling gun	*	*
GAU-12	25mm Gatling gun	*	*
GPU-5A/GAU-8A	30mm Gatling gun	*	*
AGM-65 (AF)	Maverick missile (TV/IR/laser)	*	*
MK 21/29	WALLEYE I 1,000-pound bomb (TV guided)	275m	500m
MK 23/30	WALLEYE II 2,400-pound bomb (TV guided)	*	*
AGM-123A	SKIPPER 100-pound bomb (laser guided; rocket boosted)	275m	500m

* Minimum safe distances have not been determined.
** Not recommended for use near friendly troops.
PI - probability of incapacitation; LD - low drag; HD - high drag; LGB - laser guided bomb; FFAR - folding fin aircraft rocket; GBU - guided bomb unit.

Figure 1: "Close Air Support (CAS) Ordnance Reference Data" from *FM 71-123 Tactics and Techniques for Combined Arms Heavy Forces: Armored Brigade, Battalion/Task Force, and Company/Team* (Table 7-2 on Page 7-12)

can and should call in indirect fires much closer to their troops than the distances listed in the table. (See FM 6-141-1, Paragraph 4-15.) Because this table gives risk estimates for personnel assaulting (standing), the combat commander can reduce the risk of bringing fires closer than the table's distances by using the smallest caliber weapon system and positioning personnel prone and (or) behind cover.

Note that the risk estimate distances *do not* represent the maximum fragmentation envelopes of the weapons listed.

Distance Computations

The distances in the table allow the commander to estimate the risk in terms of the percent of friendly casualties that may result from an indirect fire attack against the enemy. The distances are based on fragmentation patterns.

Note that risk estimate distances are for combat use and *are not* MSDs for peacetime training. See the Joint Munitions Effectiveness Manuals (JMEMs), appropriate service or command guidance for peacetime or combat restrictions.

The data in Figure 2 are derived from *FM 101-62-1 JMEM, Fragmenting Munitions: Safe Distances and Assessment of Risk to Friendly Troops (U)* and the accuracy of the systems. The data is based on all attacks being perpendicular to the forward line of own troops (FLOT). Distances are determined from the intended mean point of impact (MPI) using an aiming policy appropriate for the systems. Probable errors for the systems (precision and MPI errors) are included in the risk estimate distance.

Assumptions. The distances assume that the firing unit has had its fires adjusted onto the target by an observer. For all determinations in Figure 2, the soldier was assumed to be standing (posture closest in the model to assaulting), in open terrain and on a line perpendicular to the line of fire.

Casualty Criterion. The casualty criterion is the serious-wound/lethal-wound criterion for a standing soldier in winter clothing and helmet. The PI for this criterion means the soldier is required to be evacuated from the battlefield. A PI value of less than 0.1 percent means the soldier has less than or equal to one chance in one thousand of sustaining injuries requiring evacuation.

Troops in Contact. Unless the ground commander determines otherwise, the fire support officer should regard friendlies within one kilometer of targets as "troops in contact" and advise the ground commander accordingly. Note that friendlies outside the 0.1 percent PI distance and MSD may *still* be subject to weapons fragments. Commanders and fire supporters must carefully weigh the choice of ordnance and the accuracy and proficiency of the firing unit in relation to the risk of fratricide.

Ground commanders must accept responsibility for the risk to friendly forces when targets are inside the surface danger zone parameters set forth in AR 385-63. When they approve the delivery of ordnance, they accept the risk inherent in those zone parameters.

With the risk estimate distances table, commanders can make informed decisions

• *Warning:* Risk Estimate Distances are for combat use and are not minimum safe distances for peacetime training. See the Joint Munitions Effects Manuals (JMEMS), appropriate service or command guidance ("Army Regulation 385-63 Range Safety" or *FM 90-20/FMFRP 2-72 Multiservice Procedures for Joint Application of Firepower)* for peacetime and combat safety restrictions.
• *Warning:* Risk Estimate Distances do not represent the maximum fragmentation envelopes of the weapons listed.
• *Basis of Calculations:* The distances were calculated based on data for troops standing (e.g., assaulting) in winter uniform with helmet (no fragmentation vest) on open terrain. This chart assumes the firing unit has had its fires adjusted onto the target by an observer.

				10% PI (Radius in Meters)			0.1% PI (Radius in Meters		
Caliber	# of Guns	System	Shell/Fuze	1/3 System Range	2/3 System Range	Max Range	1/3 System Range	2/3 System Range	Max Range
60-mm	3*	M224	HE/PD or VT	60	65	65	100	150	175
81-mm	3*	M29 M29A1	HE/PD or VT	75	80	80	165	185	230
105-mm	4*	M119 M102	HE/PD or VT	85	85	90	175	200	275
155-mm	4	M109 M198	HE/PD or VT	100	100	125	200	280	450
155-mm	4	M109 M198	DPICM	150	180	200	280	300	475
203-mm	4	M110	HE/PD or VT	195	235	275	365	390	520
5-Inch/38-mm*	1 Gun, Multiple Rounds	5"/38	HE/PD or VT	210	225	250	450	450	600
5-Inch/54-mm*	1 Gun, Multiple Rounds	5"/54	HE/PD or VT	210	225	250	450	450	600

*Current limitations in the model require computations for the number of weapons indicated although the number differs from the number of weapons in actual firing units.

*Naval surface gunfire's relatively flat trajectory results in a large range probable error. The dispersion pattern of the naval gun is roughly elliptical with the long axis in the direction of fire. The gun-target line and its relation to the forward line of own troops (FLOT) must be considered by the fire support officer (FSO) in selecting naval gunfire as a fire support means. Because of the movements of the ship while firing, the gun-target line may change. Friendly units should avoid the gun-target line. If possible, the gun-target line should be parallel to the FLOT.

Legend:

HE: High Explosive

DPICM: Dual-Purpose Improved Conventional Munition

PI: Probability of Incapacitation (This means a soldier is required to be evacuated from the battlefield. A PI value of less than 0.1% can be interpreted as being less than or equal to one chance in 1,000 of requiring evacuation.)

PD: Point-Detonating Fuze

VT: Variable-Time Fuze

Figure 2: Risk Estimate Distances for Observed Fires

regarding when to shift friendly indirect fires during an assault. Instead of knowing only the limit of total safety, they can balance risks with indirect fire effectiveness to get the assault force as close as possible to its objective before the battle becomes strictly a direct fire contest.

It has been many years since the United States has been involved in a protracted conflict against a foe determined to overcome our technological advantage by "hugging our belt" and bringing the fight in close. Regardless of technologies, the close fight will always be with us.

The risk estimate distances table will help commanders determine the risk they will accept from friendly indirect fires to accomplish the mission.

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Lonnie R. Minton has been an Operations Research Analyst with Tec-Master, Inc., Lawton, Oklahoma, since 1995. For 25 years, he worked in the Directorate of Combat Developments in the Field Artillery School, focusing on test design, model development and database development. In the latter, he specialized in data for computing the terminal effects of weapons against targets. He was the FA's Coordinator for Joint Munitions Effectiveness for 24 years and Chairman of the Study of Artillery Effects (SAE) Group for five years. He holds a Master of Science in Mathematics from the Florida Institute of Technology.

Iraqi 122-mm SP Howitzer in 1991; Photo by CWO4 Kenneth Brooks, USMC

Removing the Unknown from Counterfire BDA— A 90 Percent Solution

by Major Raymond C. Hodgkins

The development and validation of a battle damage assessment (BDA) model was one of the results of the 10th Mountain Division (Light Infantry) Battle Command Training Program (BCTP) Warfighter exercise last October at Fort Drum, New York. The BDA model provided the 10th Division Artillery Commander a fairly accurate estimate of the disposition of the enemy's indirect fire systems—accurate enough to help in counterfire decision making.

The model combines both the art and science of BDA to produce a "Murder Board"—a snapshot of the enemy's indirect fire strengths at a given period in the battle. The scientific portion of the model is the estimation of the effects of specified volleys of shell/fuze combinations as listed in the Joint Munitions Effectiveness Manuals (JMEMs). The model also takes into account what we know about the doctrine and tactics of the enemy.

The artistic portion of the model relies on the division artillery S2's templating skills and two "rules of thumb" for the minimum time required to execute general support (GS) fire missions from acquisition to steel on target. The end state is an approximately 90-percent solution that helps the division artillery commander in the critical counterfire fight.

The Model. The model, in principle, is simple. In conjunction with the Field Artillery intelligence officer (FAIO) and the division G2, the division artillery S2 determines the initial enemy order of battle, including the number and types of his fire support systems. This estimate comprises the listing on the artillery Murder Board. (See the sample page of a Murder Board in Figure 1.) Once the shooting starts, the S2 crosses the enemy systems off the Murder Board (blackens in the holes on the matrix in Figure 1) when damage is observed or unobserved fires comply with the rules of thumb. The model accounts for the many sources in the division that can capture BDA.

Type	Unit	MM	# of Tubes
2S5	1/101 National Artillery	152	000000000000000000
2S5	2/101 National Artillery	152	000000000000000000
D-20	3/101 National Artillery	122	000000000000000000
D-20	4/101 National Artillery	122	000000000000000000
D-20	5/101 National Artillery	122	000000000000000000
BM-22	1/101 National Rocket	220	000000000000000000
BM-22	2/101 National Rocket	220	000000000000000000
BM-22	3/101 National Rocket	220	000000000000000000
2S5	1/601 National Artillery	152	000000000000000000
2S5	2/601 National Artillery	152	000000000000000000
2S5	3/601 National Artillery	152	000000000000000000
2S5	4/601 National Artillery	152	000000000000000000
2S5	5/601 National Artillery	152	000000000000000000
S23	601 National Artillery	180	000000000000000000

Figure 1: Murder Board. This is one page of a chart that tracks battle damage to enemy artillery systems. The initial listing is based on military intelligence and knowledge of the enemy's doctrine and tactics. When the battle begins, the division artillery S2 blackens in a circle for every system neutralized or destroyed.

For battle damage caused in observed fires, the fire direction officer (FDO) in the direct support (DS) battalion tactical operations center (TOC), the FAIO at the division main command post (DMAIN) and the fire support officer (FSO) at the maneuver brigade fire support element (FSE) collect the artillery BDA for consolidation by the counterfire officer at the FA brigade TOC. These reports capture what the forward observers (FOs) saw on the battlefield.

For unobserved GS fires, the BDA is collected and consolidated by the counterfire headquarters—the FA brigade. Because there are no observers to count the damaged tubes or launchers, the model relies on mission-fired reports (MFRs) for missions executed within a certain time.

During Dragon Summit, the 10th Division Artillery applied two time rules before assessing battle damage on unobserved targets. The first was for fires delivered by the counterfire headquarters. In this case if rounds were sent down range within five minutes of the moment the target was acquired by the Q-37 Firefinder radar, then the counterfire officer in the FA brigade TOC assessed the damage according to the JMEM.

The FAIO in the DMAIN applied the second rule. In this case if a division-level delivery system—fixed-wing air, attack helicopter, Army tactical missile system (ATACMS), etc.—attacked a stationary target within 30 minutes, then the FAIO determined the damage by the JMEM. For BDA to be posted on the Murder Board, the unobserved mission fired had to be executed within the time specified by the rules. This time constraint ensured the targeting data was still valid when the mission was fired.

The FAIO in the DMAIN plays an important role in artillery BDA collection. (See the "FAIO's Steps in Killing a Target" on this page.) He accounts for not only the unobserved fires executed within 30 minutes, but also observed fires from assets available at the division-level—for example, special operations forces (SOF) or unmanned aerial vehicles (UAVs).

The FAIO, the S2 at the division artillery TOC and the counterfire officer at the FA brigade TOC each independently updates his copy of the Murder Board, analyzing the raw BDA data, and then pools the information collected every four hours. The fire supporters at these organizations resolve discrepancies among the Murder Board versions before updating the division artillery commander.

Baptism Under Fire. At the beginning of the exercise, the 213 enemy systems recorded on the Murder Board (enemy strength based on knowledge of/intelligence on the enemy) as compared to the 202 actual systems were about 95 percent accurate. This initial estimate set a solid data base upon which to determine BDA when the Warfighter preparation fires began.

Figure 2 shows the actual and perceived enemy strengths recorded approximately 24 hours after the exercise started. The Murder Board statistics reflect that the 10th Division had reduced the enemy's indirect fire systems by 127 systems with a perceived total of 86 systems remaining. In reality, the enemy had lost 67 of its indirect fire systems for an actual total of 135 remaining systems—a 36 percent disparity between reality and the Murder Board. (At this point in the battle, unobserved counterfires accounted for nearly 90 percent of the BDA on the Murder Board.) Clearly, the model needed to be

Iraqi D-30 Howitzer, 1991

FAIO's Steps in Killing a Target

1. A target is acquired.
2. The Field Artillery Intelligence Officer (FAIO) at the division main command post (DMAIN) checks the time of acquisition to ensure the targeting data is still valid.
3. The FAIO evaluates the target: is the target on the high-payoff target list (HPTL), is the target location error (TLE) of the collection asset good enough and are there enough firing units and ammunition available? If the acquirer's TLE is too imprecise to fire a target on the HPTL, the FAIO can initiate collection by a more accurate acquisition asset.
4. If target data meets the requirements, the FAIO generates a fire mission; delivery assets include the Army tactical missile system (ATACMS), attack helicopters, fixed-wing aircraft, naval surface fires, etc.
5. When the time the target was fired is sent back to the FAIO, he assesses battle damage. For unobserved fires, he assesses battle damage from the Joint Munitions Effectiveness Manual (JMEM) if a target acquired by the all-source collection element (ACE) was attacked within 30 minutes or if a target acquired by a Q-37 radar was attacked within five minutes. He records the damage to enemy artillery systems on the Murder Board, a "bean-counting" document also maintained by the S2 at the division artillery tactical operations center (TOC) and the counterfire officer at the FA brigade TOC.
6. When the shot time does not get sent to the FAIO, he can use intelligence collectors, such as the unmanned aerial vehicle (UAV) or special operations forces (SOF), to assess the damage. He records the battle damage observed by the UAV or SOF on the Murder Board.
7. Every four hours, the FAIO shares his Murder Board information with the division artillery S2 and FA brigade counterfire officer.
8. A new target is acquired, and the steps repeat themselves.

MAJ J.C. Pollman, FA
FAIO, Div FSE
10th Mtn Div (Lt IN), Fort Drum, NY

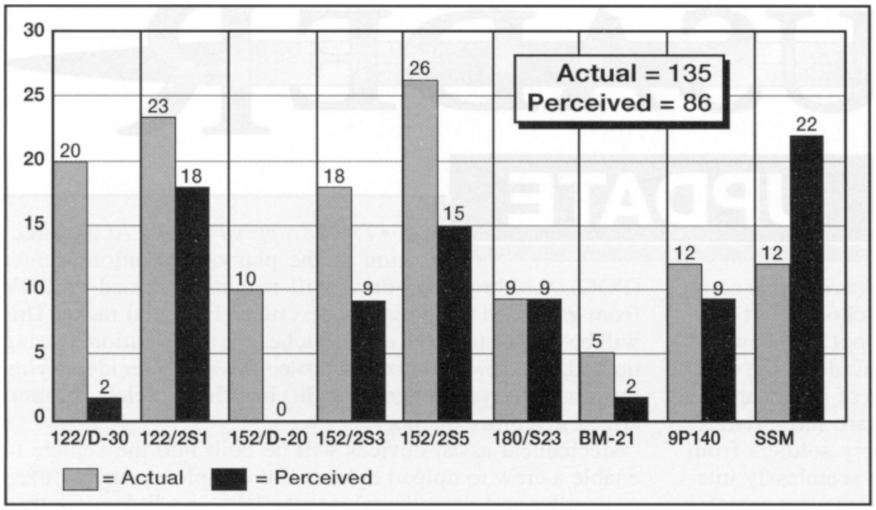


Figure 2: Initial BDA Model Statistics. This figure charts the actual and 10th Mountain Division Artillery's perceived battle damage statistics on enemy artillery strengths collected by the BCTP observer/controllers 24 hours after the Dragon Summit Warfighter exercise started. Based on the initial BDA model, this data shows a 36 percent disparity between the actual and perceived enemy artillery strengths; the model had not accounted for enemy replacement systems.

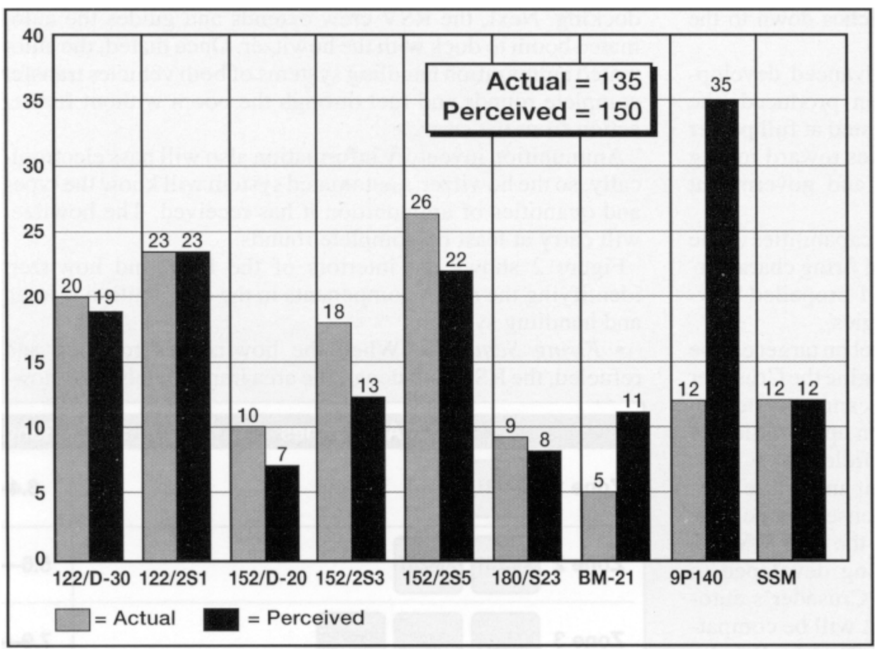


Figure 3: Modified BDA Model Statistics. Based on the revised model, this figure charts the actual and 10th Mountain Division Artillery's perceived enemy artillery strengths 24 hours after the exercise started; the data was collected by the BCTP observer/controllers. The perceived battle damage statistics were about 90 percent accurate—accurate enough to be useful for decision making.

refined to provide accurate enough information for decision making—regardless of the fact that the data was based on the less accurate unobserved fires.

Tweaking the Model. The primary difference between the original model and the tweaked model was the accountability of the enemy's resupply and repair capabilities. The original model failed to account for the enemy's replacing his destroyed or damaged enemy indirect fire systems. In the Dragon Summit Warfighter scenario, he could replace or repair approximately 50 percent of his losses within 24 hours.

In Figure 2, the enemy's actual total strength of 135 operational systems accounts for the replacement of 34 enemy systems (50 percent rate); however, the Div Arty's perceived estimate of 86 operational systems did not account for any replacement tubes; this oversight contributed to the disparity between the two totals.

Figure 3 reflects the revised BDA data from the tweaked model. As compared to Figure 2, the perceived enemy strength total went up from 86 to 150 systems by adding the estimated 50 percent replacements to the estimated total losses. Because the number of actual losses (67 systems) was unknown at that time, the 64 replacement systems added to the total was calculated using 50 percent of the perceived losses (127 systems). A comparison between the actual and perceived totals produced a respectable 10 percent disparity.

Conclusion. Knowing the actual strength of the enemy's indirect fire systems would allow the division artillery commander confidently to focus his limited friendly artillery assets on the battlefield. Unfortunately, the enemy does not volunteer this information. During Dragon Summit, the estimates from the Murder Board were, perhaps, the next best thing.

The 10th Mountain Division Artillery's model provided a fairly accurate and reliable tool that accounted for BDA from both observed and unobserved fires. The Murder Board provided the division G2, FAIO, FA brigade counterfire officer and division artillery S2 common information on the enemy's artillery order of battle for targeting.

Undeniably, the revised model aided the 10th Mountain Lightfighters to defeat the enemy during Dragon Summit.

Major Raymond C. Hodgkins is the Assistant S3 of the 10th Mountain Division (Light Infantry) Artillery at Fort Drum, New York. In his previous tour, he earned a Master of Art in National Security Affairs from the Naval Post Graduate School, Monterey, California. He also has served as S3 of the 4th Battalion, 27th Field Artillery, 41st Field Artillery Brigade in Germany; Plans Officer for VII Corps Artillery during Operations Desert Shield and Storm; and Counterfire Officer for the 41st Field Artillery Brigade in Germany. For two years, Major Hodgkins commanded B Battery, 6th Battalion, 27th Field Artillery, part of the 75th Field Artillery Brigade, III Corps Artillery, Fort Sill, Oklahoma.

CRUSADER UPDATE

Program Update. The first in a series of Crusader Battle Lab Warfighting Experiments (BLWEs) was recently completed at the US Army Field Artillery School, Fort Sill, Oklahoma. These experiments allow the school to review and refine emerging operational doctrine for Crusader at the same time United Defense Limited Partnership of Minneapolis, Minnesota, is designing the system's hardware and software.

During the first BLWE, III Corps Artillery soldiers from Fort Sill used live tactical control systems seamlessly integrated with simulated maneuver forces and Crusader vehicles to fight a Southwest Asia-based battle. Crusader's "shoot and scoot," mobility and automated resupply tactics were validated, allowing the user to gain valuable insight into the command and control of Crusader.

The next BLWE is scheduled for mid-1997 at Fort Hood Texas, with players from the 1st Cavalry Division. The focus of this BLWE again will be on Crusader tactics down to the battery level.

The Crusader program is currently in advanced development. Crusader's specifications have been produced, the 1,500 horsepower diesel engine has been tested at full power and development of all subsystems continues toward rolling out prototypes in late 1999 for industry and government testing.

Shoot. This update highlights the "Shoot" capabilities of the Crusader system, including the resupply and firing characteristics of the resupply vehicle (RSV) and self-propelled howitzer and how we'll employ these technologies.

For academic purposes, putting enough steel on target can be thought of as a "pipeline flow" problem. Imagine the Crusader system as the biggest "pipe" (most efficient cannon system to be fielded in the world) and you will gain an appreciation of the impact Crusader will have on the battlefield.

• *Ammunition.* Crusader will fire all current and future 155-mm projectiles and fuzes, including the sense and destroy armor (SADARM) projectile. In addition, the new XM773 multi-option fuze artillery (MOFA) is being developed to reduce logistics burdens and capitalize on Crusader's automated ammunition handling system. MOFA will be compatible with Crusader as well as other 155-mm systems—Paladin and the towed M198. MOFA will be set electronically and function in four modes: time (T), variable-time (VT), super-quick (SQ) or delay.

Crusader won't fire the current bag charges: the M3, M4, M119 or M203 series of propellants. Instead, Crusader will have a new solid propellant known as the modular artillery charge system (MACS).

MACS consists of two different combustible case charge increments: the XM231 and XM232. The increments will be shaped and sized like coffee cans and built to withstand the rigors of machine handling. MACS will provide zoning solutions for all ranges up to 40 kilometers. The increments will be fired in combinations as shown in Figure 1.

• *The Resupply Process.* At the direction of the platoon operations center (POC), the three-man crew will manually upload its RSV from grounded palletized load system (PLS) flat racks. This will be the last time the crew touches the ammunition. During upload, the crew will fuze the projectiles and enter identifying information (type, lot and weight) into the vehicle's computerized inventory memory.

Mechanical-assist devices will be built into the vehicle to enable a crew to upload at least 130 complete rounds (fuzed projectiles and propellants) into the RSV in a little more than an hour. Concurrently while the crew is uploading the RSV, a petroleum, oil and lubricants (POL) tanker will refuel the RSV.

The RSV then will move either to a hide area or to a howitzer that needs ammunition. To initiate rearm operations, the RSV approaches the rear of the howitzer and positions itself for docking. Next, the RSV crew extends and guides the automated boom to dock with the howitzer. Once mated, the automated ammunition handling systems of both vehicles transfer complete rounds and fuel through the boom without further action from the crew.

Ammunition inventory information also will pass electronically, so the howitzer's automated system will know the types and quantities of ammunition it has received. The howitzer will carry at least 60 complete rounds.

Figure 2 shows the interiors of the RSV and howitzer, identifying the major components in the ammunition storage and handling system.

• *Firing Sequence.* When the howitzer is rearmed and refueled, the RSV will depart the area immediately. The howitzer

	MACS Zones						Range Bands
Zone 1	XM231						3.4—7.9 km
Zone 2	XM231	XM231					5.6—11.9 km
Zone 3	XM232	XM232	XM232				7.9—20.2 km
Zone 4	XM232	XM232	XM232	XM232			10.4—24.7 km
Zone 5	XM232	XM232	XM232	XM232	XM232		15.8—30.5 km
Zone 6	XM232	XM232	XM232	XM232	XM232	XM232	19.0—40+km

Figure 1: Modular Artillery Charge System (MACS) Zones. MACS has two combustible case charge increments—XM231 and XM232. The increments are fired in combinations to provide zoning solutions for ranges up to 40 kilometers (kms).

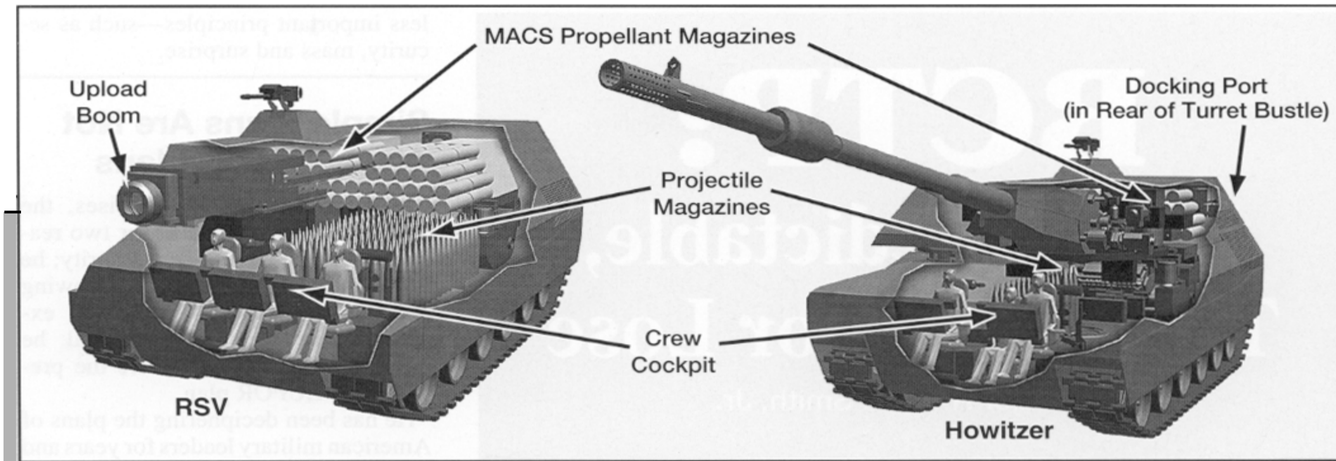


Figure 2: Locations of Major Components for Ammunition Handling and Storage

will employ standard occupation-of-position tasks but will accomplish them faster and with fewer demands on the crew through the use of automation. For example, the howitzer's sensors automatically will perform site-to-crest and local security, both overseen by a crewman watching his display monitor. The howitzer automatically will generate and send the chief of section's occupation report to the POC.

The crew's burden associated with firing a mission also will be reduced greatly. Fire orders will be transmitted digitally from the POC to Crusader's computer to calculate its firing solution. The howitzer will disengage the travel lock and use information from its position and navigation (POS/NAV) system to automatically orient the cannon on the correct deflection and quadrant elevation.

Simultaneously, the howitzer will choose the correct projectile from its magazines, set the fuze for the proper functioning mode and time, load the complete round into the breech and place the right number of MACS increments behind it. (See Figure 3.) With the Crusader howitzer laid on the target and ready to fire, the crew's final action will be to fire the projectile by igniting the MACS increments via laser.

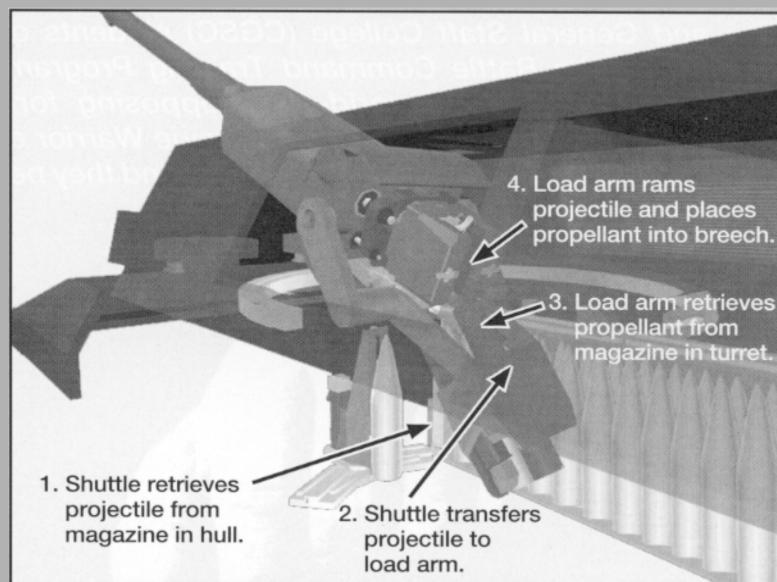


Figure 3: Breech and Autoloading Equipment

At no time during resupply or firing will any of the crewmen leave their seats in the forward portion of the vehicle. This high degree of automation ensures Crusader will respond to fire missions within 20 seconds when emplaced or within 45 seconds from the move.

An on-board velocimeter will measure the velocity of each round as it exits the muzzle of the tube, and a projectile tracking system will track the round past apogee. These measurements will be fed back into the fire direction computer to provide continuous corrections for subsequent rounds. In this manner, the howitzer will correct for tube wear, different Met conditions, changes in gun position caused by recoil and different propellant lots.

• *The Armament System.* To achieve the required range of 40 kilometers with the M549A1 rocket-assisted projectile (RAP), Crusader will use the XM297 cannon. This new design will have a multi-lug, downward-opening breech block coupled to a tube 52 to 56 calibers in length. This is in contrast to the interrupted-screw breech block and 39-caliber tube on Paladin.

To sustain the required maximum rate of fire of 10 rounds per minute, Crusader's cannon will use a revolutionary approach called integral mid-wall cooling (IMC) to limit heat buildup after firing. The system will circulate a modified antifreeze mixture through passages built into the wall of the tube and through exterior-mounted cooling jackets located forward of the IMC portion of the tube.

Crusader also will be capable of firing multiple-round, simultaneous impact (MRSI) missions—one-gun time-on-target missions.

Conclusion. Crusader's automated shooting capabilities will set the standard for future self-propelled artillery. By providing responsive, accurate and continuous fires, Crusader will dominate the close battles fought by Army XXI.

MAJ John R. Holland, FA
Field Artillery School Representative
Team Crusader, Minneapolis, MN

BCTP: Be Unpredictable, Take Risks—or Lose

by Major R. Powl Smith, Jr.

For the first time in history, the 1996 Command and General Staff College (CGSC) students defeated the Battle Command Training Program's (BCTP's) vaunted world-class opposing force (WCOPFOR) during the annual Prairie Warrior exercise at Fort Leavenworth, Kansas. And they beat the WCOPFOR quite soundly.

Senior BCTP Observer General (Retired) James Lindsay said it was the best performance of a student corps and one of the best ever performances of a blue force (BLUFOR).[1] How did the II (Student) Corps defeat the WCOPFOR? II Corps exercised one of the most overused buzz phrases in the Army: "think 'outside the box.'" In short, II Corps studied the WCOPFOR's application of the principles of war of *security* through his masterful use of deception, *mass* and *surprise* and turned the tables on him.

BLUEFOR commanders and their staffs usually are predictable—they opt for the safe, conventional, "two up, one back" answer to tactical problems. In part, this is due to their adherence to another principle of war: simplicity. In war, even the simplest tasks are difficult—no one will deny that. However, slavish application of "simplicity" can preclude the application of other, no less important principles—such as security, mass and surprise.

Simple Plans Are Not Always Good Plans

In most Warfighter exercises, the WCOPFOR is successful for two reasons. First, he emphasizes security; he prevents the BLUFOR from knowing his plan, usually through a well executed deception effort. Second, he quickly and easily deciphers the predictable BLUFOR plan.

He has been deciphering the plans of American military leaders for years and is very good at it. Therefore, if it's a simple plan, the WCOPFOR probably can figure it out very quickly—which puts him inside the BLUFOR decision cycle, giving him the initiative.

Having lost the initiative, the BLUFOR must rely on its technological edge.[2] It must use its better intelligence sensors and better attack helicopters, tanks and artillery to win—a matter of brute force instead of tactical finesse. This tends to result in the BLUFORs conducting a series of almost Napoleonic frontal assaults.

But the WCOPFOR is ready for the high-tech bludgeoning. Time and again he has countered brute force attacks by applying the principles of security, mass and surprise. He maintains security, masses his artillery on "strike sectors" and then masses his maneuver forces in a surprise envelopment. The WCOPFOR fights to win while the BLUFOR fights to gain a draw or a pyrrhic victory.

II Corps adopted the WCOPFOR's own "recipe" to beat him: one defeats a high-quality opponent by getting inside his plan and denying him yours. At Prairie Warrior 96, the II Corps Commander and staff chose security over simplicity. They developed and fully resourced a deception plan and executed a complex operational plan, both of which exploited the WCOPFOR's own predictability. II Corps took risks to achieve mass and surprise.

Know Thy Mission

In mission and task analysis, II Corps made two assumptions. First, to win, the corps had to take and keep the initiative. More experienced at fighting in the corps battle simulation (CBS), the WCOPFOR had advanced pucking (computer) skills, battle drills and tactical command and control (C^2) procedures that could be devastating if he gained the initiative as he usually did. Therefore, II Corps had to control the fight from the start.

Secondly (and no surprise to anyone experienced at BCTP), II Corps had to beat him decisively in the deep fight. The corps had to desynchronize his plan, coax and corral him and defeat his center of gravity, his massive artillery force. II Corps could not let the WCOPFOR close unscathed on friendly units or mass his considerable fires. It had to neutralize or destroy his artillery, especially the many long-range multiple rocket launchers (MRLs).

The corps mission was difficult: rapidly penetrate an infantry army defending behind a series of major rivers, then fix and rapidly defeat the advancing army group reserve. The WCOPFOR defense consisted of two weakened infantry divisions augmented by more than 350 army-level guns and MRLs. Although he had to cover a sector 60 to 70 kilometers wide, he had the advantage of defending from behind a series of rivers, all of which required engineer support to cross. While II Corps had a 3:1 combat power advantage, the artillery was 1:1. That left II Corps conducting opposed river crossings under heavy artillery fire, a huge tactical challenge.

After crossing the rivers and penetrating the WCOPFOR's defense, II Corps faced a meeting engagement with a force of comparable or greater size and combat power: the 39th Mechanized Corps with more than 500 T-80B tanks, 1,000 BMP-2 infantry fighting vehicles, 400 artillery tubes and 100 MRLs plus additional artillery and maneuver units attached from the army level. II Corps was tasked to meet and defeat this powerful corps.

The ground II Corps would fight on was a tactical nightmare (see Figure 1). The corps area of operations was bisected and dominated by the Harz Mountains with major rivers bordering both ends. The high ground of the key terrain on the eastern side of the mountain mass dominated both the Salle River crossing and "The Turntable," a road nexus that controlled lateral north-south movement in the corps area of operations. The corps had to decide whether to send the main effort north or south around the Harz Mountains (through the Harz was even considered).

The mission was force-oriented—fix and defeat the 39th Corps—so II Corps had to go where the 39th went. II Corps couldn't afford to guess wrong about which way the 39th Corps was going and let him get into its rear. So, II Corps had to decipher the WCOPFOR's plan.

Know Thy Enemy

The WCOPFOR's doctrine states he prefers the meeting battle, but not an unconstrained free-for-all Americans often envision. His maneuver of choice is a find-fix-set-envelop battle drill tailored for the meeting battle (Figure 2 on Page 18).

Further, the WCOPFOR likes to isolate tactical fights, singling out and massing fires and maneuver against one battalion, one brigade at a time. If forced to fight in more than one direction, he can't mass effectively.

One of his greatest weapons is his operational and tactical security, allowing him to execute deception plans that enable him to achieve mass and surprise at the decisive point and time. In the January-February 1996 Center for Army Lessons Learned (CALL) Newsletter, "News from the Front," the article, "Deception and the WCOPFOR," by the (then) WCOPFOR Commander, Lieutenant Colonel Richard T. Lambert, explains the WCOPFOR's most effective tool—deception.

The WCOPFOR's unwritten motto is "Trust in 'Blue,'" meaning BLUEFOR leaders, American military leaders, are imminently predictable. This predictability starts with the over-application

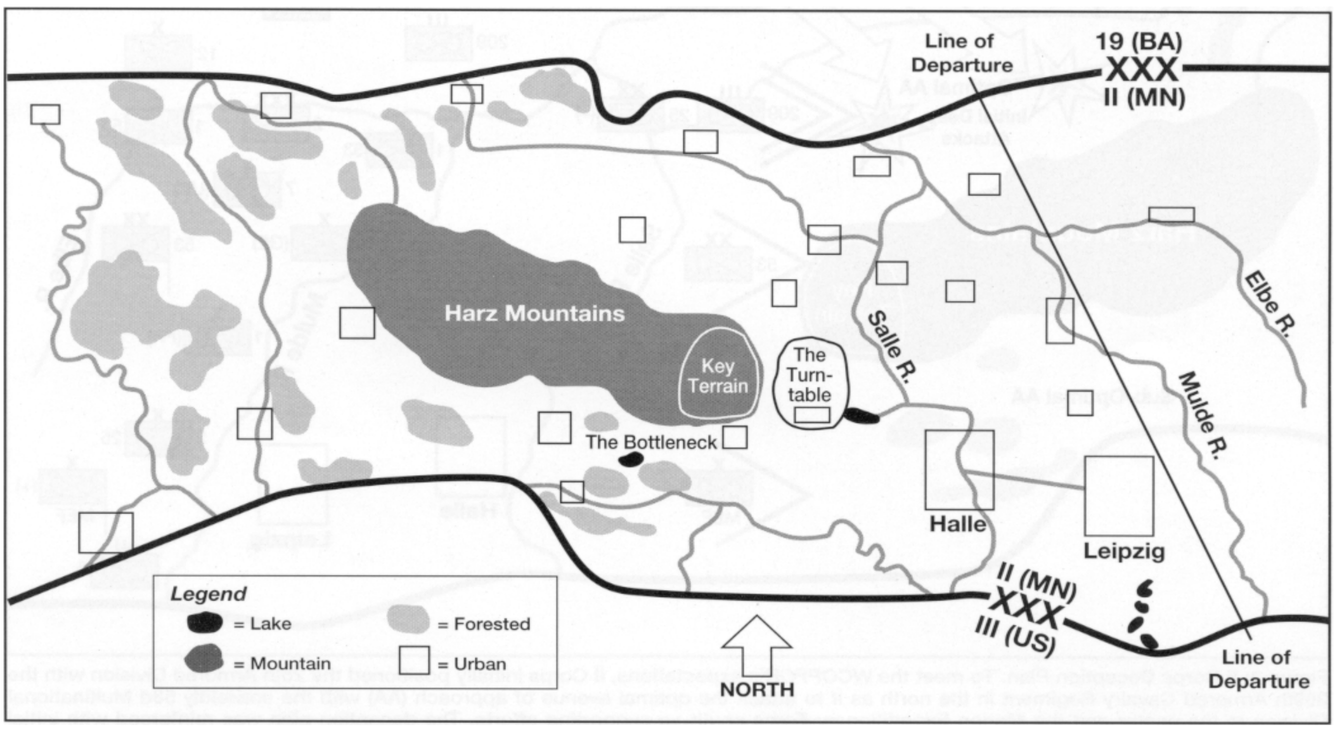


Figure 1: II Corps Area of Operations, II (Multinational) Corps' mission called for it to attack from east to west across a series of rivers.

of simplicity, but it goes much further. As noted American Army historian and frequent consultant to the Chief of Staff of the Army, Dr. Roger Spiller, recently wrote, Army staffs tend to produce consensus products that are "the safest, [and therefore] most nearly mediocre answer."[3] It is a stinging indictment of our staff analysis process that staffs tend to gravitate to the safest courses of action: i.e., the main effort on the best avenue of approach/terrain and using the least risky form of maneuver and task organization. In other words, they choose a defensive "two up, one back" stance every time. Too often, Americans optimize to obtain a draw rather than risk losing (or winning).

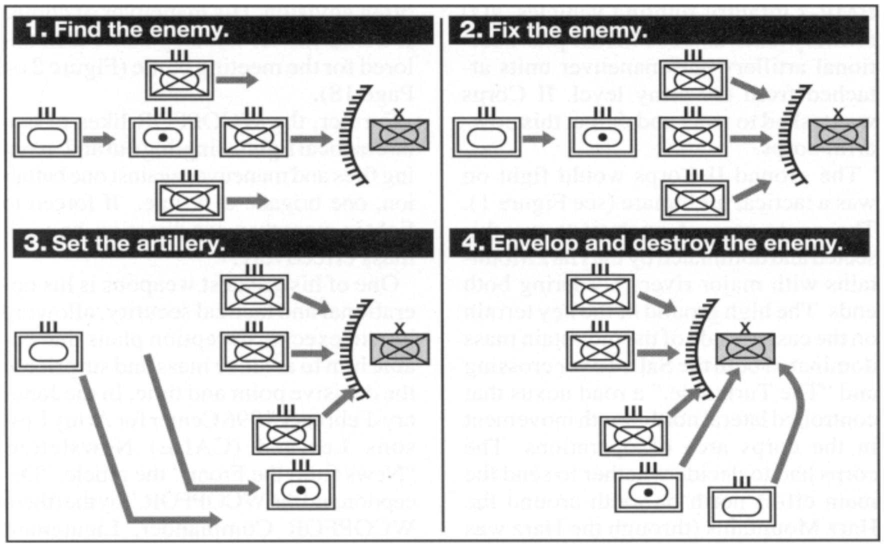


Figure 2: WCOPFOR Battle Drill: Find-Fix-Set-Envelop

The WCOPFOR bases his course of action on this military predictability. The WCOPFOR "Trusts in Blue" to select the least risky, most favorable (and most obvious) course of action.

Therefore, II Corps' planning premise was that the WCOPFOR expected—

(1) II Corps to execute the main attack on the optimal avenue (the northern avenue shown in Figure 1).

(2) II Corps to weight the main attack with a preponderance of heavy maneuver forces, preferably US-pure forces for ease of command and control in the main effort. In this case, a heavy US division covered by an armored cavalry regiment (ACR) or heavy brigade were the odds-on favorites.

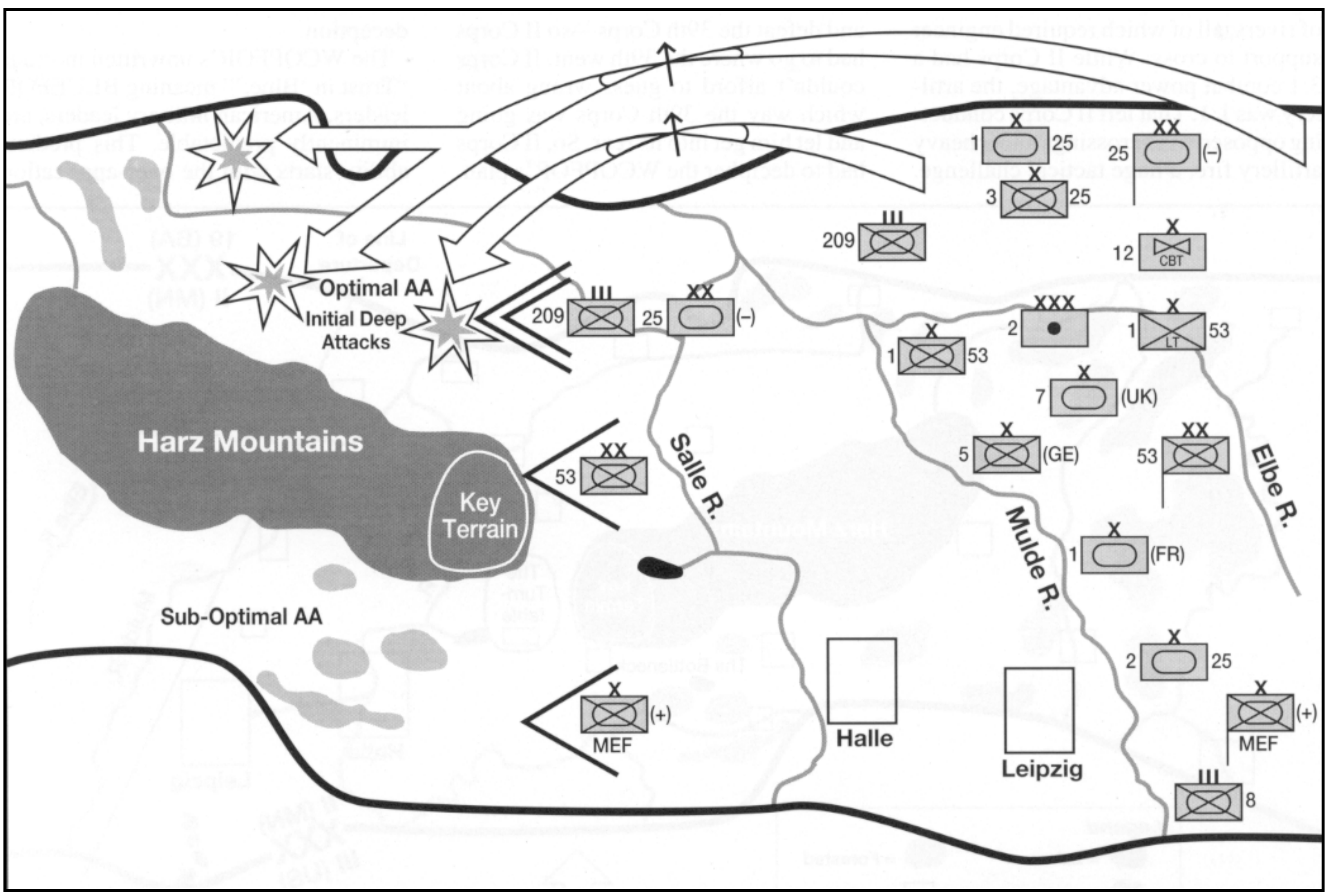


Figure 3: II Corps Deception Plan. To meet the WCOPFOR's expectations, II Corps initially positioned the 25th Armored Division with the 209th Armored Cavalry Regiment in the north as if to attack the optimal avenue of approach (AA) with the unwieldly 53d Multinational Division in the center and the Marine Expeditionary Force south as supporting efforts. The deception plan was reinforced with initial deep attacks on the Optimal AA by the artillery, Army aviation and USAF.

(3) II Corps to weight the main attack with the preponderance of general support (GS) artillery. If the WCOPFOR knows where the multiple-launch rocket system (MLRS) battalions are on the battlefield, he usually has found the reinforcing and GS artillery aligned to follow and support the main effort.

(4) II Corps to try to execute a poorly resourced deception plan, depicting the main attack along a suboptimal avenue of approach (the southern avenue).

(5) II Corps to use the II Marine Expeditionary Force (Forward) (MEF)—roughly the equivalent of a motorized infantry brigade with some armor and a large fixed-wing air component—in a semi-independent economy-of-force role. This is in lieu of integrating this self-contained, task-organized, air-land MEF structure into the main fight with dissimilarly organized US Army units—contrary to the principle of simplicity. Americans tend to see the MEF as an excellent force for a supporting effort in a heavy corps. The WCOPFOR counts on the presence of the MEF to confirm the location of a secondary attack/effort.

(6) II Corps not to use allied brigades or the multinational division as the main effort. II Corps' 53d Infantry Division was the most powerful division in terms of raw combat power; but its multinational structure of two US brigades (one light and one heavy) and two allied brigades was a command and control challenge. Using this division in the main effort, again, would be contrary to the principle of simplicity.

(7) II Corps, after penetrating the initial defense, to rush forward to the "key terrain" and "set the defense" for the fight with the WCOPFOR heavy corps. The WCOPFOR knows most US commanders avoid a meeting engagement (very risky) and don't like to attack (risky and complicated); they prefer to defend (safe and easy).

(8) II Corps to keep its divisions and brigades in their own "lanes" once across the line of departure. Moving divisions and brigades laterally across the corps zone is too complex. If the WCOPFOR knows where the major BLUFOR units are at the line of departure, essentially, he knows how they'll come at him for the rest of the fight. The WCOPFOR's excellent intelligence capabilities tells him where the BLUEFOR units are at H-Hour. (For purposes of BCTP, the "excellent intel capabilities" translate into the WCOPFOR knowing 80 percent of BLUEFOR unit locations at the start of the exercise.)

(9) II Corps to use its attack helicopters at first dark and every night thereafter to find and attack the WCOPFOR artillery. The WCOPFOR moves his artillery at dark, spreads it out, does not expose it too early, deceives as to its location and protects it with air defense artillery (ADA) concentrations. In fact, he lays ADA ambushes, especially at deception locations.

Deceive Thy Enemy

The WCOPFOR briefs that in his deception plans, he simply shows the BLUFOR commander indicators of what the commander already believes. The WCOPFOR doesn't try to change the commander's mind, he reinforces the commander's perceptions.

It sounds pretty simple. So II Corps decided to try the deception strategy too. II Corps planned to deceive the WCOPFOR based on his expectation that II Corps would employ conventional, safe mediocre tactics. This became the basis for II Corps' scheme of maneuver. Unlike typical US planning, the deception plan was not an afterthought.

II Corps reinforced the WCOPFOR's expectation of where the main attack would occur by positioning the 25th Armored Division (less one brigade) and 209th ACR (a total of 10 ground maneuver battalions) to attack on the optimal northern avenue of approach. (See Figure 3.) The GS artillery and the corps aviation brigade were positioned in the center/north to reinforce the appearance of weighting the main effort.

To reinforce the WCOPFOR's expectation of a supporting effort on the southern avenue, the MEF (with a brigade from the 25th Armored Division under its operational control for a total of seven ground maneuver battalions) was positioned east of Leipzig. In the center, facing the Harz Mountains, II Corps positioned the multinational 53d Division led by the 5th German Mechanized Brigade. This huge but unwieldy division (17 ground maneuver battalions, 13 of which were allied) painted the perfect image of a force for the supporting effort, a force that would move ponderously forward, secure the key terrain and protect the flank of the main attack to the north. To further ensure the friendly deception plan was convincing, the initial II Corps Air Force and Army aviation deep attacks focused on the WCOPFOR's artillery in the "optimal" northern avenue.

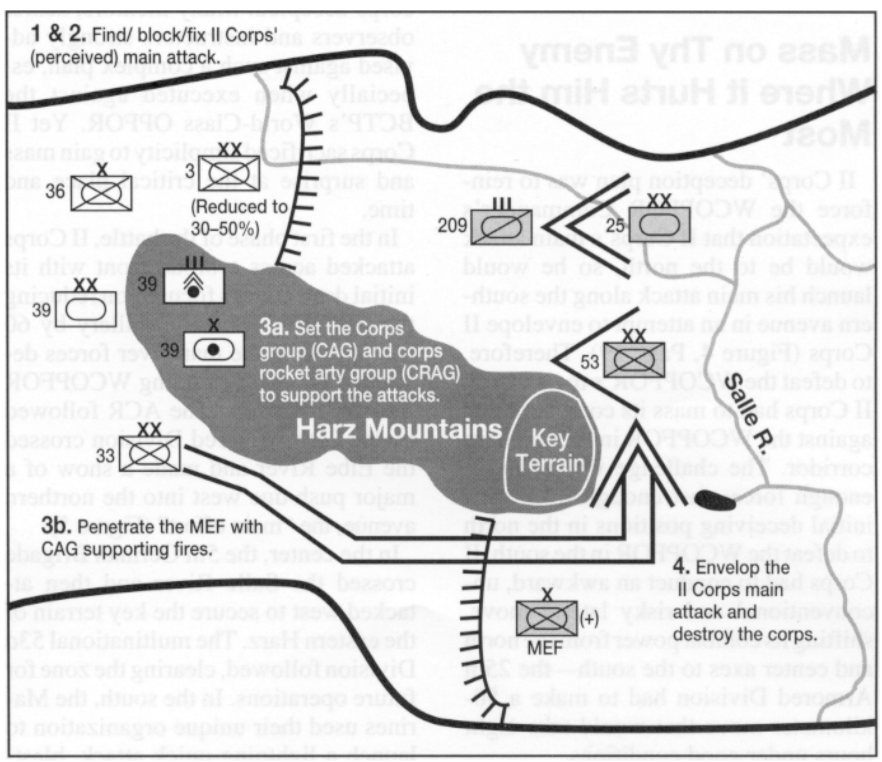


Figure 4: The WCOPFOR Plan—Find-Fix-Set-Envelop. II Corps' wargaming determined the WCOPFOR's plan would look like this. The WCOPFOR Commander would take advantage of II Corps' main effort to the north by launching his main attack in the south.

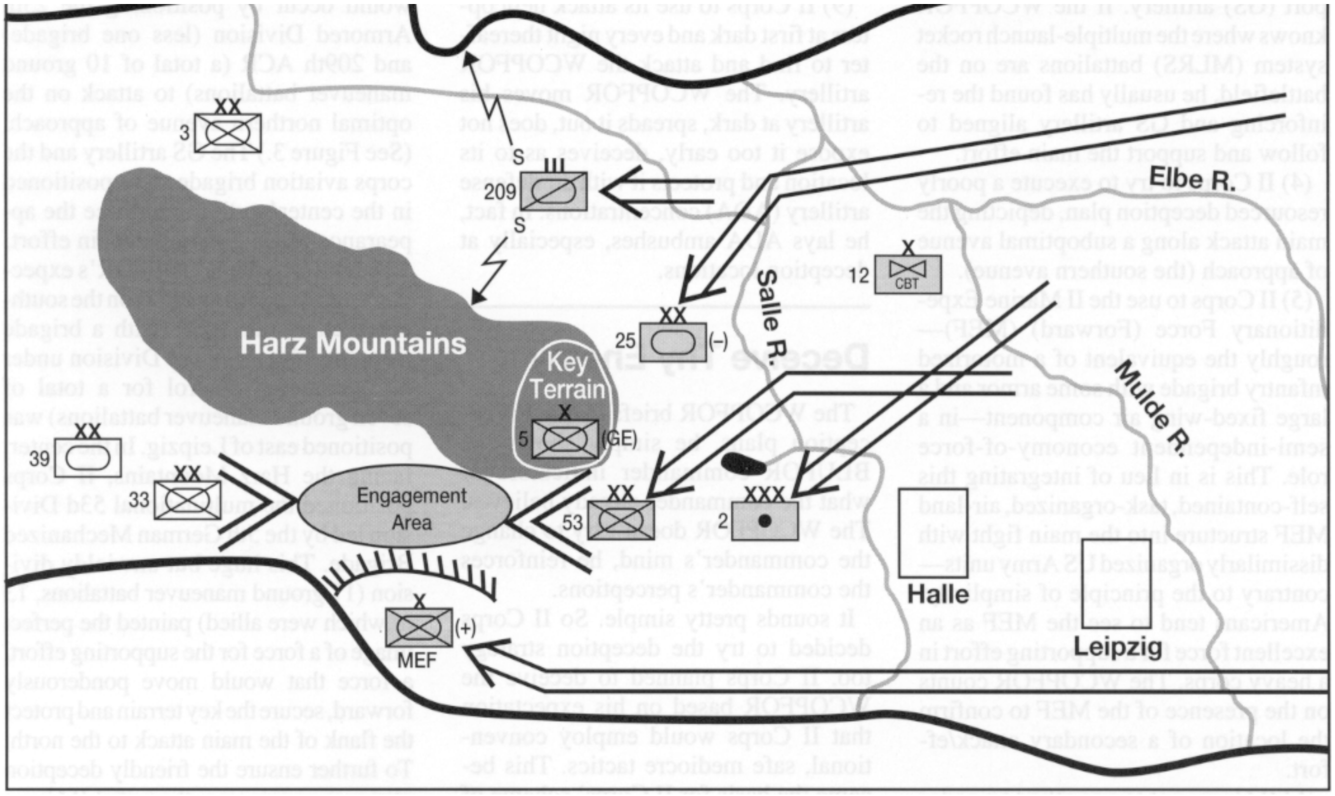


Figure 5: II Corps Scheme of Maneuver. II Corps had to make an awkward, unconventional and risky lateral move, shifting its combat power from the north and center axes to the southern one in order to defeat the WCOPFOR. II Corps' advantages were surprise and mass.

Mass on Thy Enemy Where it Hurts Him the Most

II Corps' deception plan was to reinforce the WCOPFOR Commander's expectation that II Corps's main attack would be to the north, so he would launch his main attack along the southern avenue in an attempt to envelope II Corps (Figure 4, Page 19). Therefore, to defeat the WCOPFOR's main effort, II Corps had to mass its combat power against the WCOPFOR in the southern corridor. The challenge was to move enough forces fast enough from their initial deceiving positions in the north to defeat the WCOPFOR in the south. II Corps had to conduct an awkward, unconventional and risky lateral move, shifting its combat power from the north and center axes to the south—the 25th Armored Division had to make a 50-kilometer move that would take eight hours under good conditions.

The corps' scheme of maneuver to accomplish this was complex. This was the first and greatest risk the student corps accepted. Many mentors, senior observers and instructors strongly advised against such a complex plan, especially when executed against the BCTP's World-Class OPFOR. Yet II Corps sacrificed simplicity to gain mass and surprise at the critical place and time.

In the first phase of the battle, II Corps attacked across a broad front with its initial deep attacks focused on reducing the WCOPFOR heavy artillery by 60 percent while the maneuver forces destroyed the two defending WCOPFOR infantry divisions. The ACR followed by the 25th Armored Division crossed the Elbe River and made a show of a major push due west into the northern avenue, the "main effort" (Figure 5).

In the center, the 5th German Brigade crossed the Salle River and then attacked west to secure the key terrain of the eastern Harz. The multinational 53d Division followed, clearing the zone for future operations. In the south, the Marines used their unique organization to launch a lightning-quick attack, blasting holes in the WCOPFOR defense with their air power, seizing river crossings with their air assault and amphibious capabilities and launching their light armored units followed by the Army's armored brigade to race ahead and secure the bottleneck in the southern avenue around the Harz.

By this time, the WCOPFOR's 39th Corps was committed to attacking through the southern corridor of the Harz. The narrow southern corridor gave II Corps some advantages. First, the WCOPFOR regiments and divisions would have difficulty using their preferred battle drill: find-fix-set-envelop. They would, however, still be able to mass artillery fires against II Corps in "strike sectors," allowing WCOPFOR to overwhelm the defending II Corps units. Therefore, II Corps' success rested equally on its ability to defeat the WCOPFOR artillery with deep operations and counterfire.

As the WCOPFOR piecemealed his regiments into the southern avenue, his artillery (and unavoidably his maneuver forces too) were subjected to II Corps' unrelenting deep attacks by USAF and Marine aircraft in air interdiction (AI) and "deep" close air support (CAS), Army aviation and the Army tactical missile system (ATACMS).

In the southern corridor, the enemy expected to be able to mass one of his heavy divisions and his corps artillery group (CAG) and corps rocket artillery group (CRAG) against the defending, isolated MEF at 3:1 or better odds. Instead, his lead division was canalized by the restrictive terrain and caught in a two-direction attack from the MEF and the 53d Infantry Division while II Corps deep attacks destroyed his center of gravity, the supporting CAG and CRAG.

II Corps took a lot of risks. Would the WCOPFOR buy the deception plan and go south? (If II Corps guessed wrong and the 39th Corps went north, the 209th ACR stretched across 40 kilometers could not hold off the WCOPFOR until the rest of II Corps turned around and redeployed to the north. The deception plan had to work, or II Corps was finished.)

Could the ponderous, multi-lingual, multi-doctrinal 53d Division shift directional axis and then get there in time to spring the ambush? Could the corps deep attacks neutralize enough of the WCOPFOR artillery? Could the 25th Armored Division move laterally from the north to south axis in time to be ready to follow and assume the attack?

So, even when the deception worked, II Corps was hardly assured of victory. Successful deep operations and rapid, large-scale movement to bring maneuver mass to bear were the keys to victory. With the WCOPFOR in the narrow southern trap, the next requirement was to strip him of his best means of extricating himself—his artillery.

Win Deep or All is Lost

The II Corps Commander from the outset emphasized the importance of winning deep. II Corps created a deep operations coordination cell (DOCC) based on a combination of the V and III Corps' DOCCs and standing operation procedures (SOPs) and tailored its structure for Prairie Warrior 96.

II Corps' deep operations won not only the deep battle, but the entire fight as well. Deep operations accounted for an astounding amount of damage to the WCOPFOR when compared to damage inflicted in the close fight; ten times more ADA systems, cavalry and infantry fighting vehicles, anti-tank systems, artillery pieces and tanks were destroyed in the deep and counterfire fights than in the close fight. In the first 12 hours alone, II Corps' deep operations and counterfire destroyed more than 60 percent of the WCOPFOR's army artillery group (AAG) and army group of rocket artillery (AGRA) assets—more than 200 pieces.

The success of II Corps' deep operations was due both to excellent G2 analysis and to an unswerving focus on finding and destroying the WCOPFOR's air defense and artillery. Only one deep aviation attack was targeted specifically at his maneuver forces.

II Corps Artillery set a new record for the number of WCOPFOR artillery systems acquired and attacked—in fact exceeded the WCOPFOR's own usually enviable performance. By the end of the exercise, deep operations and counterfire had destroyed or damaged more than 1,300 enemy artillery systems. The WCOPFOR tactical center of gravity had been neutralized within hours of the start of the exercise and, thereafter, was hounded to destruction.

II Corps' deep operations were so successful that on the second night, the BCTP staff declared that all AH-64 attack helicopters in the corps were grounded due to "bad fuel" and that half the ATACMS in theater were "blown up by saboteurs." The next day, fixed-wing aircraft were declared grounded because of "bad weather" over the corps zone. II Corps' deep operations were too successful and had to be artificially turned off—otherwise, a close battle might not occur in Prairie Warrior 96. Unfortunately for the 39th Corps, it was already too late.

Get Close To Thy Enemy and Polish Him Off

The 39th Corps reacted as planned, advancing rapidly toward the southern corridor. Fooled by the deception plan, the lead division steered directly for the Marines and the ambush, only to be brought up short by a corps deep attack. Before the division ever got into the corridor, it was nearly destroyed by AH-64s.

The WCOPFOR's trail division fared little better, finding itself hounded by fixed-wing air in daylight and attack helicopters at night. By the time the division reached the ambush, the MEF needed no help in polishing it off.

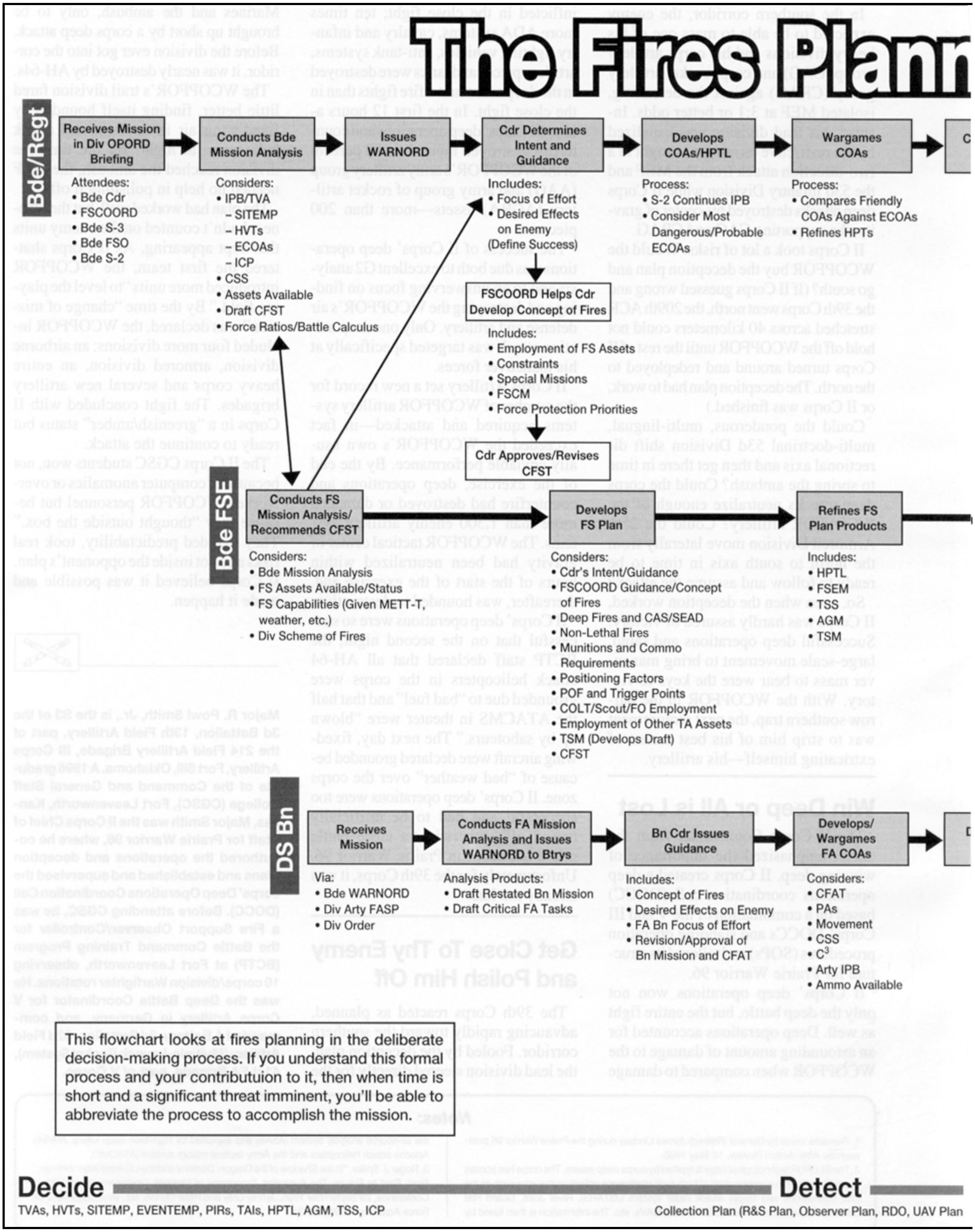
The plan had worked well, but the planners hadn't counted on the enemy units that kept appearing. As II Corps shattered the first team, the WCOPFOR introduced more units "to level the playing field." By the time "change of mission" was declared, the WCOPFOR included four more divisions: an airborne division, armored division, an entire heavy corps and several new artillery brigades. The fight concluded with II Corps in a "greenish/amber" status but ready to continue the attack.

The II Corps CGSC students won, not because of computer anomalies or overworked WCOPFOR personnel but because they "thought outside the box." They avoided predictability, took real risks and got inside the opponent's plan. II Corps believed it was possible and made it happen.

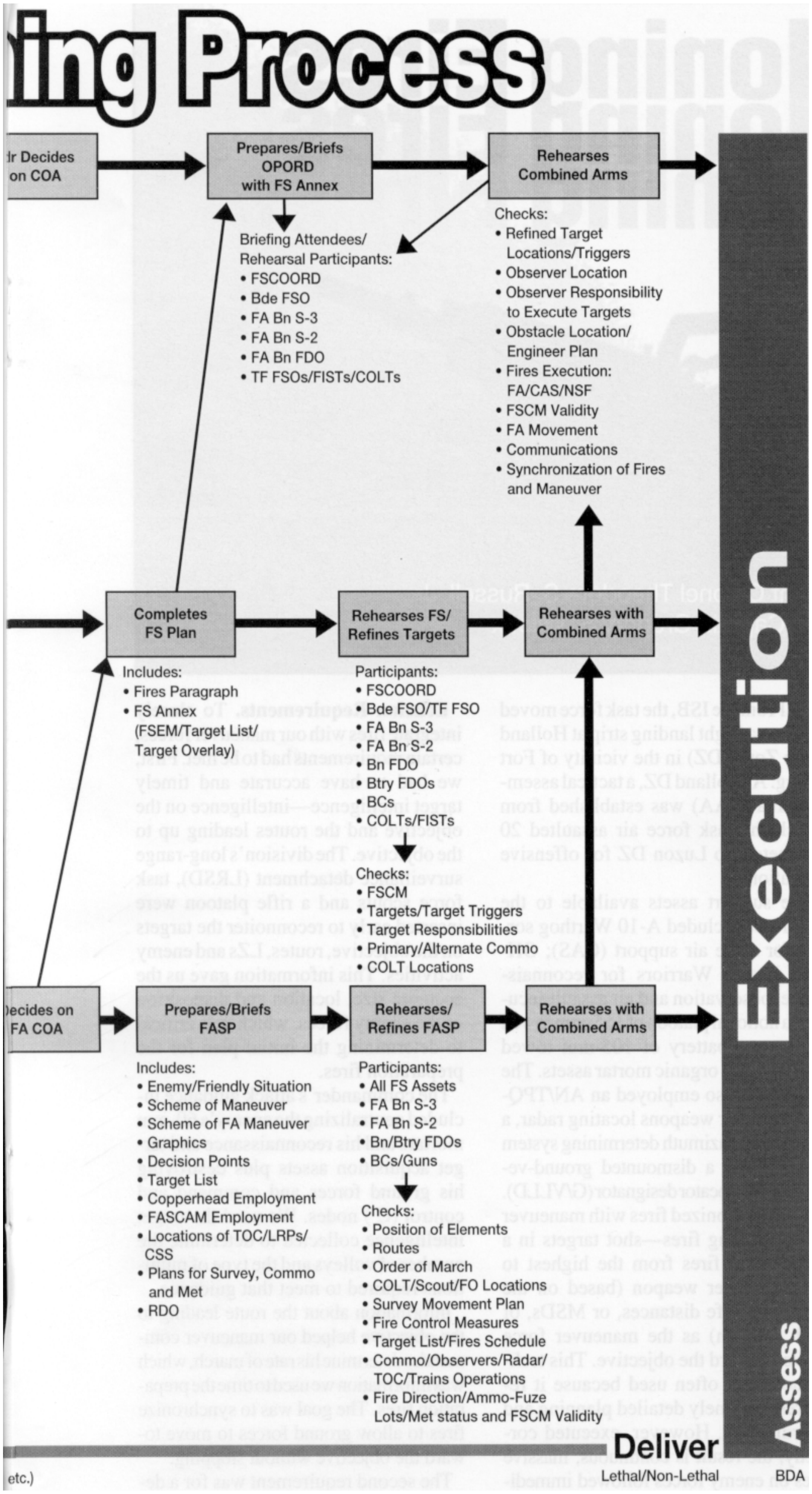
Major R. Powl Smith, Jr., is the S3 of the 3d Battalion, 13th Field Artillery, part of the 214 Field Artillery Brigade, III Corps Artillery, Fort Sill, Oklahoma. A 1996 graduate of the Command and General Staff College (CGSC), Fort Leavenworth, Kansas, Major Smith was the II Corps Chief of Staff for Prairie Warrior 96, where he coauthored the operations and deception plans and established and supervised the corps' Deep Operations Coordination Cell (DOCC). Before attending CGSC, he was a Fire Support Observer/Controller for the Battle Command Training Program (BCTP) at Fort Leavenworth, observing 10 corps/division Warfighter rotations. He was the Deep Battle Coordinator for V Corps Artillery in Germany, and commanded A Battery, 2d Battalion, 32d Field Artillery (Multiple-Launch Rocket System), 41st FA Brigade, part of V Corps.

Notes:

1. Remarks made by General (Retired) James Lindsay during the Prairie Warrior 96 post-exercise After-Action Review, 15 May 1996.
2. The BLUFOR technological edge is typified by corps deep assets. The corps has access to intelligence from a combination of high-tech intelligence collection systems such as the joint surveillance and target attack radar system (JSTARS), Rivet Joint, Guard Rail Common Sensor, unmanned aerial vehicles UAVs, etc. The information is then fused by the all-source analysis system (ASAS) and exploited by high-tech deep killers: AH-64s Apache attack helicopters and the Army tactical missile system (ATACMS).
3. Roger J. Spiller, "In the Shadow of the Dragon: Doctrine and the US Army After Vietnam." *From Past to Future: The Australian Experience of Land/Air Operations,* Army History Conference, 29 September 1995. Jeffrey Grey and Peter Dennis, ed., (Australian Defence Force Academy: 1995), 20-21.



This flowchart looks at fires planning in the deliberate decision-making process. If you understand this formal process and your contributuion to it, then when time is short and a significant threat imminent, you'll be able to abbreviate the process to accomplish the mission.



This chart is a checklist/organizer for the major steps in the fires planning process; it is not intended to be comprehensive. Units need to incorporate considerations/steps unique to their missions and organizations.

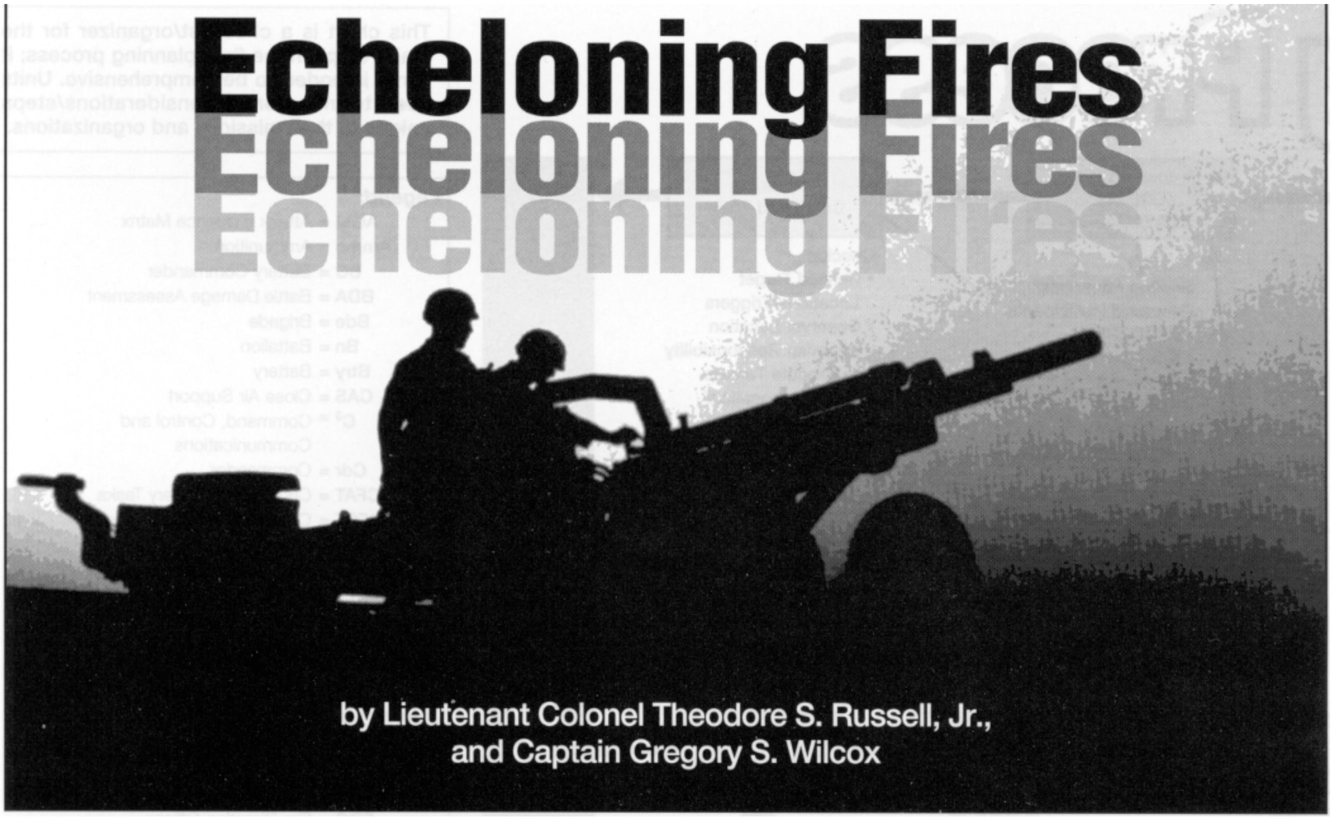
Legend:

AGM	=	Attack Guidance Matrix
Ammo	=	Ammunition
BC	=	Battery Commander
BDA	=	Battle Damage Assessment
Bde	=	Brigade
Bn	=	Battalion
Btry	=	Battery
CAS	=	Close Air Support
C^3	=	Command, Control and Communications
Cdr	=	Commander
CFAT	=	Critical Field Artillery Tasks
CFST	=	Critical Fire Support Tasks
COAs	=	Courses of Action
Commo	=	Communications
COLT	=	Combat Observation Lasing Team
CSS	=	Combat Service Support
Div	=	Division
Div Arty	=	Division Artillery
ECOAs	=	Enemy Courses of Action
EVENTEMP	=	Event Template
FA	=	Field Artillery
FASCAM	=	Family of Scatterable Mines
FASP	=	Field Artillery Support Plan
FDO	=	Fire Direction Officer
FISTs	=	Fire Support Teams
FO	=	Forward Observer
FS	=	Fire Support
FSCOORD	=	Fire Support Coordinator (also FA Battalion Commander)
FSCMs	=	Fire Support Coordination Measures
FSEM	=	Fire Support Execution Matrix
FSO	=	Fire Support Officer
HPTL	=	High-Payoff Target List
HVTs	=	High-Value Targets
ICP	=	Intelligence Collection Plan
IPB	=	Intelligence Preparation of the Battlefield
LRPs	=	Logistics Resupply Points
Met	=	Meteorology
METT-T	=	Mission, Enemy, Terrain, Troops and Time Available
NSF	=	Naval Surface Fires
OPORD	=	Operations Order
PA	=	Position Area
PIRs	=	Priority Intelligence Requirements
POF	=	Priority of Fires
R&S	=	Reconnaissance and Surveillance
RDO	=	Radar Deployment Order
SEAD	=	Suppression of Enemy Air Defenses
SITEMP	=	Situation Template
TA	=	Target Acquisition
TAIs	=	Target Areas of Interest
TF	=	Task Force
TOC	=	Tactical Operations Center
TSM	=	Target Synchronization Matrix
TSS	=	Target Selection Standards
TVAs	=	Target Value Analysis
UAV	=	Unmanned Aerial Vehicle
WARNORD	=	Warning Order

Advanced Fire Support Branch
Fire Support and Combined Arms Operations
Department Field Artillery School, Fort Sill, OK

Echeloning Fires

by Lieutenant Colonel Theodore S. Russell, Jr., and Captain Gregory S. Wilcox



Maneuver and fires must be integrated and synchronized by the combined arms commander to realize the full potential of each system available—just getting the systems into the fight is not enough. And, further, fire supporters must synchronize all available fires at the critical time and place on the battlefield to support the commander's intent.

Task Force 2-87 Infantry of the 10th Mountain Division (Light Infantry), Fort Drum, New York, deployed to Fort Bragg, North Carolina, as part of an XVIII Airborne Corps emergency deployment readiness exercise (EDRE). The task force's mission was to conduct a raid on an airfield held by enemy forces. An integral part of the mission was to integrate fires to support the major phases of the operation: reconnaissance, air assault, movement-to-contact and assault on the objective. The division commander's intent was to attrit the enemy forces by 50 percent before the assault on the objective by integrating and synchronizing all his fire support.

The scenario for the exercise required the task force to conduct a strategic movement from Fort Drum to an intermediate staging base (ISB) at Hunter Army Airfield, Georgia. Here the task force planned and rehearsed the operation. From the ISB, the task force moved by air to a flight landing strip at Holland Drop Zone (DZ) in the vicinity of Fort Bragg. At Holland DZ, a tactical assembly area (TAA) was established from which the task force air assaulted 20 kilometers to Luzon DZ for offensive operations

Fire support assets available to the task force included A-10 Warthog sorties for close air support (CAS); OH-58D Kiowa Warriors for reconnaissance, observation and air assault security; a notional platoon of 155-mm towed artillery; a battery of 105-mm towed artillery; and organic mortar assets. The task force also employed an AN/TPQ-36 Firefinder weapons locating radar, a position and azimuth determining system (PADS) and a dismounted ground-vehicular laser locator designator (G/VLLD).

We synchronized fires with maneuver by echeloning fires—shot targets in a schedule of fires from the highest to lowest caliber weapon (based on the minimum safe distances, or MSDs, of each weapon) as the maneuver force moved toward the objective. This technique is not often used because it requires extremely detailed planning and coordination. However, executed correctly, the result is continuous, massive fires on enemy forces followed immediately by a ground assault on the objective.

Echelon Requirements. To closely integrate fires with our maneuver forces, certain requirements had to be met. First, we had to have accurate and timely target intelligence—intelligence on the objective and the routes leading up to the objective. The division's long-range surveillance detachment (LRSD), task force scouts and a rifle platoon were inserted early to reconnoiter the targets on the objective, routes, LZs and enemy activities. This information gave us the accurate size, location and disposition of the enemy forces, which was critical to determining the initial plan for the preparation fires.

The commander's attack guidance included neutralizing the enemy's 60-mm mortars and his reconnaissance and target acquisition assets plus destroying his ground forces and command and control (C^2) nodes. We used the target intelligence collected to determine the number of volleys and the type of munitions required to meet that guidance.

Information about the route leading to the objective helped our maneuver commander determine his rate of march, which was information we used to time the preparation fires. The goal was to synchronize fires to allow ground forces to move toward the objective without stopping.

The second requirement was for a detailed communications plan. Because the prep involved so many fire support assets located across considerable distances, reliable and redundant means of digital and voice communications were essential. We used a ground-mounted retransmission node and, during the main attack, an airborne C^2 helicopter. These means ensured the fire support coordination net had continuous, redundant communications.

We needed a retransmission node because the distance between the division fire support element (FSE) and the task force FSE was more than 20 kilometers. All fire support agencies monitored this net during the preparation to ensure fires were synchronized.

A third requirement was to thoroughly rehearse the prep plan as a combined arms force to synchronize and trouble-shoot all aspects of the plan. The task force conducted two detailed rehearsals. The first was with key leaders using a terrain model that included graphics and targets. The second involved the entire task force and included all aspects of the operation from the air assault to the actions on the objective. We used radios for this second rehearsal.

In addition to the two combined arms rehearsals, we conducted three fire support rehearsals. Two were backbriefings to review the details of the prep, and the third covered the schedule of fires on the actual radio nets. This third rehearsal was conducted in the TAA on the afternoon before execution and served not only to verify the schedule of fires, but also to test our digital and voice communications between all nodes.

Other measures the task force took to ensure that all its indirect fire assets could contribute to the fight was to air assault the 105-mm battery before the infantry companies left the TAA and insert two mortar sections early with the scouts. These measures ensured fire support assets were positioned to support the attack. The battery could provide fires to suppress enemy air defenses (SEAD), as required. The mortars with the scouts could provide suppressive fires for the scouts if fires were needed to break contact during reconnaissance operations. The mortar platoon leader located near the air assault LZ controlled all the mortars.

Preparation Schedule. Because synchronization was so critical, we used an operations schedule to execute the preparation, code name "Thunder." (See Figure 1.) This schedule delineated the critical events and identified by call-sign the

Event #	A-Time	Time	Event	Responsible Agency
1	A-35	2200	Communications Check	Mtn 35
2	A-5	2230	OH-58D on Station	Saber 06
3	A-5	2230	A-10 at IP, Contacts Saber 06 and Alpine 11	Kuda 01, 02
4	A-Hour	00 (Approx 2235)	Time Hack	Mtn 35
5	A+8	08	A-10 Departs IP	Kuda 01, 02
6	A+9	09	OH-58D Laser Requested	Echo 36
7	A+9:50	09:50	155-mm Shot	Kuda 01, 02 to Saber 06
8	A+10	10	CAS/155-mm Impact (Splash)	Echo 36
9	A+14:37	14:37	105-mm Shot	Bulldog 36
10	A+15	15	105-mm Impact (Splash)	Bulldog 36
11	A+21	21	CAS Complete	Kuda 01, 02
12	A+25	25	BDA on CAS Strike	Saber 06
13	A+37	37	155-mm Rounds Complete	Echo 36
14	A+44	44	81-mm Shot	Raven 09
15	A+45	45	105-mm Rounds Complete	Bulldog 36
16	A+45	45	81-mm Impact (Splash)	Raven 09
17	A+51	51	81-mm Rounds Complete	Raven 09
18	A+51	51	60-mm Shot	Apache 09
19	A+51:25	51:25	60-mm Impact (Splash)	Apache 09
20	A+55	55	60-mm Rounds Complete	Apache 09
21	A+60	60	Prep Complete	Mtn 35
22	A+75	75	BDA on Objective	Saber 06

Call-Signs:

Alpine 11 = Tactical Air Control Party (USAF)
Apache 09 = 60-mm Mortar Platoon Fire Direction NCO
Bulldog 36 = B Battery (105-mm) Fire Direction Officer
Echo 36 = E Battery (155-mm) Fire Direction Officer
Kuda 01 = A-10 Pilot
Kuda 02 = A-10 Pilot
Mtn 35 = Deputy Fire Support Coordinator (Airborne in a Command and Control Aircraft)
Raven 09 = 81-mm Mortar Platoon Fire Direction NCO
Saber 06 = Air Battle Captain

Legend:

BDA = Battle Damage Assessment
CAS = Close Air Support
IP = Initial Point

Figure 1: Operations Schedule for Preparation "Thunder." This schedule delineates the critical events in echeloning fires and the agent responsible for each event by call-sign. The prep was estimated to begin at approximately 2230; the time had to accommodate the troops' rate-of-march from the air assault landing zone to the vicinity of the objective.

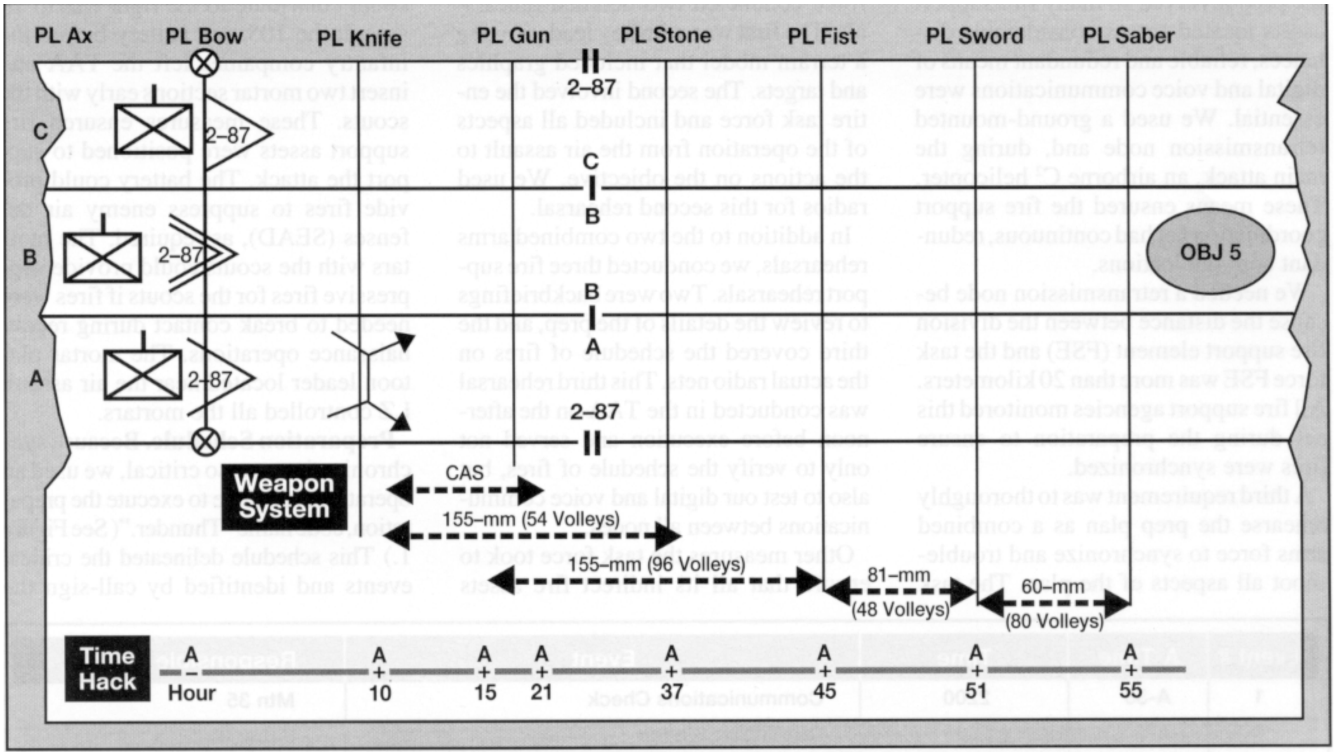


Figure 2: In echeloning fires for offensive operations, each phase line (PL) entered into the PLGR corresponded to the minimum safe distance of the weapon system to be firing as the force progressed to the objective.

agent responsible for each event. Once the prep began, this schedule was essential for the task force fire support officer (FSO) to monitor the prep and advise the task force commander on the status of fires.

Based on the rate of march from the air assault LZ to the objective, we estimated the prep would begin at approximately 2230 hours. The first critical event of the prep was a time check that initiated A-Hour. This time had to be flexible due the possibility our ground forces could make contact with the enemy during their movement to the objective.

The A-Hour could be adjusted by as much as one hour, based on the loiter time of the A-10s. The A-10s were to be at the initial point (IP) at 2230, so the prep had to start no later than 2330 to ensure CAS would be part of the prep. The time hack used was not based on clock time but started at 00.00; so A-Hour equalled 00.00. CAS was to impact at A+10.00.

As it turned out, this flexible A-Hour was crucial because as the lead company moved forward, it encountered a small enemy bunker complex not identified previously. The company took about 15 minutes to clear the bunker, so the clock time for A-Hour was slipped to 2245.

Phase Lines as MSD Control Measures. As the task force moved toward the objective during the prep, the lead maneuver company FSO needed a means to ensure the company was not moving inside the weapon systems' MSDs. He used the precision lightweight global positioning system (GPS) receiver (PLGR) to provide an accurate location as units moved along the infiltration routes.

The MSDs for each weapon system corresponded to a phase line, and the FSO entered these phase lines as way points into the PLGR. This allowed the task force and company commander to use the phase lines as control measures and ensure the lead company was outside the MSDs for each weapon system as it moved toward the objective. (See Figure 2.)

The MSDs were calculated based on personnel in the open or in lightly wooded terrain, the bursting radius of the munitions, the location of the delivery assets and the percentage of casualties the commander was willing to risk, given that all five elements of accurate predicted fire were met. Because the phase lines and MSDs were calculated in relation to the location of the targets for the prep, it was essential that we received accurate target data early. These control measures were incorporated into the plan early enough so they could be published and rehearsed. To do this, a target cutoff time was established to ensure we could include all target refinements in the final plan.

Although the phase lines were planned as control measures, the intent was for our maneuver force to move to the objective without losing momentum. The duration of the prep for each weapon system was designed based on the rate of movement of our ground forces.

The most lethal weapon in the prep was laser-guided 500-pound bombs delivered by the A-10s; laser-guided munitions were requested. OH-58Ds with their lasing capability were the primary observers with the G/VLLD and reconnaissance rifle platoon as backups. This redundancy proved its value as the USAF tactical air control party (TACP) collocated with the maneuver commander temporarily lost communications with the OH-58Ds, and the G/VLLD had to lase for one of the A-10s.

Prep Execution. The prep went smoothly, and all fires were delivered from CAS down to the 60-mm mortars as the maneuver companies assaulted the objective. The task force massed direct and indirect fires and destroyed the enemy forces on the objective.

The lead company was able to move faster than expected, once it cleared the enemy bunker complex; therefore, it had to slow its movement while the prep continued. Once the prep was completed, ground maneuver forces were in position for the assault.

The success of the operation was due, in part, to the additional assets that deployed with the task force during the EDRE. Although this operation was not executed with live ammunition, it was a great success.

When echeloning fires, maneuver commanders and battle staffs must understand the capabilities of the fire support systems available to them, and the FSE must integrate all fires to support the maneuver commander's intent. The intent for fires in this operation was to set the conditions for the direct fire fight so that friendly casualties were minimized. The technique of employing echeloned fires in support of a movement-to-contact requires meticulous planning and detailed rehearsals to carefully synchronize the commander's fires.

The challenge for fire supporters in echeloning fires is to ensure ground forces can maneuver to the objective without losing momentum and with minimal casualties. If friendly forces' momentum allows them to reach the objective before the preparation fires have achieved their effects, the challenge for the maneuver force is to exercise battlefield patience. It's important to remember that the issue is not whether fires are controlling maneuver or vice versa but that the combined arms meet the goal of destroying the enemy on the objective with minimal friendly casualties.

LTC Theodore S. Russell, Jr., commands the 2d Battalion, 15th Field Artillery, 10th Mountain Division (Light Infantry) at Fort Drum, New York. Also in the 10th Division, he served as the Deputy Fire Support Coordinator (DFSCOORD) and Joint Force Fires Coordinator (JFFC) for Operation Uphold Democracy in Haiti. He commanded C Battery, 1st Battalion, 92d Field Artillery, 2d Armored Division, Fort Hood, Texas; C Battery, 1st Battalion, 37th Field Artillery, 172d Light Infantry Brigade, Fort Wainwright, Alaska; and the US Army Recruiting Company, Columbia, South Carolina. He also served as Chief of the Command Planning Group at the Combined Arms Command, Fort Leavenworth, Kansas.

Captain Gregory S. Wilcox until recently was the Fire Support Officer for 2d Battalion, 87th Infantry and was assigned to the 2d Battalion, 15th Field Artillery as part of the 10th Mountain Division (Light Infantry) at Fort Drum. His previous assignments include serving as Fire Direction Officer and Platoon Leader with B Battery, 2d Battalion, 17th Field Artillery, 212th Field Artillery Brigade and Aide-de-Camp to the Commanding General, both in III Corps Artillery, Fort Sill, Oklahoma. He is a graduate of the Field Artillery Officer Advanced Course, Fort Sill. Captain Wilcox has left the Army and is now a Candidate Consultant with Orion International Consulting in Cincinnati, Ohio.

Technological Advances in Training

The Field Artillery School, Fort Sill, Oklahoma, is replacing the traditional classroom with the "classroom of the future" and developing advanced technology multimedia modules for training. Classroom XXI and Distance Learning are changing the way the FA trains. Classrooms will be the trainer and student "on-ramp" to the Information Highway while Distance Learning will make FA training available on the Internet and via other means. Standardized training with "real-time" updates will be readily available to the entire force.

Classroom XXI. FA School classrooms are being modernized to enable instructors and students to communicate from room to room as well as with remote sites. Classroom capabilities are classified as Levels 1 through 5.

• Eleven classrooms have been upgraded from traditional classrooms to Level 1 where training can include computer-generated slide shows, animation and demonstrations.

• One Level 2 classroom has computers for student access to the local area network (LAN) and World Wide Web Internet.

• Two Level 3 classrooms have multimedia computers and video teletraining capabilities with two-way audio-video possible between Fort Sill and remote training sites. The first students to train from a remote site via one of these classrooms were III Corps Redlegs at Fort Hood, Texas, who received the FA Basic NCO Course (BNCOC). Portions of Paladin New Equipment Training (NET) are scheduled for teletraining in the third quarter of this FY.

• Two Level 4 classrooms can receive and send simulated training exercises. Students can use the computer-generated simulations throughout their course.

Distance Learning. The Army Distance Learning Plan outlines the path we'll take to transform instructor-centered training to student-centered, computer-generated methodology. Digitized lessons, interactive computer-based modules and on-line training modules are being developed for the FA military occupational specialties (MOS) with the 13F Fire Support Specialist MOS completed.

The digitized lessons are multimedia, computer-based instruction that can be delivered on demand to any student with access to the World Wide Web; the lessons also can be deployed on a LAN or distributed via CD-ROM.

The lessons contain video clips of instructors teaching, demonstrations on equipment, terrain features and simulated exercises. Each module has a series of teaching objectives, practical exercises and exams. Student interaction is possible at any point during learning.

The student also can take a diagnostic exam and then complete only the lessons in his weak areas. An embedded course manager module records the student's progress for review by a course administrator or his instructor.

The Field Artillery School has developed 185 digital lessons for all skill levels of MOS 13F. The lessons are presented in 48 modules on 18 CD-ROMs that can be used for formal and refresher training or individual soldier self-development training. An additional 170 digital lessons are being developed for MOS 13B Cannon Crewman, 13E Fire Direction Specialist and 13M Multiple-Launch Rocket System Crewman.

Units can order the course and 13F CD-ROMs from the Army Training Support Center, Fort Eustis, Virginia, using their 12-series publications (pinpoint distribution) account numbers.

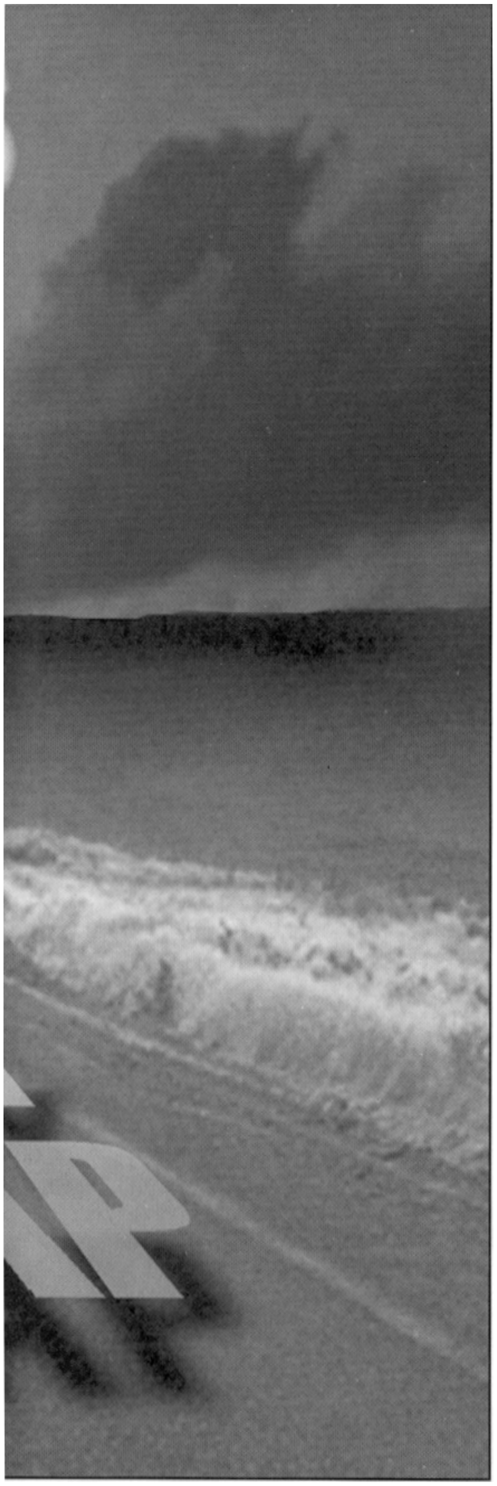
F. Janice Carter, C, Trng Man Div
Warfighting Integr and Dev Dir (WIDD)
FA School, Fort Sill, OK

Lee Gibson, Fort Sill TSC

> *There are a handful of moments in history when the pressure of technological progress is so powerful that it transforms the way nations fight. Today, we are paused at one of those historical moments, facing the demanding challenge of harnessing new technology that will optimize the Army's emerging warfighting concepts....The Field Artillery stands at the center of this great transformation—providing the commander assured, precise, responsive, effective fires to accomplish the mission and protect the force in every phase of Army operations.*
>
> **"Shape the Battlespace" Concept Paper**
> **TRADOC "How to Fight" Seminar**
> **26 September 1995, Fort Sill, Oklahoma**

by Susan I. Walker

Moving from a vision of future warfighting to reality is a demanding process, one we must implement with care. And as the products and doctrine for Army XXI materialize and evolve, we must remember they did not do so overnight. Many of the innovations we've employed recently or are still developing were conceived during the Cold War.



In the Field Artillery, we're sowing the seeds of the Army After Next—the FA of the year 2015 and beyond—with a sense of urgency. We call it the Field Artillery Road Map.

The FA Road Map is a living document with time lines of developmental courses of action, milestones and decision points to achieve our vision. The plan graphically depicts critical programs and actions as thrust lines stretching 25 years into the future that are revised as new factors impact modernization: funding decisions, the results of analyses and experimentation, new technologies, etc.

The overriding goal of the Road Map is to preserve and protect Army XXI programs and developments and define the future operational capabilities and insights required for the Army After Next. In achieving this goal, we must pursue several broad objectives across the Training and Doctrine Command's domains of doctrine, training, organizations, materiel, leader development and soldiers with the Fort Sill-added domain of simulations (DTLOMSS). These objectives are to enhance accuracy and lethality, improve target acquisition, provide adaptive Field Artillery organizations, reduce the logistics burden and leverage information technology.

Getting from Here to There

Nineteen hundred and ninety-four marked the beginning of a far-reaching endeavor to envision America's Artillery in 2020. The result of this effort is Vision 2020—a distant aiming point for a strategically flexible and significantly more lethal and versatile FA on the battlefields of the next century. The vision combines futuristic technologies with the Army's emerging warfighting concepts and applies them to our system of systems. (For more information, see the article "Field Artillery Vision 2020" by former Assistant Commandant of the Field Artillery School Brigadier General Leo J. Baxter in the December Red Book 1994.) It is, however, only a vision.

In October 1995, the Field Artillery School at Fort Sill, Oklahoma, began to chart the course of transforming this notional FA warfighting world of 2020 into reality—began developing a comprehensive strategy called the FA Road Map. The Senior Field Artillery Advisory Council of December 1995 and the Senior Fire Support Conference of March 1996 both helped shape the path of the FA's development through 2020 by identifying critical events and issues. In July, the Field Artillery School hosted a meeting of selected Army leaders to review the FA Road Map and give the school a combined arms "compass check" on a number of key emerging insights affecting the future of the Field Artillery.

FA for Army After Next

In the next quarter century, technology will profoundly change the way the joint commander exercises battle command. He will go beyond synchronizing his forces to *fuse* them into a single deadly dynamic. While elements of the joint and combined arms team will remain separate, each performing its discrete combat functions, they'll have continuous, common situational awareness and seamless secure connectivity, enabling their instantaneous execution as "one" force.

As part of this force, the FA of 2020 is expected to have expanded battlespace awareness, relevant combat knowledge, unified execution of battle and adaptive organizations.

Expanded Battlespace Awareness. On a battlefield where every soldier and system is a sensor, leaders will have unprecedented access to information. The data will be available in real-time and presented in ready-to-use formats for leaders, virtually, at every level of command anywhere on the battlefield. As a result, all leaders will share situational awareness at all times. Essentially, this common awareness will dramatically expand the commander's battlespace.

Relevant Combat Knowledge. The systems of 2020 will give each commander combat knowledge relevant to his battlespace. The systems will tailor the information to his needs—filter, collate, prioritize and format it for him.

The filters will be "smart" or intelligent. They not only will process volumes of data, but they also will automatically provide the commander information he doesn't yet know he needs. For example, in 2020, our intelligent system will "know" the commander's intent and automatically report additional high-payoff targets as the battle progresses.

But the artillery leader also will be able to request information, based on his intuitive assessment of the battle. He might elect to analyze, view or even smell a specific point on the battlefield.

Armed with relevant combat knowledge, the commander will be able to make sounder tactical decisions more rapidly.

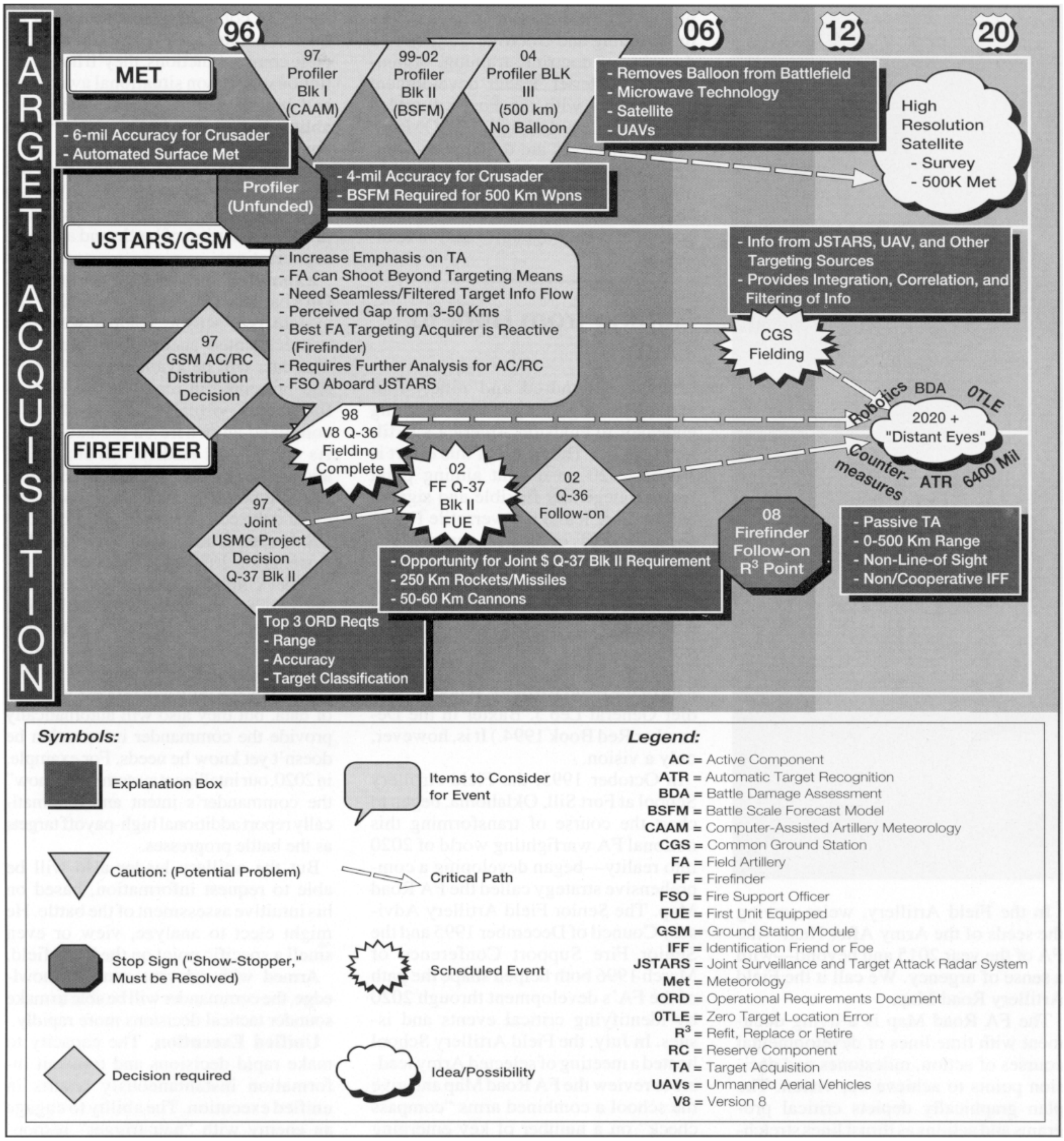
Unified Execution. The capacity to make rapid decisions and transmit information instantaneously results in unified execution. The ability to engage an enemy with "hair-trigger" responsiveness breaks the current fire support paradigm.

The fundamental requirement to attack targets at the time, place and with the effects that meet the commander's intent won't change. However, shared situational awareness will allow us to verify the conditions of engagement and vector fires in real-time without evaluation by multiple layers.

Adaptive Artillery. The future artillery must be adaptive, must be able to act as part of this unified combat power. Ad hoc solutions won't work.

The FA will have embedded, universal command and control connectors internetted with every facet of the force. We then will be able to support rapidly changing decisions with a balance of capabilities for the full range of military operations.

This mission adaptiveness will change the way we package forces. Rather than packaging forces with mixed capabilities and systems for each contingency, we'll design them to be modular, rapidly



Sample Target Acquisition Page of the FA Road Map on the Internet. The "living" document maps the development of the FA for the Army After Next. It can be accessed via the Fort Sill Home Page (http://sill-www.army.mil/index.htm).

tailorable and reconfigurable and to remain interconnected. In fact, leaders even will be able to reconfigure FA organizations in the middle of operations. For example, they may form special artillery strike forces (combined cannons and multiple-launch rocket systems) to accomplish specific missions.

The versatility of our adaptive organizations will give force commanders the flexibility to take advantage of operational and tactical opportunities across the range of military operations.

The Road Map "Routes"

The Road Map is a thought-provoking look at what we know about the future in terms of threat, future warfighting concepts, technology and resource constraints. It has three components. The first is a periodically updated compilation of FA assessments, insights and issues, future capabilities and developmental thrust lines with critical paths across the DTLOMSS. This first component of the Road Map is available on the Internet via the Fort Sill Home Page (http://sill-www.army.mil/index.htm).

The second is a comprehensive, automated Field Artillery Modernization Data Base (FAMDA), also available via the Fort Sill Home Page. This data base contains all we know about FA modernization and future developments, such as mission needs statements (MNS), operational requirements documents (ORDs), related briefings and other documentation. It also contains systems information formerly published in the Red Book by the Directorate of Combat Developments in the FA School.

The third component will be an automated decision aid now being developed. The decision aid will help combat and training developers project a variety of courses of development linked to project milestones and conduct "what if" drills for key FA modernization efforts. It also will be a tool for the leaders of today and tomorrow to make plans and decisions and check our progression on the map, keeping the Field Artillery on track toward our vision of the future.

The challenges associated with modernizing the FA are unlike those of other branches. Fire support is the aggregate of a complex system of systems and functions: cannons; rockets and missiles; target acquisition; support and sustainment; and command, control and communications (C^3). Therefore, our road map strategy must consider them all in a balanced approach. For example, developments increasing lethality or range must take into account target acquisition or C^3 abilities and limitations. Similarly, actions or issues involving ammunition supply and distribution will affect weapons-target pairing or the effects on a given target.

The Road Map begins with an assessment of current Field Artillery capabilities and projects the FA of the future over time, starting with the near-term years out to 2006, mid-term of 2007 to 2012 and far-term years of 2013 to 2020 and beyond. For the most part, our near-term capabilities are system-specific. This is because our requirements for Army XXI are current and well along the developmental path.

During the mid- and far-term, several warfighting capabilities will be integral to the FA's evolution. The ranges of our weapons and target acquisition systems will need to be extended out to 500 kilometers with automatic target acquisition, target-type recognition and battle damage assessment (BDA) capabilities. Smart or brilliant munitions are essential. We'll need real-time information collection and fusion capabilities to link sensors-to-shooters with access to communications and info distribution systems that are interoperable with widely dispersed joint and combined forces and effective over all terrain. Seamless, global, secure C^3 is critical. We also must enhance our survivability, deployability and mobility.

We're only a few years away from writing the mission need statements and future operational concepts for the Army After Next. We must maintain the momentum for modernization.

What's Next?

The FA School has established Field Artillery integrated concept teams (ICTs) to translate our future warfighting vision into warfighting concepts. The Road Map serves as a guide for the four ICTs: target acquisition, weapons and munitions, combat service support and C^3.

Each ICT is a multi-disciplinary team comprised of members from throughout the Army, industry and academia. The members are those who develop the concepts, do the warfighting, develop and test the equipment or who buy the equipment.

The ICTs purpose is to determine holistic DTLOMSS requirements that consider cost as an independent variable. Cost is considered early in this process—not because it's always the determining factor, but because it's a consideration in a period of limited resources.

Initial meetings for three of the four ICTs have been conducted. The combat service support ICT will be later this year to leverage information from the other three. Recommendations by the executive committee of each ICT that are approved by the FA School Assistant Commandant and Commandant are plotted on the Road Map.

As future technology becomes available for integration into one or more of our systems, milestones for insertion of that technology and the steps for implementing them will be plotted on the Road Map. As capabilities and issues arise, the process begins again—an ICT convenes to analyze them and make recommendations.

By the end of the year, the Field Artillery Management Decision Aid will be available. This tool will not only facilitate efficient and timely decisions optimized for our system of systems, but it also will aid decisions Army-wide. Combat and training developers will have unprecedented access to essential information concerning many of the Army's ongoing projects and programs.

The challenge for the Field Artillery Road Map is to chart our course through the turn of the century to our objective Vision 2020. The map will help us harness technology to translate our visionary Army After Next into reality—the right equipment, training and doctrine to the right place, at the right time—faster and cheaper.

Susan I. Walker is a Field Artillery Specialist and the FA Road Map Project Officer in the Force Programs and Priorities Division of the Directorate of Combat Developments (DCD), Field Artillery School, Fort Sill, Oklahoma. She has worked for DCD 18 years on a variety of Field Artillery programs and currently is concentrating on programs related to FA science and technology initiatives. Susan Walker has completed selected portions of the Field Artillery Officer Basic and Advanced Courses and the Field Artillery Target Acquisition Staff Officers Course, all at Fort Sill, and the Command and General Staff College, Fort Leavenworth, Kansas.

The Mortar Fire Control System

by Lieutenant Colonel L. Steve Davis, Jr., AC

The XM95 mortar fire control system (MFCS) exponentially increases mortars' capabilities and their contribution to the task force fight. With prototypes in existence for advanced warfighting experiments (AWEs) and other tests, the MFCS applies the power of the processor to fire control of the 81-mm mortar and new 120-mm battalion mortar system (BMS). Mortar units, both heavy and light, could start receiving MFCS as early as 2001, depending on funding.

The system provides position determination, on-board navigation and ballistic computation, information display for the driver and gunner, and digital connectivity. It uses the M30 mortar ballistic computer (MBC) software improved to accommodate the additional requirements of MFCS.

This article addresses increases in mortar lethality, survivability and digital connectivity with the addition of MFCS.

Lethality. One of the systems MFCS will support is the more lethal 120-mm BMS being fielded to armored, heavy cavalry and mechanized units. This smoothbore mortar's M934 high-explosive (HE) round provides 50 percent more lethality than the M329A2 4.2-inch round it's replacing. Although the specific effects are classified, a comparative "lethality ratio" has been established. Assuming a relative lethality factor of 1.0 for the 60-mm mortar, the 105-mm HE howitzer rates 2.0 and a 120-mm mortar rates 5.8.

The 120-mm has excellent growth potential, especially for precision-guided mortar munitions and an enhanced range dual-purpose improved conventional munition (DPICM) round. The mortar will increase the lethality of the heavy force maneuver battalion commander's organic indirect firepower.

The MFCS also enhances lethality by increasing the mortar platoon's accuracy. Depending on the situation, the MFCS reduces the circular error probable (CEP) by about 75 percent. MFCS combines the accuracy of the global positioning system/inertial navigation system (GPS/INS) with the ability to incorporate digital meteorological (Met) messages instead of the standard Met messages mortar platoons traditionally use. This increased accuracy results in the platoon's using fewer rounds to adjust fire, reducing the logistics burden.

Future versions of MFCS will add an inductive fuze setter, allowing soldiers to automatically set fuzes on rounds. This will speed up round setup, especially at night, and reduce the chances of soldiers' making mistakes setting fuzes.

Survivability. The system has participated in three AWEs where it reduced mortar call-for-fire response times from the Army training and evaluation program (ARTEP) standard of eight minutes to approximately one minute on the carrier-mounted mortars. All Active Component mortar units will receive the new M113A3 reliability improvement for selected equipment (RISE) power package, allowing mortars to keep pace with Abrams main battle tanks and Bradley fighting vehicles. Mortars will be able to tuck up behind the lead Abrams or Bradleys and stop and fire when they receive a fire mission.

With mortars' increased responsiveness and speed, they'll have a "Paladin-like" shoot-and-scoot capability. This capability is no surprise because design engineers used a Paladin dynamic reference unit (DRU) for the prototypes. Mortar engineers are leveraging as much as makes sense from the Paladin program.

The MFCS facilitates split-based operations, increasing crew survivability. Guns can operate individually, in pairs, as a section or as a platoon.

The AWEs have demonstrated that the user-friendly, menu-driven MFCS has reduced computational errors significantly, thus reducing potential fratricide. The mortar gun crew can compute the firing data of other mortars, if required. And being user friendly, it takes less time to train mortar fire direction center (FDC) personnel.

The open architecture of the MFCS system will allow situational awareness capabilities to be added as the Army's approach evolves. These capabilities will include displaying targets, friendly units and fire support measures graphically on a computer and sharing that and other information with all MFCS stations in real-time via the tactical internet. This will allow the FDC, forward observers (FOs) and individual guns all to have the same awareness of the situation on the battlefield.

The new 120-mm BMS will work with MFCS to provide flexibility and radically change mortar employment. Carrier-mounted mortars won't have to operate from traditional static firing positions. Instead, the heavy mortar platoon (six guns and two M577A2 command tracks) can move continually in its position area, stopping only to execute fire missions. With MFCS, fire missions are received and executed digitally—mortarmen can compute the fire mission on the move, emplace and never leave the vehicle to fire. Gone is the requirement for aiming circles.

Additionally, on the tracked mortars, MFCS has a display for the driver to position his mortar on the designated firing azimuth while the gunner has a separate firing display. The towed 120-mm configuration has a dismountable computer that gives the crew azimuth, elevation, deflection and other critical firing data.

The survivability of the mortar system also is increased by the redundancy MFCS provides. One MFCS station can compensate for the loss of the aiming, firing or FDC functions of another station.

Digital Connectivity. Many consider mortar digital connectivity to the fire support architecture the biggest improvement that MFCS will bring to the indirect fire team. Previously, mortars haven't been full players in both fire support planning and execution. The current M23 mortar ballistic computer (MBC) has limited connectivity with the tactical fire direction system (TACFIRE). However, MFCS is compatible with TACFIRE, the initial fire support automation system (IFSAS) and the advanced Field Artillery tactical data system (AFATDS). Versions 1 and 2.

With digital connectivity, FOs can send fire missions directly to the mortar FDC or guns via the FO system (FOS). Units have been experimenting with different tactics, techniques and procedures (TTP) to make sensor-to-shooter links more lethal and responsive. For example, a commander could give priority of fires for Field Artillery to one company and priority of fires for mortars to a supporting company. The supporting company FOS could send fire missions directly to the mortars. Such TPP is being tested and revised in the AWEs.

MFCS also allows maneuver platforms to call for fires digitally. During the light force AWE Focus Dispatch with the 10th Mountain Division in October 1995, M1A2s equipped with intervehicular information system (IVIS) determined target grid locations and established quick-fire channels with mortars. Clearing quick-fire channel fires and managing fire missions from start to finish are procedural challenges for the future.

Task Force XXI AWE. The 1st Battalion, 5th Infantry (Light) is part of the heavy-light component of Task Force XXI for the March rotation at the National Training Center (NTC). Fort Irwin, California. The battalion will have a towed version of the 120-mm mortar to replace its the 81-mm mortars and increase its firepower.

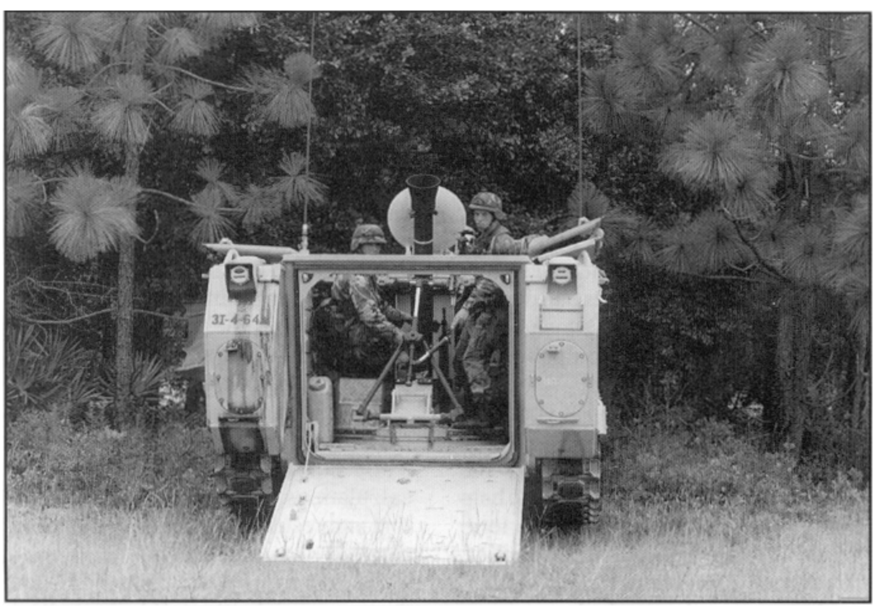
The Infantry Center, Fort Benning, Georgia, is exploring the "Arms Room Concept." The concept is that light infantry battalions would have both 81-mm and 120-mm mortars and would deploy them based on the mission, enemy, terrain, troops and time available (METT-T).

MFCS is one of the top candidates for the warfighting rapid acquisition program (WRAP). WRAP provides funding to move promising programs to the field faster. Of the programs competing for WRAP funding, MFCS is the only one that puts "steel on target."

Assuming WRAP funding in FY 97, the interim digitized division would receive the MFCS in 2001 with both heavy and light units receiving MFCS thereafter. If funding is not forthcoming, units won't receive the MFCS until 2003.

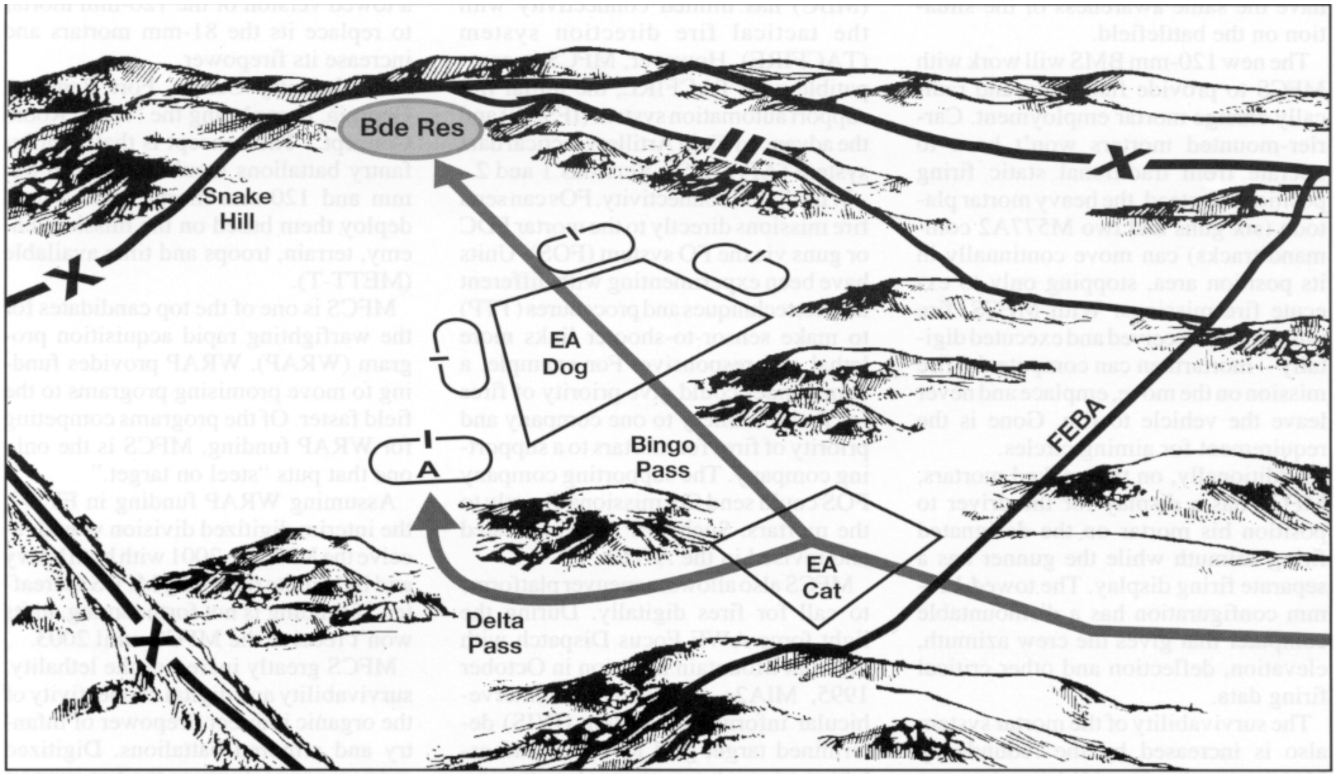
MFCS greatly increases the lethality, survivability and digital connectivity of the organic indirect firepower of infantry and armored battalions. Digitized mortars connectivity to the fire support system will give fire support officers real-time, updated information on the status of mortar systems, ammunition and locations.

Mortars are an inexpensive versatile, responsive and lethal weapon for the land force of the next century.



M121 120-mm BMS Mortar on M113A3. The new 120-mm BMS will work with MFCS to radically change mortar employment.

Lieutenant Colonel L. Steve Davis, Jr., Acquisition Corps, is the Product Manager for Mortars at Picatinny Arsenal, New Jersey. His previous acquisition assignments include serving as Missile System Staff Officer in the Office of the Secretary of the Army for Research, Development and Acquisition at the Pentagon and Project Director for the Project Manager for Training Devices in Orlando, Florida. He also served as executive officer for a light infantry battalion, assistant operations officer at the brigade and division levels and commander of three infantry companies. Among other courses, he is a graduate of the Defense Systems Management College Program Managers Course at Fort Belvoir, Virginia, and the Infantry Mortar Platoon Officers Course, Fort Benning, Georgia. Lieutenant Colonel Davis holds a Master of Science in Contract and Acquisition Management from the Florida Institute of Technology. He also holds a Master of Arts and Science from the Command and General Staff College, Fort Leavenworth, Kansas.



Battle Calculus and Fire Support Planning

by Major Thomas L. Kelly

You are the new fire support officer (FSO) for Task Force 1-89 Armor and are part of a 3x6 155-mm Paladin direct support battalion. It's your first opportunity to plan combat operations as part of the task force battle staff. The mission is to defend the Bingo-Delta pass complex against a motorized rifle regiment (MRR) at 70 percent strength to prevent the MRR's penetration of the task force's defense. The regiment is leading the attack with a Forward Detachment, a motorized rifle battalion-plus-sized formation. The Detachment's mission is to control one of the two passes so the remainder of the regiment can follow on its way to seize the defensible high terrain just east of Snake Hill.

The task force commander outlines his concept of the operation: "I want Team A to limit the Forward Detachment's ability to control Delta Pass, forcing the remainder of the regiment to go through Bingo Pass. This will allow me to mass the effects of the other three company teams' direct and indirect fires into EA [Engagement Area] Dog on the reverse slope of Bingo Pass to destroy the rest of the MRR.

"Fires must disrupt the Detachment's ability to seize Delta Pass from Team A. allowing me to focus the other three teams into EA Dog. I believe Team A can retain Delta Pass if fires can destroy at least one of the Forward Detachment's MRCs [motorized rifle companies] in EA Cat."

The commander looks up at you from his notes and says, "Can you do it?"

How can you possibly answer the commander's question? One tool to help you is battle calculus. While the term "battle calculus" may not be familiar, the idea of applying planning factors, combat power values and other numeric and scientific parameters to military planning is not new.

The brigade trainers at the National Training Center (NTC), Fort Irwin, California, have defined battle calculus as "the process of using doctrinal rates, factors, speeds and other data to conduct detailed analyses that support military decision making. Through this process, commanders and staffs are able to analyze relative combat power, estimate and verify capabilities, translate [those capabilities] into missions, conduct predictive analyses and allocate resources to defeat the enemy."

For fire support planning, battle calculus can help answer questions such as "How long will it take?" "How much ammunition is required?" and "When do I need to trigger fires?" While battle calculus does *not* provide certainty, it does improve the likelihood of success. There is a danger in "over quantifying" your planning: the more you must assume as you calculate, the less realistic and accurate your work may become.

The real benefits of battle calculus occur with practice. As the task force battle staff consistently employs battle calculations, the process becomes routine and results in better developed and detailed plans and orders.

The fire support element (FSE) and the maneuver battle staff begin to "calculate" as a natural part of course of action (COA) development. The "science of war" is reflected in realistic plans that can achieve the commander's intent. The detailed, step-by-step logical process used in battle calculus (such as the example in this article) becomes second nature and quickly gives way to "rules of thumb." When the FSO can build feasible plans rapidly and train his commander to have realistic expectations of fire support, the fire support planning process is streamlined and more effective.

Can You Do It?

Using basic battle calculus, you can determine the feasibility of your fires achieving the commander's guidance. Note that this example is based on the assumptions outlined in the scenario and is not "the formula" for answering all commanders' Can-you-do-it questions. Rather, this example shows the process of trying to best-guess the integration of time, space and asset variables to achieve a specific goal.

Step 1: Translate the commander's guidance into a quantifiable effect. Once you've defined the task and purpose for fires (critical fire support task), you quantify that task to measure success or failure.

In this case the commander's guidance was..."destroy at least one MRC in EA Cat," and his purpose was to "disrupt the Detachment's ability to seize Delta Pass from Team A, allowing me to focus the other three teams [against the MRR's main body funnelled] into EA Dog."

You must at least destroy one MRC. You consult with the S2 to confirm how many combat vehicles are in an MRC: 3 T-80 tanks and 8 BMP infantry combat vehicles.

Step 2: Equate the required effects to the required ammunition. This calculation normally is based on the graphical munitions effects tables (GMETs) as captured manually or using an automated device. For this example, I use the NTC "GMET": to kill one tank, it takes 54 155-mm dual-purpose improved conventional munitions (DPICM) and to kill one BMP, it takes 18 155-mm DPICM.

Therefore, you can calculate how many rounds it takes to achieve the effects:

3 Tanks x 54 RDs	=	162 DPICM
8 BMPs x 18 RDs	=	144 DPICM
Total RDs Required	=	306 DPICM

You've already checked to see how many rounds of DPICM your battalion has on hand: enough for 54 battalion-three volleys of DPICM—more than enough to achieve the effects.

Step 3: Determine the minutes available for the attack. For this step, you need some additional facts and must make some assumptions. You must attack the Forward Detachment with fires in EA Cat. Because time is a function of distance, rate of movement and formation size, you gather the information you need. From the S3 and operations overlays, you determine that EA Cat is nine kilometers long. In consultation with the S2, you assume that a Forward Detachment in march formation in EA Cat is about one kilometer long by 250 meters wide. Also in conjunction with the S2, you assume the enemy rate of march in EA Cat is 30 kilometers per hour (KPH). From your FSO's "Smart Book," you determine that 30 kilometers per hour is one kilometer (KM) every two minutes.

With this info, you calculate the time available to attack the enemy in EA Cat:

1-KM Det Pass Time	=	2 MIN
Travel 9 KM in EA x 2 MIN per KM	=	18 MIN
Total Time Available	=	20 MIN

Step 4: Determine if the required ammunition can be delivered in the time available. Now you determine if we can deliver 306 DPICM (Step 2) in 20 minutes (Step 3). You look in your Smart Book to verify that your battalion's 18 155-mm tubes' rate-of-fire is one minute per round, based on the battalion's most recent Army training and evaluation program (ARTEP) times. Therefore:

20 MIN x 18 Tubes per RD per MIN = 360 RDs in Time Available

In this step, you've learned that the battalion can deliver 360 rounds in the time available—more than the 306 rounds required to achieve the desired effects. It would appear your mission is do-able.

Unfortunately, the enemy formation you must engage is moving, so you also must calculate how many volleys your battalion can fire on the Forward Detachment at a single target location.

Step 5: Determine maximum volleys that can be fired on the moving formation at one target location. With your assumptions that the Detachment is 1,000 meters long by 250 meters wide while in march formation in EA Cat and that it will move at 30 kilometers per hour, you can calculate a pass time of two minutes—the time from the lead vehicle to the trail vehicle's crossing the same point on the ground.

Figure 1 shows how you calculate that your FA battalion can fire three volleys on the moving formation before the enemy can pass completely through the target location.

Step 6: Determine the number of attacks (battalion-three volleys) needed to deliver the required ammunition. You know that the battalion's 18 tubes firing a three-round volley is 54 rounds per attack. Therefore:

306 Required RDs ÷ 54 RDs = 6 Attacks on Distinct Targets

Because the battalion must fire at a target and then shift six times, you now must determine if the enemy will be in EA Cat long enough—if EA Cat has enough space—to achieve the desired effects.

Step 7: Determine if time and space are available to execute the required attacks. From your Smart Book ARTEP data, you know it takes your battalion two minutes to deliver a battalion-three

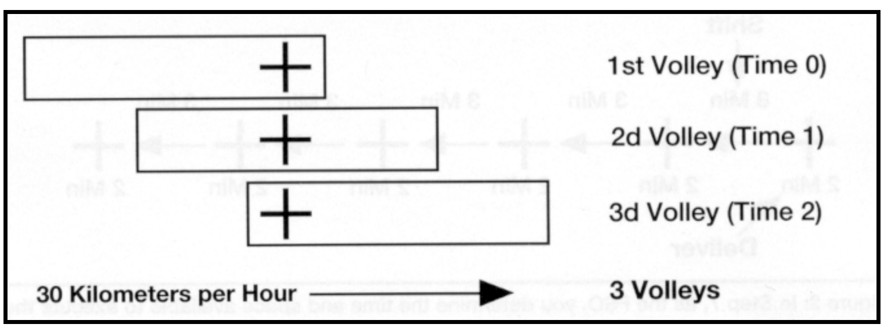


Figure 1: In Step 5, as the FSO, you determine the number of volleys your DS battalion can fire at one target location in EA Cat before the 1,000-by-250 meter enemy detachment moving 30 kilometers per hour can pass through that location.

and three minutes to shift a volley from one target to another. Figure 2 shows how you add up the shift and fire times to determine how long it will take the battalion to achieve the required effects—in this case, it's 27 minutes.

You already know the moving enemy formation will have passed through EA Cat in 20 minutes. Therefore, the answer to the question, "Can you do it?" is "No, Sir" ....That is, unless you can increase—

• The space available. Can you put an observer in position to acquire the enemy farther out? Can the battalion range the enemy farther out?

• The time available. Can you slow the enemy down in the EA with family of scatterable mines (FASCAM), other obstacles, jamming, mechanical smoke, etc.?

• The volume or lethality of fire. Can you get reinforcing artillery, close air support (CAS) or attack aviation? Can you fire Copperhead rounds?

This example demonstrates that battle calculus is not a pure science and won't generate a flawless solution to every battlefield fire support problem. In fact, the battle calculus "answer" is rarely a definitive "Yes" or "No" but instead suggests how you can make success more likely by integrating obstacles, employing intelligence and electronic warfare (IEW), repositioning observers or adding killing assets and other combat multipliers. The answer should only be "It can't be done" after you've exhausted all means to meet the commander's guidance.

There are many ways to use battle calculus in fire support planning. Even the steps in the example in this article may change as mission, enemy, terrain, troops and time available (METT-T) change. To facilitate the process, the FSO should have at least the planning information listed in Figure 3 readily available in his Smart Book or through his FSE. The basic thought process of applying reasonable assumptions and tested planning factors to try to improve the feasibility of fire support plans and their synchronization with maneuver is sound.

To use battle calculus will not guarantee your fire support plans will succeed; but, when used routinely, battle calculus will result in fire support plans that *can* succeed. And that may be all an FSO can plan on.

- Number of Killer Missions by Munitions and Target Types
- Time Required to Fire Killer Mission by Munition (Ready to Rounds Complete)
- Artillery Shift Time by Weapon and Target Types (Planned or Target of Opportunity)
- Minimum and Maximum Ranges by Weapon and Munition Types and Primary Method of Delivery
- Copperhead Planning Factors (Copperhead Coverage Template)
- Observer Status (Location, Equipment, Observation Limits)
- Radar Status and Capabilities
    - Systems Available
    - Ranges
    - Cumulative Cue Time/Threat
    - Zone Planning Factors/Considerations
- Close Air Support (CAS)
    - Available Aircraft by Types and Sorties
    - Aircraft Capabilities
    - Available Munitions and Restrictions/Limits of Each
    - Response Time for Immediate CAS (Request to Command Post)
    - Station or Loiter Time (Command Post to Off-Station)
    - CAS Tactical Planning Data: Threat and Tactics, Required Airspace, Coordinating Alternative and Suppression of Enemy Air Defenses (SEAD) Timing/Separation
- Radio Ranges by Radio Type/Configuration
- Family of Scatterable Mines (FASCAM)
    - Number of 400 by 400 Medium Density Minefields
    - Time Required to Emplace by Battery/Two Batteries/Battalion for On-Order and Be-Prepared
- Number of Minutes of Illumination by Weapon Type
- Number of Modules of Smoke: 600 x 15 Minutes x Wind Direction x Conditions
- Target Spacing Minimums: Rate-of-March (Kilometers/Minutes) x [Shift Time + Deliver Time]
- Trigger Leads: Rate-of-March (Kilometers/Minutes) x [Time-on-Target Process Time + Time of Flight]
- Commander's Intent
- Commander's Planning Guidance

Figure 3: Fire Support Planning Factors for Battle Calculus. This kind of information and more should be readily available in the FSO's "Smart Book" or through his FSE.

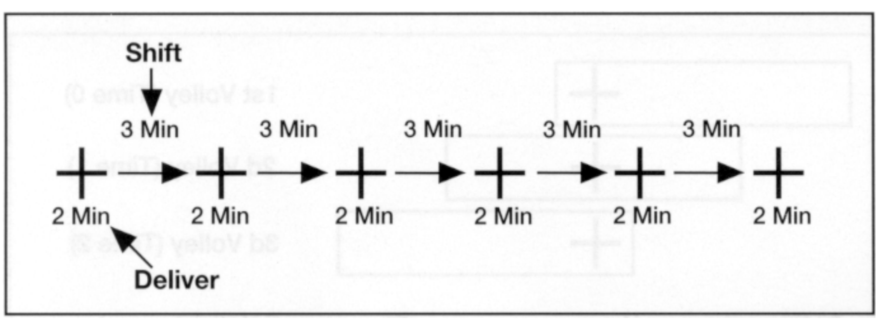


Figure 2: In Step 7, as the FSO, you determine the time and space available to execute the attacks. You know your battalion can deliver a battalion-three in three minutes and it takes three minutes to shift from a volley on one target to a volley on another. With that information, you can determine the battalion will take 27 minutes to deliver enough rounds to have the required effects.

Major Thomas L. Kelly is a Small Group Leader in the Officer Advanced Course of the Field Artillery School, Fort Sill, Oklahoma. In his previous assignment, he served as a Firing Battery Trainer, Assistant FA Battalion Operations Center (TOC) Trainer and Assistant Brigade Fire Support Trainer at the National Training Center, Fort Irwin, California. He commanded B Battery, 3d Battalion, 320th Field Artillery in the 101st Airborne Division (Air Assault), Fort Campbell, Kentucky. Also in the 101st Division, he served as Task Force Fire Support Officer for 2-187 Infantry during Operations Desert Shield and Storm.

ATACMS Block IA
Fires Deep and Deadly

Two hundred and fifty kilometers behind enemy lines, a Special Forces team reports a Scud launcher rearming for an additional strike. The corps deep operations coordination cell (DOCC) immediately transmits a call-for-fire (CFF) to the general support (GS) Field Artillery brigade, ordering two Army tactical missile system (ATACMS) Block IA missiles be fired.

The brigade processes the mission and transmits the CFF via computer to the multiple-launch rocket system (MLRS) battalion, which is expecting the call. The fire direction system (FDS) computer at the battalion processes and transmits the order to the firing battery and M270 launcher. The launcher, with two ATACMS Block IA missiles on board, acknowledges the CFF and fires both missiles at the rearm site—all within seven minutes of the initial report from the Special Forces team.

Although this scenario is fictitious, it's totally feasible—given the capabilities proven in recent tests. Rapidly hitting an enemy launcher with pinpoint accuracy from 300 kilometers away is not only a requirement for effective theater missile defense, it's also a reality when the ATACMS Block IA missile is fielded in early 1998.

Rarely can we engage high-priority, fleeting targets at depth today because of the limited range of Army weapons and the delayed response times of aircraft or cruise missiles. Operation Desert Storm proved that aircraft could not engage deep mobile targets, such as Scud launchers, because of the targets' short dwell time. In contrast, the quick response time of the Block IA missile coupled with it's 300-kilometer range and precision allows corps and theater commanders to engage these targets without risking the lives of pilots or loss of expensive aircraft.

The ATACMS Block IA missile, designated the M39A1, is the extended-range variant of the current M39 Block I. It can deliver 310 M74 anti-personnel/anti-materiel bomblets to ranges up to 300 kilometers. The accuracy of the inertial missile guidance system on the Block IA, which is more accurate than Block I's guidance system, is augmented further with a global positioning system (GPS) receiver that gives the missile precision accuracy at all ranges. To facilitate the transfer of GPS data, the Block IA missile is fired from either a modified M270 or the M270A1 MLRS launcher. The missile retains the random off-axis launch capability that significantly reduces the counterfire threat to the launcher.

The ATACMS Block IA underwent rigorous operational testing at Fort Sill, Oklahoma, and White Sands Missile Range, New Mexico, in August and September 1996. During the operational test, soldiers of the 2d Battalion, 18th Field Artillery of the 212th Field Artillery Brigade, III Corps, Fort Sill simulated the employment of the new missiles during two 96-hour tactical field exercises at Fort Sill and, later, fired two live missiles at White Sands.

In addition to operational testing, five pre-production qualification test flights were flown to verify the Block IA's capabilities, the last one in October 1996. Flight and climate condition tests have proved ATACMS Block IA can easily achieve its 300-kilometer range and precision accuracy requirements (classified) in all weather conditions.

In March 1997, the Army leadership will decide whether or not to proceed with full-rate production; Block IA will be fielded in early 1998.

CPT David L. Johnson, FA
Asst. TSM-Rockets and Missiles
Fort Sill, OK

ATACMS Block IA, 1996, White Sands Missile Range, NM

Firing Tables Update

More than two years have passed since the Gunnery Department (GD) of the Field Artillery School, Fort Sill, Oklahoma, published an update to the firing tables used by the Army and Marine Corps (February 1995). The updated information in the following tables was compiled using data from the Armament Research Development and Engineering Center (ARDEC) at Aberdeen Proving Ground, Maryland, the Gunnery Department and the Graphical Firing Tables Manufacturing Plant, Fort Sill, Oklahoma.

While not truly a firing table, the new Muzzle Velocity Correction Tables (MVCT-1) have been published as of June 1996. This new publication replaces the old MVCT 90-2 (Changes 1, 2 and 3). MVCT-1 now allows for fuze weight corrections on all current weapon systems, providing fire direction officers (FDOs) a manual verification of the M93/M94 muzzle velocity system (MVS) computations. Units can order the MVCT-1 through ARDEC at the address listed in the next paragraph.

To receive new or replacement tabular firing tables (TFTs), order them through the Adjutant General publication channels using DA Form 4569. To order graphical firing tables (GFTs), requisition them through your supply section as expendable items and cite CTA 50-970 as the requisitioning authority. Firing tables marked with "PAD," "PROV" or "*" can't be obtained through normal channels. To order them, write a letter justifying your requirement to: Commander, US Army ARDEC, ATTN: AMSTA-AR-FSF-T, Aberdeen Proving Ground, MD 21005-5001.

If you have questions about getting TFTs, contact Lisa Walters, Rock Island Arsenal, Illinois, at DSN 793-6981/4920. General questions regarding the use of all tables and questions concerning getting GFTs should be addressed to the Officer Instruction Branch, GD, at DSN 639-6379/4973 or commercial (405) 442-6379/4973.

Capt Dean E. Robison, USMC
Officer Instruction Branch, GD
Field Artillery School, Fort Sill, OK

Tabular Firing Tables

Firing Table	Projectile	Remarks
105-mm M101A1		
FT 105-H-7 w/C-1, 3, 4, 5, 6, 7	Ctg, HE, M1	HE
FT 105-ADD-B-2 w/C-1	Ctg, HE, M444	APICM
*FT 105-AV-1 w/C-1	Ctg, HE, M548	RAP
*FT 105-H-6 (PROV SUPP 1)	Ctg, CS, M629	CS
105-mm M102/M119		
*FT 105-AS-3 w/C-1	Ctg, HE, M1/M760	HE
FT 105-ADD-F-1 w/C-1	Ctg, HE, M444	APICM
*FT 105-AU-1 w/C-1, 2	Ctg, HE, M548	RAP
*FT 105-AS-2 (PROV SUPP 1)	Ctg, CS, M629	CS
*FT 105-AW-0	Ctg, HERA, M913	RAP
155-mm M109/M114A2		
FT 155-AH-3 w/C-2, 3, 4, 6, 7	HE, M107	HE
FT 155-ADD-E-2 w/C-1	HE, M449 (A1) (E1)	APICM
FT 155-AK-2 w/C-1	HE, M483A1	DPICM
FT 155-ADD-G-2	HE, M483A1	DPICM
FT 155-ADD-M-1	HE, M692/M731	FASCAM (ADAM)
FT 155-ADD-P-1	HE, M718/M741	FASCAM (RAAM)
*FT 155-ADD-S-0	SMOKE, M825	SMOKE
FT 155-AL-1	HERA, M549 (A1)	RAP
155-mm M109A2/A3/A4/A5/A6 and M198		
FT 155-AM-2 w/C-1, *2	HE, M107	HE
*FT 155-ADD-I-2	HE, M449 (A1) (E1)	APICM
*FT 155-ADD-K-1 w/C-1	CHEM, M687A1	BINARY, GB2
*FT 155-ADD-T-0 w/C-1	SMOKE, M825/M825A1	SMOKE
*FT 155 ADD-Q-0 (REV) w/C-1, 2	SMOKE, M825/M825A1	SMOKE
*FT 155-AN-2 w/C-1	HE, M483A1	DPICM
*FT 155-AR-0	HE, M795	HE (LONG)
*FT 155-ADD-O-0	HE, M483A1	DPICM
FT 155-ADD-R-1	HE, M483A1	DPICM
FT 155-ADD-J-1 w/*C-3	HE, M483A1	DPICM
FT 155-ADD-L-1 w/C-1, 2	HE, M692/M731	FASCAM (ADAM)
FT 155-ADD-N-1 w/C-1	HE, M718/M741	FASCAM (RAAM)
*FT 155-AO-0 w/C-1, 2	HERA, M549/M549A1	RAP
FT 155-AS-1	GUIDED, M712	COPPERHEAD
*FT 155-AU-PAD w/C-1	HE, M864	BASE BURN
*FT 155-ADD-U-PAD	HE, M864	BASE BURN
*FT 155-ADD-W-0	SADARM, M898	SADARM
*FT 155 ADD-V-PAD	AD/EXJAM, XM867	
203-mm M110A2		
FT 8-Q-1 w/C-1, 3, 4, 6, 7	HE, M106	HE
FT 8-ADD-F-1 w/C-1	HE, M404	APICM
FT 8-S-1 w/C-1	HERA, M650	RAP
FT 8-T-1 w/C-1	HE, M509A1	DPICM
FT 8-ADD-G-1	HE, M509A1	DPICM
FT 8-ADD-L-1	HE, M509A1	DPICM
14.5-mm Trainer		
FT 14.5-A-1	Ctgs, M181, M182, M183	

Graphical Firing Tables

Based on TFT	Description	NSN	No. Rules	Charges
105-mm M101A1				
105-H-7	GFT HEM1 (LA) w/ICM	1220-01-038-0761	3	1-3, 4-5, 6-7
105-H-7	GFT HEM1 (HA)	1220-00-151-4155	1	ALL
105-H-7	GFT ILL M314	1220-01-021-7275	2	3-4, 5-7
105-H-6	GST HEM1	1220-00-815-6190	1	ALL
105-H-7	BAL SCALE HEM1 (LA)	1220-01-037-7284	1	1-3, 4-5, 6-7
105-mm M102/M119				
105-AS-3	GFT HEM1 (LA) w/ICM	1220-01-315-7912	4	
105-AS-3	GFT HEM1 (HA)	1220-01-315-7913	1	1-7
105-AS-3	GFT ILL M314	1220-01-315-7917	4	1-7
105-AS-3	GST HEM1	1220-01-315-7915	1	1-7
105-AS-2	BAL SCALE HEM1 (LA)	1220-01-037-7285	1	1-3, 4-5, 6-7
105-AS-3	GFT HEM760 (HA & LA)	1220-01-315-7914	1	8 ONLY
105-AS-3	GST HEM760	1220-01-315-7916	1	8 ONLY
155-mm M109/M114A2				
155-AH-3	GFT HEM107 (LA) w/ICM	1220-01-038-2413	3	1-3, 4-5, 6-7
155-AH-3	GFT HEM107 (HA)	1220-00-551-3042	1	ALL
155-AH-3	GFT ILL M485	1220-01-038-7199	2	1-3, 5-7
155-AH-3	GST HEM107	1220-00-551-3041	1	ALL
155-AH-3	BAL SCALE HEM107 (LA)	1220-01-037-7287	1	1-3, 4-5, 6-7
155-AK-2	GFT HEM483A1 (LA)	1220-01-038-7204	3	1-3, 4-5, 6-7
155-AK-2	GFT HEM483A1 (HA)	1220-01-038-7203	1	ALL
155-AK-2	GST HEM483A1	1220-01-038-7202	1	ALL
155-AL-1	GFT HEM549A1 (LA)	1220-01-065-9844	1	7R (RKT ON)
155-AL-1	GFT HEM549A1 (HA)	1220-01-065-9843	1	7R (RKT ON)
155-AL-1	GST HEM549A1	1220-01-065-9842	1	7R (RKT ON)
155-mm M109A2/A3/A4/A5/A6 and M198				
155-AM-2	GFT HEM 107 (LA) w/ICM	1220-01-215-3929	4	2-4, 3, 5-6, 7-8
155-AM-2	GFT HEM107 (HA)	1220-01-215-3961	1	ALL
155-AM-2	GFT ILL M485	1220-01-215-3962	2	2-3, 5-7
155-AM-2	GST HEM107	1220-01-215-3930	1	ALL
155-AM-2	GST HEM107/M825	1220-01-224-2513	3	3-4, 5-6, 7-8
155-AM-1	BAL SCALE HEM107 (LA)	1220-01-037-7288	1	3-4, 5-6, 7-8
155-AN-2	GFT HEM483A1 (LA)	1220-01-425-7102	5	3-4G, 5G, 3-4W, 5-6W, 7W-7R
155-AN-2	GFT HEM483A1 (HA)	1220-01-425-7103	2	3, 4, 5G, 3-7W, 7R
155-AN-2	GST HEM483A1	1220-01-426-3532	2	
155-ADD-Q-0	GFT HEM483A1/M825	1220-01-224-2514	1	8R
155-ADD-Q-0	GST HEM483A1/M825	1220-01-224-2515	1	8R
155-AO-0	GFT HEM549A1 (LA)	1220-01-065-9845	1	7R, 8R, 8S
155-AO-0	GFT HEM549A1 (HA)	1220-01-065-9847	1	7R, 8R, 8S
155-AO-0	GST HEM549A1	1220-01-065-9848	1	7R, 8R, 8S
155-AU-PAD	GFT HEM864 (LA)	1220-01-333-4120	1	7W, 7R
155-AU-PAD	GFT HEM864 (LA)	1220-01-333-4121	1	8 (M203)
155-AU-PAD	GFT HEM864	1220-01-333-4122	1	ALL
155-AS-0	GFT M712 (LA)	1220-01-102-7851	3	4-5G, 4-5W, 6-7W
155-AS-0	GFT M712 (LA)	1220-01-102-7850	1	8
155-AS-0	GST M712	1220-01-102-7849	1	ALL w/1 EXTRA SLIDE
155-AS-0	GFT M712 (HA)	1220-01-116-3268	1	ALL
155-AS-1	CLGP M712 CPHD	1220-01-224-2588	1	FOOTPRINT TEMPLATE

Graphical Firing Tables *(Continued)*

Based on TFT	Description	NSN	No. Rules	Charges
203-mm M110A2				
8-Q-1	GFT HEM106 (LA) w/ICM	1220-01-038-2410	5	1-2, 3-4, 5-6, 7-8, 9
8-Q-1	GFT HEM106 (HA)	1220-01-021-7273	1	ALL
8-Q-1	GST HEM106	1220-01-021-7274	1	ALL
8-Q-1	BAL SCALE HEM106	1220-01-102-4202	1	1-3, 4-5, 6-7
8-T-1	GFT HEM509 DPICM (LA)	1220-01-067-7169	5	1-2, 3-4, 5G-5W, 6-7, 8-9
8-T-1	GFT HEM509 DPICM (HA)	1220-01-067-7170	1	ALL
8-T-1	GST HEM509	1220-01-067-7171	1	ALL
8-S-1	GFT HEM650 (LA) w/M753	1220-01-070-8970	7	1-2, 3-4, 5G-5W, 6-7, 8-9, 7R, 8R, 9R
8-S-1	GFT HEM650 (HA)	1220-01-067-7172	2	ALL
8-S-1	GST HEM650	1220-01-067-7173	1	ALL w/1 EXTRA SLIDE
14.5-mm Trainer				
14.5-A-1	GFT	1220-00-442-2446	1	
14.5-A-1	GST	1220-00-221-6328	1	
14.5-A-1	BALLISTIC SCALE	1220-01-038-1226	1	

MVV Corrections in BCS and BUCS for Light FA Units

Army light and Marine artillery units have been having problems with computations of muzzle velocity variations (MVVs) in two of our computer systems. The following procedures have been developed to compute MVVs in the battery computer system (BCS) and backup computer system (BUCS).

BCS and the M119 Propelling Charge

All iterations of Version 10 BCS software can't store or compute technical firing data for the M119 propelling charge. To best explain the corrections, this article presents four scenario-dependent procedures.

Scenario #1: Shooting Strength of the Howitzer is Unknown and M119 Propellant Efficiency is Unknown. The lot designator and quantity of on-hand M119 propellant is entered into the BCS AFU;AMMO message format as M119A1 propellant. In the appropriate howitzer's BCS;MVV file, an MVV entry of -9.0 meters per second (M/s) is entered into each projectile and the *M119A1* propelling charge combination that is anticipated for firing. This MVV entry corrects the M119A1 propellant muzzle velocity to the M119 muzzle velocity, regardless of projectile. (Note: M119A1 MVVs and M199 MVVs cannot exist in the BCS;MVV file at the same time.)

Scenario #2: Shooting Strength of the Howitzer is Known and M119 Propellant Efficiency is Unknown. The lot designator and quantity of on-hand M119 propellant is entered into the BCS AFU;AMMO format as M119A1 propellant. In the appropriate howitzer's BCS;MVV file, make the entry as follows:

> Projectile MVV = Shooting Strength* + (-9M/s)**
>
> * Computed from the tabular firing tables (TFTs).
> ** The M119 correction value for the M119A1 propellant.

Scenario #3: Shooting Strength of the Howitzer is Known and M119 Propellant Efficiency is Known. The lot designator and quantity of on-hand M119 propellant is entered into the BCS AFU;AMMO format as M119A1 propellant. In the appropriate howitzer's BCS;MVV file, the following MVV entry is made:

> Projectile MVV = Shooting Strength + M119 Propellant Efficiency* + (-9M/s)
>
> *The efficiency is M119 lot-specific.

Scenario #4: M119 Propellant Lot is Calibrated. The lot designator and quantity of the calibrated M119 propellant lot is entered into the BCS AFU;AMMO format as M119A1 propellant. Make appropriate entries (M90 chronograph readout average, propellant temperature, ammunition lot designators, fuze and gun number) into the BCS;MVD message format. The BCS will automatically enter the correct MVV into the appropriate gun's BCS;MVV file, comparing and accounting for the difference between the M119 and M119A1 propellant.

If a calibration was conducted using the M94 chronograph, subtract 9 M/s from the MVV and enter the value directly into the gun's BCS;MVV file under the correct projectile/M119A1 iteration.

BUCS and the M119/M119A1 Howitzer

BUCS Revision 1 software for the M119/M119A1 howitzer was developed by the Army's Ballistic Research Laboratory in 1986 and 1987 based on the initial firing table test in 1985. Unfortunately, the production verification tests (1988) and the subsequent publication of fire control information in Firing Table 105 AS-3 (December 1989) updated and changed the data used to produce Revision 1 of the BUCS ROM cartridges.

Charge	Correction Value
1	+2.7
2	+1.2
3	+0.7
4	+3.3
5	+5.1
6	+7.3
7	+7.7
8 (M200)	+0.2

Muzzle Velocity Correction Values for BUCS/TFT 105 AS-3

As a result of the rapid software development, a discrepancy in M119/M119A1 howitzer MVVs exists. The following are two methods to resolve the discrepancy:

(1) After completing a calibration with the M90 or M94 chronograph, follow the procedures for determining and storing an MVV as outlined in the *ST 6-40-31 FA Backup Computer System (BUCS)*, Page 2-24. Display the stored MVV and add the appropriate correction value from the table on this page. Reenter the corrected MVV into the gun's MVV file.

(2) If predicting the MVV from shooting strength and propellant efficiency data, update the MVV formula from *FM 6-40 Field Artillery Manual Cannon Gunnery*, Page 4-12, as follows:

MW = Shooting Strength + Propellant Efficiency + Correction Value*

* Determined using the table on this page.

If Redlegs have questions about the procedures outlined in this article, call the Officer Instruction Branch of the Gunnery Department, Field Artillery School, Fort Sill, Oklahoma, at DSN 639-6379/4973 or (405) 442-6379/4973.

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The New M94 Muzzle Velocity System

By now, the entire Marine Corps and most of the light divisions of the Army have the M94 muzzle velocity system (MVS). This article briefly discusses some of the capabilities and limitations of this new system.

The automated systems proverb of "garbage in equals garbage out" is applicable to the M94 MVS. Accurate data in the form of good muzzle velocity variations (MVVs) can only be obtained with an accurate data base in the MVS. The cannoneer managing the MVS data base with correct lot designations and propellant temperatures is as vital to accurate firing data as the fire direction specialist behind the fire direction center's (FDC's) battery computer system (BCS).

Establishing unit standing operating procedures (SOPs) that dictate the frequency of MVS data base updates is a *must*. At a minimum, the cannoneer enters an update for every lot change (propellant or projectile). Every half hour, the data base manager should enter an update for the latest propellant temperature. During a registration or deliberate calibration, the fire direction officer (FDO) should dictate the frequency of MVS data base updates to accurately account for nonstandard conditions on the registering/calibrating gun, based on the current conditions.

The MVS's greatest capability lies in its MVV storage capacity. One thousand data slots are available to store MVVs related to howitzer numbers, projectile types, propellant types, charges and lot combinations. The entire 1,000 slots can be erased at once or an individual MVV can be erased alone. However, as long as the data base is maintained correctly, the MVV memory will never need erasing. If a new MVV is calculated today or 10 years from today, it will overwrite the previously stored MVV as long as the howitzer number, projectile type, propellant type, charge and lot combination match *exactly*.

The stored MVV is calculated from the data of three to 99 firings of the howitzer. The average muzzle velocity of these firings is normalized to account for non-standard square weight and propellant temperature when the operator chooses to calculate an MVV. Consequently, it's imperative to have the average propellant temperature from the calibration period entered into the MVS when an MVV is calculated. Bottom line: the MVS does *not* account for non-standard conditions with each round fired.

A number of developments lie on the MVS' horizon. DA Form 4982-1-R, the M90 Velocimeter Work Sheet, will undergo a dramatic facelift. Changes will be incorporated to aid the gun line in the continuous MVS data base management process. Until the new form is published, units should continue to use the old one.

Redlegs may send suggestions for the format of the new work sheet to the Commandant, US Army Field Artillery School, ATTN: ATSF-GC, Officer Instruction Branch, Gunnery Department, Fort Sill, Oklahoma 73503-5600.

An MVV data base management program will be available for all computers by the end of the year. This program will allow an FDO to download MVVs from the MVS into a computer in the battery office, the battalion S3 shop or at home. The MVVs can be manipulated and later up-loaded into the MVS before going back to the field to fire.

Finally, the most dramatic development in store for the MVS will arrive with the battery computer system (BCS) Version

11 software in 1998. A new piece of hardware, called the MVS communications adapter (MCA), will allow BCS Version 11 to interface directly with the MVS over the gun display unit (GDU) communications line. From the FDC, the FDO will be able to up-load current MVV data into the BCS with a few keystrokes.

As questions arise, units should read the documentation provided by the mobile training teams (MTT) and Army *TM 9-1290-364-14&P/Marine Corps TM09814A-14&P The Technical Manual for the Conventional Muzzle Velocity System*. If units need more information, they can call the Officer Instruction Branch of the Gunnery Department (GD) at the Field Artillery School at DSN 639-6379/4973 or commercial 405-442-6379/4973.

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Corrections to FM 6-40: HOB Illumination Calculations

An error occurred during the printing of *FM 6-40/FMFRP 6-6-40 Tactics, Techniques and Procedures for Field Artillery Manual Cannon Gunnery*. The mistake pertains to manually computing illumination safety using the tabular firing table (TFT) method.

Changes to Page 15-16

The error is that a "+" sign instead of a "-" sign is used in matrices and examples for correcting illumination height of burst (HOB). The following incorrect portions have been corrected and can be incorporated as interim changes to FM/FMFRP6-6-40. The highlighted areas are where the errors actually occurred in the original manual.

There are two changes on this page. The first is to Step 5 in "Table 15-5 Low-Angle Illum, TFT Method, Minimum Range."

STEP	ACTION
5	**Determine and record HOB (600 - VI [DETERMINED IN STEP 4]). Use 750 instead of 600 for 105 mm.**

The second change is to "Figure 15-11 Illum Matrix for Minimum Range Using TFT HOB Correction."

RG	CHG	VI ≈ NEAREST 50 M	600 - VI = HOB	HOB ÷ 50	x	ΔQE FOR DEC OF 50 M HOB	=	CORR TO QE	+	QE COL 2	MIN =QE	M565	M577
5000	5GB	-10 ≈ 0	600 - 0 = 600	600 ÷ 50 =12		-10.6	=	-127		403	276	16.2	16.3

Change to Page 15-17

The one change on this page is to "Figure 15-12 Illum Matrix for Maximum Range Using HOB Correction."

RG	CHG	VI ≈ NEAREST 50 M	600 - VI =	HOB	HOB ÷ 50	x	ΔQE FOR DEC OF 50 M HOB	=	QE CORR COL TO QE + 2	MAX = QE
7000	5GB	+19 ≈ 0	600 - 0 =	600	600 ÷ 50 = 12	x	-8.6	=	-103 +500	= 397

Changes to Page 15-25

Two changes are necessary on this page. The first is to Figure 15-20 Illum Matrix for Minimum Range Using TFT HOB Correction."

RG	CHG	VI ≈ NEAREST 50 M	600 - VI = HOB	HOB ÷ 50	x	ΔQE FOR DEC OF 50 M HOB	=	CORR TO QE	QE COL 2	MAX QE
5000	5GB	-10 ≈ 0	600 - 0 = 600	600 ÷ 50 =12		+0.5		+6	1297	1303

The second change is to "Low angle, shell illumination, TFT, HOB correction method," a portion of "Figure 15-22 Safety Matrixes."

Low angle, shell illumination, TFT, HOB correction method:
(155 mm: HOB = 600 m, 105 mm: HOB = 750 m

RG	CHG	VI ≈ NEAREST 50 M	ILLUM HOB- VI = HOB	HOB ÷ 50	x	ΔQE FOR DEC OF 50 M HOB	=	CORR TO QE	+	QE COL 2	MIN QE	M565	M577

Change to Page 15-26

The one change to this page is to the "High angle, shell illumination, TFT, HOB correction method," another portion of "Figure 15-22 Safety Matrixes (Continued)."

High angle, shell illumination, TFT, HOB correction method:
(155 mm: HOB = 600 m, 105 mm: HOB = 750 m

RG	CHG	VI ≈ NEAREST 50 M	ILLUM HOB- VI = HOB	HOB ÷ 50	x	ΔQE FOR DEC OF 50 M HOB	=	CORR TO QE	+	QE COL 2	=	MAX QE

Redlegs are encouraged to bring any other errors in this FM/FMFRP 6-6-40 to the attention of the Office Instruction Branch of the Gunnery Department (GD) at the Field Artillery School, Fort Sill, Oklahoma. Corrections will be published as rapidly as possible as interim changes until Change 1 (which will include these corrections) is available.

If units have questions, call the Officer Instruction Branch at DSN 639-6379/2622 or commercial (405) 442-6379/2622.

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Automated Training Management and MTPs—Breaking the Paper Paradigm

New SATS Version. The standard Army training system (SATS) Version 4.0 software was fielded last summer to all battalions, Active and Reserve Components.

Much more than just a tool to develop weekly training schedules, Version 4.0 automates the training management doctrine found in *FMs 25-100 Training the Force, 25-101 Battle Focused Training* and *100-5 Operations*.

SATS Version 4.0 is a user friendly, Windows-based application. Highlights of its six modules include: *Battle Focus* to choose missions, develop and approve a mission-essential task list (METL) and choose individual and collective tasks; *Planning* to compile a list of exercise codes, develop training strategies and long- and short-range training plans, plan coordinating activities and develop a weekly training schedule; *Resourcing* to compute projected and actual expenditures for executing an exercise; *Execution* to evaluate the collective task and steps as they are being performed; *Assessment* to assess training of each collective task; and *Operational Readiness* to compute percentages of tasks with trained/needs practice/untrained (T/P/U) assessments and project training assessment based on training plans.

The next SATS software, Version 4.1, is scheduled for fielding in the third quarter of FY 97. Among several improvements, the software will enhance reporting and communications and provide a system to plan multi-echelon training exercises and develop training strategy guidance. The communications system upgrade is probably most significant, allowing users to go on-line on the Internet and download current data base files to support the SATS program (http://206.135.244.11/).

Training developers at the Field Artillery School, Fort Sill, Oklahoma, are updating and linking individual and collective tasks, doctrine, training strategies and support products in the automated systems approach to training (ASAT) data base. This is the proponent (schoolhouse) source from which SATS will draw data when a user goes on-line for an update. After SATS Version 4.1 is fielded, the Army will no longer distribute the CD-ROMs that contain this data base.

If units have questions about or problems with SATS, they can call the SATS Help Desk at 1-800-201-SATS or DSN 927-4744. If the SATS questions are Field Artillery-specific, they can call the Unit Training Division in the Warfighting

Integration and Development Directorate (WIDD) of the Field Artillery School.

Paperless MTPs Coming Soon. The Field Artillery School will publish six updated mission training plans (MTPs) in 1997 and 1998—quite possibly the last paper-based MTPs the FA will publish. This FY, the school will develop the final versions of five MTPs:

- *ARTEP 6-037-30-MTP Field Artillery Cannon (Consolidated) Firing Battery*
- *ARTEP 6-102-MTP Corps Artillery, Division Artillery, Field Artillery Brigade Command and Staff Section, and Headquarters and Headquarters Battery*
- *ARTEP 6-115-MTP Field Artillery Cannon Battalion Command and Staff Section, and Headquarters and Headquarters Battery; Headquarters and Service Battery; or Service Battery*
- *ARTEP 6-395-MTP Field Artillery Multiple Launch Rocket System (MLRS) Battalion Command and Staff Section, and Headquarters and Headquarters Service Battery*
- *ARTEP 6-397-30-MTP Field Artillery Multiple Launch Rocket System (MLRS) Firing Battery*

The *ARTEP 6-303-30 MTP Target Acquisition Battery* is scheduled for revision next FY.

The publication of these six MTPs probably will be the last time units will be able to get paper copies of MTPs through their publication accounts. In the future, these manuals will be found on the Internet in the Automated Training Digital Library at the Army Training Support Center (ATSC), Fort Eustis, Virginia, (http://www.atsc-army.org/atdls.html), which will be linked to the Fort Sill Home Page (http://sill-www.army.mil/tngcmd/tcuser.htm) or on CD-ROM data disks printed by ATSC.

The new ARTEP 6-037-30, the consolidated cannon battery MTP, combines the material formerly included in all the cannon battery MTPs into one. In a paper-based environment, this approach will eliminate redundancy and conserve paper. However, in a digital environment, a SATS user can download and work with only those tasks applicable to his unit. SATS users in cannon battalions should use one of the following MTPs for their firing batteries:

- *ARTEP 6-017-30-MTP Field Artillery Self-Propelled 155-mm Cannon Firing Battery-Paladin (M109A6)*
- *ARTEP 6-127-30-MTP Field Artillery Towed 105-mm Cannon Firing Battery*
- *ARTEP 6-167-30-MTP Field Artillery Towed 155-mm Cannon Firing Battery*
- *ARTEP 6-455-30-MTP Field Artillery Self-Propelled 155-mm Cannon Firing Battery*

If units have questions about either SATS or MTPs, call the Unit Training Division, WIDD, at (405) 442-2335/2824 or DSN 639-2335/2824.

LTC David M. Annen, FA
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Field Artillery School, Fort Sill, OK

US Marine Corps Essay Contest

The US Naval Institute, Annapolis, Maryland, is holding its ninth annual US Marine Corps Essay Contest. The Naval Institute will award prizes of $1,000, $750 and $500 to the authors of the three winning essays and will publish them in its monthly magazine *Proceedings*. Some entries not awarded prizes also may be published in the magazine.

Contest Rules. Anyone may enter. The entry must be an original essay exploring current issues and (or) new directions for the Marine Corps. The essay should be no longer than 3,000 words and typewritten, double-spaced on eight-by-11 1/2-inch paper. If the essay is typed on a computer, contestants should include an IBM-compatible disk (indicating the word-processing software used) with the essay hard copy.

Essays must be sent to the Editor-in-Chief, *Proceedings* (USMC Contest), Naval Institute, 118 Maryland Avenue, Annapolis, Maryland 21402-5035. The Naval Institute Editorial Board will judge the essays; contestants will be notified of the results by mail on or about 1 July 1997.

Entries must be original and not previously submitted or published elsewhere.

The essays will be judged anonymously. When submitted, the name of the author should not appear on the essay. Each author should include a motto (in lieu of the author's name) in addition to a title on the cover page of the essay. The motto also should appear by itself on the outside of an accompanying sealed envelope containing the motto and title of the essay with the author's name, address, telephone number, social security number and short biography. The Naval Institute will not open this envelope until the Editorial Board has made its selections.

Naval Institute. The 124-year-old professional society for the maritime and military services is an independent, non-profit association. The 90,000-member Naval Institute's purpose is to advance naval and sea knowledge through research in archives, seminars and the publication of *Proceedings, Naval History, Naval Review* and some 600 books.

If readers have questions, they can call Ms. Valry Fetrow, Public Relations, US Naval Institute at (410) 268-6110.

Reflections—

Admiration of an NCO

The neatly framed and matted print on the wall had been the perfect birthday gift and hung prominently as the finishing touch to furnishing my new office. Simply titled "Reflections," the impressive work by artist Lee Teter portrayed the emotional visit of a veteran of my generation to our shrine, the Vietnam Memorial in Washington, DC. "Reflections" revealed a reunion of soul mates from an era long forgotten and often forsaken by many, but profoundly and indelibly etched in the memory of a faithful friend and proud soldier.

Reaching to carefully square the frame, the reflections seemed to draw my attention to the faces peering from beyond the wall. Beyond the many names of valiant, fallen warriors, I suddenly saw familiar faces of old friends, men who had earned my respect and admiration.

I saw the reflection of a young staff sergeant, standing tall in his crisp, starched uniform and "Smokey" drill sergeant hat. He taught me to be strong, to move quickly and quietly, to thrust a bayonet, zero my M-14, keep my weapon clean and to never underestimate Charlie. We ran and we ran and pushed the ground until our arms were firm and strong.

He taught me that it was a privilege and an honor to serve our nation at a time when burning the flag seemed to be more popular. He spoke of the moral courage to stand up for what I believed though contrary to the wisdom of many. He turned a young, raw, skinny recruit into a soldier—a boy into a man.

I saw the reflection of an older mess sergeant, pouring cold water from a dipper into a 20-gallon pot of boiling water, cooling the mix just enough to settle the coffee grounds to the bottom. He taught me the significance of his daily 0430 wake-up; it was essential his soldiers get that early "cup 'o joe" in the frosty, morning hours of field duty. I recalled the loaf of bread and jar of peanut butter invariably available in his mess tent because it was important his soldiers never go hungry. He taught a young NCO a powerful lesson of leadership: always care for your men.

I saw the reflection of a chief of firing battery shouting instructions from his aiming circle to a young artillery gun chief. A soldier called "Black Magic," he was better than the rest—even on his worst day. He was a warrior who, with nothing more than a map and compass, could deliver lethal fire on the enemy with such skill that he was revered as our leader, a true "King of Battle." My teacher and mentor, my counselor and trusted friend, he taught me to level my bubbles, to keep the powder dry, and to "move, shoot and communicate."

He spoke about integrity: "First and foremost, say what you mean and do what you say." He showed me how to take risks, make bold decisions in the face of adversity and accept responsibility for my actions.

He taught me to succeed, but never at the expense of my soldiers. He reminded me that having a private carry projectiles from Gun 1 to Gun 6 in the sweltering heat of battle was a poor way to redistribute the ammunition when the lieutenant should have adjusted the base piece. When I became a lieutenant, I remembered the weight of such a projo resting on my shoulder and adjusted the base piece.

I saw the reflection of my command sergeant major, a gentle warrior who affectionately nicknamed me "the daring young lieutenant" and taught me the value of trust, confidence and teamwork. He instructed me in the use of tact and diplomacy with my seniors and the art of leading my subordinates. "The mission—it's all about hard work, job competence, planning and training together," echoed the reflection. He taught me to delegate authority commensurate with my responsibility and to avoid the disruptions of over supervision. He also taught me that our readiness and military professionalism ultimately lessens the risk of having to fight at all, but if we must fight, we must fight to win.

I saw the reflection of a burly sergeant, six feet four, tenderly embracing a small child as he emerged from the twisted, tornado-ravaged debris of the child's home. In one glance, he taught me compassion: the job of a warrior often calls for the tenderness of a parent and enduring love for fellow Americans.

I saw the face of my sergeant and then felt his hand gently touch my shoulder, consoling me in my loss of a classmate, fellow officer and best friend. He revealed to me the code of our NCO corps: alone, we exist, but together we simply *are*. He helped me understand that the honor of serving this great country far exceeds the sacrifices soldiers make around the world to maintain our nation's freedom.

And he was right. I saw no remorse, no regret in the faces of my soul mates peering from the other side of the reflection, only pride in a job well done.

Perhaps in some future cause of freedom my name, too, may be etched for eternity on a cold, dark monument in memory of some battle or war yet to be waged. May God grant me the ability to lead my soldiers in such a way that I may be a "reflection"—be remembered as an officer who earned the respect and admiration of an NCO.

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