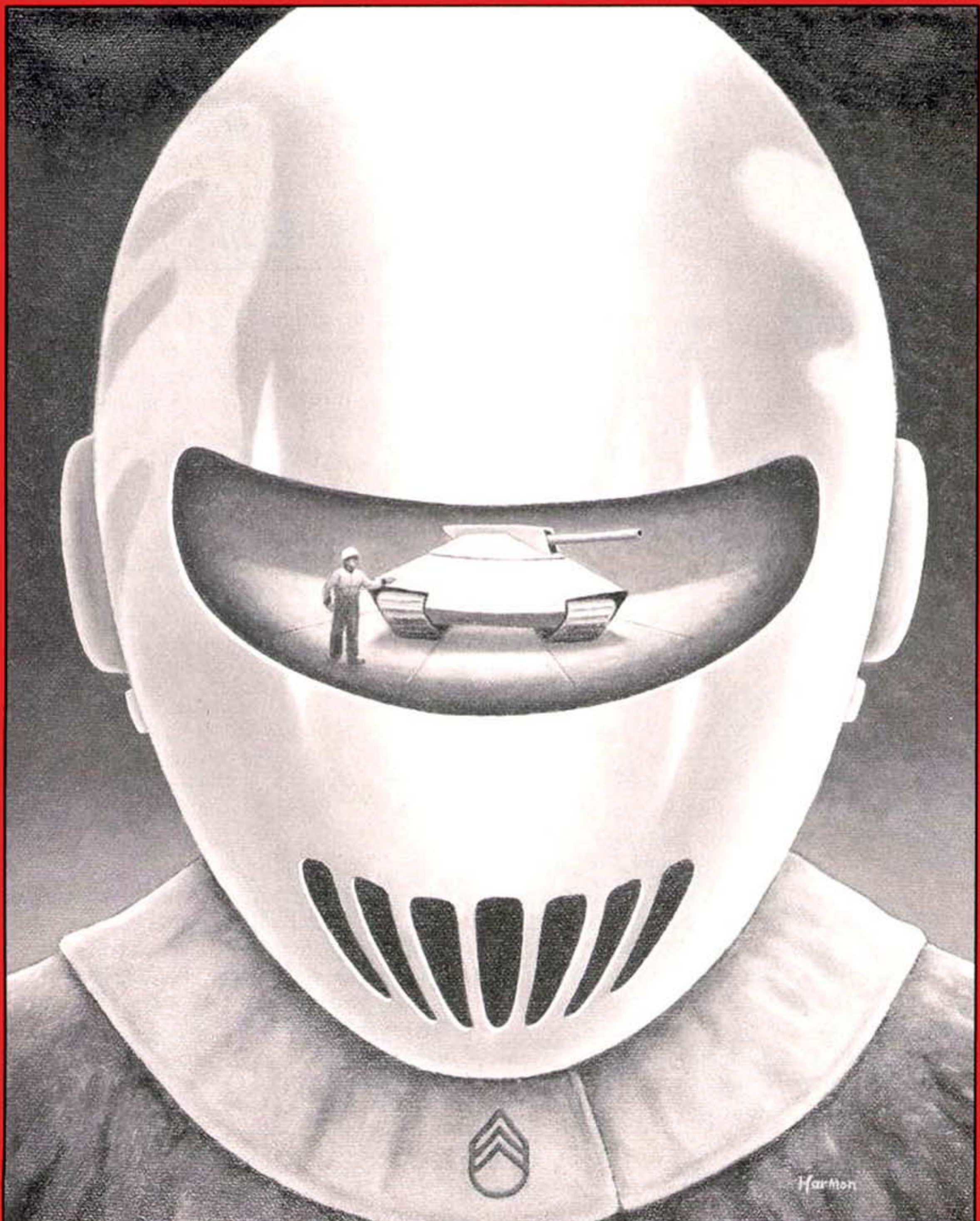
ARMOR



ARMOR: 2000 AND BEYOND

PB 17-93-1

January-February 1993

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First With The Most

If you have ever held up a late summer dandelion and blown the tiny, white petals into the wind, you know what has happened to the Warsaw Pact weapons arsenal. With the restructuring of our old nemesis-turned-world-ally, there has been and will continue to be a diaspora sending Warsaw Pact technology drifting around the world in search of a place to take root. Once rooted, it is also likely to be cultivated, pruned and improved by local gardeners, eventually resulting in a deadlier variety of weapon system. And as the New World Order blooms amid inevitable global upheaval, the United States Army will be expected to work the fields. Even in barren Somalia, American soldiers are harvesting a bumper crop of small arms and light antitank weapons. They may not be sophisticated or flashy, but as one Somali thug told a U.S. journalist recently, "an old bullet will kill you just as dead as a new one." And over in the next ripening field, Bosnia-Herzegovina, they are playing with even bigger toys. So I wouldn't throw away those old vehicle ID cards and Threat training aids just yet. Remain alert and stay current on the standard, garden-variety tanks and tank killers we've come to know so well; and don't be surprised to see some of the old species flourishing among new high-tech hybrids in the hot-spots of the world.

Here in our own backyard, we will be busy in the hothouse — thinking, planning, designing and growing our own crop of weapon systems. At the 4-6 May Armor Conference we will plant the seeds that will eventually grow into a premier Armor Force. In this issue of our professional journal, you will find several interesting and intellectually stimulating discussions of the nature of tanks and mobile armored warfare in the years to come. Colonel Hobbs (Ret.) talks of future tanks and robotics, Major Warford looks ahead at the Premium Tank Five, and Major Crawford offers us a British perspective. These views and others like them will be the focus of our Armor Conference as we plan the dominant role of Armor on the battlefields of 2000+ A.D.

— J.D. Brewer

By Order of the Secretary of the Army:

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ARMOR

The Professional Development Bulletin of the Armor Branch PB-17-93-1

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LETTERS

Wiesel-Mounted Scouts

Dear Sir:

In 1990, the U.S. Army decided to downsize the mobility of scout platoons in tank and mechanized infantry battalions from the heavier, higher-profile M3A2 Cavalry Fighting Vehicle (CFV) to the lighter, lower-profile M-998 High Mobility Multipurpose Wheeled Vehicle (HMMWV).

Proponents argued that the HMMWV would enhance scout stealth, an important factor in successful ground reconnaissance.

Perhaps the Army should consider further downsizing from the HMMWV to the Wiesel, a small, three-ton, fully-tracked vehicle fielded with German airborne forces.

Compared to the M-998 HMMWV, Wiesel is:

- •Armor-protected against 7.62-mm ammunition, grenade, and mortar fragments,
- •Less detectable (smaller frontal presented area),
- •More deployable by strategic airlift (six Wiesels for file HMMWV) or sealift (nine Wiesels for four HMMWVs).

Both Wiesel and the HMMWV are airmobile by UH-60 Blackhawk helicopter. However, replacing the M-998 HMMWV with the HMMWV Heavy Variant (HHV) would gain armor protection, but lose airmobility by Blackhawk.

Wiesel has been field-tested as a potential carrier for a TOW missile launcher, automatic cannon, 60-mm mortar, and cal .50 machine gun. An MK 19-3 40-mm grenade machine gun could also be mounted.

Wiesel-mounted scouts would have an effective self-defense capability, if ambushed. Disengagement would be facilitated, as both covering and maneuvering vehicles would be armor-protected.

In an emergency, Wiesel-mounted scout platoons could conduct armed reconnais-

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sance and economy of force security operations.

Wiesel is an off-the-shelf, non-developmental item (NDI) system, which means faster fielding and minimum expenditure of research and development (R&D) funds. The U.S. Army Tank-Automotive Command is currently evaluating Wiesel in both manned and robotic roles.

As a resource-constrained, force-integration strategy, Wiesel could be procured in limited quantities to dual-equip selected scout platoons in CONUS-based contingency forces.

Negotiating a long-term lease agreement with the manufacturer, with an indemnity clause for possible combat damage, could be more affordable than pursuing classical life-cycle ownership.

In summary, dual-equipping scout platoons with Wiesels would enhance their ground reconnaissance capability in either heavy or light forces. Commanders would have an additional option in contingency operations where significant threat and terrain uncertainties exist.

RICHARD K. FICKETT
Herndon, Va.

TCGST Needs Revision

Dear Sir:

Should we change the Tank Crew Gunnery Skills Test (TCGST) in light of FM 25-101, *Battle Focused Training*? According to FM 17-12-1 with Change 3, we use the TCGST to "ensure that all personnel have a standard level of individual skills." But is it the correct standard?

FM 25-101 came out two months after Change 3. Recognizing that we don't have time or resources to teach every task to every soldier, it tells us to "refine the list of mission related tasks" for training and testing to those "that are essential to the soldier's duty position." The goal is to train only those tasks needed for the unit to perform its combat mission. Does the TCGST do that?

The TCGST does measure a tank commander's abilities, both in training gunnery and in combat. The TC must either perform or supervise every task on which he is tested. It's also a pretty good test for the gunner. Gunners (at least on leaders' tanks) must do just about everything on which they're tested except issue fire commands and lay the gun from the TC's position.

The system starts to break down with the loader. In how many units is it mission essential for a loader to fire the main gun, and so need to know misfire procedures? I grant that he must know when and how to handle a round after a misfire, but why test him on trigger sequence? In how many units is it mission essential for him to put the gunner's station into operation? Finally, in how many units is it mission essential for a loader to perform the gunner's station part of boresighting? He might be on the muzzle boresight device, but not in the hot seat, at least not on any tank that I command.

The situation for the driver is worse. The only TCGST task that might be essential to a driver's duty position is identification of friendly and threat armored vehicles, and that is shaky. If an enemy tank is close enough for a driver to ID it by nomenclature through his vision blocks, the turret crew isn't doing its job. Yes, drivers do assist the turret crew with maintaining machine guns and sometimes run the MBD on a boresight. They also sometimes man the TC's station to pull night security, but that's not their duty position.

I'm not saying that it isn't good for all tankers to know the present TCGST. I just can't justify us saying that it's mission essential by duty position for every unit and tank crew in the Army. As train-up training or cross training, it's great. Is it always, or even usually, mission essential? I doubt it.

How about it, Weapons Department? You guys have been at this game longer than I have. Does the TCGST need a rewrite?

SFC JOHN M. DUEZABOU
Montana Army National Guard
Dillon, Mont.

Solving the Minefield Problem

Dear Sir:

Major Bennett's article, "Minefield Breaching: Doing the Job Right," which appeared in the July-August 1992 issue, provides a compelling overview of the need to develop better obstacle breaching systems. However, the conclusions and recommendations derived from the overview are laden with inaccuracies.

First, the Combat Mobility Vehicle (CMV) operational requirement documents are based on the need to field a system that will provide maneuver forces an in-stride breach capability for complex obstacles. The interim vehicle, known as the Breacher, is also justified, based on the same capability issue. If the need was to only clear minefields, the materiel solution could be different.

Second, the operational requirements will dictate the system design. An examination of the requirements and a cursory cost analysis dispel the notion that a kit attached to a battle-configured M1 tank would provide the necessary capability. The M1 chassis' mechanical and electrical subsystems were not designed to accommodate ad hoc kits which would give it the capabilities of a Swiss Army knife. Placing a robust blade with automatic depth control, and a power driven arm for digging, lifting, and grappling would require massive redesign of the M1 chassis and its subsystems.

Third, fielding of the CMV has been deferred until the next decade. However, the Breacher is scheduled for fielding starting in late FY98. The streamlined acquisition strategy approved at the Milestone I Decision Meeting in May 92, was a direct response to the urgent need for this capability.

Fourth, engineers are integral members of the maneuver task force. Though the Breacher will not be organic to the battalion-size armor unit, it will be in the task force which includes the armor unit. Just because something is not organic to a unit, it is a non sequitur to assume the equipment will not be available.

Finally, I concur with the recommendation that we need to provide better breaching capability. Major Bennett's solutions have merit which should be explored through the Mounted Battlespace Laboratory.

MAJ JAMES E. KOCH
TRADOC Project Officer,
Combat Mobility Systems
Ft. Leonard Wood, Mo.

Glider Concept Won't Fly

Dear Sir:

As an Armor officer working on a masters degree in Aeronautical Engineering, I must reply to Major E.C. Parrish's article, "It's Time to Consider Glider Delivery of the M1 Abrams," which appeared in the September-October 1992 issue. Although Major Parrish's arguments are intriguing and the historical references to gliderborne assaults were quite informative, I do not think the use of gliders to deliver Abrams tanks is at all feasible.

A glider large enough to carry two M1 tanks would be huge. An assumed gross weight of 150 tons (300,000 pounds) is nearly the empty weight of a C5-B (374,000 pounds) and is twice the weight of a space shuttle orbiter (151,205 pounds). Although a glider would not require engines or fuel, the estimated weight of 10 tons for the airframe, wing, flight controls, and the necessary floor reinforcement to carry the vehicles is a conservative estimate at best. One must remember that in order to generate enough lift to carry the two tanks, this glider would require a very large wing, probably one larger than a C-5's. Obviously, this gigantic aircraft could be built, but could it fly?

In order to fly anywhere, the glider and its tug must first get airborne. An aircraft's required takeoff distance is a function of its weight, aerodynamic drag, rolling resistance (from the wheels), and its required liftoff velocity. Assuming that the glider would be designed to have a stall speed approximately equal to its tug's (again requiring the huge wing), the liftoff velocity can be assumed to remain constant. By adding a net weight of 300,000 pounds to the 580,000-pound gross weight of a C-17 aircraft, and assuming the glider and C-17 have identical rolling and aerodynamic drag, the glider and tug would need approximately triple the takeoff distance of a fully-loaded C-17 without the glider, since the tug provides all the thrust for both aircraft. Do we have that kind of runway anywhere near our military installations?

Assuming our C-17 and glider could get airborne, the combination's speed and flight endurance would be drastically reduced. Any intercontinental flight would require several midair refuels, possibly straining our national air tanker fleet. In any crisis requiring rapid deployment of tanks, there will undoubtedly be many other aircraft deploying to the region, such as troop carriers, supply carriers, fighters, etc., all of which would require the use of aerial tankers. How much would the deployment of tank gliders delay the deployment of these other aircraft?

Unrelated to the engineering issues discussed above, how would we support these tanks once they arrived in theater? Even one single tank in a theater requires fuel, a maintenance/support base, and a mobile command and control infrastructure in order to be effective for more than just a few hours. I do not know how the 82d Airborne supports its tanks in the early phases of a deployment, or how long into the assault they normally arrive, but based upon my knowledge and experience with heavy armored and cavalry forces, we cannot just show up with our tanks, drop the glider ramps and charge into the fray without a massive support structure already in place to sustain that force.

I agree with Major Parrish and Mr. Adams in that we do need to improve our strategic armored reach, but I don't think gliderborne tanks are a practical solution. A C5-B can carry a payload of 261,000 pounds (130 tons) — several lighter vehicles, such as the AGS or even Bradleys could be flown in conventionally from prepositioned sites, such as Diego Garcia. A "floating POMCUS," similar to those used by the Marine Corps, could also be stocked with equipment removed from deactivated units and deactivated European stocks, and could be embarked on slower, military-owned cargo vessels. One or more of these ships could operate between friendly ports and sea lanes near any trouble spot, and CONUS-based units earmarked for this mission could fly to link up with the ships, analogous to the European REFORGER process. I believe a system such as this would be cheaper and more practical than the use of gliders to carry tanks.

MONROE B. HARDEN JR.
CPT, Armor
Monterey, Calif.

The Author Replies

Dear Sir:

An excellent letter!

These are precisely the same obstacles World War II engineers overcame as they made tank-carrying gliders fly. Captain Harden's arguments are eerie echoes of the ancient caution: "We can't do it, so don't try."

If we already had tank-carrying gliders, we wouldn't have to invent them. Perhaps as part of his course work at the Naval Postgraduate School, Captain Harden can explore the concept on behalf of his branch. He might do what engineers do best — make the impossible possible. Or if there truly is no way to make tank-carrying gliders work, he can isolate a solution to the probem, which is: Parachute-assault commanders need main-battle tanks, and we can't deliver them.

Acknowledging the problem, our only **wrong** course of action is to do nothing to solve it.

Thankfully, World War II engineers dealt with a huge handicap Captain Harden won't face — comparatively abysmal, piston-engine power.

I offer Captain Harden the following ideas:

To increase lift, why not combine wing and lifting-body technology?

To decrease weight, don't use steel. Be truly innovative. Assemble small, prestressed-ceramic components, perhaps casts of boron nitride, a material at least as hard as diamonds. Like the 'working hull' of ancient Viking ships, ceramic assemblies form incredibly light, strong structures; and it's high time we incorporated them in the aerospace industry.[1] Who knows, in the process you might identify the material of which we'll cast light, near-invulnerable tanks ten years from now. It could change the way we build everything on earth.

To decrease takeoff distance, don't limit yourself to the tug's engines alone. We need tank-carrying takeoff capability at only a few airfields — Pope Air Force Base, Fort Hood, and NTC come to mind. So how about building a steam-powered catapult alongside the most-used runway at each? Don't worry about takeoff runs elsewhere. If you've built a glider to transport tanks, empty it'll leap from the runway.

Why not put that 'very large wing' to use. Fill it with jet fuel. Tow with a boom rather than a cable, and run a fuel line through it to the tug. That makes it possible for the glider to become the tanks' fuel point after arrival.

So **strain** the national air-tanker fleet. Global, tank-carrying glider deployment will be a one-time-per-conflict show.

Don't mistake Bradley Fighting Vehicles or Armored Gun Systems for tanks. The main battle tank offers mobility, firepower, and **protection;** nothing but a tank can do a tank's job.

And by the way, since the purpose is to insert tanks as part of an airborne operation, which of course could include special operations, we do indeed want to "show up with our tanks, drop the glider ramps, and charge into the fray without a massive support structure."

That's what **Airborne's** all about.

[1]Hove, J.E. and W.C. Riley (eds.), *Modern Ceramics*, John Wiley & Sons, Inc., New York, 1965, pp. 210-211.

E.C. PARRISH III
MAJ, Armor
Ft. Knox, Ky.

12th AD History: A Clarification

BG Elmer F. Bright, USA, Ret., writes to clarify and correct the unit history of the 12th Armored Division that appeared in the September-October 1992 issue of *ARMOR*. BG Bright, who was the battalion S2 of the 56th Armored Infantry Battalion, one of the division's units, said that his unit, not the 17th AIB, was the first Third Army subunit to reach the Rhine River. "Although the 17th AIB was a damned good outfit, they were not the first unit of the Third Army to reach the Rhine River... The first unit to do so was the 2d squad, 2d platoon, B Company, under the command of 2LT Charles Peischl... My halftrack was about 50 meters behind LT Peischl when we reached the river..."

BG Bright quotes from the first history of the 12th AD as noting the 56th AIB reached the Rhine an hour and a half before the 17th AIB.

— Armor Staff

MG Paul E. Funk
Commanding General
U.S. Army Armor Center

Looking Ahead To This Year's Armor Conference

We who are in the fighting business seem to face some sort of watershed each year, and 1993 will surely prove to be a pivotal year. We must focus our attention on those matters of the armor force we can control: leadership, training and anticipating the dominant role of Armor on the battlefield of the future. It is this latter theme that will resound at our Armor Conference at Fort Knox 4-6 May 1993.

At the conference, we intend to present a compelling argument for Armor in the future. We will be forward-looking in our assessment of warfare and innovative in developing the tactics and capabilities to ensure victory. Through a series of intellectually challenging presentations and discussions, the 1993 Armor Conference will set an agenda for our future as a combined arms, warfighting branch.

This business of defining and redefining the role of Armor is not new. The key to our success, both on the field of battle and in the number-crunch of peacetime, has been our ability to recognize the changing nature of combat and evolve with that change. In the 1939 issue of the *Cavalry Journal* (predecessor to *ARMOR*), then Chief of Cavalry MG John K. Herr was facing one of those watershed periods. Europe was thundering amid the gathering clouds of World War II when he wrote:

"... we confront an American situation which is different from the problems of European countries and which looks forward in case of hostilities to war of movement; that in any such war the principal element is the Infantry-Field Artillery-Cavalry ground combat team; that **such a force is the bone and sinew of any real fighting Army** or armies; that at least a resonable nucleus should be highly trained and ready to fight at once; and that all our thoughts and preparations, including our industrial preparation, should be geared toward a war of movement rather than one of static defense by means chiefly of materiel."

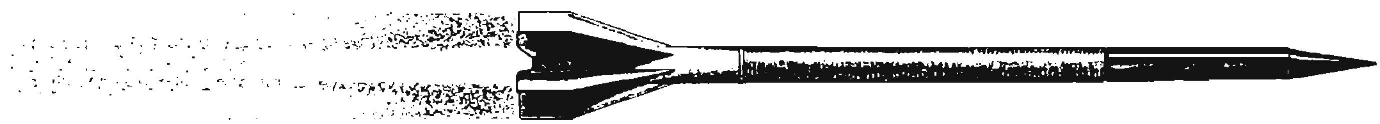
Sounds familiar, doesn't it? Herr and others after him were good stewards of the role of Armor/Cavalry, and by defining its mission in futuristic terms, guaranteed that we would have the chance to ride and shoot and defend this country with the firepower of Armor. But we, today, must be no less stewards of Armor; and by force of our intellect and virtue of our recent desert experience, we must articulate the role of Armor at every opportunity.

At another watershed point in our past — the critical transition from horse cavalry to mechanization — MG J.G. Harbord said in the 1937 issue of the *Cavalry Journal*, "Paths ahead will be opened by men unwilling to barter the possibilities of days to come for the false promise of present security..." The kind of men he was referring to are soldiers like you: platoon sergeants, gunners, mechanics, platoon leaders and company commanders. It is from you that the best ideas emerge — ideas that will define the force in the 2000's. In this issue of *ARMOR*, and at our May conference, you will see and hear about the technology that will make armor the dominant force on future battlefields. While technology is both exciting and important, it is you, the Armor soldier of the future, who will be decisive.

MG Harbord had it right back in 1937 when he said,

"...wars are still won — finally — by soldiers with their feet on the ground, who take and hold territory. No military invention, however ingenious, can ever take the place of soldiers. When the line does not hold or when an expected advance does not materialize, the failure can be traced to human beings. Modern equipment is necessary to win a moderate engagement, but there must be men of stamina there who know how to use it to fullest advantage."

It is this careful blend of mission, personnel and technology that we will be brainstorming in May. Whether you participate in the Armor Conference personally, or are represented by others, it is your force we will be shaping, and you will have to live with the consequences. Get involved and stay involved.



Tank Gun Accuracy

by Major Bruce J. Held and Master Sergeant Edward S. Sunoski

The Accuracy Problem

Operation DESERT STORM showcased the technological capabilities of the M1-series tank. Its combination of unmatched mobility, lethality, and survivability proved unstoppable. Additionally, the accuracy of the M1A1 120-mm main gun exceeded all expectations. First round hits at two to three thousand meters were common. However, the Army cannot afford to be satisfied with the M1A1's current level of accuracy. The M1-series itself is an example of what superior technology means on the battlefield. We can expect the next generation of tanks, to include those belonging to potential adversaries, to be more accurate than even the M1 series. This article will discuss some of the problems that scientists, engineers, and tankers must overcome in order to achieve the accuracy needs of the future.

The average NATO tank target is approximately 2.3 meters by 3.4 meters. At 3,000 meters, this equates to an angular measure of only 0.4 mils from the target's center of mass to its upper or lower edge. Therefore, with an aimpoint in the middle of this standard target, the tank's total system accuracy must be less than half a mil in order to hit consistently at 3,000 meters.

To emphasize how small half a mil is, picture the second hand of a watch. The angle it sweeps in five one thousandths of a second is about a half of a mil (see Figure 1). At longer ranges or against defilade targets, accuracy must exceed even this.

Accuracy Error Sources

Perhaps the easiest way to describe sources of accuracy error is to proceed chronologically through the engagement process and identify the potential problems. Once a target is identified, this process proceeds from finding an aimpoint on the target to the projectile hitting or missing the target. Potential accuracy errors occur during this entire process. Some of these can be minimized by the tank's crew, and this article will point out crew actions that will help minimize accuracy problems. Finally, this article only deals with a stationary firing tank versus a stationary target. The accuracy equation gets much more complicated when the firing tank, target, or both are maneuvering.

Laying the Reticle on the Target

Once a target is identified, the next step in the engagement process is laying the reticle on the target. An integral part of the fire control system in any tank is the gunner. Even with a perfect system and perfect conditions, accuracy can still be poor if the gunner uses his system ineffectively. Factors that affect gunner performance include: fatigue, fear, inexperience, and excitement. Fortunately, the effects of these problems can be reduced through good training and practice. While it may seem boring at times, repetition is what makes correct action automatic for the tank crew. Crew drills and the COFT are the skill builders that best integrate the men and machine so that they operate as a single, efficient system, even under harsh training or combat environments.

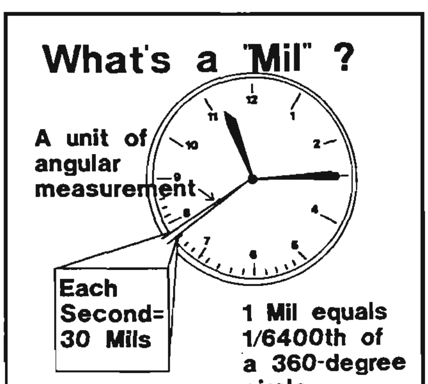


Figure 1.

One basic assumption that we make in aiming any direct fire weapon is that the light path to the target is straight. Unfortunately, this is not always true. Just above ground level, heat is exchanged between air and soil. The result of this is that the air temperature at the surface of the ground is not constant. As light passes through air of varying temperature, its path bends. This means that the line of sight between a tank and its target is not always a straight line. This phenomenon is known as optical path bending, and when it happens, the cannon cannot be effectively laid on its target since the line of sight to the target is no longer a straight path (see Figure 2). Optical path bending is at its worst after the ground has been heated up and the air is still and cool,

Optical Path Bending

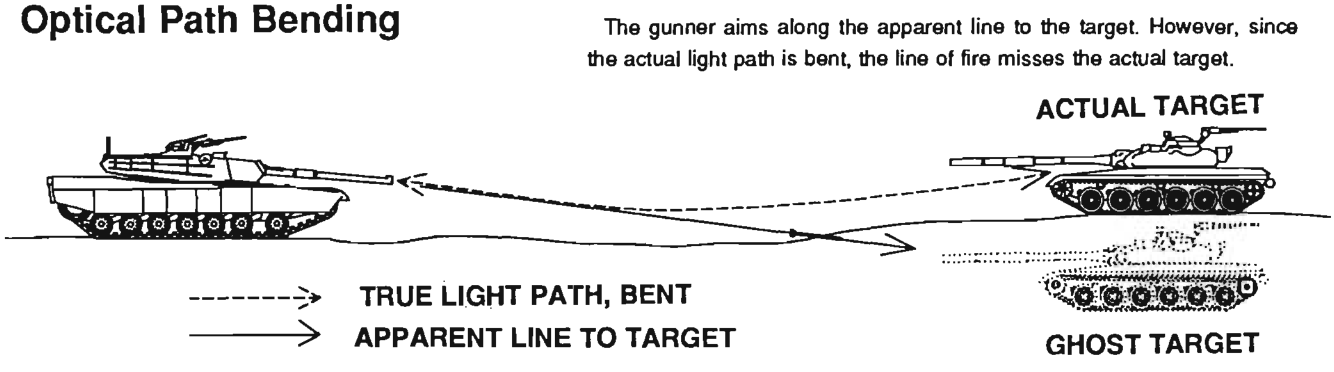


Figure 2.

such as in the desert at night. The same kind of atmospheric conditions also cause heat shimmer, which also has a detrimental effect on accuracy. Under extreme conditions, the error can be greater than a mil.[1] Typically, though, this error is less than a tenth of a mil, so even at long range, it is not a big problem under normal conditions.

Even when conditions are right for optical path bending, its effects can still be minimized. When the tactical situation permits, positioning of the firing tank so that the line of sight to potential targets is well above ground level will reduce the problem. Generally, it does not take much. Keeping the line of sight as little as three or four meters above the ground for most of its path will virtually eliminate any problems from optical path bending.

In addition to the optical path bending problem, there is an error associated with finding the aimpoint on the target. Generally, tankers are trained to use the center of presented target mass as the aimpoint. The problem is that estimating the center of mass is not a precise process. To demonstrate this to yourself, stand a few meters from a blank piece of butcher paper. Have someone mark what you think is the center of mass on the paper. While you can get reasonably close, it is difficult to be exact. The same is true for real targets. Without some defined aimpoint on the target, there will be some small error associated with estimating the center of target mass. Fortunately, this is an error that the gunner can reduce. The key, of course, is practice. During any slow time, such as in the motor pool or waiting to enter a range, the gunner can find 'targets' and practice estimating their centers of mass. Use of the reticle lines as a guide will also help. After some practice, gunners should have little difficulty quickly and precisely estimating the target's center of mass.

Laying the Gun

Once the aiming circle has been placed on target, a whole series of complex events occur that result in pointing the cannon along a trajectory that intersects the target. The first potential error source at this point is one that probably occurred long before a target was ever seen — boresighting. Boresighting procedures are established in order to align the sighting system with the cannon's muzzle axis. Error is introduced in these procedures if the boresight is inherently inaccurate, if it is out of calibration, or if the procedures for using the device are not correctly followed.[2] For these reasons, boresighting does not always perfectly align the cannon and sighting system. Additionally, for various maintenance, environmental, and equipment reasons, it is often difficult to maintain the calibration between the cannon and fire control system once it is established with boresighting procedures. For example, temperature changes across the cannon from environmental factors such as sun, wind and rain or from firing can change the shape of the gun in just seconds. Muzzle reference systems (MRS) and thermal shrouds are designed to minimize the calibration errors between the muzzle axis and the sighting system between boresighting occasions. Unfortunately, MRSs are themselves subject to some error and may not always perfectly realign the system.[3] They also depend on being correctly boresighted themselves and on being used often enough between boresighting events. Finally, while thermal shrouds help a great deal, they cannot perfectly manage thermal bending of the gun tube.[4]

Tests conducted at Ft. Knox and Aberdeen Proving Ground have shown that the boresight devices used by the Army are quite accurate. This means that the tank crew is the key to reducing boresight error. By following the boresighting procedures precisely and by carefully maintaining and caring for the boresight device, a tank's crew can assure itself that it will have an accurate boresight. By conducting a boresighting exercise whenever possible and performing frequent MRS updates between boresighting events, the crew will help ensure that the muzzle/sight alignment error is small.

On older tanks, the cannon and the sights used to aim the cannon were hard-mounted together. Superelevation was applied through the use of stadia lines and ballistic cams, while other ballistic corrections were applied with the application of 'Kentucky Windage.' On modern tanks, except in degraded mode, the fire control computer uses the factors that went into 'Kentucky Windage,' along with a precise measurement of range, and knowledge about the ammunition being fired and calculates the direction to point the cannon. To do this, the fire control computer depends on various data inputs (cant, propellant temperature, ammunition type, etc.). It applies these inputs to mathematical algorithms and calculates the projectile's ballistic path. Errors occur in this calculation for two reasons. First, the mathematical algorithms only approximate models of reality. The approximations are very good, but they are not perfect. Some of the factors that affect the ballistic path are imperfectly understood, or there may not be a satisfactory way to measure them. This means that some factors that influence the ballistic path may not be included in the mathematical algorithms, or are not modeled completely. Second, the math algorithms depend on the various inputs mentioned above. If the measurement of these variables is incorrect, or if they are incorrectly entered into the computer, error is introduced into the fire control solution.

The tank crew can ensure that the fire control computer operates most effectively by carefully following published procedures. Like all other computers, the fire control computer goes by the maxim of 'garbage in, garbage out.' Data that is manually entered into the computer, such as barometric pressure, should be as current as possible. Tankers should demand such data on a routine basis and units need to have SOPs in effect that update this information as often as possible. Additionally, good preventive maintenance checks and services (PMCS) will ensure that sensors on the tank, such as the crosswind sensor, are in good operating condition and are not providing bogus input to the fire control computer.

Once a fire control solution has been calculated, it must be applied to the various motors, hydraulic pumps, and other mechanisms that control the motion of the gun. Since no electronic or mechanical system is perfect, implementation errors between the calculated fire control solution and what is possible in the machinery occur in this process. Complete PMCS by the tank crew, to include special gunnery checks, will ensure that implementation errors are minimized. If the system is well maintained and problems are quickly and effectively corrected, the fire control system errors should be very small.

The Shot Process — In Bore

The firing of modern tank ammunition is an exceptionally violent process. Once the cannon, target, and sighting system are ballistically aligned, the gunner starts what is essentially a controlled explosion. In the space of less than five meters and in less than a hundredth of a second, the projectile accelerates to a velocity of 1,600 meters per second; roughly Mach 5 (over 3,500 mph). The pressure needed to push the projectile to these velocities in such a short time span approaches 100,000 pounds per square inch for some ammunition types. Precise control of this process is necessary if accuracy is to be maintained. Understandably, perfect control is very difficult to achieve in this violent environment.

Cannon systems are not completely rigid. Unleashing the energy that propels the projectile can also cause the cannon to rotate about its trunnion, recoil along its longitudinal axis, shake in its recoil mechanism, and bend and vibrate in all directions. This all starts to happen before the round exits the muzzle, so that by the time it does, the muzzle is not pointed in the same direction as when the trigger was pulled.[5]

The cannon's dynamic action would not hurt accuracy if all shots and all tanks were the same. If that were the case, a fire control computer correction could correct the problem. In fact, computer correction factors do correct some of the gun dynamics errors. Unfortunately, a cannon's dynamics are a little different on each shot,[6] and there are significant differences in the gun dynamics between tanks.[7] This means that the change in muzzle pointing angle at the time of shot exit from the cannon cannot always be accurately predicted and accounted for. While the muzzle pointing error that this lack of predictability creates is relatively small, the cannon's dynamic response to the shot process also ties in with some other phenomenon, such as an accuracy dependence on ammunition temperature and the projectile aerodynamics. Because of this, controlling the cannon dynamics is significant to improving the tank's accuracy.

The tank crew's ability to influence the gun tube dynamics depends, once again, on good PMCS. By ensuring that the cannon and recoil system are constantly inspected for problems, and that identified problems are corrected, the tank crew will be doing its part toward ensuring that the gun dynamics remain as constant as possible for every shot.

As the round travels down the length of the cannon, it not only gets pushed from behind by the burning propellant, it also gets pushed sideways, up and down. This occurs for several reasons. It was already noted that the cannon is vibrating before the round exits. Imagine quickly shaking a tube up and down while a tennis ball rolls from one end to the other. The same thing happens to the projectile as it moves down the cannon.

Additionally, no tube is perfectly made. Small bumps and bends are introduced in the manufacturing process that the projectile must ride over as it travels down the cannon.

Also, thermal bending of the gun tube occurs. This creates more curves for the projectile to negotiate. Finally, the gun tube is a long, heavy structure that is only supported at one end. This

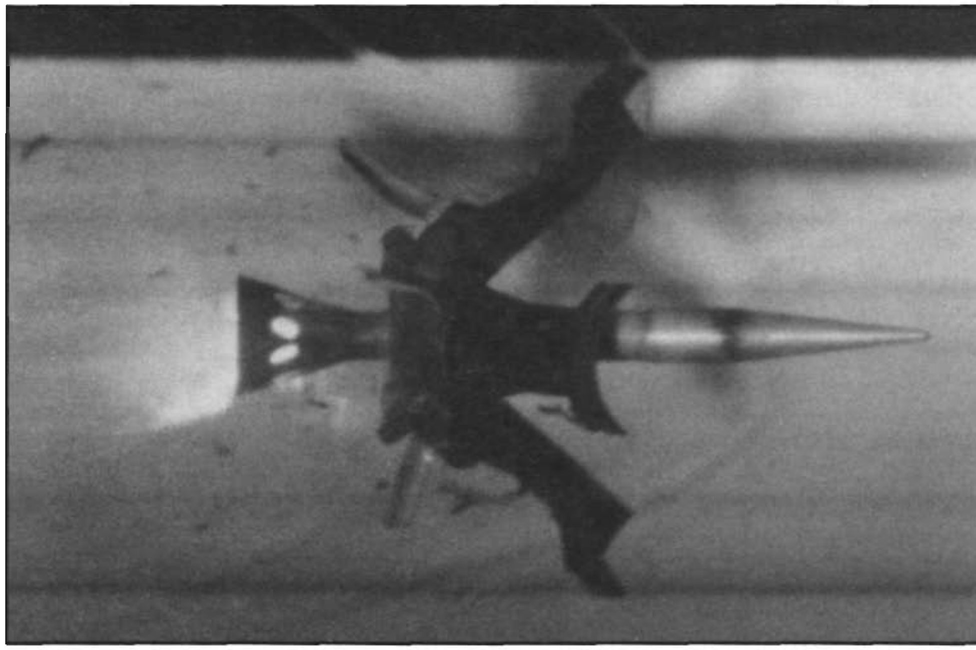


Figure 3.

Photograph captures the moment when the sabot petals of an M865 training round break free from the penetrator.

Note the visible shock waves generated by the discarding sabot petals.

means that gravity causes it to droop toward the muzzle.[8]

These two factors, the gun dynamics and the static tube shape (caused by manufacturing irregularities, thermal distortions, and gun tube droop), do two things that affect accuracy. First, they cause a projectile to follow a crooked path down the gun. Second, they cause the projectile to vibrate in bore. This is known as projectile balloting. The crooked path the projectile follows in bore, and balloting, are important to accuracy because they can influence the direction of flight with which the projectile leaves the muzzle. Also, they cause the projectile to flex and vibrate, which affects later portions of the shot process.

The Shot Process — Transition to Free Flight

During the transition from in-bore travel to free flight, the projectile is subject to several more processes which can affect accuracy. As the round exits the cannon, the projectile and sabots undergo rapid decompression from the in-bore flexure and compression. This can slightly change the direction of flight and later affects the sabot discard process and the aerodynamic properties of the round. Also, as the projectile's obturator seal exits the muzzle, the hot gases behind the projectile expand and accelerate around the projectile. This means that the air flow over the projectile is the reverse of normal, free flight air flow. In this flight configuration, the projectile's fins are actually destabilizing. The muzzle blast can thus cause deviations from a perfect launch and magnify round-to-round variations in the launch.[9]

Saboted ammunition has additional accuracy problems. As the sabot petals begin to fly free from the penetrator (Figure 3, above), they can interfere with the penetrator both mechanically, by striking the rod,[10] and aerodynamically, with the shock waves that they create.[11] The mechanical and aerodynamic interactions between the sabots and the projectile vary with every shot. Therefore, accuracy is affected because the effect of sabot discard cannot be predicted precisely and accounted for.

The Shot Process — Free Flight

Finally, once a projectile enters free flight, it is subject to aerodynamic forces. These forces can alter the projectile's line of flight even further from the one originally intended. This is known as aerodynamic jump. A projectile's aerodynamic characteristics depend on its shape and its pitching/yawing motion.[12] Pitching describes the up and down rotation of the projectile and yawing is the side to side rotation (Figure 4). This motion is imparted to the projectile during earlier phases of the shot process. Since pitching/yawing motion varies from round to round, the aerodynamic jump will also vary from round to round.

During its free flight phase, crosswind affects every projectile to some degree. HEAT ammunition is much more susceptible to crosswind effects than saboted ammunition because of its lower initial velocity, higher retardation (loss of velocity with range), and larger cross sectional area. Crosswinds can vary to a large degree in both magnitude and direction over the flight of the projectile, and thus cannot necessarily be compensated for by the measurements made at the tank by the crosswind sensor. This is particularly true when the tank is dug into a defensive position and the crosswind sensor is shielded from the wind. In general, the ability to estimate crosswinds diminishes with range, so crosswind effects increase with range. At short range, crosswind errors for high-velocity ammunition can be negligible, but at long range, the effect can be significant. As mentioned ear-

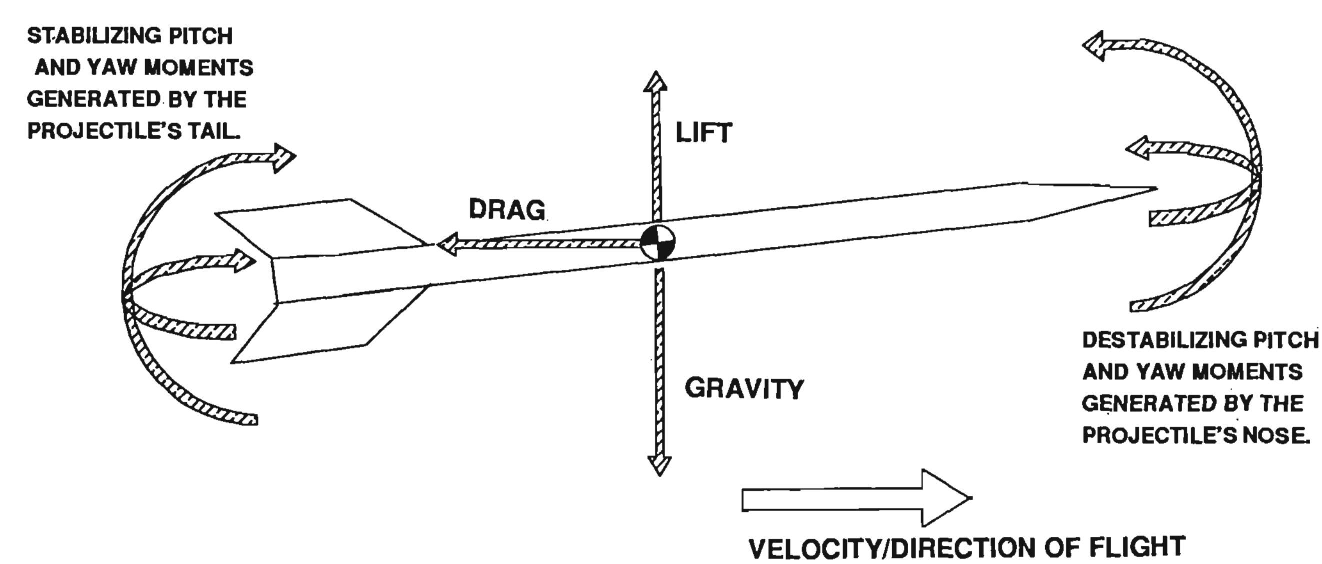


Figure 4. Aerodynamic Forces Acting on the Projectile.

lier, good PMCS of the crosswind sensor ensures that the fire control computer has the most accurate information possible, which helps reduce crosswind error.

Amazingly, the earth's rotation can also have a noticeable effect on the accuracy of tank ammunition. Imagine riding a merry-go-round and trying to throw a ball at someone else sitting on the other side of the ride. The rotating paths on which you and your target are traveling make this a much more difficult problem than it would seem at first. This effect, known as coriolis acceleration, is particularly noticeable at long range with slower projectiles, such as HEAT, but even high-velocity ammunition is affected at very long range. While the mathematical solution for this effect is easily calculated, it depends on knowing the tank's location and the absolute pointing direction of the cannon. Since this information is not available to the fire control computer of M1A1s and M1s, there is currently no compensation for the rotation of the earth effect.

Finally, improper storage and handling of ammunition can cause damage that will seriously impair the accuracy during every phase of the shot process. Damage to cases and improper storage can introduce moisture into the cartridge and cause uneven propellant burning. This causes the in-bore time and muzzle velocity of the ammunition to vary. Damage to obturators, sabots, and sealing rings can cause problems in-bore and during the projectile's disengagement from the tube. Damage to a projectile's tip and fins will affect its aerodynamic performance. Any one of these various factors will cause accuracy problems. Taking care to protect ammunition is also critical from a safety standpoint. The key here is to inspect and correct. If ammunition looks bad, it probably is, and should be carefully checked by a certified ammunition specialist. Not qualifying on Table VIII because of improperly maintained or inspected ammunition is a tank crew's nightmare. The effect in combat could be worse.

Concluding Remarks

At the crew and unit level, the key to tank gun accuracy is constant training and effective, continual PMCS of both the engagement system on the tank and the ammunition it will fire. Dedication to and enforcement of these two principles will reduce or eliminate the element of human error in the accuracy equation. On the material side of the accuracy equation, research and testing of new ideas and new technologies must continue in the areas of fire control, cannon systems, and ammunition. The ideas and technologies that are developed need to be evaluated and, where appropriate, incorporated in existing and future tanks. As mentioned at the beginning of this article, we have achieved an amazing level of accuracy with the M1-series tank. Crews feel confident about hitting targets at ranges in excess of two or three kilometers. This creates a danger that we may become complacent. To win in the future, our tanks must continue to be able to find and hit targets before they find and hit us. From the lab to tank tables, constant attention and correction of accuracy problems is critical to future success.

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Careful handling of ammunition is critical to accuracy as well as safety. Physical damage to cases and moisture can affect propellant burning rates, causing shot-to-shot variations in accuracy. Damage to penetrator tips will affect the projectile's flight path, and hence, the shot's accuracy.

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A Black Beret's Vietnam Odyssey

by Kenneth P. Lord

My arrival in Vietnam was a study in surrealism. The air-conditioned Boeing 707 descended with its million candlepower lights through the pitch black night, while outside this thin-skinned silver bird, tracers, exploding artillery, and flares could be seen on the horizon.

The immediate feeling of helplessness was increased by the night landing and the ensuing drive into Saigon along blackened streets with vaporous images of individuals seen through screened bus windows.

Culture shock was immediate, nor was it lessened by the first few days at Koepler Compound. This former French hotel, which bespoke volumes about French culture, was the inprocessing point for all Military Assistance Command (MACV) personnel who were to become advisors to the various Republic of Vietnam military units, to include the para-military Regional (RF) and Popular Force (PF) units. It was here that armor officers and noncommissioned officers found out if they would advise Vietnamese armor/cavalry units, or be assigned to straight leg infantry with the RF or PF advisory teams.

Once all the brief formalities were over, another bus ride took us to the airfield for embarkation aboard various types of aircraft for movement to the field.

In the case of Armor advisors to the 6th Cavalry, located at My Tho, south of Saigon, the flight was normally on a Caribou aircraft to Dong Tam, the combat and support base for the 9th (U.S.) Infantry Division and the Mobile Riverine Forces, followed by a short, hair-raising ride to the advisory team headquarters, Team 75, where some additional briefings would take place. Then the new advisor met with the 6th Cavalry Squadron senior advisor for an update on squadron/troop operations. Finally, a short helicopter ride took him to wherever the troop was located.

It was at this point that the real meaning of culture shock set in. The debarkation from the helicopter at that troop location was, like passing through the looking glass, the entrance into another world.

It should be noted at this time that advisors arrived at their posts with a variety of training experiences. The time was the late 1960s, and the buildup in Vietnam was still continuing. For the most part, the officer advisors detailed to the 6th Cavalry during 1967-1968 had no prior combat experience. Some had been fortunate enough to attend the Ft. Bragg advisory training session called MATA/Sector/Unit Training, and then received some rudimentary language training. Others were pulled directly from other U.S. units and arrived with little or no experience.

This lack of experience created immediate problems. As the stated mission was to provide advice to our Vietnamese counterpart, I was chagrined to find that my counterpart needed little of what I could provide.

My counterpart had been schooled at various Vietnamese schools, to include the Vietnamese Cavalry, and I found it was I who was placed in the position of learning.

Another stated goal of the advisory mission was to gain rapport with your Vietnamese counterpart, as this was essential for any type of successful "advisory" effort.

Rapport implies friendship. Friendship implies some shared goals, ambitions, interest, and commonality of language. The basic lack of experience on the part of the incoming advisors, the complete lack of knowledge of a difficult language, and the feeling by the Vietnamese that the advisor was, in fact, a snoop for MACV, created an environment of immediate distrust which took many months to overcome.

For the most part, the advisors became fire support coordinators and MEDEVAC facilitators for their Vietnamese counterparts. This, in itself, was vital not only to build that "rapport" necessary to function at all, but vital to ensure battlefield survivability for both the advisors and the Vietnamese.

Culture shock and acclimatization were ongoing processes. No amount of training and no amount of briefings could compensate for that feeling of absolute aloneness.

For individuals familiar with the normal support umbilical cord reaching from the forward-deployed elements to the COMMZ, to include showers, porta-potties, ice, rations, sundries, mini-exchanges, and the pack that follows the organized military units into battle, the total lack of this support tail became immediately obvious to the new advisor.

The Republic of Vietnam (RVN) cavalry units were organized as mechanized infantry; however, this was where the similarity ended. Generally, the MTOE reflected the absence of the infantry portion of the equation, and the entire organization began to take on the appearance of reconnaissance cavalry. There were three armored personnel carriers per platoon and three platoons per troop, a command track, maintenance track, and a support section consisting of the road-bound combat trains.

The troop had .50 caliber cupola-mounted machine guns on each M113, two .30 caliber side-mounted machine guns per M113, an 81-mm mortar, and occasionally a 57-mm recoilless rifle. During the course of the year, some additions were scrounged, to include a 90-mm recoilless rifle, some light antitank weapons (LAW), and a Rube Goldberg coffee grinder contraption that spewed 40-mm grenades. The primary problem was to find ammunition and repair parts to non-MTOE equipment such as the items scrounged.

There was no mess section. Each M113 had an appointed cook. The requirement for culinary ability was not standard, therefore it fell to the newest, or most hapless, track member to do the cooking.

Formal rations apparently were nonexistent. There were a few instances where a freeze-dried type of rice was made available, but the Vietnamese shunned this unless nothing else was available. Meat was carried in the M113 in the form of live chickens. This created some problems in combat situations while grabbing for ammo boxes and for sleeping at night. But the chicken was fresh, and in some instances, befriended prior to the butchering process. This occurred along the side of the road using whatever water source was available. Most commonly used were the cisterns of water located at each Vietnamese house. Fresh vegetables were obtained locally. Proper sanitation was nonexistent.

The meal itself was generally chopped, soy-stirred chicken bits, rice, soy and *nouc mam* sauce, fresh cucumbers, a vegetable stew and hot stew, and hot tea. This meal seldom varied.

Breakfast was hot French coffee and soup. Breakfast came from local soup shops set up in the various villages along the side of Highway Four, the main north-south route from Saigon to the Ca Mau Peninsula.

Lunch depended on operational considerations. If an operation was pending, there was an immediate rush after breakfast to the *ban my* (bread) shop. There, a loaf of hard crust French bread would be cut down the middle. Inside would be placed a mixture of roast pork, pepper sauce, and some unidentified items. The bread would be wrapped in a sheet of newspaper. By placing this on the top of the AN/VRC-46 radio, the bread would be warm by lunch.

During one road march, the men cooked prawns over the exhaust grate of the M113, and served them wrapped in thin rice paper and dipped in brown bean sauce. This put a new spin on fast food.

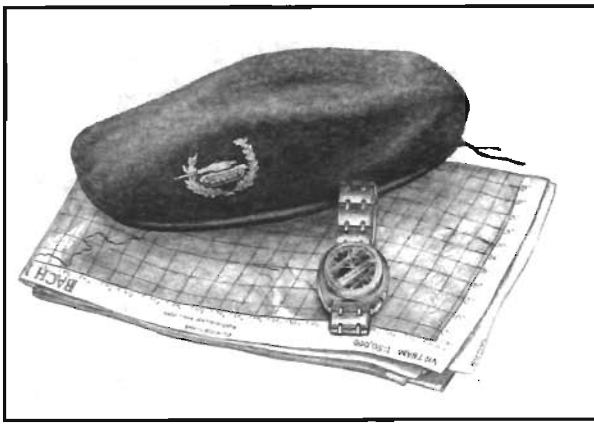
While on combat operations, lunch would mean a complete cessation of movement while the "cooks" scurried to nearby homes to either scrounge, or in the case of known VC areas, liberate, food. Fires were immediately lit, rice cooked, and the meal consumed.

Due to the climate of Vietnam, one spent six months soaking wet and hot and the next six months hot and soaking wet. The first six months, assuming one arrived in June, was the monsoon season. This meant being rained on four to five times a day. The second part of the year was the dry season — one stayed just as moist from perspiration.

Accommodations were always spartan. If one was small enough, the back seat of the advisor's jeep could be a passable residence.

Sleeping inside the M113 was not advisable due to the presence of the menagerie — Vietnamese crew members hung up in hammocks and the ever present mosquitoes. Some sought relief in jungle hammocks slung between M113s or on the back deck of the M113. Cots were available, as were Vietnamese hammocks, albeit too small to be comfortable.

During some evenings, Vietnamese residences were used, as were school buildings, sheds, or warehouses —



wherever shelter could be found, it was used.

Acclimatization also required the advisor to learn to live with no more than three hours sleep. As most advisory teams only had two advisors, an officer and an NCO, and both were generally separated by either hundreds of feet or several kilometers at any one time, sleep at night became a luxury.

The 6th Cavalry also had, under operational control of the troop advisors, a searchlight section from a field artillery unit located at Can Tho.

The searchlight section provided two xenon searchlights and were used at night, using infrared observation of possible VC/NVA movement to interdict Highway Four. The searchlight sections also were used on several occasions during rapid night movement to relieve elements in contact, leading the troop with their white light capability. The light could also bounce off clouds to illuminate areas under attack and to identify pick up points for incoming MEDEVAC birds.

This required the troop advisor or NCO to remain up to provide the interface with the searchlight section and the Vietnamese. Additionally, the poor security posture of the Vietnamese generally caused angst among advisors. Sleep, when it did come, was during the hottest part of the day when all operations ceased for the traditional siesta.

Mail depended upon passing U.S. convoys both for delivery and pick up. Laundry was the same. Sick call meant attempting to explain one's symptoms to the Vietnamese medic. This always resulted in the receipt of one large red pill. This pill always seemed to work.

Maintenance was superb. If the Vietnamese cavalry trooper excelled at anything, it was maintenance of his equipment. There was always some cleaning going on, either of weapons, tracks, or individual equipment. During Tet 1968, tracks evacuated for combat loss generally were returned to action within 24 hours or less. There still may have been an RPG hole in the hull, but the internal workings had been repaired, and the track was operational.

The problem with maintenance was above organizational. It took almost a year, but the concept of direct exchange (DX) was finally put into place. This began to resolve a lot of the problems, especially with machine gun barrels. Prior to DX, the barrels were removed, the guns made inoperable, and not placed back into action until the barrel was reworked or determined to be completely unusable.

Wheel vehicle maintenance was not as good, and was reflected in the poor appearance of the rolling stock. It was simply not a priority.

The most serious problem facing the advisor was the operational radio. Generally, the troop advisor had the AN/VRC-46 while the NCO had the PRC-25. For normal operations this was adequate. It became critical, especially after Tet 1968, when multi-unit operations were initiated. The radios were not sufficient for all of the coordination necessary.

During movement to contact, it was necessary to communicate with not only your own NCO but with adjacent cav troops, the cav squadron, most probably the regiment to which you were OPCON, the battalion advisor(s), and sometimes the divisional and province senior advisors, Air Force forward air controllers, the artillery at Dong Tam, MEDEVAC birds, and helicopter gunships. This meant jumping from the top of the track to the inside to continuously change radio frequencies. Some of the problems were resolved by scrounging additional PRC-25 radios.

Communications generally failed at the moment they were needed the most. The command track, upon which the troop advisor was riding, looked like a porcupine, with a minimum of four to a maximum of eight antennae. During some close encounters of the most intense kind, these antennae were some of the first casualties.

Combat operations were frequent. Combat operational planning was not. For the troop advisor, the most common Vietnamese warning order was, "We go." This generally meant the advisor spent the next harrowing minutes racing down the highway, spreading out a map sheet and trying to copy the graphic of an overlay received by the RVN troop commander perhaps only minutes before. The next portion of the operation was spent trying to raise the squadron senior advisor for clarification of mission or trying to contact the unit to which the troop was to work OPCON.

Troop advisors were never, at least during 1967-1968, brought into the combat operational planning at the squadron/troop level. There were two occasions where the 7th RVN Division staff briefed all of the advisors on a large operation; however, this was the exception, not the rule.

Intelligence of enemy activities was as poorly orchestrated. It was not until the spring of 1968, when the 7th RVN Division commander began using special funds and purchased intelligence, that combat operations actually began to bag large VC/NVA units. Prior to this, it would appear we would arrive too late, or if we found the enemy, it was simply by accident.

However, once the enemy was found and the battle joined, the cavalry troopers fought with tenacity and bravery. On several instances, frontal assaults, both with regular RVN troops or RF units, were made on entrenched VC/NVA forces. Maximum use was made of artillery, combat air support, and helicopter gunship support. During one particular engagement east of My Tho, in Go Cong Province, a battle initiated by an RF company resulted in the insertion of two battalions of 11th RVN Regiment soldiers and the entire 6th Cavalry. This culminated in a cavalry charge with the entire squadron on line, resulting in a resounding loss for an entire VC/NVA battalion.

It most probably also resulted in the ensuing attack on the 6th Cavalry advisor's residence in My Tho approximately a month later. This attack, in apparent retribution for the success of the cavalry over the previous year, resulted in the deaths of the squadron senior advisor and one noncommissioned officer. But it did not stop the continuing success of the 6th Cavalry.

The year 1967-1968 was a hard year for advisors with the 6th Cav. During that year, three advisors were killed, almost every advisor wounded one or more times, and one searchlight member wounded. Casualties to the Vietnamese troopers were not insignificant. During Tet, virtually two platoons of 3/6 Troop were wiped out after being ambushed while attempting to reach the bus station in downtown My Tho. Ambushes were frequent, and it was not unusual to lose two to four troopers per ambush.

Life with the Vietnamese was always unusual. We couldn't help but see that the people with whom we were living needed the basics of medical help. We saw many children with suppurating sores from working in the constant watery environment of the rice paddies. One child was suffering from a raging fever.

Impromptu medical treatment was provided by the troop advisors and included treatment of the sores, bandaging cuts, and passing out soap. Treatment of the child with the fever resulted in attempting to provide dosage instructions to the mother in Vietnamese. The child, by the way, did get well. The joy on the face of the mother was all the payment anyone could expect or want.

What was not acceptable was the lack of concern of the Vietnamese trooper for the suffering of his own kind. Finally, by the work the advisors were doing, the Vietnamese cavalry did relinquish some of their own medical supplies to assist, albeit grudgingly.

The year came to an end in much the same way it began. A helicopter ride to My Tho; a turn-in of equipment; a mind boggling drive to Saigon in a jeep; and more equipment turn-in, orders processing, and then waiting. This time the wait was in tin sheds at Ton Son Nhut. Even to the end, the VC/NVA made life miserable. Rocket attacks occurred nightly between 2300 and 0300. One landed next to the officer's club; however, there was virtually no break in the routine. Everyone ducked, then ordered another round.

A day or two later, I took another bus ride to the plane. As I waited to board, the passengers who had just arrived began to deplane — wrinkled khakis, wrinkled noses, and looks of bewilderment. To "old soldiers" like myself, this was "new meat." A few steps later, we were enclosed in an air conditioned cylinder and shortly whisked away. There was gladness to have "made it." There was sadness that the job had not been done, and that the long awaited "rapport" had actually grown to friendship. A glance back through the plane's window showed emerald green below, tracked by long brown fingers of brown water and the puffy white of clouds full of rain. A cheer went up from the passengers, a collective sigh of relief. We were on our way home.

By mid-1975, it was all over. Politics and failed policies had lost what blood, sweat, and tears had won. Walking the long, hot streets of Fort Indiantown Gap, I searched for familiar faces among the uprooted Vietnamese refugees. None were found. During a passage of the waters off Vietnam in 1982, while assigned to the *USS Midway* (CV-41) as a Special Agent Afloat with the Naval In-

Counterparts Association

In 1989, spurred by similar associations, I decided to see if I could re-contact both advisors and counterparts and form an association of armor and cavalry advisors and counterparts. For the past three years, this effort has continued at various operational tempo.

There are currently 32 former advisors and counterparts who have been identified and who have shown an interest in an association. In the interim, a new association called Counterparts was formed. This association is made up of advisors and their counterparts from all organizations which were active in Vietnam.

Recently, with the interest expressed by the then commanding general of Fort Knox, Major General Foley, in an association of armor/cavalry advisors and counterparts, new efforts are underway to identify officers and noncommissioned officers who served in that capacity.

It is anticipated, using Counterparts as the base organization, that a subgroup, made up of former black berets, both U.S. and Vietnamese, could be formed.

One of the major goals is to document for history the role of the armor/cavalry advisor in the Vietnam War. It is also to rekindle the camaraderie of a unique group of individuals and to foster the spirit of armor and cavalry.

Counterparts membership is available by writing to Counterparts, Post Office Box 40, Circleville, WV 26804. Additional information related to an armor/cav association should be directed to the author at 1504 Wheatstone Cove, Germantown, TN 38138.

vestigative Service, I experienced deja vu. Thirty-two Vietnamese boat people were picked up from a sinking scow. Virtually all of the refugees were from Dinh Toung Province or Kien Hoa Province. Some recalled my counterpart. All were fleeing the repressive Communist regime.

Kenneth P. Lord graduated from ROTC at Middle Tennessee State University in 1966 with a commission in Armor. He served with B Company, 6/32 Armor with 16th Armor Brigade until deployment to Vietnam in June 1967 as senior advisor with 2/6 Cavalry, 7th ARVN Division, My Tho, Vietnam, until June 1968. He then served as both a BCT company commander and aide-de-camp to the CG, Ft. Gordon, Ga., until retuming to RVN as commander, E Troop, 11th Brigade and 11th Brigade S4. After completing AOAC, he served at St. Lawrence University as an ROTC instructor. He branch transferred to MP in 1972 and subsequently served as S1, 519th MP Battalion and commander, 293d MP Company. After resignation from Active Duty in 1975, he served with the 2d Maneuver Training Command and 87th Maneuver Area Command as an MP, and with HQ, IX Corps/USARJ as a MOBDES. He subsequently served five years with the 220th MP Brigade as plans and operations and as S3, and is currently commanding the 304th MP Battalion (EPW/CI), USAR with the 125th ARCOM at Nashville, Tenn. In civilian life, he is a Special Agent with the Naval Investigative Service, where he is primarily involved in the investigation of white collar crime.

OPERATION RINSO

Some concepts transcend all barriers of language and culture – like a mail-order offer of free matching towels in tasteful contemporary colors...

Burt Boudinot, a now-retired lieutenant colonel, wore the black beret as an advisor assigned to MACV's J-3 office in Saigon. Like any American first exposed to the Vietnamese culture, he couldn't get over how utterly different Vietnam was. And the lack of a common language didn't make it any easier.

He remembers his billet in the Massachusetts Hotel, just outside Tan-son-nhut Air Base, which had been commandeered to house U.S. officers. A Vietnamese chambermaid was assigned to care for several rooms on each floor.

"I came back to the room one day at noon, and there was mama-san working on the room. She was between 40 and 60 years old, but it was hard to tell. She started chattering and waving her arms, and I figured out she wanted my dirty clothes. The sergeant at the front desk said to leave a certain amount on my bed every Friday, and over time, I would also leave her an apple, an orange, or some cookies I'd brought back from the mess hall.

"One day, when I was changing uniforms, mama-san came to the door and started giggling and chattering. I went out to the hall and asked if anyone knew what she was talking about. A teenaged Vietnamese girl told me that mama-san wanted to touch the hair on my chest. I said OK, and when she did, she cried out a word.

I looked at the girl. The teenager explained, "She say, 'Barbarian! Barbarian!'"

"Let me ask you something else," I said, "Why does she always hand me the empty Rinso box?" By that time, over the months, he'd bought her eight or ten boxes of the detergent to do his clothes, and after each was empty, she would bring it to him.

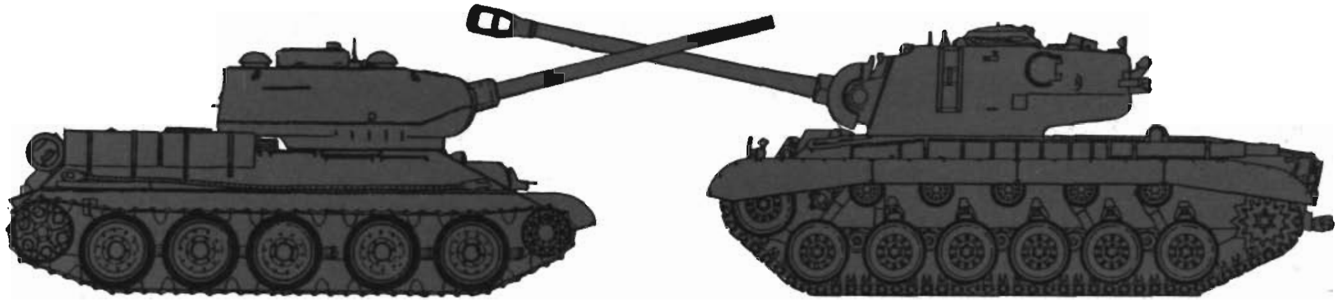
She held up the box, pointing to the back panel, which described the company's free towel offer — send in six box tops and get a set of matching towels. "She want you to send for this," the supervisor said.

He agreed, and the next day, there were 36 box tops on his bed. Boudinot took the boxtops, filled out the coupon, and sent it all off to the soap company, somewhat doubtful that the free offer was even good in a war zone. But about two months later, there was a call from the mailroom, and sure enough, there was a big box from the States. It was from the soap company.

Boudinot alerted the floor supervisor that the towels had arrived, and within a few minutes, she was in the room with the maid — and all the other maids in the hotel. They gathered around as mama-san opened the large box. "She let out a cry like a banshee and kissed both of my hands." The noise level in the room soared as the other maids clucked and chattered their approval. The arrival of the towels from the States had taken on a legendary, manna-from-heaven aura that must certainly rank as a high-point in U.S.-Vietnamese relations.

"Of course, that's not the end of the story," Boudinot said. "You can probably figure out what happened next... The next evening, there were almost a hundred box tops on my bed, probably every Rinso boxtop in Saigon. Word traveled fast.

"I sent them all away, but pretty soon, I was gone, too. I always wondered if the second shipment ever arrived... ."



Jousting with Their Main Guns: A Bizarre Tank Battle of the Korean War

by Major Arthur W. Connor, Jr.

When asked to describe a typical tank battle, most people talk of long range gunnery duels and massed formations of tanks rumbling through Europe or the desert.

During the war in Korea, however, there was no such thing as a typical tank battle. The terrain was restrictive, roads almost nonexistent, and the weather atrocious. Tanks were an integral part of the American effort in the war, but their battles did not follow the textbook examples taught at Fort Knox before the war began. The following vignette describes the experience of one American tanker as he and his crew fought for their lives in October of 1950.

The Korean War was barely two months old on 11 September 1950, when President Harry Truman approved ground operations north of the Thirty-eighth Parallel and into North Korean territory. After the spectacular success of the Inchon landings of 16 September, Republic of Korea (ROK) soldiers crossed the parallel on 30 September, with U.S. soldiers crossing on 7 October. Seoul had been recaptured by troops of X Corps only two days before.[1]

I Corps, with the 1st Cavalry Division and 24th Infantry Division assigned, along with the 1st ROK Division and the 27th British Brigade, led the way into North Korea. Arriving in the vicinity of Kaesong on 8 October, the 1st Cavalry Division led the way across the parallel as it attacked Kumchon the next day.[2] The tankers of the 70th Tank Battalion, assigned to the 1st Cav, played a crucial role in spearheading the drive into North Korea.

Resistance was fierce. A Company, 70th Tank Battalion could make little headway in its attacks with the 5th Cavalry on 9 October. On 13 October, B Company was supporting the 8th Cavalry when it ran into a company of North Korean tanks supported by infantry. Moving north out of Kaesong along the main road toward Kumchon, the M-26 Pershings of the tank company led the regimental attack to seize the village. On the outskirts of Kumchon, a group of four T-34s attacked the American Pershings. The lead platoon of B Company fired at the approaching enemy tanks, killing all four with their opening rounds. Two of the T-34s were destroyed when 90-mm hypervelocity armor piercing (HVAP) rounds penetrated the tanks, detonating the ammunition and blowing the turrets off. The third tank burned when hit, and the fourth tank was abandoned by its crew after being struck in the front slope. The North Korean crews were no match for the American tankers.[3] Two more T-34s were destroyed in separate fire fights that day, but as darkness fell, the enemy counterattacked.

A heavy ground fog settled over the tankers and 8th Cavalry positions as the B Company commander placed three tanks astride the road leading into Kumchon, tying in his perimeter defense for the night. In one of the most bizarre tank-versus-tank engagements of the war, four more T-34s rumbled out of the mist to contest once again the American supremacy of the battlefield.

The tank commander of the center tank, Sergeant Marshall D. Drewery, saw the first T-34 when it was less than 50 meters away from his position. He screamed at his gunner to fire, and the American tank bucked under the recoil of the main gun. The tank had a high explosive round loaded in the chamber, and it struck the T-34 directly in its gun tube, splintering it. The North Korean tank was now helpless, but instead of panicking and abandoning the vehicle, the crew charged and rammed the American tank, preventing it from firing a

Continued on Page 49

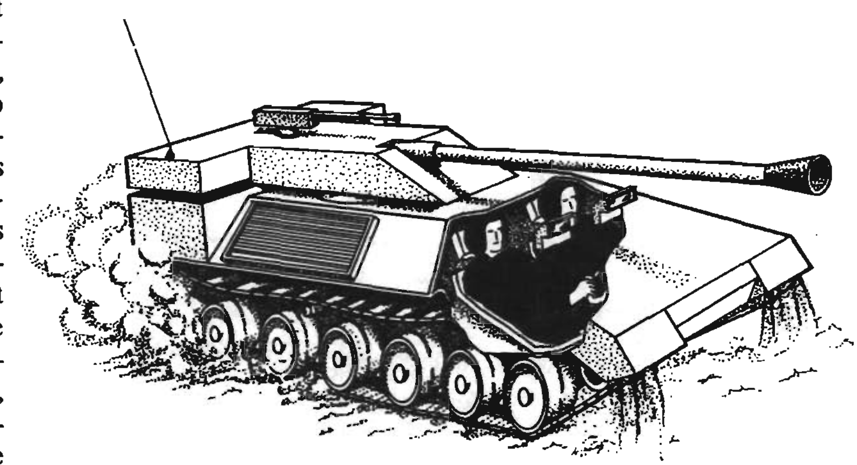
The Main Battle Tank: Future Developments — A British Perspective

by Major S. W. Crawford, RTR

Most of today's MBTs are descendants of the Soviet T-34.

In the seventy-odd years since it made its first appearance on the battlefield, near Bapaume at first light on 15 September 1916, the tank has evolved to maintain its role as the most important battlefield weapon system that armies possess. The lumbering, thinly armored, unsprung, and noisy vehicles of the World War I have given way to fast, reliable, superbly protected feats of engineering which can hurl armor-piercing projectiles with deadly accuracy to ranges in excess of 2,000 meters.

It is generally acknowledged that today's main battle tanks (MBTs), with one or two exceptions, are direct descendants of the Russian T-34 of 1940. It was in this vehicle, arguably for the first time, that the MBT's characteristics of firepower, mobility, and protection were welded together to produce a balanced and formidable weapon system. The T-34 was armed with a dual-purpose 76-mm gun firing high explosive and armor-piercing shells, unusual in a tank of this vintage, which considerably outranged and outperformed the weapons of the German tanks opposing it. Its armor was sloped to give added protection, and a combination of a rugged, reliable diesel engine, broad tracks, and Christie-type suspension gave it an excellent cross-country capability. The Germans were shocked and impressed when they first met the T-34 in combat, and for a time seriously considered producing a copy vehicle. They may have regretted that they went on to produce the Panther instead for, although technically a superior vehicle, it was considerably more complicated and expensive to produce and quite unreliable in its early days.



Modern MBTs have more or less followed the T-34/Panther formula, with the notable exception of the Swedish "S" Type tank. Most of today's vehicles fall into the 45-65-ton weight range, and are armed with high-velocity guns of 105-125-mm caliber. Protection is provided by steel, laminate, and, in some cases, reactive armor packs which test the ammunition designer's ingenuity to the full. Power comes from diesel, multi-fuel, or occasionally gas turbine engines that produce between 1,000-1,500 bhp. Typical of such vehicles are the German Leopard 2, armed with a 120-mm smoothbore gun and powered by an MTU 1,500-bhp diesel engine, the British Challenger with 120-mm rifled gun and 1,200 bhp Perkins CV12, and the Soviet T-80 with 125-mm smoothbore barrel and 985-bhp gas turbine.

So, how will the tank develop to meet the new challenges and threats of the battlefield in the next 20 or so years? By 2010, technological advances will lead to a proliferation of sophisticated weapon systems. In a scenario where real time intelligence is provided by satellite and RPVs, where pinpoint attacks on ground targets can be launched at extreme ranges using TGSMs, and where ADP-based systems give automatic and instant information access and update to commanders, the tank needs constant refining and upgrading to maintain its position in land warfare.

It is convenient to assess future improvements to MBTs under the familiar headings of firepower, mobility, and protection, to which automation will be added to include all discussion on ADP, information, and control system developments. However, before setting forth on an analysis of these factors, there is one other heading which, to British tank designers at least, should be of paramount importance — reliability. In war, many more tanks are lost be-

The WWII-era German Panther, above, drew on many of the T-34's concepts, as does its descendant, the Leopard II

cause of mechanical unreliability than to enemy action. In a withdrawal, such unreliability can be disastrous, as broken-down vehicles can rarely be recovered. A major proportion of British tank losses in the Western Desert in 1941-43 were attributable to poor reliability. Even when advancing, poor reliability can significantly weaken the attacker's effort.

British MBTs have an unfortunate tradition of unreliability that stretches back to before World War II. During that conflict, the problem persisted with such vehicles as A13 and Crusader being horribly prone to breakdown. The problem continues today, and no one can be unaware of Chieftain's engine fiasco in the early days. Thankfully, Challenger is some improvement, and Chieftain has become much more available towards the end of its service life, partially through better reliability and partially owing to the large spares back-up now available.

Despite these improvements, however, British vehicles still lag behind their NATO counterparts in reliability terms. Leopard II is generally recognized as being an extremely reliable tank, while IDR recently quoted an MDBF for M1's gas turbine engine of nearly 16,000 kilometers. Even if this figure is halved, it is still impressive. Reliability like this costs, of course, and reliability engineering is a science in itself. Some will argue that availability, which can be achieved by large repair pools, spares, and manpower resources, is a better aim. But bitter experience shows that, when money is to be saved, it is the spares and repair pools that are always cut first. Far better to have a reliable tank in the first instance. Sound engineering with no cutting of corners, plus a detailed and lengthy period of trials on production standard (as opposed to prototype standard, and therefore hand-built) vehicles, is the key. The field commander of the future will find little use for tanks that are prone to failure or need extensive maintenance.

Firepower has always been near the top in terms of priorities for tank design, and future technological innovations will have a quite dramatic effect on gun performance. As already described, most modern MBTs have conventional guns of 105-125-mm caliber firing KE and CE ammunition. The ammunition is either "fixed," meaning that shell and charge come in one piece, as per the German 120-mm smoothbore, or separated, as carried in Chieftain, Challenger, and the Soviet T-64/72/80 series.

Despite the impressive improvements made in KE ammunition performance over the last few decades, further enhancements will soon be required. Chemical energy natures, such as HEAT and HESH, have to a large extent been made obsolete by the introduction of composite and reactive armors, while KE needs improved performance to meet the projected threat. The three main areas for future gun technology are improved powder guns, liquid propellant guns, and electromagnetic (EM) guns.

There is a general consensus that conventional powder guns in the 105-125-mm caliber range are nearing the limit of their stretch potential, and that future improvements in performance necessitate an increase in caliber. Such guns will probably be in the 135-140-mm caliber range and be conventionally configured, although the bulk of the ammunition will probably mean separate charge and shot and some form of autoloading. Developments in propellant research and KE penetrator technology will allow designers to take full advantage of these larger calibers.

Conventional wisdom has decreed that separated ammunition, allowing the stowage of the highly vulnerable propellant charges below the turret ring as in Chieftain, increases the tank's survivability. This view is now being challenged on a number of counts; it may have been true in the days when, if a tank was hit in the turret, it was penetrated. But tank turrets are now generally the best protected parts of MBTs, and it seems to make sense to stow charges where they are best protected. Closely allied to this are developments in mine technology, which have significantly increased the belly attack threat, and thus the threat to hull-stored charges. Finally, the USA has developed the technology of "blow-off panels" to allow stowage of charges in the turret bustle. If the charges are initiated by penetrative attack, the force of the explosion is directed away from the crew compartment. These changes may well have negated the historical advantage of charge stowage below the turret ring.

Autoloaders were first fielded by the Soviets in the late 1960s in T-64, followed by T-72 and T-80, and can thus be considered to be mature technology. It is almost inconceivable that fu-

PRINCIPLE OF RAIL GUN ACCELERATOR

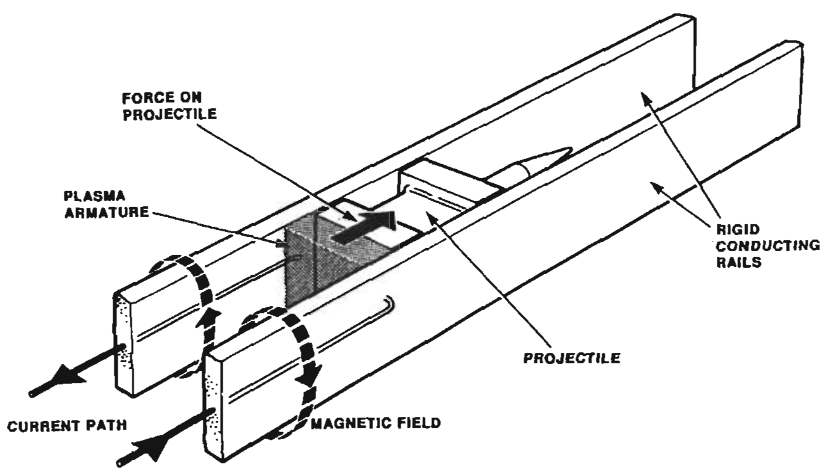


Figure 1

ture MBTs will be designed without autoloaders, and France has incorporated one in their new MBT, the Leclerc. The most obvious advantage of an autoloader is that it allows reduction of the crew to three, and thus increased survivability by a reduction in the overall dimensions of the tank. It also allows radical design concepts, such as the external gun tank, to become a serious proposition. Opponents will stress the need for four men in a crew to carry out all the multifarious tasks of servicing, maintenance, sentries, administration, and so on, but at a time when manpower is becoming scarcer and more expensive, this argument cannot be long sustained. There may, however, be a case for relief crews to allow rest after "sorties," rather like air forces man their aircraft.

Liquid propellant guns have now rather fallen by the wayside as contenders for the next generation of tank guns. While they offer advantages in propellant stowage, which being a liquid can be molded into available space, and survivability, as the volatile mixture need only be mixed from individually inert components in the gun chamber, there are basic design problems. Breech design is complicated by the requirements of sealing and the need for controlled ignition of the propellant to avoid pressure peaking. It would also seem that the improvements offered by liquid propellant guns are not of sufficient magnitude to warrant the expense of research and development, for tank guns at least. The application of liquid propellant gun technology is more likely to be in the field of lower velocity artillery pieces.

The most exciting development in tank gun techology however, is undoubtedly the EM gun. Briefly, this gun works on the principle shown in Figure 1. The forces generated will enable KE penetrators to be launched, eventually, with muzzle velocities of between four and six km/s — a real quantum leap. All the indications are that this technology will be mature by 2010. This vast increase in muzzle velocity would appear to place the advantage in the gun/armor relationship back with the gun, although research on the terminal effect of penetrators at such high speeds has yet to be completed.

The implications of the EM gun are enormous. With muzzle velocities in the four to six km/s range, all targets will become in effect static targets. The time of flight of the projectile is so short that there will be no need to aim off for moving targets, and therefore, fire control systems can be vastly simplified. The flat trajectory of KE penetrators flying at this velocity may need only one point of aim in the gunner's sight, at which point complete automation of the gunner's function becomes a distinct possibility.

Such high velocities also allow reduction in KE penetrator mass. As the penetrator performance of a KE projectile is given by the formula $\mathbf{mv^2/d^2}$, where **m** is the mass of the projectile, **v** the velocity, and **d** the diameter, any increase in v combined with either the same or a lesser value of **d** dramatically increases the penetration. Reduction in the KE penetrator mass offers two advantages: either the space required to stow the same amount of ammunition is very much reduced, and thus overall tank size is reduced, or a significantly greater number of rounds can be carried, thus easing the strain on the logistic resupply chain. Probably a sensible compromise can be reached.

Two final points must be made about the EM gun. First, there is no propellant, and consequently propellant vulnerability problems vanish. Second, the technology required to produce such high electrical power levels has other system applications and may enable, for example, adoption of such enhancements as electric transmissions. All in all, EM gun technology is an exciting prospect for future MBT design. Research is well underway at present and, having proved the feasibility of the concept with various demonstrators, efforts are now being directed to make the present bulky prototype systems into a size compatible with incorporation in MBTs. It is considered unlikely that MBTs mounting EM guns will appear before 2010.

Before leaving firepower, the MBTs need for an antihelicopter capability must be discussed. It is a popular notion that the armed attack helicopter has developed into a "threat vacuum" with no natural predators and has flourished accordingly. Certainly, its appearance has added a new dimension of threat to the MBT, and efforts are being made in many countries to counter it. There is little doubt that a dedicated antiair system is the best solution, and weapons like the Short Starstreak HVM on Stormer would seem to be ideal. However, such systems are expensive and in short supply, and cannot be guaranteed to be in constant support because of all the other demands that will be made on them.

The tank, therefore, needs its own capability. Whether an MBT needs to knock a helicopter out of the sky is another matter, for arguably all that is required is a "mission abort" or helicopter suppression system. In the shorter term, however, the solution would seem to be a gun-launched, proximity-fused, HE round of some kind, probably launched at a higher velocity than current tank CE rounds to give greater accuracy. This, added to the proximity fuse, gives a high probability of a hit. The real problem for the MBT is how to **detect** an attacking helicopter. The probability of seeing one through the episcopes of a closed-down, bouncing tank going across country is very low indeed, and some form of automatic detection device is required. It is in this area, above all else, that the dedicated antiair system scores high and is able to make full use of its weapons.

The protection requirements of MBTs can be broadly divided into two types: direct protection or the ability to survive a hit, and indirect protection, or the ability to avoid being hit in the first place. In terms of direct protection, MBTs have come a long way since the 12-mm thick plate armor of the Mk IV of 1917. By 1945, the U.S. Pershing had sloped armor some 102-mm thick at the front, while the mighty King Tiger boasted plates of 185 millimeters. Such quantum increases in protection have continued to the present day, and current MBTs have considerably enhanced (and classified) levels of protection.

SECTION DRAWING OF T-80 AND T-64B GLACIS ARMOUR

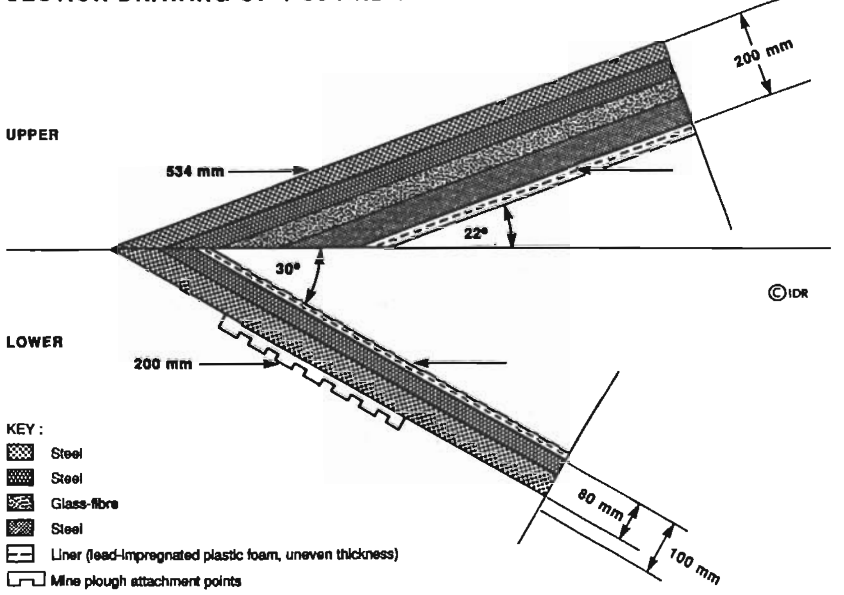


Figure 2

Much of this increased protection is due to the development of complex armors. Although the Germans developed such techniques as face hardening to improve resistance to penetration during the last war, until recently tanks relied mainly on thickness of rolled homogenous armor (RHA) to keep projectiles out. However, armors like the pioneering British Chobham armor have become first choice for modern MBTs, and are fielded on Challenger, M1 Abrams, Leopard 2, and the T-64/72/80 series. T-80's armor, which is representative of the genre, is shown at Figure 2. These laminated armors are designed both to absorb the energy of KE penetrators and diffuse the attack of CE munitions, and can be optimized against either. They are most effective against HEAT and HESH attack and have led to the KE round being once more the premier mode of antiarmor attack.

OPERATION OF EXPLOSIVE REACTIVE ARMOUR

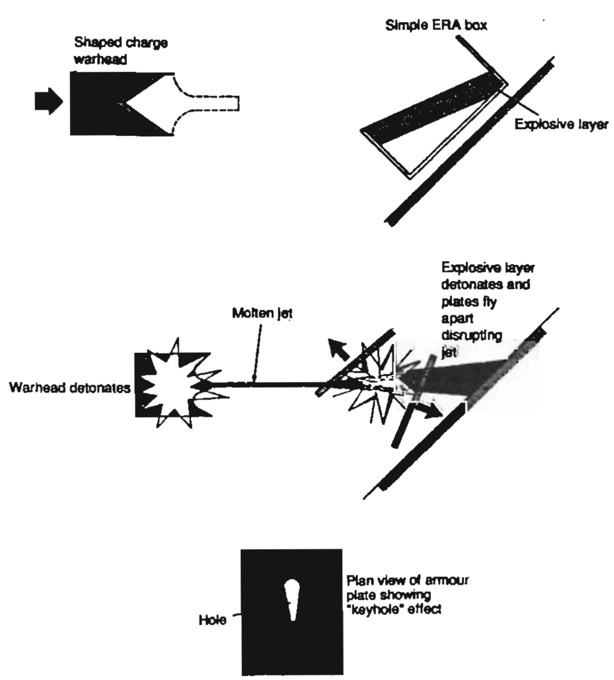


Figure 3

The decrease in effectiveness of CE rounds against armor has been reinforced by the introduction of explosive reactive armor (ERA). ERA was first brought to public attention by the Israeli use of it under the name Blazer during the Lebanon campaigns of 1982. This armor is bolted in boxes on tank hulls and turrets, and consists of explosives sandwiched between armor plates. When attacked by HEAT, for example, the explosive detonates, sending the plates flying outwards and disrupting the incoming jet, as shown in Figure 3. Although ERA has little effect on KE attack, its combination with Chobham-type armor has made CE warheads, as used by most ATGW systems, almost obsolete.

Active armor takes ERA one stage further, and aims to defeat incoming projectiles before they reach the tank. It is still very much in the development stage, and embryo systems propose either to shoot down incoming missiles with guns or antimissile missiles, or by means of explosive charges and self-forming fragments. There is no doubt that active armor may well counter CE attack and TGSMs, but KE, especially with the velocities postulated for the EM gun, may be another matter. However, it is conceivable that active armor systems will be deployed after the year 2000.

However well protected an MBT may be in the primary threat arcs, the restrictions of weight and size dictate that armor on the sides, rear, and top and belly, will be lighter, and therefore more susceptible to penetration. Accepting that penetration will happen on occasion, there are a number of measures which can be used to minimize the damage. Spall liners can defeat low levels of residual penetration, while body armor is already worn by many nation's tank crews for the same purpose. British tank crews currently have neither spall liners nor body armor, although there are plans for both. They will undoubtedly become standard in the future.

The greatest danger following penetration, however, is that of an ammunition fire. Propellants that burn slowly in the open will detonate when confined, with disastrous consequences for vehicle and crew. Attempts have been made with sealed, fire-extinguishing charge bins to nip ammunition fires in the bud, but as the propellant itself can contain the necessary oxygen for combustion, this is only partially successful. In British tanks, propellant has traditionally been stowed below the turret ring, but the rationale behind this may now be obsolete, as previously discussed. Perhaps the FRG and U.S. current practice of turret bustle stowage with blow-off panels is the way ahead. Crew compartment fire suppression systems, like that of Leopard 2, have their main task in putting out hydraulic fires caused by damage to the gun control equipment (GCE) and small fires in oil and rag waste and other peripheral equipments. Such systems are likely to be a feature of future MBTs, although it is interesting to note that Leclerc uses the safer electrical GCE and the FRG are considering an electrical system for retrofit to Leopard 2.

Fuel fires present a lesser hazard, with fuel being generally stored in self-sealing tanks. Indeed, diesel has been proposed as a suitable outside layer for ammunition stowage bins with the idea that it will cool down penetrating splinters and thus prevent ammunition fires. Diesel fuel is particularly effective at suppressing shaped-charge attack, as long as the attack is below the fuel/air interface.

So much for direct protection. Indirect protection has just as important a role to play in enhancing the survivability of the tank. This form of protection can be achieved by the combination of a host of factors such as size, agility, silhouette, use of camouflage, tactical handling, and the more recently developed techniques of signature reduction. As already mentioned, adoption of the autoloader can reduce the overall height of an MBT because there is no need to provide room for a standing human loader. Indeed, autoloading may allow future MBTs to mount the gun externally and dramatically reduce the size and vulnerability of the vehicle. Battlefield agility, a function of an MBT's acceleration and speed across country, can reduce exposure times during movement and thus considerably enhance survivability. In extreme cases, a highly mobile tank can outperform the traversing performance of an enemy turret, a capability claimed for the Cromwell when faced with the German Tiger in the last war.

It is in the field of signature reduction, however, where the most subtle enhancements to survivability may be made. The value of camouflage has long been understood, and research continues into better patterns, paints, and materials. IR-defeating materials have been fielded for some time, and methods to counter TI surveillance are now developed. Much can be done in the future at the design stage to ensure that exhausts are shielded and hot fumes dispersed, while radar signatures can be reduced by use of some of the aircraft industry's stealth techniques. Noise can be reduced too, and one of the benefits of the M1's (and presumably T-80's) gas turbine engine is that it is extremely quiet, the tracks being the major contributor to the vehicle's noise signature.

The protection levels of future tanks, therefore, will be considerably enhanced by a combination of new armors (ERA and active armor), enhanced survivability measures to counter the effect of penetration, and a continuing increase in indirect protection. The end result is likely to be that MBTs will be much harder to acquire, track, and hit, and even a hit will not, as is the case even now, guarantee incapacitation of the target.

Turbine engines, like those in the M1-series, at left, and the Russian T-80, right, deliver high power from small size, but use much more fuel.

These advances will go a long way to counter the projected firepower enhancements.

In mobility terms, modern MBTs offer levels of agility, speed, and maneuverability far in excess of those achieved only 20 or so years ago. Then, Centurion with its 650-bhp engine could muster 25 mph as against today's Challenger which can achieve 56 kph from its Perkins CV 12 1,200-bhp engine, a figure which itself is low when compares to T-80's 75 kph. A better measure of agility, perhaps is power to weight ratio. Centurion had a power to weight ratio of 12.7 bhp/ton, compared to Leopard 2's 27 bhp/ton. However, engine power and power-to-weight ratio alone do not dictate an MBT's mobility. Many other factors, like ground pressure, length-to-width ratio, track design, and so on all play their part.

Modern MBTs are powered by either conventional diesel or gas turbine. Such engines currently generate between 900 and 1500 bhp to power their highly agile charges. It is generally thought that 1500 bhp will remain the standard power required for a 45-65-ton MBT, and attention in the future will tend to be focused on how to make tank power packs smaller, more efficient, and more reliable.

Here, the gas turbine engine has an undoubted advantage. It is inherently more compact and lighter than a conventional diesel engine, and also more reliable on account of its simpler design. Turbine engines are now in service with the two major tank-producing nations of the world, the U.S. and Russia, and it is unlikely that such technically sophisticated nations introduced gas turbine engines in M1 and T-80 without careful thought. It is true that these engines use considerably more fuel than normal diesel engines, but much of this is consumed during the engine idling time that takes up so much of an MBT's battlefield day. The U.S., whose M1 uses roughly twice the fuel that Challenger does, is now actively considering the installation of an auxiliary power unit to reduce fuel consumption.

Because of these advantages, therefore, it seems likely that progressively more and more MBTs will be powered by turbine engines, and by 2010 will be the first choice of tank designers. There remains considerable scope for further development of these engines, and use of adiabatic technology and transverse mounting may allow for shorter and lighter hulls. The combination of turbine engines of increasing power and the decreased weight of hulls could produce a significant increase in the MBT's mobility and agility.

Of all the other factors that determine a tank's mobility, perhaps one of the most important is suspension design. Challenger, Leopard 2, and the like have improved suspension with greater wheel play, which allows cross-country bumps and dips to be tackled at speed without disruption or injury to the crew. It is interesting to note that Chieftain's poor mobility is not engine-limited, despite the disastrous early days of the L 60 engine. Recently, a Chieftain fitted with hydrostrut suspension — a development of Challenger's excellent hydrogas system — proved considerably more mobile across country.

While such suspension systems represent a considerable improvement over what went before, there is even greater scope for improvement using active suspension. Now, active suspension systems are not exactly new, having been tested in prototype form on the US/FRG MBT-70 project and indeed being used currently by the Swedish "S" Type tank to lay and aim the gun. However, these suspensions are programmed by crew input, and are used in static situations or preprogrammed maneuvers. The real advantage of active suspension will be revealed when it operates automatically, for example "seeing" when the tank is about to encounter a ditch and altering the suspension accordingly. This technology is by no means yet mature, but by the next century should allow MBTs to travel at considerable speed across the roughest terrain.

It will be in the field of automation, however, encompassing ADP, fire control computers, information and control systems, and so on, that will make the major impact on MBT design over the next 20 years. Although fire control computers like Chieftain's Improved Fire Control System have been around for some time, only recently has the full potential of computer technology for future tanks begun to be realized.

New French Leclerc MBT will include a battlefield management system to help simplify the tank commander's workload.

A host of functions and actions that at present require crewman input could be automated. In particular, it has long been realized that the tank commander is overloaded, and attempts are now being made to lessen his burden. Most nations have some active research into this area underway. The U.S. has its Battlefield Management System, while the UK is busy formulating its requirements for its Battlefield Information Command and Control System. The French have recently fielded a system in Leclerc.

So, what will such systems offer the MBT crewman in the future? The attributes of an information and control system can be divided into several broad functional areas: these are, the provision of computer-generated mapping, some sort of land navigation system, the maintenance of a data base of information on the enemy, friendly forces, minefields etc., and the handling of messages. All of these will have implications for the future and can be considered both individually and collectively.

Computer-generated mapping, presented on VDUs, will allow a large store of terrain data to be presented as required to MBT crews. Information on, say, routes and obstacles can be demanded and presented either isolated from, or integrated with, the main geographical map. New information on enemy locations and forces can be plotted and automatically transmitted to friendly vehicles to ensure an all-informed intelligence picture. Indeed, it may be possible to integrate the MBT's fire control laser and navigation system with the computer map, so that enemy vehicles identified and ranged by an individual tank are automatically plotted on every friendly MBT's system.

Additionally, more formal orders can be planned and plotted in graphic overlay form and transmitted without need for hard copy. The amount of paper which presently encumbers tank commanders may be dramatically reduced, and the days of trying to refold a large map while closed down and moving at speed cross-country may well be drawing to a close.

Closely allied to computer-generated mapping is the land navigation system. No matter how skillful at reading a map they may be, most MBT commanders spend much time and effort in trying to map read themselves from location to location, especially at night and in low visibility. Any tank commander who claims to never have been lost must be treated with suspicion, and the burden is particularly great on subunit commanders. A navigation aid will be a great assistance to tank crew efficiency and need not demand pinpoint accuracy; up to plus or minus 100 meters is probably sufficient for almost all situations. Provision of this facility will signify a major breakthrough in relieving overload on commanders.

It is obvious that maintenance of a comprehensive and up-to-date database is fundamental to the whole concept. The scope for storage of information is enormous and only limited by the capacity of the software. On top of the terrain data stowed for the computer mapping, the database must contain details of enemy strengths, locations, equipment, and the same for friendly forces. It must also contain, although not necessarily on every MBT, details of own unit personnel, equipment, logistic requirements, and so on. It should give the commander a constantly updated situation report on his own troops, with details like vehicle readiness, ammunition states, vehicle and personnel casualties, and estimated repair times of damaged tanks, among other items.

All this information will then enable the final attribute of such systems, that of automatic message sending. Commanders at all levels are burdened by a large number of reports and returns which must be sent to enable others to produce relevant plans for future operations and logistic resupply. Future information and control systems will be able to produce such reports and returns without crew input; MBTs will produce the information, either automatically or when demanded by the commander's vehicle system.

The introduction of such a capability has major implications. Not only has the tank commander's workload been considerably reduced, allowing him to concentrate on fighting his vehicle and subunit, but all MBTs in a group will have instant access to intelligence information. Some nations have already begun to plan how they might modify their tactical groupings to take advantage of these new facilities. For example, it may no longer be necessary for troop leaders to provide an interim level of command between tank squadron leader and individual MBTs. With the instant access to information provided by an information and control system, the squadron leader may easily command up to 15 vehicles directly.

The implication that is exciting tank designers, however, is one of crew size. It is possible to provide these facilities to any crew member and this, allied to the commander's reduced workload, may mean that by judicious reallocation of tasks and transfer or duplication of operating controls, crew numbers may be further reduced. The two-man crew becomes a distinct possibility, where each member has a common crew station which allows him to drive, command, fire the gun, and operate radios and other equipment as necessary. A two-man crew, in turn, may allow reduction in the size of the MBT, thus enhancing survivability.

Having said all that, the two-man crew concept is probably unlikely to be in service in any great numbers before 2010. So, having given a resume of likely future developments in firepower, protection, mobility, and automation, we must return to the original question of how the tank will develop over the next 20 years or so. It would be timid not to make a speculative judgement as to what form it might take. The task is made considerably easier if we can divde the predictions into two; that is to say, what sort of tank might be produced by a major tank producing power in the period 2000-2010, and what might be produced after 2010.

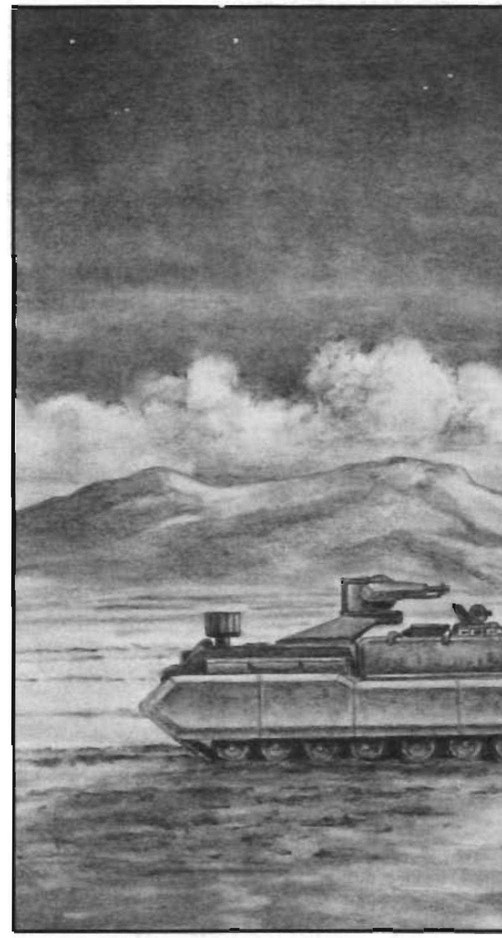
There seems little doubt that a tank introduced into service in the first period will have a conventional powder gun. This gun will almost certainly be smoothbore, unless the UK continues with its ill-judged commitment to the rifled barrel, and will fire KE and CE fin-stabilized ammunition. The CE round is not likely to have an antiarmor role, but may well be able to be proximity-fused for antihelicopter use. The gun will be fed by an autoloader, and the crew will be reduced to three. This may also allow the MBT to have a low profile or reduced volume turret. Armor protection will be provided by a combination of laminate armor and ERA, and protection against overfly top attack will be incorporated. Towards the end of the period, active armor may be introduced, probably in the form of an autonomous radar-controlled gun turret to acquire and shoot down incoming missiles and TGSMs. The vehicle is as likely to be powered by a gas turbine as a conventional diesel engine, probably of around 1,500 bhp; if the former, an auxiliary power unit will be used to reduce fuel consumption at idle. An information and control system will be incorporated, considerably reducing the crew's workload and perhaps allowing modification of tactical groupings by removing some interim levels of command.

After 2010, the design of MBTs may go through a quite radical change. The maturing of EM gun technology will greatly simplify gun control systems and reduce ammunition size. The gun will certainly be autoloaded and may well be mounted externally, thus reducing the vulnerability of the crew compartment. The KE round will be effective against armored ground targets and all but the fastest of air targets because of its high velocity. It will also fire a slower, general purpose secondary round for general support tasks. Armored protection will now be by a combination of laminate, reactive, and active armors, and the full impact of stealth technology will have made the MBT much harder to acquire. Diesel engines will have given way to gas turbines, which will be more compact and mounted transversely to save space and weight. Active suspension will enable high-speed, cross-country movement. Most significantly, automation will truly have come of age, and the introduction of the common crew station concept will have allowed crew reduction to two, each able to perform all functions within the vehicle. Interim levels of command, for example, at troop leader level, will have disappeared, and sustainability in continuous operations will be achieved by alternate crews moving up under light armor during replenishment.

There will be those, of course, who say that by 2010 there will be no need for the MBT on the battlefield. Other weapon systems, for example the armored helicopter, will have greater flexibility and sustainability. These prophets must be reminded that by 2010 the "threat vacuum" into which the helicopter has developed will be filled with sophisticated antihelicopter systems, and its vulnerability will make it a fragile asset to be carefully conserved. We have yet to see attack helicopters used extensively in mechanized operations against first class opposition. What is certain is that helicopters cannot carry the fight forward to the enemy in the face of heavy fire, nor can they assault a strongly fortified and stoutly defended position without heavy casualties. They do not have the ability to absorb punishment and continue operating, one of the fundamental attributes of the tank. It is for reasons such as these that no one weapons system is likely to be able to take the place of the MBT on the battlefields over the next 20 years. The tanks innate ability to create **and maintain** shock action, by a combination of its attributes of firepower, mobility, and protection, and the fact that it is able to continue to exploit its own success, make it certain that it will remain as the commander's main asset in future highly mobile and intensive mechanized operations.

Major S. W. Crawford graduated from Cambridge University in 1976 with an MA in Land Economy. After three years in civilian employment, he entered the Royal Military Academy, Sandhurst, in 1979. On commissioning, he joined the 4th Royal Tank Regiment in Munster, Germany. After completing the British Army Staff Course, he served as a weapons technical officer on the staff of the Director, Royal Armoured Corps. He returned to the 4th RTR in 1989 as a squadron leader, serving six months as part of the UN peacekeeping force in Cyprus. He became OIC of the Regiment in October 1990, but was extracted and sent to HQ, British Forces Middle East in Riyadh during the Gulf War. At present, he is attending the U.S. Army Command and General Staff Course at Fort Leavenworth.

Planning for a Future Tank Must Consider Technology Leaps, Robotic 'Crews'



by H. H. Dobbs

"The time has come," the Walrus said,
"to talk of many things:
Of shoes — and ships — and sealing wax —
Of cabbages — and kings . . ."

Lewis Carroll,
Through the Looking Glass

With apologies to Lewis Carroll and his Walrus, whose Wonderland is scarcely stranger, and certainly less threatening, than ours, perhaps the time has come to talk of kings — of who, or what, may be 'King of the Killing Zone'[1] a decade or more hence, when the Army can hope to get its next main battle tank, the replacement for the M1 series.

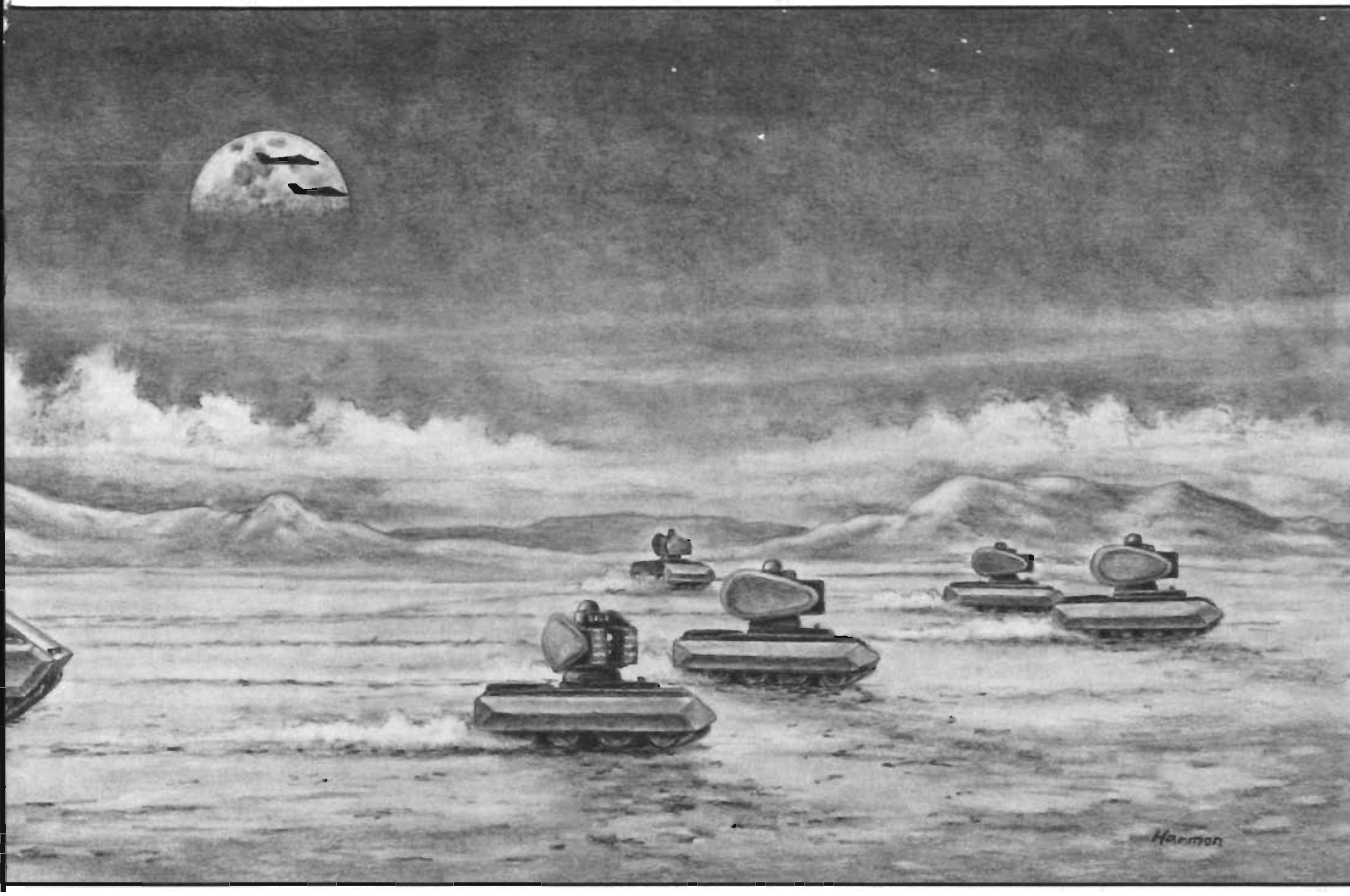
The Armored Systems Modernization program has been greatly reduced in scope, a consequence of the collapse of the Soviet threat and the Army's successes. The logic of its rational schedule to keep the Armored Force in step with improvements in technology has been enveloped and bypassed by the larger question of the mission to be served by making the investment required to accomplish this. Despite imminent sales of the production-ready, vastly superior M1A2 to foreign armies, the cost effectiveness of upgrading the U.S. Army's M1-series tanks to the M1A2 configuration is questioned. Even this logically unassailable proposal may not be fully implemented. Even arguments for maintaining the unique production base for armored combat vehicles are met with skepticism in some quarters. The schedule for an M1 replacement, the Future Main Battle Tank, is hazy and ill-defined. The only certainty is that this proposed principal armored combat vehicle will not be in the Armored Force much before 2010, at best.

Obviously, this is not a very satisfactory situation from the Army's point of view, but there are aspects of it which can be turned to advantage. It eliminates the need to focus on a near-term replacement of the M1 series, and permits — in fact, demands — an unconstrained long-term look at where technology is going over the next two decades. It is possible that we need a major redirection in both hardware and combat development objectives. The purpose of this article is to discuss briefly why that may be the case, suggest the direction it might take, and initiate further discussion on the subject.

It is not difficult to see why, in the public view, the Army's concerns with further improving our combat vehicles should be something less than a major concern to the country at large. Obviously, even after the reductions now underway, the Army's force-in-being will be unmatched by any other on the planet. Given that training and morale are maintained, it will remain that way — unless, of course, some of its numerous potential adversaries improve their capabilities significantly.

Unfortunately for the complacent, some of those potential adversaries will make such improvements. New threats are inevitable in a world culture made up of a multitude of highly competitive nationalistic states existing in a capitalistic world economy based on international trade whose key drivers are high technology and technological innovation. This is the basic 'engine' described by Kennedy,[2] O'Neil,[3] and others as that which carried European civilization to world domination. It now has become global, and generates change far more rapidly than in the past. To ignore it is to risk unpleasant surprises.

The purpose of our R&D programs over the past 50 years has been to prevent such surprises, and they largely have been successful in that regard. This has been a continuous process and it has been possible to meet projected threats by modifying our equipment and forces in relatively small steps. When projections must be made farther ahead, however, a thorough grasp of the implications implicit in ongoing improvements in the relevant technology is likely to indicate the need for a discontinuous change in equipment and tactics.



The time involved need be no longer than the roughly two decades between the present and 2010, when a new U.S. MBT reasonably may be possible. This is comparable to the time between the two world wars. Then, as now, existing technology at the beginning of the period promised further developments which could drastically change the way armies fought. Writers such as Fuller, Hart, and Mitchell, among others, discussed the potential of tanks and airplanes, but, *"Despite this, the evidence of the initial battles of WWII from 1939 to 1941 would indicate that only the Germans paid serious attention to the analyses of how the technology best could be employed. However, here too this may be giving too much credit for intelligent military innovation with regard to technology. As the historian Tuchman has stated with respect to a much earlier war, '...most military innovations,' (evolve) '..from defeat, ignominy, and paucity of means.'[4] Certainly all these factors influenced the German situation prior to WWII."* [5] At the start of that conflict, the Allied armies paid a heavy price for their lack of, "..intelligent military innovation.." Their losses confirmed the wisdom of the U.S. Army Armor Branch's founders, whose battles within the Army to overcome conservative opposition to creation of the Armor Force have become an often told story out of the Corps' history.

It appears to me, as I have stated in previous articles, that we again are at a major turning point in the tactics of ground warfare, the first since WWII.[6,7] The course taken by the Corps' founders 60 years ago should be the model for that to be followed today. A critical examination of the implications of the developing technology is needed to determine the best path to follow. The two basic questions are:

1. What technological developments could threaten current armor forces?

2. How could these offer an opportunity to a potential adversary?

The current focus for a FMBT is on development of a 'super M1' in which all of the characteristics of the outstanding current tank are improved. This is a conservative approach. However, its apparent virtues may be meretricious, giving a false assurance of battlefield success 20 years hence. An alternate approach to a future principal armored combat vehicle may offer much more. We need to keep in mind that, *"Armor is a state of mind — an instinctive sense of mobility,"*[8] not a specific type of hardware. Much still can be done to improve the MBT in its current form. The separation of forces in "close combat" in DESERT STORM stretched out to over 3,000 meters in many cases, five-to-six times that in WWII tank battles. This overmatch can be increased with improved ammunition, such as X-ROD or the XM943 STAFF.[9] Longer range vision systems and fire control systems also will increase vehicle lethality. Cross-country speed also can be significantly increased. Improved communications such as IVIS will improve organizational effectiveness greatly, but of course will do this regardless of the specific vehicle systems used.

Ultimately, however, when the needs of Armor are reviewed[10] there are limitations inherent in the current MBT type which currently for which foreseeable technology has no good answers. Strategic (air) deployability and high survivability obviously are contradictory requirements. Passive armor is heavy, reactive armor of limited effectiveness, and close-in, vehicle-mounted active systems are an unproven concept. The kill ranges in DESERT STORM already exceed continuous intervisibility distances in many potential combat areas. And, as DESERT STORM demonstrated, the ability to kill at longer range provides the greatest improvement in survivability.

This also allows a lower force density, which can further improve survivability.

Improvements in weaponry have dictated trends toward greater separation of forces and lower force density on the battlefield since warfare began. The technology now evolving will accelerate those trends. That technology, encompassing communications, artificial intelligence (AI), robotics, and related fields, is well recognized by the military, but is largely independent of military budgets. It has applicability in a multitude of areas, and will be implemented ubiquitously. Ultimately it will dominate military activities as well. It promises to greatly extend "close combat" ranges, greatly reduce the density of soldiers (but not necessarily machines!) on the battlefield, and greatly improve the survivability of those who remain.

The many military robotics programs now underway implicitly recognize this potential.[11] Concept of Employment Evaluation (COEE) exercises already have been conducted.[12] The review of emerging technologies in the March-April 1992 issue of ARMOR discusses the application of AI and robotics to the armor mission, and indicates the eventual use of unmanned systems.[13] Unmanned aerial vehicles were used successfully in DESERT STORM for both intelligence gathering and naval fire direction.

The development of AI and robotics is going to progress much faster than is generally realized. Moravec predicts human equivalence at the supercomputer level by 2010, and at the PC level within 20 more years.[14] The trends support that projection. This is much more capability than will be needed for very effective semi-autonomous, tele-directed, robotic fighting vehicles. Current concepts for a FMBT effectively are going to be overrun by the advancing technology if it is going to take us till 2010 to field it. The logical response to this is a concept of an FMBT fully exploiting those technologies.

I would propose that the best choice for a FMBT for the 2010 time frame is a vehicle system consisting of a manned control vehicle "armed" with a variable number of semi-autonomous tele-directed robotic surrogates as its main weapon. The control vehicle would have approximately the protection levels and armament of the Bradley, and greater mobility, but at no more than 20 tons weight. This should be an achievable goal within the time frame. The robotic surrogates would be configured for the mission at hand. Their primary function, however, would be to engage and destroy the enemy. They would be fighting vehicles, probably armed with missiles, and directed by the soldiers in the control vehicle. Nominally, a complete FMBT system would consist of a control vehicle and six robotic surrogates. Both functionally and in configuration it compares to a current MBT in much the same way an aircraft carrier compares to a battleship, an equivalent change in naval systems which occurred in approximately the same length of time involved here.

This approach appears (to me) to retain the mobility of current systems while having the following advantages over the conventional MBT configuration:

- Better strategic deployability, due to the system's lighter, smaller component vehicles;
- Much longer striking range, due to the ability of the robotic fighting units to attack 10 kilometers or more ahead of the control vehicle in almost all terrain conditions;
- Higher survivability (of the control vehicle), due to being out of range of many enemy weapons;
- Higher lethality, due to the difficulty a conventional MBT will have coping with a simultaneous attack from several directions by a number of small, fast units uninhibited by risks;
- Much greater intelligence gathering power, due to the larger number of sensing units involved and the potential for direct input into an IVIS system;
- Quick repair of battle damage by replacement of the robotic units;
- System flexibility through choice of robotic units to fit specific missions;
- Reduced chance of fratricide for the manned units of the system.

There are, of course, unsolved technical problems with this concept too. It is not a conservative approach. The most challenging of these appears to be in the communication links between the control unit and the robotic units. Some of these are:

- Bandwidth requirement, which may be resolved by new compression techniques;
- Transmission security, which may be improved by techniques and algorithms based on so called "fuzzy logic," and will become less critical as the robotic units become more autonomous;

•Line-of-sight transmission requirements, which could be met through use of Unmanned Aerial Vehicles (UAV), albeit with the limitations inherent in that approach.

I have no particular expertise in that area of technology, and it is one which should be addressed by an author who does have that expertise as part of a thorough critique of the proposed concept. The basic question here, as with all of the technologies involved, is not what can be done now, but what can we reasonably expect to be able to do in 20 years.

A broader critique of the concept than any single person can bring to the discussion obviously is critical to determining whether there is any merit in this proposed change in focus. The technology is only one aspect of the question. All aspects of employing such systems in combat should be explored. What effect would they have on tactics? How could they be employed most effectively? Would they really have the advantage over conventional systems it appears they might? What are their weaknesses? How would such systems fight others of their own kind? What are the logistic impacts? Certainly more knowledgeable readers will recognize other topics which also should be included.

This is, I believe, a topic worth serious discussion within the Armor community. It appears to me there is reason to believe that relatively simple and inexpensive robotic vehicle systems in the hands of our potential adversaries will be a far more dangerous future threat to our forces than any number of obsolescent Russian battle tanks. Long before 2010 such systems, probably using optical cable guidance and operated by infantry, almost certainly will become available in quantity to almost any country that wants them. Superior equipment based on the same advances in technology should be the most effective counter. A super MBT, like the battleship in WWII, may prove to be only a more expensive target.

If what has been proposed above is wrong, the reasons why it is wrong should be clearly established. If thorough discussion and analysis indicates it is right, our course should be adjusted appropriately. In that discussion, however, it should be kept clearly in mind that "Armor is a state of mind — an instinctive sense of mobility," a corps of fighting men imbued with that spirit, not a particular type of fighting machine.

Notes

[1]Kelly, Orr, *King of the Killing Zone,* W.W. Norton & Company, Inc., New York, 1989.

[2]Kennedy, Paul, *The Rise and Fall of the Great Powers,* Random House, New York, 1987, Chapters 1-3.

[3]McNeill, William H., *The Pursuit of Power,* The University of Chicago Press, Chicago, 1982.

[4]Tuchman, Barbara W., *A Distant Mirror,* Alfred A. Knopf, New York, 1978, p. 187.

[5]Dobbs, Herbert H., "The Changing Environment — Combat Vehicle Technology in a Historical Perspective," The Society of Automotive Engineers (SAE), May 1984, Paper #840852, p. 4, col. 1.

[6]Ibid., p. 2, col. 2.

[7]Dobbs, Herbert H., "Key Thrusts in the Combat Vehicle Technology Base," U.S. Army TACOM, Warren, Mich., Sept. 1983. Presented at the ADPA Combat Vehicle Systems Meeting, 20-21 Sept. 1983, Fort Knox, Ky. Paper #840852, p. 4, col. 1.

[8]Foley, Thomas C., Viewgraph (VG) on "Essence of Armor," "Report to the Total Armor Force 1992." The Chief of Armor's report, 1992 Armor Conference, May 1992, Fort Knox, Ky.

[9]Naylor, Sean D., "Silver Streak," *Defense News,* The Army Times Publishing Co., Springfield, Va., 14 Sept. 1992, p. 33.

[10]Foley, various VG's throughout presentation.

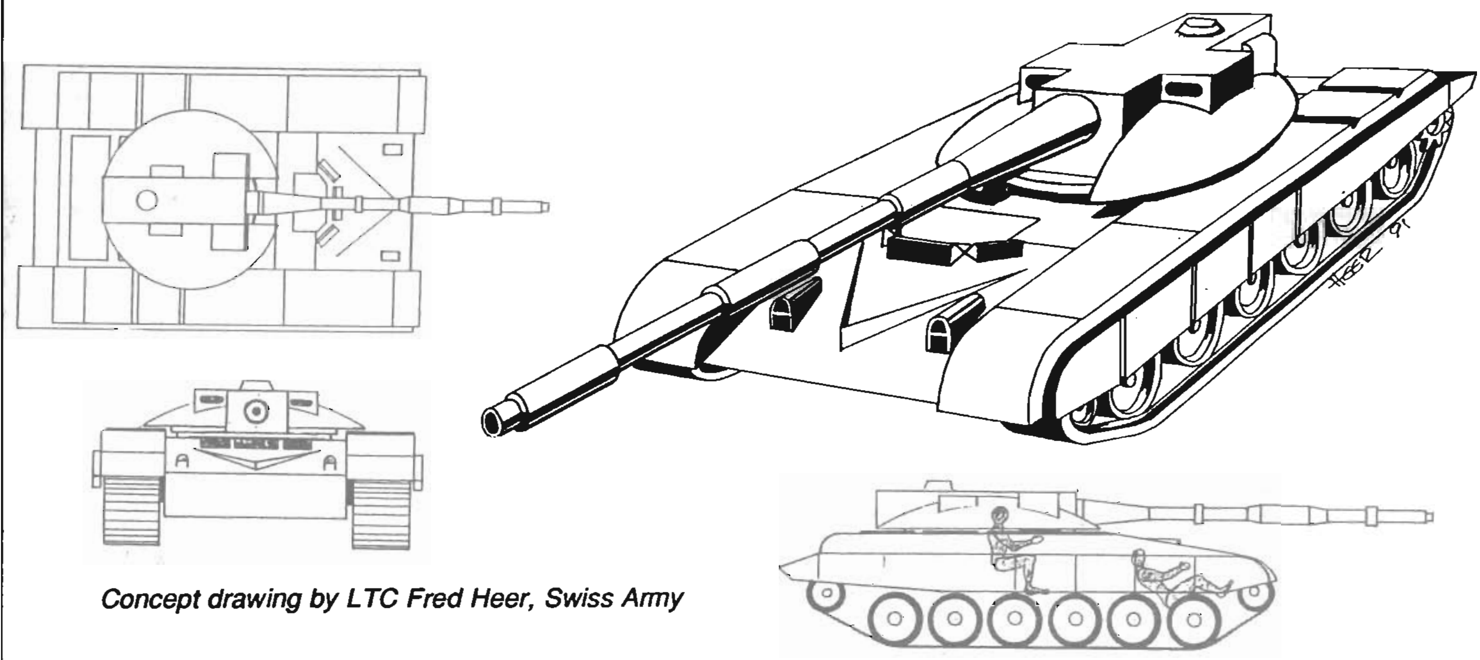
[11]*Unmanned Systems,* The Magazine of the Association for Unmanned Vehicle Systems, Spring 1992, Vol. 10, No. 2. Issue devoted to unmanned ground vehicle systems.

[12]Hennebeck, L. M., and Powell Johnson, "Lessons for Tomorrow's Battlefield," *Unmanned Systems,* Spring 1992, Vol. 10, No. 2, pp. 31-33.

[13]Payne, Edward W., "The Army's Key Emerging Technologies," *ARMOR,* March-April 1992, Vol. CI, No. 2, pp. 6-12, Figure 10.

[14]Moravec, Hans, *Mind Children, The Future of Robot and Human Intelligence,* Harvard University Press, Cambridge, Mass., 1988, p. 64.

Colonel Herbert H. Dobbs, U.S.A., Ret., has intermixed a remarkable 18-year career managing the research and development of military systems with over 10 additional years as a hands-on engineer and scientist. He holds a masters and doctorate in mechanical engineering from the University of Michigan, and is a graduate of the U.S. Army War College and the C&GSC, among others. He has worked on such diverse projects as the B-58 bomber, the Polaris missile system, the Copperhead guided artillery projectile, Hellfire missile guidance, and air filtration on the M1 tank engine. He organized and ran the 'Red Ball Express' office in Saigon in the mid-1960s, developing a quick response supply network to keep weapon systems repaired. From 1978 to 1985, he served as director of the TACOM laboratory at Warren, Mich., chief of the Systems and Technology Planning Office of TACOM's R&D center, and the command's Technical Director. He holds the Legion of Merit, Bronze Star, two awards of the Meritorious Service Medal, and the Joint Services Commendation Medal. A private consultant since 1986, he was a principal in a new company formed to exploit high technology. He also holds several patents — for improved breech-sealing systems, wind sensors, and methods for reducing bore erosion in cannons.



Concept drawing by LTC Fred Heer, Swiss Army

The Premium Tank-5: The Armor Threat of the 1990s

by Major James M. Warford

The August international arms exhibition known as Desert Security II (DSEC II) was very well attended and included the normal amount of documented surprises. Like most of the large military showcases of recent years, DSEC II provided both the well-known arms purchasing powers, as well as emerging new countries, a marketplace for increasing their military strength. This year's exhibition, however, was more significant since it finally confirmed the existence of a threat that various Western intelligence agencies had been trying to track down for several years. The recently formed tank design consortium hosting DSEC II included a previously unseen tank as the centerpiece of its armored vehicle display. Called the Premium Tank-5 (PT-5) by its designers, the new tank's firepower, mobility, and protection characteristics demonstrated a new and significant threat to U.S. armor. The real possibility that this truly innovative and advanced tank could be provided to potential adversaries sent shock waves through the U.S. armor community. The PT-5's designers had managed to continue what had once been a dramatic Soviet capability, with the result being a new tank that was clearly superior to its competition. As one senior U.S. Army observer attending the exhibition put it, "with the 120-mm guns of DESERT STORM now long silent, history may have once again repeated itself in the shape of an innovative new tank superior to our own. Perhaps the most frightening point to consider is that the PT-5 is here and it's for sale..."

According to *The Military Balance 1991-1992*, in June 1991 the Soviets could have fielded a tank force of approximately 54,400 tanks. Unlike the total tank strength of a Western army, these Soviet totals embodied the results of a unique Soviet concept. The concept concerned the fielding of a tank force consisting of two different tank types in a high-low mix. The Soviet Main Battle Tank (MBT) was designed as a low-cost tank that was intended to be fielded in lower priority Soviet divisions, as well as being made available to Soviet allied countries. These tanks had the necessary capabilities to be competitive on the battlefield, while being inexpensive and simple enough to be produced in very large numbers. MBTs constituted the bulk and the low-end of the Soviet tank fleet's high-low mix.

The Soviet tank type that made up the high-end remainder of the fleet was the Premium Tank (PT). A premium tank is defined as a very high value and innovative tank that incorporates the highest technology available at a given time. According to the premium tank concept, both the less sophisticated MBTs and the premium tanks were fielded concurrently, with the reserve forces employing the same MBT as the bulk of the active force.

Since its debut in July 1941 with the Russian T-34 Model 1940 and Model 1941, the premium tank has heralded the use of innovation and high technology in tank design. When compared to the contemporary tanks fielded by its competition, the innovation and high technology incorporated into each of the Soviet premiums resulted in a crisis being impressed upon its opponents. The success of the premium tank did not go unnoticed by the Western armies that were forced to react to its capabilities. The short-lived American T-95 premium tank project of the 1950s, and the successful American and German programs to field high technology MBTs in the 1980s, are examples of the Western response to the Soviet premium tank experience. Prior to the collapse of the Soviet Union in 1991, Western intelligence agencies were very concerned about Soviet innovations that were projected to appear in the near future. While the threat imposed by a future premium tank from Russia or the Ukraine has been downgraded significantly, the threat of the premium tank employed by a new adversary demands attention. The task at hand is to identify this threat and respond to it, prior to the imposition of a dangerous crisis in tank and antitank warfare.

The Premium Tank-5

The identification of the future premium tank could take place in a wide variety of different scenarios. These possibilities range from the tank being identified during operational testing by U.S. national assets, to it being openly displayed as an export candidate, or for the purpose of proving a given country's military prowess. In whatever scenario the future premium tank eventually appears, it will most likely be based on the product and process of the Soviet experience. Following the established line of Soviet premium tank developments — the T-34, postwar heavy tanks, the T-64 series, and the T-80 series — the examination of the future premium tank will be based on the projected Premium Tank-5 (PT-5). The PT-5 is the result of a combination of the available open-source information and the analysis of this author.

The PT-5, at figures 1 and 2, will be the first tank of unconventional design to appear since World War II. After the M48/LEOPARD 1 and M1/LEOPARD 2 generations, the appearance of the PT-5 will mark the start of the third postwar generation of tank development. The PT-5 will go into limited production in the early 1990s, with the push to full scale production between 1994 and 1996. Due to its cost, complexity, and revolutionary design, the numbers of PT-5s eventually produced will be somewhat lower than past premium tanks. The PT-5 will reach its Initial Operational Capability (IOC) during the same time frame it reaches large scale production.

Improved Firepower

The PT-5 will mount either the new third-generation 125-mm main gun or the new "Rapira-4" 135-mm main gun. The third-generation 125-mm gun will have a maximum effective range of 2,500 meters, and will fire a new family of HVAPFSDS, HEAT-FS, and FRAG-HE ammunition. For any engagements beyond 2,500 meters, the PT-5 will be able to fire an improved laser beam-riding ATGM through the gun tube. A key characteristic of this gun will be an improved barrel-life over that of currently fielded 125-mm tank guns. The PT-5 may also mount the new Rapira-4 135-mm main gun, which will increase the maximum effective engagement range of the PT-5 to approximately 3,200 meters. The Rapira-4 will not only fire a completely new family of ammunition, including a new Depleted Uranium (DU) HVAPFSDS round, it will also fire a more powerful laser beam-riding ATGM out to a maximum effective range of 6,000 meters. The secondary armament will consist of a coaxial 7.62-mm PKT machine gun and a 12.7-mm NSVT antiaircraft machine gun. Both machine guns will be capable of being fired while the PT-5 is fully buttoned-up.

While the main gun carried by the PT-5 represents a huge increase in capability, the heart of the tank's improved firepower will be the new "hunter-killer" fire control system. Incorporating the most advanced capabilities available, the hunter-killer system will include a laser rangefinder (LRF), a thermal night fighting capability for both the tank commander and gunner, and an advanced shoot-on-the-move capability.

Like the very similar systems used on the M1A1 and Leopard 2 MBTs, the PT-5's hunter-killer fire control system will allow the tank to accurately engage multiple long-range targets, while stationary or on the move. One important advantage of the PT-5's hunter-killer system will be the employment of both active and passive defensive countermeasures.

Active and Passive Countermeasures

The active countermeasure system will be based on the Soviet Drozd (Thrush) system. The Drozd system, which was first seen on the T-55AD MBT in the late 1980s or early 1990s, consists of a radar sensor that detects incoming ATGMs, and then fires a volley of pellets from modified turret-mounted grenade launchers to destroy an attacking missile before it hits the targeted tank.[1] The passive countermeasure system will consist of two different elements; a Laser Warning Receiver (LWR) network and the "Shadow" infrared "projector."

The LWR network consists of three sensors, one mounted on the turret roof and one mounted on the left and right side of the hull. The purpose of the sensor network is to warn the PT-5's three-man crew that they are being illuminated by a laser rangefinder or laser designator, and to identify the direction of the threat. Once given that information, the crew can conduct the necessary evasive maneuvers to avoid the incoming antitank projectile or missile.

The truly innovative Shadow infrared projector is designed to project a duplicate infrared and radar image of the PT-5 ten meters to the right of the projecting tank. The intent of the Shadow is to confuse Precision Guided Munitions (PGMs) or smart-bombs into locking onto and attacking the projected image and not the actual PT-5. As discussed by the Soviets in the late 1980s, and confirmed by Operation DESERT STORM, combat in the future will include the large scale employment of PGMs. The PT-5 will be the first tank in the world fully capable of operating in the intense PGM environment expected to characterize battlefields of the future.

Mobility of the PT-5

The mobility characteristics of the PT-5 will also be given a high priority. Unlike its Soviet predecessors, the PT-5 will not have the initial mechanical problems historically associated with premium tanks. The PT-5 will be powered by the new Smerch (Tornado) diesel engine, providing between 1,200 and 1,500 hp. This new engine will combine the power and reliability of European tank engines, with the innovation and light weight normally associated with premium tank designs.

The PT-5's engine and fully automatic transmission will give the tank a maximum speed of 85 kph, and a range of operation of approximately 700 kilometers. This very impressive performance is possible because the low-profile/low-volume turret and lightweight engine allow the PT-5's combat weight to be only 50 tons. In addition to the new engine and transmission, the PT-5 will also incorporate a hydro-pneumatic suspension system. This type of suspension will allow the height of the PT-5 to be raised or lowered by adjusting the tank's ground clearance to best suit the available terrain. Although already in use by the Japanese Type 74 MBT and fully tested in the American T-95 premium tank project, the PT-5 will be the first fielded premium tank to use this type of suspension.

The Innovative Protection of the PT-5

Like the firepower and mobility design areas discussed above, the protection provided to the PT-5 will be very impressive and represent a huge increase in capability. The turret used on the PT-5 will be entirely new, and truly revolutionary. The PT-5's unconventional turret will be of a low-profile/low-volume design; that will not only reduce the tank's weight, but will also give the PT-5 a very low overall profile. The tank commander will be seated on the right, and the gunner seated on the left, both low inside the turret. When occupying a hull-down fighting position, the target presented by the exposed turret will be almost impossible to detect. If the turret was hit, however, the armor would certainly provide the level of protection necessary to defeat currently fielded antitank weapons.

The PT-5 will be fitted with two different types of armor protection, advanced composite armor on the turret and new "active" armor on the tank's front slope. The turret armor of the PT-5, like earlier premium tanks, will consist of a combination of both ceramic material and cast steel. In the PT-5's turret, however, the ceramic material will not be limited to the turret front. Since the PT-5's turret is much smaller than that fitted to other tanks, there is no restriction to limit the use of composite armor to save weight. Therefore, the composite armor fitted to the PT-5 will protect all sides of the turret through 360 degrees. Instead of the filled internal cavities incorporated into the turret fronts of other premiums,[2] the PT-5 will employ an innovative "ceramic shell" placed between the outer and inner layers of cast steel armor. This ceramic shell will ensure complete coverage of the turret from all angles of attack. While the exact ceramic material used in this composite is not known, it will certainly be more advanced than that employed by the T-64 and T-80 premium tanks.

The most revolutionary aspect of the PT-5's armor protection is the active armor fitted to the tank's glacis. Open sources have claimed that the Soviet tank originally known as the FST-2 included "proactive armor" that would intercept an attacking projectile before it actually hit the armor.[3] According to retired General Donn Starry, the FST-2 could also have incorporated electromagnetic armor. The intent of electromagnetic armor is to destroy an attacking projectile with an extremely powerful electric charge. When an incoming round hits the tank armor it completes an electric circuit and basically destroys itself.[4] While these possibilities still may appear in the future, they are not part of the active armor fitted to the PT-5.

Known as "snap-lock armor," the revolutionary laminate consists of a six-layer array incorporating two outer layers of steel, two middle layers or plates of advanced ceramic "active" armor, and two inner layers of steel. The two active plates are mounted on top and bottom guides, in a concept very similar to that used with household sliding glass doors. When in motion, the top and bottom guides ensure that the plates travel and return in the correct manner. The intent of the new armor is to defeat the long dart-like DU penetrators in APFSDS ammunition. When the front slope of the PT-5 is hit, the penetrator is slowed by the two outer layers of steel. As it reaches the two middle active plates of the snap-lock armor, the plates slide to the left and right simultaneously; and then slide back to their original positions. Both of these actions occur in the smallest fraction of a second, with both active plates moving in unison. The result of this snap-lock action is the penetrator being neatly cut into three separate pieces. The kinetic energy of the severed penetrator would be drastically reduced, leaving the remaining energy and undirected parts of the penetrator to move laterally and be absorbed within the laminate. The two inner layers of steel would provide more than enough protection to protect the PT-5's crew from the remnants of the DU penetrator. The advanced composite and snap-lock laminate armor carried by the PT-5 could potentially provide complete protection against conventional antitank weapons.

The appearance of the PT-5 could be a primary force behind the decision to fully develop and field the next generation of battlefield weapons.

The PT-5 Scenario

As previously mentioned, the identification of the PT-5 could occur in a wide variety of different scenarios. Any problems associated with identifying this new threat, however, will be magnified if the potential adversary follows the Soviet premium tank example. The defense-related press, as well as a variety of open sources, could help keep any new tank developments secret by denying that any other country has the capability to develop high technology weapons. Several sources will argue that a given country is simply not capable of producing a tank with the very sophisticated characteristics of the PT-5. It should be remembered, however, that these same sources once believed the combination of a large caliber smoothbore main gun, an innovative engine, and the use of composite armor was too sophisticated for the U.S. Army to field (with the T-95 Premium Tank), at virtually the same time the Soviets fielded the T-64. Since the Soviets have historically been able to develop and field high technology premium tanks, there is no reason to assume that other nations are incapable of the same achievement. According to *Soviet Military Power 1989*, Soviet tank technology was not only equivalent to that of the U.S., the relative technology level was in fact changing significantly in favor of the Soviet Union. "We discovered that things we had predicted they would have ten years from now, they already had."[5] It would clearly be an example of assuming away enemy capabilities if the U.S. Army allows itself to be caught off-guard by the deployment of the PT-5.

Apparently, the potential impact of a future premium tank like the PT-5 may have already been identified. Open sources reported in 1988 that the U.S. Army had developed a new innovative type of armor using depleted uranium. While the program to field as many of the American M1A1 "heavy metal" tanks to the deployed forces prior to the start of Operation DESERT STORM confirms the capabilities of Soviet MBTs, it only tells part of the depleted uranium armor story. Apparently, the program to put DU armor on the M1A1 began in 1983, and was upgraded to a "program of national priority" in 1985.[6] Perhaps the U.S. Army identified the threat presented by the PT-5 and its 135-mm main gun prior to August 1990. If the Soviet experience with the T-64 is used as an example by the developers of the PT-5, the lack of information concerning the PT-5 can be understood. When the T-64 was first deployed to the Western Group of Forces (WGF) in East Germany it was already 11 years old. Like the T-64, the first public appearance of the PT-5 may only confirm the threat it imposed on the U.S. Army long before its projected IOC of 1994-1996.

The New Crisis In Tank and Antitank Warfare

In the near future, the desire to sell the M1A1 and M1A2 MBTs to U.S. allies may provide a valuable opportunity for potential adversaries to observe these American MBTs during demonstrations and vehicle displays. Given the increasing capabilities of weapons producing countries, and the previously unheard-of availability of weapon design teams and production know-how, it is very possible that certain military delegations may view the M1A1 and M1A2 and not be impressed. In fact, they might not even believe that these MBTs are the best the U.S. Army has to offer. As with the case of the German Army in the spring of 1941 when it was confronted by the T-34, the logical conclusion to the above scenario would be that a given country could already secretly possess a tank superior to the M1A1 and M1A2.

If the U.S. Army of the 1990s and beyond continues the same pattern maintained by the opponents of past premium tanks, a new crisis in tank and antitank warfare may give an opponent a critical advantage. The threat of a potential adversary applying the process of the Soviet experience to produce a future premium tank in the shape of the PT-5, must be identified and effectively countered prior to the deployment of U.S. forces to the battlefields of the future.

Notes

1"Russian Reports," *Armed Forces Journal International*, February 1992, p. 27.

2Major James M. Warford, "The Tank That Could Have Won the Next War: An Assessment of the Soviet T-64 Premium Tank," *ARMOR*, March-April 1990, p. 26.

3Tom Donnelly, "Soviets Plan Exotic Tank for the '90s," *Army Times*, 10 October 1988.

4Ibid.

5John Barry, "A Failure of Intelligence," *Newsweek*, 16 May 1988, p. 21.

6Ibid.

Major James M. Warford was commissioned in Armor in 1979 as a Distinguished Military Graduate from the University of Santa Clara, Calif. He has commanded D/1-66 Armor, A/2-66 Armor (COHORT), and HHC/2-66 Armor, and has served as an AOAC Small Group Instructor at Ft. Knox. Since his graduation from CGSC in June 1992, he has been assigned as the S3, 2d Squadron, 4th U.S. Cavalry, 24th ID (M) at Ft. Stewart, Ga.

A Visit to the Soviet Airborne Training Center at Ryazan

MSG William T. Powers of Dedham, Mass. forwarded these photos of Soviet airborne armor taken on a recent visit to the Ryazan Airborne Training Center in Russia. The vehicles on exhibition at this static display show the wide range of smaller armored vehicles tailored for air drop, in some cases fully rigged.

BMD-1, at left, with suspension collapsed and prepared for air drop. Note two soldiers in foreground, mounted in special seats, called "Kintava," that are custom-formed for each man. These two crewmen remain inside the vehicle during the air drop, and the special seats cushion impact. Above right, a BMD variant called the 1V119, similar to a FIST vehicle, is at the center of the static display, with a 2S9 mortar/howitzer version beyond it at far left.

Above, a BMD-2 with 30-mm cannon identical to the 30-mm on the BMP armored personnel carrier. On the turret roof is a launcher mount for the AT-4 missile.

2S9 SP Mortar/Howitzer with suspension collapsed and prepared for air drop. Later BMD variants, like this fire-support vehicle, use longer chassis with six roadwheels, rather than five.

This BMD-2 carries its ZSU-23 twin antiaircraft gun on the top deck during air drop, then acts as its prime mover once on the ground.

This variant of the BMD is the BTR-RD antitank missile vehicle, with launcher on top deck and an additional launcher used in ground mount configuration.

1st Cavalry Division reconnaissance troops in Vietnam prepare to mount up.

Bring Back the Blues

by Captain Brace E. Barber

An armor lieutenant clutched his M16 as he watched the landscape rush past below. He and his platoon prepared to dismount the helicopters that brought them to the enemy's doorstep, and the beginning of another mission in support of the division cavalry squadron. Wait, this does not make sense! An armor lieutenant with an M16?.., DISMOUNT?..., Helicopters???...; is this some kind of a joke?

Actually, it is not a joke. Rather, it describes what was formerly the airmobile reconnaissance platoon of the DIVCAV squadron. The organization dates back to the beginning of aircav with the blues platoons of the 1st Cavalry Division in Vietnam. Unfortunately, it has been ignored and allowed to die in the quickly reorganizing cavalry. The disappearance of recon platoons with the new J-series in 1986 left a gap in DIVCAV recon and security capabilities.

DIVCAV squadrons must recapture this asset and it's abilities — medium-range reconnaissance, rapid response to rear area threats, and the conduct of raids in the enemy's rear. The recon platoon provides the squadron with intelligence, security, and flexibility that no other unit can match.

The framework is already present in the DIVCAV to add the needed personnel and equipment easily. The organic aviation unit maintenance platoon and III/V platoon can easily handle the small number of UH-1H or UH-60 helicopters needed to lift a platoon of 31 men.

Medium-range reconnaissance is the primary mission of the recon platoon. Twelve to 24 hours before the squadron zone reconnaissance begins, helicopters insert the platoon forward of the forward line of own troops (FLOT). They then move by foot to set up a screen line five to 20 kilometers in front of the squadron. Current information received from the platoon on the enemy situation allows the commander to improve his plan, and employ artillery, and CAS effectively.

By inserting early, the recon platoon can confirm or deny the accuracy of the intelligence preparation of the battlefield (IPB), allowing the commander time to alter his plan. Because the DIVCAV squadron is the first unit to move into an area, the IPB is key to their success. The commander's revised plan, based on up-to-date information, focuses squadron assets and increases their chances of success and survival.

Good enemy intelligence allows the line of troops to move rapidly and with confidence. The result is more time spent on reconnaissance, not wasted hiding from an enemy that is not there.

Without a recon platoon, the squadron relies on the division long-range surveillance unit (LRSU) for intelligence. Though an effective intelligence-gathering tool, they report to the division and are concerned with the division deep battle. They do not provide information that can immediately help the squadron, even if communications were rapid enough to get the intelligence to the squadron in a timely manner.

Through detailed planning of enemy air defense suppression (SEAD), no-fire areas, landing zones (LZ), and false LZ's, the helicopters of the lift platoon can safely and quickly move across the FLOT to insert the recon platoon.

Working in team-sized elements, the platoon moves by foot the remaining distance to observation posts (OP). Chances of success are greatly increased by conducting these missions under the cover of darkness. Stealthy movement in limited visibility situations allows the teams to penetrate enemy reconnaissance. From these positions, they provide information, control friendly indirect fire, and employ close air support, to harass or destroy the enemy.

For effective communication with the squadron, teams carry radios with a green net capability. A vehicle placed just behind the FLOT, or one team located to the rear of the screen can act as a relay station for reports. To sustain operations, teams carry sufficient rations, small camouflage nets, and institute sleep plans immediately.

Recovery of the teams is accomplished by aerial extraction, exfiltration, or the movement of the squadron or other friendly troops past their positions. This is the most difficult of the missions to accomplish for the squadron. Once again, detailed planning is needed to protect the recon soldiers from friendly fire and enemy detection. Downed Pilot Pickup Points are already part of the squadron plan and can be used to extract the soldiers.

Another mission of the recon platoon is that of rear area reaction force. The platoon can rapidly move by helicopter to delay or destroy a level II threat. A trained combat platoon will be effective against the light enemy forces expected to disrupt our rear area operations.

Also, as a reaction force, the platoon can destroy or maintain contact with light enemy forces bypassed by a squadron zone reconnaissance. Line troops maintain flexibility of maneuver, by not becoming decisively engaged or having to leave a platoon back to maintain contact with the enemy. This powerful resource allows the squadron to keep maximum reconnaissance forward and oriented on the objective.

An additional mission of the recon platoon is that of deep operations. In the case where an enemy command post or other soft, high value target is identified, the recon platoon can be tasked with its destruction. Inserted in the same way as for a screen line, the platoon moves in squads or as a platoon to maintain its full combat power consolidated. Making the most of limited visibility and surprise, the platoon attacks violently with massed small arms fire and grenades to destroy the enemy position, deceive them as to the size of the attacking force, and create as much confusion as possible. It is important that the raid and aerial extraction are swiftly executed to take advantage of enemy disorganization and avoid a coordinated pursuit.

A disjointed recon and counterrecon effort by the enemy, which could result from such an operation, would substantially increase the effectiveness of the DIVCAV squadron.

The platoon's mobility and dismounted operation also make it ideal for numerous other missions. Their ability to bypass obstacles that delay mounted forces make them valuable as far-side security for obstacle-breaching and river-crossing operations. The platoon operates well in difficult terrain, where mounted scouts lose their mobility. When this condition necessitates the use of air troops independent of ground troops, the recon platoon can fill the ground role of reconnaissance and security.

The DIVCAV squadron must regain the airmobile reconnaissance platoon, a cavalry unit whose capabilities and benefits are enormous compared to its size. Without it, the squadron is operating in a degraded mode, making plans that cannot compensate for recent enemy shifts, counting on division for information that may or may not help, using valuable assets to maintain contact with bypassed enemy, and risking enemy success in our rear area.

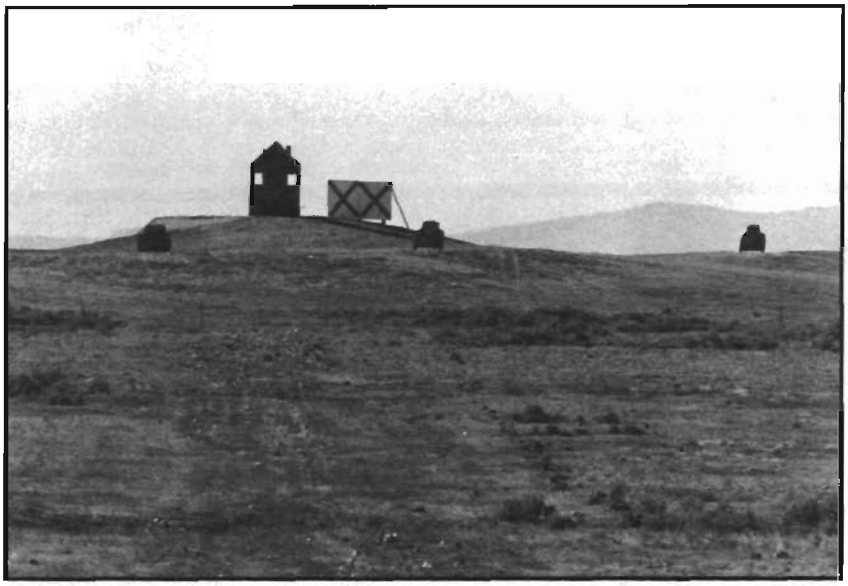
Author's Note: Blues platoons did not disappear in 1986, I was the platoon leader of the 1/9 Cav "Head Hunters" recon platoon until its inactivation in 1990. At first, I was observer/controller for the platoon when it received praise for its success at the NTC in 1989. Later, I led the platoon through training in both desert and forested environments. As an armor officer, I never expected to be clutching that M16, but, since I have, I am convinced that this asset is invaluable to DIVCAV squadrons.

Captain Brace E. Barber is a 1987 graduate of the United States Military Academy. A graduate of AOB, AOAC, Ranger and Airborne Schools, he served as a tank platoon leader and XO with 1/72 Armor, Camp Casey, Korea; scout platoon leader, reconnaissance platoon leader, and HHT XO with 1/9 Cavalry; and aide-de-camp for First Corps Chief of Staff, Ft. Lewis, Wash. He is currently the commander, B Troop, 5-12 Cavalry.

"THE RANGE FROM HELL"

The Multipurpose Range Complex at Orchard Training Center near Boise, Idaho

by Major James D. Brewer



Target reference points on the massive range keep tank commanders oriented.

Gone are the days when a sharp tank commander could G-2 the qualification range, memorize where the targets came up, and plan ahead for his hot run. Engaging targets at the multipurpose range complex (MPRC) built by the Idaho National Guard presents a fresh challenge to every crew, and offers a target array that is so varied, it's virtually impossible to memorize.

The largest range of its type in the world, construction began in November of 1988 and was completed in December of 1990. Covering some 5,200 acres, the Idaho facility offers nine manuever lanes, each averaging 2.3 miles in length; and a road network of 29 miles links all aspects of the available training ground. With armor fighting positions in each lane, including 68 hull-down firing points and multiple stabilization runs, the tank commander that fires a table on this range will have his skills stretched to the limit.

The wide-open spaces and long engagement distances make excellent tank country; and the heat inversion and gently rolling ground test a crew's ability to find the target.

"Target acquisition here is a challenge," says MSG Gary Petruska, operations NCO. "A real tank is a lot easier to see than a thermalized target. Sometimes the lava rock piles are actually hotter than the target."

More than once a crew has fired-up the mid-afternoon heat signature of a stand of high desert lava rock.

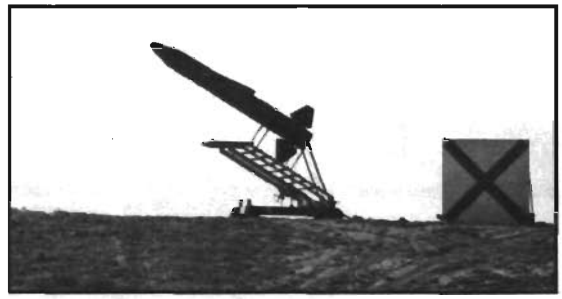
"After 2:00 a.m. it's great shooting," explains LTC Alan Gayhart, commander of the 2-116th Cavalry and full-time MPRC manager. "Things have cooled down by that time."

If terrain and visibility were not enough to distract the crew of a determined tank, the designers of the MPRC have 11 moving armor targets (some covering 1,000 meters), 60 stationary armor targets, 153 stationary infantry targets, and 45 moving infantry targets. All of these targets are both MILES and thermal equipped; thus the MPRC can evaluate individual, crew, section, platoon and company-team units up through Tank Table XII.

But for all the exotic target array, the capability that drives this range into the 21st century is the combination of video teaching aids and the Enhanced Remoted Target System (ERETS), a computerized program that allows the tower personnel to tailor the range to meet most gunnery tables. Daylight and thermal cameras mounted at the tower, linked with the MPRC's vehicle intercom monitoring radios, allow the range operator to observe and hear the tank crews actions on the range. This system provides not only information on the tank and target, but permits additional safety surveillance of the range. And when the crew completes the run and returns for an after-action review, the video record, plus tape recordings of the vehicle's radio transmissions, provide a solid record for analysis.

"I told the loader HEAT, a tank commander may say," explains LTC Gayhart, "but you play back the tape and it's right there. SABOT, the guy says, and there's no denying it."

But the trainers in Idaho are not satisfied with the status quo; they're on the cutting edge of technology that takes qualification ranges even further into the future. They have requested, through the National Guard Bureau, a GPS system that locates each vehicle on the firing range, providing an icon



The MPRC's target-rich environment includes moving infantry targets, left, moving tank targets, including some that travel 1,000 meters, and a SAM site, at right.

on a graphic display that shows both vehicle location and gun tube orientation for each tank on the range. When a tube violates the left or right limit of the range, or acquires another tank, the fire control system of the tank can be automatically shut down. This system goes further than the present one used by the National Training Center in that it is preemptory.

"To ensure maximum safety, we currently require a safety officer in a vehicle to trail the firing tank; however, dust and obscuration frequently inhibit his ability to see all actions by the tank. With our proposed system, we will be able to anticipate and prevent fratricide, rather than determine afterwards what happened."

The Army's MOLS (multiple objects locating system) was designed to fix these safety problems. However, this multimillion dollar system was never purchased and made available for use by multipurpose ranges, according to Gayhart.

"The system we want is being used in cities around the country for locating critical vehicles like police cars and ambulances. It's used around remote oil drilling sites, too."

The cost of this system? A small fraction of the cost of MOLS.

The MPRC is the jewel amid the sprawling 138,000-acre Orchard Training Center, where National Guard units nationwide conduct up to battalion-size force-on-force operations. Under the present system, units land at Gowen Field, some 26 miles north, then move by bus to the Orchard Training Area. Next they draw equipment, move to a support facility (mess, water, classrooms), upload at the Ammo Supply Point, then either (a) roadmarch to firing positions at the MPRC, or (b) conduct manuever training enroute to the firing positions. Upon arriving, units can choose from the list of training possibilities at Figure 1.

The range is presently being safety surveyed to support firing of the HELLFIRE missile. The inclusion of the Area Weapons Scoring System (AWSS) on the range presents the AH-64 crews with the same high scoring standards faced by the M1 crews. Six thousand meter shots for Apaches are just one more of LTC Gayhart's goals to make the MPRC an even greater challenge for soldiers.

Tank commander, if you think your crew is good, then this range will either prove it beyond any doubt, or it will humble you in a matter of moments. The first unit that fired this high desert training facility qualified only two out of 52 crews. The record is now 17 crews from a single battalion. That's why just one run down any of the nine lanes will convince you that the sign over the target maintenance shack is right. This truly is the "range from hell."

Training Possibilities at the MPRC

- •CALFEX (Combined Arms Live Fire)

Armor Units

- •Tank Gunnery Tables V-XII
- •Tasks Supporting Tank Tactical Tables C-I

Infantry Units

- •Company-Level Offensive & Defensive Operations

Aviation Units

- •AH-64 Commander's Gunnery Tables (day & night)
- •AH-64 Crew Gunnery Tables (day & night)
- •AH-64 Team Gunnery Tables
- •AH-64 CALFEX

Figure 1

"The Emperor's New Clothes"

(or "A Maneuver Commander's Guide to the Decision Support Template")

by Major John F. Antal and Lieutenant Colonel Lee R. Barnes Jr.

"A leader must meet battle situations with timely and unequivocal decisions."[1]

The children's story, the "Emperor's New Clothes," is an amusing tale about pride and ignorance. In the story, two tailors have failed to make the emperor a new robe on the scheduled fitting date. In desperation, they develop a scheme to cover up their mistake. After long and elaborate argument, the tailors convince the emperor that they have created a beautiful new robe that is made from completely new materials. The tailors insist that the material in the robe is so special that only the most intelligent and enlightened people could appreciate it.

At first, the emperor was suspicious. He explained the story of the new robe to his trusted advisors, as he stood before them dressed only in his underwear. The advisors, unwilling to admit to the emperor or to each other that they were not intelligent enough to see the new material, began to describe the robe in vivid detail. Others, wishing to demonstrate that they too were intelligent enough to see the new robe, stated that the robe was the most beautiful robe that they had ever seen. Not willing to seem ignorant, everyone the emperor met admitted to seeing the robe. Eventually a child tells the emperor the truth. The emperor suddenly realizes that there is no robe, and everyone learns a lesson in humility.

In many ways, this story is a fitting introduction to the topic of the Decision Support Template or DST. The DST has been a part of the U.S. Army's lexicon for several years. Like the emperor's clothes, most professional soldiers admit to the value of preparing and using a DST. But why do so few staffs understand how to produce one? Is the DST a tool of the S2, the S3, or the commander? Is the DST a process or a product? Is the DST the final step in the synchronization of the plan? If everyone understands how to use a DST, then why do so few units ever develop a DST for combat operations?

Our intent in this article is threefold: First to answer some questions we can't get answered from existing doctrinal literature. Second, to challenge some doctrinal answers that we feel are incorrect or don't apply at the battalion or brigade level. And third, to show how the DST can be a valuable decision-making tool. To accomplish this task, we will review the history of the DST, offer an improved definition of what a DST is, and provide an example product. Armed with this article, and some practice, it is the hope of the authors that DSTs will assist commanders to make battlefield decisions in a "timely and unequivocal manner."

The DST: An Evolving Concept

What is a DST? The current doctrine on the Decision Support Template is confusing. *FM 100-5, Operations* (1986), the Army's capstone manual for warfighting, does not mention the DST. *FM 101-5, Staff Organization and Operations* (1984), the Army's primary manual for staff planning and decision making, is also silent on the subject. *FM 101-5-1, Operational Terms and Symbols* (1985) does not list the DST as an operational term. It is only in more recent manuals, the ones produced in the late 1980s and early 1990s, that the DST concept appears. A chronological review of some of this literature reveals that the DST is an evolving concept.

FM 71-3, Armored and Mechanized Infantry Brigade (May 1988), mentions the DST in a section on the Intelligence Preparation of the Battlefield (IPB). This manual states that the "DST consolidates the steps in the (IPB) process. The S3 briefs the commander on the DST. The DST does not dictate decisions to the commander. It outlines friendly courses of action, relative to time and location, that the commander may execute."[2] A DST sketch is given as an example in FM 71-3. FM 71-3 goes on to say that the "DST focuses on critical areas and times needed to plan for and execute friendly force employment...at brigade, the intelligence estimate is likely to be in DST format."[3] This last sentence hints that the DST is a tool of execution and an orders product. Unfortunately, FM 71-3 does not mention the DST again anywhere else in the manual. No explanation is provided as to how to create the DST.

In September 1988, the Army published *FM 71-2, The Tank and Mechanized Infantry Battalion Task Force.* In this manual the DST is defined and a defensive sketch is provided as the DST product. FM 71-2 explains the DST as "the final template of IPB. It does not dictate decision to the commander, but rather identifies critical events and threat activities relative to time and location which may require tactical decisions. Critical events and threat activities are displayed on the decision support template using target areas of interest, decision points and time lines."[4] FM 71-2, however, does not explain the DST further. In Appendix B, Combat Orders, the FM 71-2 clearly leaves out the DST as an orders product. In addition, FM 71-2 emphasizes the Troop Leading Procedures (TLP) as the primary "task force command and control process."[5] In the TLP, the IPB process is mentioned in the "Estimate of the Situation" and "Analyze Courses of Action — War Game" steps. The DST then, according to FM 71-2, is a wargaming tool and not an orders product. Nowhere in FM 71-2 does it state that a commander uses his DST to fight the battle.[6]

FM 34-130, Intelligence Preparation of the Battlefield (May 1989), is the primary reference for the IPB process. The DST is listed 22 times in FM 34-130. This manual includes a definition, a sequence to develop the DST, and depicts various types of DSTs (air, enemy counterattack, enemy defense, enemy withdrawal, friendly, friendly attack, and rear operations). FM 34-130 establishes the DST as a staff product that is produced after wargaming the most probable course of action. "The staff then develops decision support templates (DSTs) for the most likely enemy course of action and probable branches and sequels. The staff then briefs the commander on the DST."[7] The commander then wargames the DST to make sure that it covers all potential enemy courses of action (COAs) and integrates his intent. "The commander then updates the PIRs (Priority Intelligence Requirements), based on the DST, and issues a decision and concept of the operation."[8] FM 34-130 depicts these actions in a diagram that integrates the IPB process with the "Commander's Decisionmaking Process." FM 34-130 clearly shows the DST in the decision-making process and establishes the DST as a product that is issued to subordinate leaders as a part of the final order. It describes the threat integration process as having three steps: develop situation templates, develop event template and matrix, and develop decision support template. FM 34-130 states that the DST, in final form, is a "combined intelligence estimate and operations estimate in graphic form."[9] In addition, the manual states that several DSTs will be needed for each operation.

In July 1989, Fort Leavenworth produced *ST 100-9, The Command Estimate.* Although a student text (ST) does not carry the weight of an Army field manual, this text did describe the DST in a section concerning the IPB process:

"The decision support template relates the details of event templates to decision points that are of significance to the commander.... The decision support template provides a structured basis for using experience and judgment to reduce battlefield uncertainties.... Decision support templating identifies those areas where enemy or terrain targets can be attacked to support the commander's concept for fighting close and deep operations. It also relates projected battlefield events and targets that will require the commander's decision."[10]

ST 100-9 (1989) provides a diagram of a DST for an offensive operation. In addition, ST 100-9 states that a DST:

"depicts the TAIs (Target Area of Interest) and decision points. To save time, the decision support template can be combined with the situation template and event template... The decision support template will highlight the commander's opportunities and options and ensure timely and accurate decisions, thus providing the means to influence enemy actions rather than just reacting to them... The template is not the battle map. It does not represent locations of enemy units that are confirmed by intelligence; rather, it is the best guess of a G2 officer."[11]

A diagram of the IPB process and the command estimate (which includes the DST for the first time) is shown in ST 100-9 (1989). In July 1991, Fort Leavenworth printed a new version of ST 100-9 with a new title, *Techniques and Procedures for Tactical Decisionmaking.* The explanation of the DST in this new student text is a reprint from the 1989 pamphlet.

In March 1990, *FM 34-3, Intelligence Analysis,* was published. This manual explained that the IPB "supports the use of fire and maneuver to achieve a tactical advantage. Event templating facilitates following enemy forces and determining their probable course of action. Decision support templates (DSTs) enable the commander to apply combat power in a timely manner."[12] FM 34-3 prescribes that the DST is prepared during the threat integration phase of the IPB process as a shared S2/S3 product. The purpose of the DST is to assist a commander "as to when tactical decisions are required relative to battlefield events."[13] According to FM 34-3, a properly prepared DST portrays the enemy's most likely course of action and possible target areas of interest, along with time phase lines (TPLs) and decision points which relate to fire, maneuver, and combat service support (CSS). This manual also states that a "decision support matrix supplements the DST."[14] A sketch of an offensive DST is given as an example in FM 34-3.

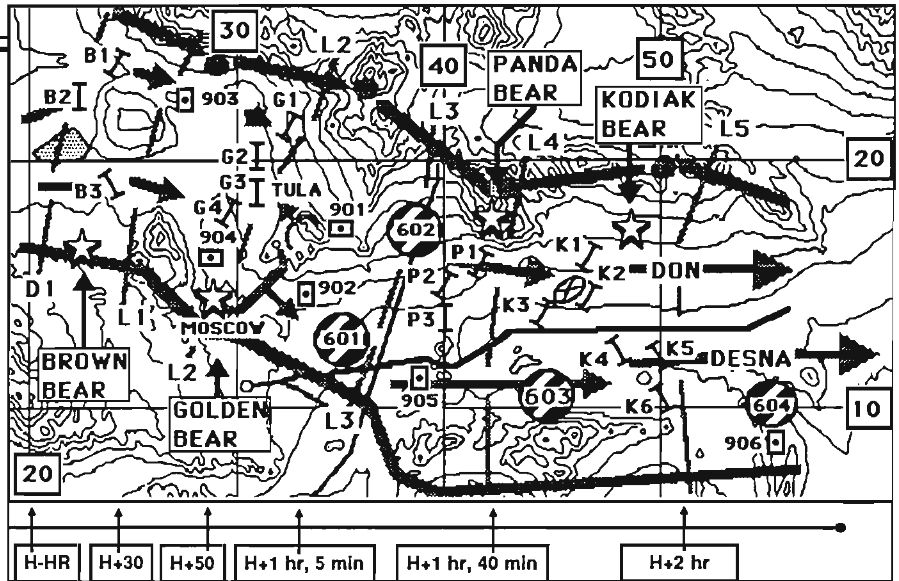
In June 1990, *FM 71-100, Division Operations,* was published. This manual made only one reference to the DST. The DST is described as a "melding of the enemy situation and event template information with the friendly course of action sketch or operations overlay of the final approved OPLAN or OPORD."[15] FM 71-100 establishes that the DST is a master execution matrix. The DST is started during the war game phase of the planning process and is expanded once a specific course of action is selected by the commander.

"The DST is, essentially, a master execution matrix. It correlates the enemy operational timetable and the friendly operational timetable while identifying decision points (DPs) for commitment of friendly combat power, target areas of interest (TAI) where the combat power must be applied, time phase lines (TPLs) to assist the

decision maker in synchronizing the combat power which is available and the named area of interest."[16]

FM 34-2-1, Reconnaissance and Surveillance (Final Draft, November 1990), established the DST as the final IPB product of the combined staff effort. Although a "Final Draft" is not approved doctrine, it does show the direction that the DST concept is heading from the Intelligence School's perspective. FM 34-2-1 states that the DST is a product of wargaming. The purpose of the DST is "to synchronize all battlefield operating systems (BOS) to your commander's best advantage. The DST consists of target areas of interest (TAI)s, decision points or lines, TPLs, and a synchronization matrix."[17] This manual depicts a diagram of a DST, with decision lines that relate directly to the matrix below the sketch. This manual also includes a diagram of a slightly different commander's decision-making process (supported by IPB) than FM 34-130.

FM 71-123, Tactics and Techniques for Combined Arms Heavy Forces: Armored Brigade, Battalion/Task Force, and Company Team (Final Draft, June 1991), adds little to our knowledge of "how to" develop and use the DST. The discussion in this manual on IPB/DST is simply a repeat of what is said in other manuals. FM 71-123 fails to carry the tactical discussion of the DST from brigade to battalion level.



Decision Point	Criteria	Action	Fires
BROWN BEAR	Enemy west of L3, moving west, passes blocked OPFOR west of D1	3 MRB - Moscow, Angel-Tula 1 MRB - B1, 2 MRB - B2 4 MRB - B3. 7 MRB - B1	903 or 904
GOLDEN BEAR	Enemy east of L3, moving west, passes clear, OPFOR east of L1	3 MRB - Moscow, Angel-Tula 1 MRB - G1, 2 MRB - G2 4 MRB - G3. 7 MRB - G4	901 601 or 902 602
PANDA BEAR	Enemy east of L4, moving west, passes clear, OPFOR east of L2	3 MRB - Moscow, Angel-Tula 1 MRB - P1, 2 MRB - P2 4 MRB - P3. 7 MRB - P3	905 603
KODIAK BEAR	Enemy east of L5, moving west, passes clear, OPFOR east of L3	3 MRB - P1, Angel - P1 1 MRB - K1/4 2 MRB - K2/5 4 MRB - K3/6 7 MRB - K3	906 604

Figure 1. Example of an OPFOR Sketch with Matrix DST.

A DST for Maneuver Commanders

Doctrinal literature is not consistent concerning the DST. It does not adequately define or describe the use or development of the DST. To be effective at the battalion level, the DST must assist the commander to execute combat decisions during the battle. In other words, the purpose of a DST is to promote agility.

FM 100-5, Operations, emphasizes agility and operational flexibility as the key to successful tactical operations. Tactical commanders are expected to be able to produce plans that "enable the commander to shift his main effort quickly without losing synchronization... To achieve this requires anticipation, mastery of time-space relationships, and a complete understanding of the ways in which friendly and enemy capabilities interact."[18] To accomplish this, we must first develop a useful definition of a DST. Our definition is a synthesis of current doctrinal literature.

The decision support template is a master intelligence and operations execution product (overlay, sketch, matrix, or combination sketch with matrix, or overlay with matrix) used by the commander and his staff to assist in the execution of the battle. The DST is a product of the initial war game of the commander's chosen course of action and is refined continuously until execution. The DST lists all critical decisions, targets and time-distance factors that will assist the commander in making accurate and timely battlefield decisions. In its final product is a master execution matrix tied to the commander's battle map.

As described above, the DST can be presented in several forms. At the battalion/task force level, the most useful form appears to be an overlay DST, or an overlay with execution matrix DST. This format should include all critical decisions, targets, and time-distance factors that will assist the commander in making accurate and timely battlefield decisions. This product is produced as a combined staff effort under the direction of the operations officer. Another useful format for a DST is a sketch with matrix.

This DST product reduces the complex operation to a simple concept. The OPFOR regiment at the National Training Center (NTC) has used an improved version of a DST to assist the regimental commander in making battlefield decisions. This version has been validated in the field in several rotations at the NTC. An example of an OPFOR sketch with matrix DST is shown at Figure 1.[19]

The DST is the commander's tool to execute fire, maneuver and combat support options during the battle. Decision points or decision lines are used to assist the commander to fire targets and execute branch plans. Decisions are based upon enemy actions. Decision points or lines also assist the commander to move along a new direction of attack based upon enemy weakness, or exploit an enemy mistake. Decision points, targets and time-space factors are calculated directly on the commander's battle map or depicted on a sketch.

DSTs are really nothing new. A rudimentary example of a DST is provided by an ordinary company/team fire plan. An effective company fire plan orients on several possible enemy avenues of approach. The company commander designates target reference points (TRPs) to help him mass his fires at the critical point. The commander decides where to direct his fires based on the enemy's actions. Primary and alternate positions are focused on the most likely enemy avenue of approach. Supplemental positions allow the company/team commander to maneuver fires in other directions (i.e. a branch plan). A DST at the battalion/task force level follows the same theme, but involves many more pieces.

The DST and Branch Plans

AirLand Battle requires a flexible and intelligent orders process that is oriented on the enemy and recognizes the critical value of time. *FM 100-5, Operations* states the challenge aptly: "Our tactical planning must be precise enough to preserve synchronization throughout the battle... it must be flexible enough to respond to changes or to capitalize on fleeting opportunities."[20]

Some maneuver commanders see no need for a DST because they often plan to execute a battle according to a rigid, yet synchronized plan. These set-piece battles usually contain only one detailed course of action. Subordinate units are expected to execute the plan. This type of operation can work if the enemy cooperates with the assumptions that were developed when the single course of action plan was devised. If a plan is inflexible, and does not include branches, there are few decisions for the commander to make after the battle has started.

But what if the enemy doesn't cooperate? What if the enemy isn't where you expected him when you issued the order twelve hours before crossing the line of departure? The key to agility is to develop plans that can be executed once the enemy situation becomes clearer. This situation usually occurs closer to battle-time or during the battle. To achieve the flexible thinking and fast reaction prescribed in FM 100-5, commanders must develop plans that are oriented on the enemy in an action and reaction thought process. This thought process demands that each plan have several branches. Branch plans provide for tactical agility and can compensate for any disadvantage associated with the chosen course of action. They can assist the commander to act decisively to exploit enemy weaknesses as those weaknesses are discovered on the battlefield. A DST can play a critical role in the execution of tactical agility by acting as a master execution matrix for the implementation of branch plans.

Branch plans are also central to effective deception planning. Deception operations exploit enemy actions by manipulating multiple friendly courses of action. Deception does not always require a separate feint or ruse to deceive. Multiple friendly courses of action become deceptions in themselves. By presenting the enemy with a pattern that depicts a strong attack in one direction the enemy may respond by moving forces to protect against your attack. If the enemy doesn't respond, continue with your planned attack. If he does, quickly execute a branch plan. This kind of agility, that attacks the enemy's newly created weakness, may often be enough to smash through his defenses before he can issue further orders.

The branch plans are driven by reconnaissance and appear on the DST as on-order plans. The commander's priority intelligence requirements (PIR) are focused on the critical information needed to make decisions about which branch plan(s) to execute.

Conclusion

Current literature on DSTs is confusing and contradictory. **The decision support template is a master intelligence and operations execution product (overlay, sketch, matrix, or combination sketch with matrix, or overlay with matrix) used by the commander and his staff to assist them in the execution of the battle.** The DST is a product of the initial war game of the commander's chosen course of action and is refined continuously until execution. The DST lists all critical decisions, targets and time-distance factors that will assist the commander in making accurate and timely battlefield decisions. **In its final form, it is the commander's battle map.**

Commanders must master time and space factors to fight effectively on the modern battlefield. A DST is one technique that helps the commander simplify time-space data. To make correct battlefield decisions in time, you must first plan the decisions that you know that you will have to make. Next you can plan decisions for possible branches and contingencies. All of these decisions involve a precise understanding of what can be done in a specified time. The DST reduces these time and space calculations to efficient battlefield information. In addition, the DST focuses the commander and his staff on the enemy. The DST, therefore, is a tool that assists the commander to think and act faster. This ability helps to synchronize combat power and allows the commander to quickly take decisive advantage of enemy mistakes as they unfold. Commanders and staffs trained to develop DSTs in a systemic fashion can increase their ability to execute tactical plans in minimum time. This makes the DST a critical enabler for AirLand Battle doctrine. It is now time for the decision support template to become part of every maneuver commander's tactical tool box. It is time that we see that the emperor's new robe, like the confused concept of the DST as related in current doctrine, is useful only if we weave some fabric into the design!

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Lieutenant Colonel Lee R. Barnes Jr., an Armor officer, is currently Bronco 07, the senior brigade staff trainer, with the Operations Group of the National Training Center (NTC). He is a 1972 graduate of the U.S. Military Academy. A 1984 graduate of the Command and General Staff College, where he earned a Masters Degree in Military Science, he has served as a tank platoon leader, a scout platoon leader, a battalion S1, and battalion S4. He commanded E Troop, 1-10 Cavalry and served in the U.S. Army Readiness Group, Fort Douglas, Utah. From 1985 to 1987 he was a lead writer in revising the final draft of FM 71-2 The Tank and Mechanized Infantry Battalion Task Force. In 1987, he served as the executive officer of 2-69 Armor and then as brigade S3, 197th Infantry Brigade. In 1990, he commanded 1-63 Armor (OPFOR) at the NTC.

Notes

[1]Captain C.T. Lanham, *Infantry in Battle*, Garrett and Masse, Richmond, 1939), p. 152.

[2]Headquarters, Department of the Army, *Field Manual 71-3, Armored and Mechanized Infantry Brigade*, Washington D.C., 11 May 1988, p. 2-10.

[3]*Ibid.*, pp. 2-10 thru 2-13.

[4]Headquarters, Department of the Army, *Field Manual 71-2, The Tank and Mechanized Infantry Battalion Task Force*, Washington D.C., 27 September 1988, pp. 2-27 thru 2-28.

[5]*Ibid.*, p. 2-14.

[6]Author's Notes: LTC Lee Barnes was a lead writer for FM 71-2 as it developed from a coordinating draft manual into a final draft manual (1986-1987). The Intelligence Preparation of the Battlefield (IPB) portion of Chapter 2 was revised several times to accommodate the evolving concepts of IPB and DST. The comments from the Intelligence Center and School at that time clearly indicated that IPB was an informal process at levels below division. The DST was viewed simply as the summing up of the previous templates — a collection of the S2 officer's assumptions, predictions and facts. The DST was considered a briefing aid for the S2 to use during the decision-making process. It was not considered an orders product to use during mission execution.

[7]Headquarters, Department of the Army, *Field Manual 34-130, Intelligence Preparation of the Battlefield*, Washington D.C., 23 May 1988, p. 3-1.

[8]*Ibid.*

[9]*Ibid.*, p. 4-66.

[10]Command and General Staff College, *Student Text 100-9, The Command Estimate*, Fort Leavenworth, July 1989, p. 7-34.

[11]Command and General Staff College, *Student Text 100-9, Techniques and Procedures for Tactical Decisionmaking*, Fort Leavenworth, July 1991, p. 7-29.

[12]Headquarters, Department of the Army, *Field Manual 34-3 Intelligence Analysis*, Washington D.C. , March 1990, p. 4-1.

[13]*Ibid.*, p. 4-6.

[14]*Ibid.*, p. 4-32.

[15]Headquarters, Department of the Army, *Field Manual 71-100, Division Operations*, Washington D.C., 16 June 1990, p. 3-17.

[16]*Ibid.*

[17]Headquarters, Department of the Army, *Field Manual 34-2-1 Reconnaissance and Surveillance* (Final Draft, November 1990), p. 2-31.

[18]Headquarters, Department of the Army, *Field Manual 100-5, Operations*, Washington D.C., 11 May 1988), p. 133.

[19]Author's Note: This DST was used by the Opposing Forces (OPFOR) regiment in a meeting engagement at the National Training Center. The battle, which occurred in the late winter of 1992, has since become known as the "Battle of Golden Bear." The DST used in this battle helped to make the action one of the most successful meeting engagements in OPFOR history.

The DST listed four separate plans. The first plan, Brown Bear, was designed to fight the battle if the OPFOR engaged the Blue Forces near CRASH HILL. This plan envisaged the BROWN AND DEBNAM passes under Blue Force control. The forward detachment was ordered to seize Objective MOSCOW in the

DEBNAM PASS. In this case, the regiment was prepared to attack through the forward detachment if the motorized rifle battalion that composed the Forward Detachment (FD) enjoyed success. If the FD was stopped cold, then the regiment would shift to defend east of CRASH HILL.

This plan had seemed unlikely, but was well within the capability of a determined Blue Force unit.

Golden Bear, the second plan, was the variant to use if the passes could be seized by the regiment before the arrival of the Blue Force. This was the best case. The forward detachment would seize Objective MOSCOW and the regiment's air assault force would seize Objective TULA. The forward detachment and the air assault forces were expected to hold their positions until the main body of the regiment arrived to back them up. Golden Bear used the key terrain in the regiment's zone to decisively defeat the Blue Force.

Panda Bear was the plan to fight at HILL 876, if the Blue Force went to ground early. No one wished this variant because it was, basically, a reverse of Golden Bear. The difference was that now the Blue Force would be stationary, in hasty defensive positions and the OPFOR would be attacking across open ground. In this case, the regiment planned to attack along the north wall of the central corridor, along Axis DON, bypassing the defenses at 876 and moving into the tactical depths of the enemy's defenses.

Kodiak Bear was the plan to fight the enemy near HILL 760. This plan seemed very unlikely, but had to be considered in case the Blue Force kicked off their attack late or developed a problem with their maneuver. Kodiak Bear was merely a repeat of Panda Bear, with the regiment attacking in the north, along Axis DON, and striking deep to the east.

In addition, the regimental staff had planned for an alternate attack axis, Axis DESNA, just in case the Blue Force decided to totally neglect the high speed approaches in the southern portion of the Central Corridor. This option also appeared unlikely. The OPFOR's planning, however, had been thorough and included this branch plan just in case.

[20] *FM 100-5*, p. 15.

Army Plans New Smoke Vehicle

The Army is investigating conversion of M901 Improved TOW Vehicles to smoke generator vehicles that will replace the M1059s now in the inventory. Like the M1059, the new Large Area Mobile Protected Smoke System (LAMPSS) would be built on the M113-style chassis, but the smoke generating equipment would be far more advanced than the 1940s-era technology on the M1059.

Instead of the TOW-launching "hammerhead" on the M901, the new vehicle would have a launcher for smoke rockets capable of projecting a smoke screen out to a distance of six kilometers.

In addition, the smoke generator on the vehicle would be capable of tailoring its smoke to specific screening purposes; for example, the defeat of infrared sighting equipment, night-vision aids, thermal viewers, or image intensifiers. It would do this by injecting carbon-based particles with the oil that is burned to create the "fog." One smoke variant would be able to mask troops and vehicles from the millimeter-wave seekers on the newest generation of guided weapons.

Other changes to the ITV would include a land navigation and turret positioning system, improved engine and transmission to increase horsepower from 212 to 300, and better accommodations for the crew of three, to include a driver, track commander, and smoke-generator operator.

The vehicle would be able to generate smoke for about an hour before requiring refueling.

Not a prototype, but a technology demonstrator of a system that will both generate and project smoke from a tracked carrier, the LAMPSS carrier has been exhibited at the Armor Conference, 11th Worldwide Chemical Conference, and at Aberdeen Proving Ground's Armed Forces Day show. It was fabricated in only 45 days at Red River Army Depot, Texas.

Small Unit Terrain Board Exercises

by Sergeant First Class John M. Duezabou

A terrain board and micro-armor models are effective tools for tactical training. While useful for teaching individual soldier tasks, like drawing sketch cards or platoon fire plans, their best use is training collective tasks.

Many leaders use terrain boards to train simple collective tasks like battle drills, but you can also run detailed platoon and company exercises. The trick is realism. Improper vehicle movement and unrealistic engagement results don't prepare soldiers for war. To have the most training value, terrain board simulation must closely resemble the battlefield. This article shows how to get started with terrain boards and increase the training value of small unit terrain board exercises.

Terrain Board Gaming Rules

Wargaming rules for micro-armor (see Figure 1) simulate modern combat on terrain boards. Rules govern movement, observation, weapons engagement, and other factors. You can find them at fantasy and historical gaming supply shops, and one is a Training Support Center (TSC) item. Mail order sources include Modelers Mart, 1183 Cedar St., Safety Harbor, FL 34695; and Merlyn's, North 1 Browne, Spokane, WA 99201.

Realism of rules affects their training value. Each game or rule book gives data on vehicle speeds, accuracy and penetrating power of weapons, and strength of armor. While game designers try for accuracy, much of their data is guesswork. You may want to vary performance data, based on your own knowledge. Either way, tell your soldiers that game performance data are only guesses. Don't bet your life some day on the way a Spandrel missile performed on a terrain board!

Selecting Scale

To set up a terrain board, first select a scale. Our scale is based on the sizes of micro-armor models available. The smallest models are 1/285 and 1/300 of actual size, which makes an M1 Abrams hull about an inch long. We chose the smaller, cheaper, and less detailed 1/300 models. They sell for about $4.00 per pack of four or five, versus about $5.50 per pack for 1/285 scale. One firm now offers packs of twenty 1/285 vehicles at lower costs per unit.

You can get models from the same sources as gaming rules, plus some hobby shops. Manufacturers include GHQ and Skytrex. You may be able to buy models for your unit through official channels. Another option, if you're just getting started, is to use small cardboard markers instead of models. These come preprinted, as in the *Team Yankee* game, or can be made locally.

We chose the terrain scale used in *Dunn Kempf*, where an inch on the board equals 50 meters on the battlefield. Any smaller scale has little training value for platoons, because you can't use separate models to represent each vehicle in the platoon. Using the 1 inch=50M scale, a 1/300 model tank is about seven times too big for the terrain, but each model can represent one actual vehicle.

At 1 inch=50M, four by eight feet is the smallest terrain board size for training a platoon. A smaller board restricts both maneuver and long range fire. A bigger board is definitely better: our battalion uses a multisection rigid terrain board of the live fire range at Fort Irwin that is over 200 square feet. On it, we can fight a U.S. task force against an OPFOR regiment! A problem with any terrain board wider than six feet, though, is that it's very tough to reach vehicle models placed in the middle of the board.

SOME GAMES AND RULE BOOKS SIMULATING MODERN COMBAT

Close and Destroy (Rule Book) by H.N. Voss. 1986. TimeLine Ltd., P.O. Box 60, Ypsilanti, MI 48197. About $10. Good compromise between detail and playability. Best overall.

Combat Commander and Battlefield Command (Rule Books) by Ken Smigelski. 1978 & 1980. Enola Games, P.O. Box 1900, Brooklyn, NY 11201. About $10 each. Highly detailed. Most current weapons effects data. Playability suffers due to precise detail.

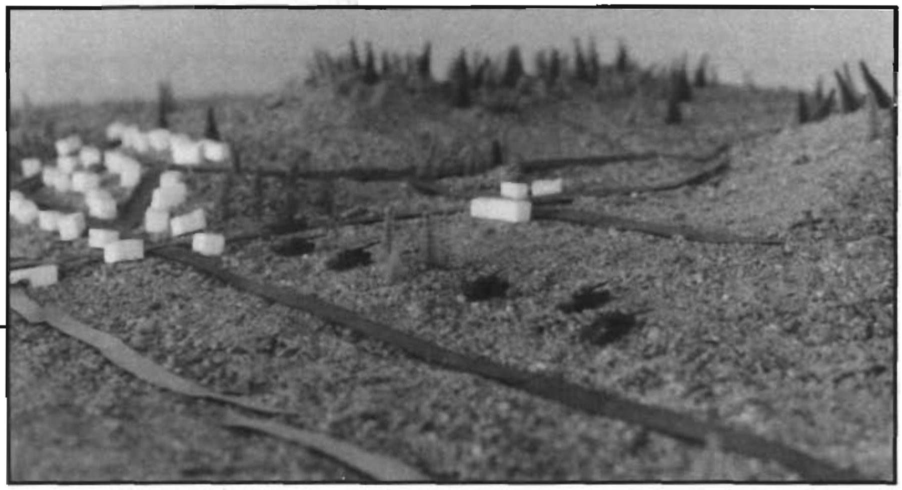
Combined Arms (Rule Book) by Frank Chadwick. 1988. Game Designers Workshop, P.O. Box 1646, Bloomington, IL 61702. About $12. Emphasizes brigade-level decision making. Not suitable for company or platoon training.

Dunn Kempf (Game). DVC-T 17-98. 1975. TSC item. Includes complete rules, rigid terrain board, and vehicle models. Does not simulate vehicles newer than M60A1 and T-62.

Team Yankee (Game) by Mark Miller & Frank Chadwick. 1987. Game Designers Workshop. About $24. Based on novel by Harold Coyle. Includes rules, flat game board, and playing pieces. Compact board allows table top use, but limits value as platoon training tool. Simple rules. A good starting point.

Total Conflict (Rule Book) by Gary Blum. 1984. Z & M Publishing, Inc., 2425 N. 47th St., Milwaukee, WI 53210. About $6. Simplified rules. Highly playable, but lacks detail. Each vehicle model represents a platoon.

Figure 1



Black and brown construction paper strips simulate roads and trails. Blue ones (foreground) are streams. White foam blocks represent buildings and chenille bumps (fancy pipe cleaners) are trees.

You can use the same terrain scale as vehicle scale, but beware: with terrain 1/300 actual size, an M1 tank can move about 13 feet in a minute and has an effective range of about 30 feet! You need a gym floor or an outdoor site to use this scale.

Building Terrain

Once you select scale, your next step is building terrain. You can start with something as simple as a large painted sheet of paper. We use a sand table, which lets us vary our terrain and place vehicles among the trees or "dig in" anywhere. Weight is a problem with sand tables: our five by twelve foot table weighs 900 pounds. To make it movable, we built it on a cart with heavy duty wheels.

Another terrain option is a rigid board with built-on features. TSCs build these, or you can build one yourself. A nice one comes with *Dunn Kempf*. These boards are usually portable unless highly detailed. An advantage of a rigid board is that you can make it wider and move vehicles by pushing them with sticks. This doesn't work on a sand table — the metal models rapidly sink out of sight. A disadvantage of a rigid board is that you're stuck with the same piece of terrain all the time, unless you build your board in small sections that can be rearranged. Another problem of rigid boards is that, if forests are cast as part of the board, as with *Dunn Kempf*, you can't actually place vehicle models among the trees, but must set them on top.

A third possibility is to build individual terrain features and place them on a flat surface. While this looks less realistic, it combines nearly infinite variety, with portability, and is the cheapest option. Sheet styrofoam is a good building material, or you can buy commercially made terrain.

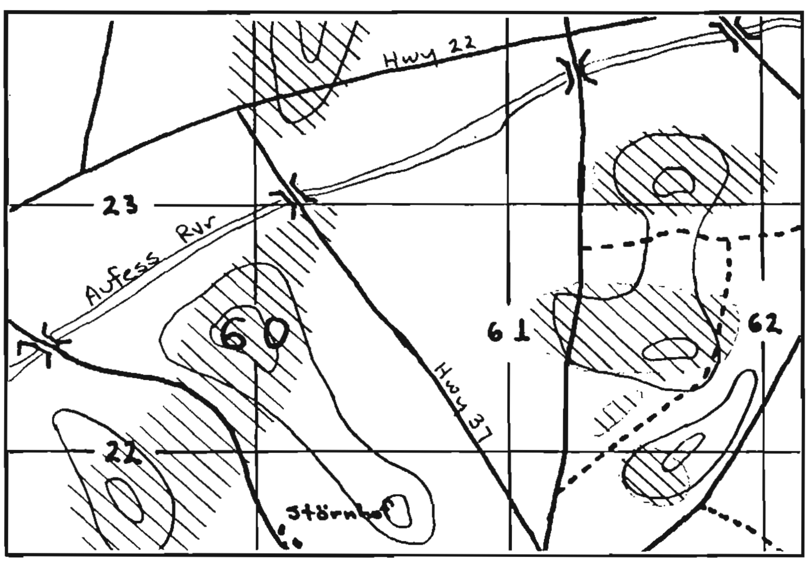


Figure 2. An adequate terrain board map. Crosshatched areas are trees and would be marked by green highlighter on a color map.

You can make your terrain more realistic with miniature buildings, roads, and trees. We use styrofoam blocks for buildings and colored paper strips for roads and streams. We make miniature trees from a craft material called "chenille bumps," a type of colored pipe cleaner (see photo above).

Whichever option you choose, you need maps that match your terrain. If used properly, they help soldiers learn map terrain association. From personal experience, it's much easier to make a map from existing terrain than to sculpt terrain to match an existing map. Your maps don't have to be highly detailed, but should include major elevation changes, plus all wooded areas, bodies of water, roads, and towns (see Figure 2). Draw maps to standard scale and include grid lines, but don't put grid lines on your terrain board! Make your soldiers work to learn map terrain association. As a training exercise, have soldiers make a map to match a terrain board, or build terrain to match a map. There is no better indoor exercise in map terrain association.

Simulating Combat Information

A big problem with wargaming rules is that soldiers get information they don't get in combat. For example, when you fire at a target with

POSSIBLE OUTCOMES OF DIRECT AND INDIRECT FIRE ENGAGEMENTS

EXPLODED/BURNING. Obvious kill. Either the entire target or its turret must be turned upside down. The target is out of the play.

NON-OBVIOUS KILL. Target is either knocked out or crew is dead. The target must stop in place. Do not turn target over. It may not move, shoot, or communicate.

IMMOBILIZED. Track, wheel or drive train damaged. The target must stop in place. It can't move until repaired. It may, at player's option, shoot or communicate.

RADIO OUT. Antenna blown off or radio damaged. The target may move and shoot at player's option, but may not communicate. (Used in indirect fire only. May be combined with IMMOBILIZED.)

NO EFFECT. Round hit, but either ricocheted or did not penetrate armor. Target may still move, shoot, communicate or "play possum" at player's option.

MISS. Round did not hit target.

Figure 3

wargaming rules, you're told if you hit the target, where the round struck and the exact effect it had: a kill, an immobilized target, or no effect. We changed our rules so that when you shoot, you're only told whether you hit or missed. The soldier controlling the target learns the effect of the round, which limits the target's actions (see Figure 3). You must decide what to do based on what the target does, just as in combat.

Another example of "too much information" involves seeing the battlefield. The "birds-eye view" soldiers get on a terrain board lets them see terrain and enemy units they couldn't see in combat. Telling a soldier to ignore what he can see and fight as if he can't see it doesn't work very well. The *Dunn Kempf* solution of limiting visibility to low angles with screens over the board is also impractical, especially when many soldiers are involved.

We've come up with another way to limit battlefield visibility. First, we concentrate on realism from the Blue Force side. To achieve it, we cover terrain that can't be seen from Blue Force positions with tarps. We uncover terrain as Blue Force units move and areas "come into sight." We put all Blue Force units on the board, then make the OPFOR ignore Blue Force units that can't be seen from OPFOR positions (you must strictly enforce this, or the exercise loses credibility). We don't put OPFOR units on the board until they would be visible to Blue Force units. This includes OPFOR units hidden in otherwise visible terrain. If OPFOR units on the board move to concealment, we remove them from the board. We track their movements on maps available to OPFOR and umpires only.

Improving Playability

For good training, you must balance realism with "playability." A set of rules that moves too slowly has little training value. Using one set of rules, we took four hours to simulate 14 minutes of combat! But rules that allow fast play without realistic results don't train soldiers for war either. Fortunately, you can modify detailed rules to speed up play without sacrificing too much realism. The big changes come in hit probability and engagement resolution.

SAMPLE CALCULATION FOR COMBINING PROBABILITIES

Let's assume the rules say that the probability of a hit (Ph) is 75 percent. They further say that 40 percent of the hits will strike the hull (Phh), 30 percent will hit the turret (Pht) and 30 percent will hit the track (Phk). Of those that hit the turret, 70 percent will not ricochet (Ptr). Of those that hit the hull, 80 percent will not ricochet (Phr). No track hits will ricochet.

Based on our own judgment, we'll assume the following about shots that don't ricochet: All track hits immobilize the target; 80 percent of turret and hull hits penetrate and kill (Ppen), but only 40 percent of kill shots cause obvious explosions (Pex).

We determine the probability of our five direct fire outcomes as follows:

The probability of a **miss** is everything but the probability of a hit (Ph) or:

1.00 - Ph = 1.00 - .75 = .25 or 25 percent.

The probability of an **immobilized target** (Pi) is:

Ph x Phk = .75 x .30 = .225 or about 23 percent

The probability of any kill, either exploding or non-obvious (Pk) is:

Ph x [(Pht x Ptr) + (Phh x Phr)] x Ppen =

.75 x [(.30 x .70) + (.40 x .80)] x .80 =

.75 x [.21 + .32] x .80 =

.75 x .53 x .80 = .318 or about 32 percent

The probability of an **exploding target** (Pext) is:

Pk x Pex = .318 x .4 = .1272 or about 13 percent

The probability of a **non-obvious kill** (Pno) is:

Pk - Pext = .318 - .127 = .191 or about 19 percent

The probability of a hit with no effect (includes ricochets and hits that don't penetrate) is whatever chance of hit is left over after the immobilized targets and kills are removed, or:

Ph - (Pi + Pk) =

.75 - (.23 + .32) =

.75 - .55 = .20 or 20 percent

Figure 4

Most rules figure hit probability (HP) using effective target size (which includes movement), target range, and weapon/ammo accuracy. Based on the number of effective target sizes and range increments, rules may have over 50 different HPs for one weapon/ammo/target combination! We reduced the number of HPs down to six if we could ignore target movement, or 12 if we couldn't.

First, we lowered the number of effective target sizes. Many rules have HPs based on a stationary and a moving variation for exposed flank, exposed front and hull-down targets. We averaged flank and front sizes and reduced the number of effective target sizes to "exposed" and "hull down" without sacrificing realism. For a firing M1, we eliminated the moving target factor based on the tank's excellent fire control system. For most weapons, we left in the moving target factor. This gave us either two or four effective target sizes, depending on the weapon.

Next, we reduced the number of range increments. In most rules, range is measured for each engagement to the nearest 100 or 500 meters, depending on the weapon. Each range increment changes HP. We lowered the number of range increments to three: short, medium, and long. The ranges for an increment vary between weapons, and can be estimated instead of measured.

USE A RANDOM NUMBER TABLE TO RESOLVE ENGAGEMENTS

10851	07246	75379	45204	25241	92286
26842	09354	88159	33824	89837	08721
54387	79953	47774	34484	02040	47954
36858	27686	68514	29148	77214	08015
50950	64969	58401	98083	27732	68607
64778	47048	65692	82406	76850	36147
70715	09303	74296	13586	34673	24805
23209	38311	64032	68665	36697	35300
90553	35808	22109	50725	36766	13746
91826	58047	45318	43236	36936	46427

Sample section of a computer-generated random number table.

If we use the outcome probabilities from Figure 4, put them in a logical order and assign them appropriate numbers from 1 to 100, we come up with the table below for one weapon/ammo/target/range. This is called an outcome probability table.

Outcome	Probability	Assigned Numbers (of 100)
Explosion	13%	1 to 13
Non-obvious kill	19%	14 to 32 (next 19 numbers)
Immobilized	23%	33 to 55 (next 23 numbers)
Hit with no effect	20%	56 to 75 (next 20 numbers)
Miss	25%	76 to 100 (last 25 numbers)

The first step to use the random number table is to pick an arbitrary starting point. Then pick an order in which you will use the numbers. For this example, let's pick the eighth number down in the fifth column from the right as our starting point (36697). For an order of use, let's go across the row to the right and, when we reach the end of the row, let's drop down to the next row and go to the left. (You should pick a different start point and order of use for each weapon.)

To use the table, look at the last two digits of the number at the starting point (97). Find the group of numbers it fits into on the outcome probability table. It fits into the "Miss" group of 76 to 100. Thus the outcome of the first engagement for this combination of weapon/ammo/target/range is a miss. Now go to the next number to the right to find the result of the next shot. The last two digits are 00. This translates as "100" and is also a miss. To find the result of the third shot, drop down to the next row. That number is 46, which is an immobilized target.

Figure 5

Engagement Resolution

Next we simplified engagement resolution, which gives the outcome of each shot. Once you have HP, all rules have you roll dice to see if the shot hit. If it hit, you roll again to find where on the target it struck, based on another set of probabilities. Then you roll again to see if it ricocheted. Then you compare penetrating power of the round to armor strength at point of impact to get the effect of the shot on the target. It sounds complicated, and it is!

Our change requires only one dice roll, since we came up with one combined probability for each of the five possible outcomes of direct fire. The math takes awhile, but you only do it once for each weapon/ammo/target/range combination. Figure 4 shows a sample calculation. If you don't want to bother with the math, you can simply make a "best guess" of the probability of each outcome. Maybe your guess will be better than the game designer's probabilities anyway!

To further speed play, we use a random number table instead of dice. It's like having a list of dice rolls. You can find these tables at any library in textbooks on probability and statistics, or you can make your own with a home computer. A table of at least 500 numbers works best to avoid using any sequence of numbers too often. Figure 5 shows a random number table and how it's used.

Finally, instead of waiting for a shot to figure its result, we do it in advance. Then we combine the results of many shots into an Engagement Resolution List, or ERL. For instance, we have three ERLs for an M1 firing SABOT at a hull down T72/T64: one each for short, medium, and long range. If you use ERLs, you can resolve engagements as fast as firers announce them by using the next outcome on the appropriate list and crossing it off as you use it. If you do lots of terrain board exercises, it's worth your time to make ERLs of a few hundred shots each and laminate them so they're reusable. Then you start each exercise at a different place on your ERLs to avoid repeating a sequence of outcomes.

Running the Exercise

Run your terrain board exercise like an "on the ground" ARTEP. You'll need an umpire and an OPFOR commander. In a pinch, both positions can be filled by one experienced person. When you're getting started, it helps to have an assistant umpire to shuffle through all the ERLs.

Base the number of participants in your exercises on the type of training. In a company mission, we use a platoon leader for each Blue Force platoon, plus the commander, XO, FIST, and first sergeant as a minimum. We include the NBC NCO, supply and maintenance people, and platoon sergeants when we can. In a platoon mission, each vehicle is run by a separate soldier.

Try to limit the complexity of rules you must explain to participants. This maximizes training time and lets soldiers concentrate on the battle. Soldiers need to know when, how fast, and how far their units can move. They need to know when they can shoot, rules of visibility, and how various events on the battlefield will be simulated. Let the umpire worry about hit probabilities and engagement resolution.

"Playing the Game"

In this article, I've used the terms "game" and "play," which is somewhat misleading. A good terrain board simulation isn't a game to play for fun, it's a way to present combat situations with minimum resources to train your troops. Make the exercise as much like combat as you can. Require the same reports that you use in battle and require them in the correct format. Make troopers communicate using proper radio procedures and grid coordinates. Program realistic consolidation and reorganization into your exercises. In short, as we're always being told, TRAIN THE WAY YOU'LL FIGHT!

Sergeant First Class John M. Duezabou holds a Bachelor of Arts Degree from the University of California, Berkeley, and a Master of Science Degree from the University of Nevada, Reno. He is currently AGR Readiness NCO (19K40) for Company A, 1-163 Cav (Montana National Guard). He is a PLDC instructor and a former scout section leader.

Jousting with Their Main Guns...

Continued from Page 17

killing shot. The gun tubes of the two tanks were locked in a deadly struggle, reminiscent more of a medieval joust than a tank battle. The other two American tanks on Drewery's flanks could not fire for fear of hitting their mate.

The T-34's engine strained to push the American tank over, when Drewery's quick-thinking driver started the engine and backed up. A distance of only three feet separated the two adversaries when Drewery's gunner pumped a hypervelocity round into the T-34, setting it on fire.

Another T-34 tried to maneuver around its stricken comrade, but it was dispatched quickly by the Pershing next to Drewery. Traversing immediately, the same M-26 destroyed a third T-34 that had just come into view. A fourth enemy tank fled the battlefield.

Other than a bent fender, Sergeant Drewery's tank was none the worse for wear. Just another typical tank battle in the Korean War.

Notes

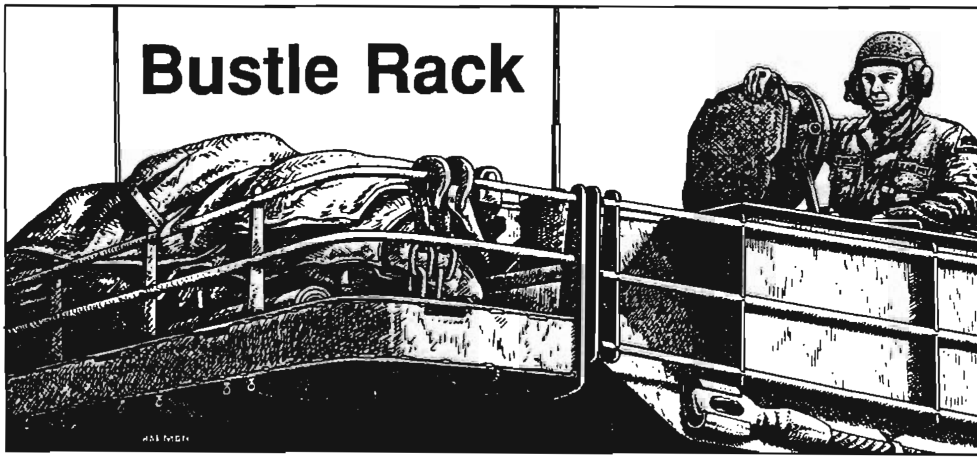
[1]Rosemary Foote, *The Wrong War: American Policy and the Dimensions of the Korean Conflict, 1950-1953*, Ithaca, New York, Cornell University Press, 1985, p. 74.

[2]Clay Blair, *The Forgotten War: America in Korea 1950-1953*, New York, Times Books, 1987, pp. 339-40.

[3]70th Tank Battalion War Diary, October 1950, Annex Number Two, "Summary of Damaged Enemy Tanks," Washington National Records Center, Suitland, Maryland, Record Group 407, Box 4433.

[4]Ibid.

Major Arthur W. Connor Jr. is currently a history instructor at the U.S. Military Academy. His previous assignments include platoon leader and executive officer in 3d Battalion (ABN), 73d Armor, 82d Airborne Division; tank company and headquarters company commander in 3d Battalion, 37th Armor, 1st Infantry Division, Fort Riley, Kan.; a tour as a United Nations Military Observer in Lebanon and Syria; and graduate school at Temple University in Philadelphia.



Saudi Troops Will Train at Fort Knox

Saudi Arabia will send 178 members of its military to Fort Knox for training this summer. The students will arrive in July and remain until February 1995.

According to Colonel Eugene D. Colgan, Project Sword director at Fort Knox, this is a direct outgrowth of DESERT SHIELD/ DESERT STORM experiences.

The Saudi government will pay $16.7 million for the Project Sword training program. The operation's name is derived from the sword emblazoned on the Saudi flag.

Forty-eight Saudi soldiers will be trained as specialists in armor gunnery, tactics, and instructional procedures, and 130 will be trained in armor and support-vehicle maintenance and turret repair. The trainees will later teach the techniques at Saudi Arabia's own armor school. The maintenance personnel will receive additional training at Aberdeen Proving Ground, Md.

As part of the agreement, Saudi Arabia will buy at least 700 M1A2 Abrams tanks from the United States.

Colonel Colgan said more Saudi students could follow this group, which is currently taking nine months of English classes at the Defense Language Institute in San Antonio. Kuwait may participate in a similar program, and has agreed to buy 235 M1A2s and perhaps as many as 760 over several years, he said.

USMA Seeks Teachers

The U.S. Military Academy Department of Social Sciences is looking for company grade ROTC or OCS officers who are interested in teaching political science or economics. If you are from basic year groups '86-'90, and you are interested in civilian graduate study followed by a teaching assignment at West Point, please contact us. We are currently considering applications of officers who might be available to start graduate study in the summer of '94 or later. For more information, write: Department of Social Sciences, United States Military Academy, ATTN: Personnel Officer, West Point, NY 10996.

Attention WWII Veterans

Professor Alton Lee is working on a history of the Jeep in World War II. If you have any unusual stories of the Jeep — adventurous, amorous, humorous — please send them to him along with your military unit designation. He will need your permission to use your story. If you do not want him to use your name, please say so. Any other experiences you would like to mention in connection with your military service would be welcomed. Send to: Professor Alton Lee, Department of History, University of South Dakota, Vermillion, SD 57069.

HUMMER for Sale

AM General Corp. has selected several dealers to market the Hummer, a civilian version of the HMMWV it builds for the military. The company hoped to have 30 dealers around the country by the end of 1992. The first 1,000 civilian customers bought directly from the factory in South Bend, Ind. Prices range from $40,500 to $44,000, somewhat more than sport utility vehicles like the Jeep Grand Cherokee and Land Rover. In addition to the vehicle, buyers will get brief driving lessons to learn the Hummer's "unique characteristics."

Senior Officer Logistics Management Course (SOLMC)

SOLMC is a one-week, multifunctional logistics course, specifically designed to provide an update for battalion and brigade commanders, primary staff officers, and DA civilians working in the logistics field. The course encompasses maintenance, supply, and transportation, as well as hands-on experience with vehicles, weapons, ammunition, medical, communications, NBC, missile, and quartermaster equipment. The course is open to officers of all branches in the rank of major or higher from Active Component, Reserve Component, U.S. Marine Corps, and Allied nations. DA civilians in the grade of GS-9 or higher are also eligible to enroll. The course is conducted 12 times each fiscal year at the Armor School, Ft. Knox, Ky. Class quotas can be obtained through normal TRADOC channels; you must enroll through your G3 or civilian training officer. For more information, contact the SOLMC staff, DSN 464-3411/8152 or commercial (502)624-3411.

SOLMC Class Schedule

FY 93		SCH 171	CRS 8A-F23
Class	Report Date	Start Date	End Date
93-03	31 Jan 93	1 Feb 93	5 Feb 93
93-04	21 Mar 93	22 Mar 93	26 Mar 93
93-05	18 Apr 93	19 Apr 93	23 Apr 93
93-06	2 May 93	3 May 93	7 May 93
93-08	23 May 93	24 May 93	28 May 93
93-09	20 Jun 93	21 Jun 93	25 Jun 93
93-503	25 Jul 93	26 Jul 93	30 Jul 93
93-10	19 Sep 93	20 Sep 93	24 Sep 93

TRADOC Organizes New "Battlelabs"

Training and Doctrine Command has organized six "battlelabs" to experiment with concepts and equipment needed for a force-projection American Army.

"Battlelabs are an initiative analyzing capabilities and requirements rather than depending on concepts based on analysis and comparison against a firm threat, like we did in the Cold War. We can't depend on Cold War analyses and processes to determine priorities," according to General Frederick M. Franks, Jr., TRADOC commander.

Since the end of the Cold War and the collapse of the Soviet Union and the Warsaw Pact, the United States military does not face one monolithic threat. Instead, there can be threats to American interests and allies from several sources.

Although some U.S. forces will be stationed overseas, the bulk of the American Army will be based at home. It will be a force-projection Army organized to protect national interests and assist allies.

Operations DESERT STORM, in the Middle East, and JUST CAUSE, in Panama, are examples of the types of combat operations the Army envisions.

The six battlelabs are Early Entry Battlelab at TRADOC headquarters, Fort Monroe, Va.; Mounted Battlespace Laboratory (armor), Fort Knox, Ky.; Dismounted Battlespace Laboratory (infantry), Fort Benning, Ga.; Depth and Simultaneous Attack, Fort Sill, Okla.; Battle Command, Fort Leavenworth, Kan.; and Combat Service Support, Fort Lee, Va.

The Early Entry Lab will work with the Navy, Marines, and Air Force to ensure initially-deployed forces are sufficiently large and lethal enough to be successful in any circumstance.

The battlespace labs will determine the best ways for armored and infantry forces to take advantage of time, distance, and space on battlefields. The goal is to engage an enemy outside his range of capabilities, day or night, while dispersing Army forces but not their effectiveness.

At Fort Sill, the Depth and Simultaneous Attack Lab will work on ways to detect and simultaneously strike an enemy throughout the depth of the battlefield.

The Fort Leavenworth Battle Command Lab is developing techniques and equipment to give commanders at all levels situational information and intelligence to optimize their ability to command forces, particularly while on the move.

Combat Service Support Lab members are devising methods and systems to provide versatile, effective, and efficient logistics support at all levels.

"We've chosen to locate battlelabs at our installations where we have soldiers, units, and ranges for maneuver, firing, and air space," Franks said.

But before any concept and equipment is tried in the field by soldiers, battlelabs will have tested them out through simulations and virtual prototyping, according to Col. Bill Hubbard, director of battlelab integration and technology at Fort Monroe.

"What battlelabs allow us to do is bring together technologists, combat developers, materiel developers, industry, and academia to build prototypes," Hubbard said. "We then send it through simulation, bring it back again, tweak it, send it back through again to get a near optimum solution..."

"By using virtual prototyping, we can look at different combinations of things on different pieces of equipment. Examples are what a new tank barrel can do on a tank, and what a new piece of armor on a tank will do," he said.

Hubbard pointed out that the battlelab design will refine solutions "on the front end of the acquisition process, rather than on the tail end."

Battlelab task forces will work with industry to develop new technologies and equipment for the modern Army. However, Franks feels that, with budgetary situations, technological "insertions" will be the primary method used to enhance battlefield capabilities for the foreseeable future. Tech insertion means placing existing technologies on available equipment.

One tech insertion is the intervehicular information system (IVIS) in M1A2 Abrams tanks. IVIS allows armored forces to communicate digitally on the battlefield.

The Fort Knox lab has been looking at ways to expand IVIS to include aircraft, artillery, and infantry to get the entire combat team on the same communications network.

As in the case of IVIS, each battlelab will not work in isolation. They will interact with major commands, units, and laboratories throughout the Army.

"There are also developments going on in the other services that we want to tap into," Hubbard said.

Battlelab task forces and the national scientific laboratories at Los Alamos and Sandia, N.M., and Livermore, Calif., have agreed to exchange information, Hubbard said. He also pointed to advances in virtual prototyping at the University of North Carolina as a case of possible academia involvement.

Mounted Battlespace Initiative Program

Soldier ideas are the foundation for improving the Army's Mounted Combined Arms forces. The Mounted Battlespace Initiatives Program is a new and innovative program designed specifically to capture those ideas.

What is the Mounted Battlespace Initiatives Program? It is a program which provides you the opportunity to submit ideas, concepts, and suggestions related to mounted warfighting. The Mounted Warfighting Battlespace Lab (MWBL) takes your ideas and then evaluates them for their potential. Those showing promise are then processed for further evaluation and possible experimentation.

The exact nature of your proposal is not important. What is important is its potential to benefit the combined arms force. All ideas are welcomed, especially if they pertain to one of the following:

- Design for new equipment
- Redesign for modification of existing equipment
- Changes to organizational structure
- Changes to tactics, techniques, and procedures

Submitting your ideas to the Mounted Battlespace Initiatives Program will not preclude you from being eligible for an incentive award through the Army Suggestion Program. Format is not important — merely submit your proposals or come by and see us at Fort Knox, Building 1109, Room 213. Pictures, sketches, narratives, or products with instructions for use will be accepted. Send your proposals to: Director, Mounted Warfighting Battlespace Lab, ATTN: ATZK-MW, Fort Knox, KY 40121-5000.

Proposals may be made by phone through the U.S. Army Armor Center and Fort Knox Armor Hotline with a toll-free service (1-800-525-6848) for CONUS users. The following numbers may also be used to reach the Hotline: DSN 464-TANK or commercial (502) 624-8265. Follow touchtone instructions to reach the MWBL. Callers are reminded the line is unsecure and to leave their name, rank, unit, phone number, and address when a proposal is transmitted.

A Dissent on the Gulf War

Arms Over Diplomacy: Reflections of the Persian Gulf War by Dennis Menos, Praeger Publishing Co., Westport, Conn., 1992, 174 pages, $42.95.

This study may only please opponents of the way the U.S. conducted the Persian Gulf War. The author does not intend to be objective; his preface says it "contains the reflections of one who was troubled by the administration's decision to go to war against Iraq for the purpose of freeing Kuwait and by the aftereffects of the conflict." Menos firmly believes the U.S. should have pursued a diplomatic solution and calls the American response high-tech gunboat diplomacy.

The author of three books on national security issues, Menos argues the war was unnecessary, unjust, and immoral. He is critical of President Bush and Saddam Hussein, calling their leadership "a textbook example of how not to manage a conflict." It was an unjust war, he says, because the U.S. didn't pursue all diplomatic alternatives before using force.

He asks many questions, among them: Why the sudden insistence by the U.S. to uphold international law while aggression goes unchecked elsewhere ("there are lots of Saddam Husseins"); why weren't economic sanctions given more time; why were reporters so heavily censored; why inflict 100,000 casualties to save 700,000 Kuwaitis; why did the U.S. greet the Shiite rebellion in "absolute silence;" and why the reluctance to ground Iraqi gunships and tanks used against the Kurds?

One of the more interesting sections deals with the Soviet diplomatic initiative, focusing on the Aziz-Gorbachev talks prior to the ground operation. Menos gives Gorbachev good marks for his performance; however, the Soviet goal of sparing the Iraqi Army was inconsistent with U.S. objectives, says Menos. "The U.S. acceptance of the Moscow initiative would have served America's interest in a number of ways," according to Menos, one of them being the preservation of U.S.-Soviet relations "at a very critical juncture."

He admits the U.S. ultimatum of February 22, 1991, was generous and that Saddam's "biggest blunder" of the war was turning it down. He also argues that the Iraqi plans for withdrawal from Kuwait became a "cruel and morally unjustified massacre" and that it was "an act of vengeance, pure and simple, that had nothing to do with the legal authority for the war."

His first two chapters were written during the war, with the remainder written afterward. The appendix contains U.N., American, and Soviet documents, and there is a chronology. His message is repeated throughout the work; there is never a doubt where he stands. "The Iraqi's actions were brutal and wrong," concludes Menos, "but so was the medicine that we handed him." He finishes the book by asking, "Did winning the war make it right?" This book addresses one half of the discussion to answer this question.

THOMAS J. VANCE
Major, USAR (IMA)
Kalamazoo, Mich.

Beyond Stalingrad: Manstein and the Operations of Army Group Don by Dana V. Sadarananda, Praeger Publishing Co., New York, 1990, 165 pages, $42.95.

Within the last two years, operational military history appears to be once again coming to the fore as both the academic and military communities search for answers regarding the problems associated with mechanized, mid-intensity warfare. Dana V. Sadarananda's *Beyond Stalingrad* is one such study, and is operational history at its best, focusing where mechanized operations were practiced and perfected almost to an art, on the Eastern Front during World War II. Sadarananda has reconstructed a brief, yet highly controversial, synopsis of General Feldmarschall Eric von Manstein's counteroffensive in the southern Don Basin from November 1942 to March 1943. The battles waged during this time period were, as Sadarananda writes, "the most critical" of the entire war, and were fought in order to halt the ongoing Soviet Army counteroffensive aimed at Group B (including the Sixth Army at Stalingrad). Sadarananda describes, at great length, Manstein's attempt to relieve von Paulus's doomed Sixth Army in the Stalingrad pocket, as well as the brilliant operational moves he undertook in order to prevent Army Group Don from being cut off at Rostov, which was the ultimate aim of both Soviet offensives (*Koltso* and *Saturn*) that had as its primary objective the destruction of von Paulus's forces inside Stalingrad.

While Sadarananda provides the reader with a wealth of information on the German plans at relief and realignment of Army Groups A and B, the author fails to include sufficient detail on the STAVKA's (Soviet High Command's) plan of attack and what the ultimate Soviet objectives were in launching *Koltso* and *Saturn*. As is now known, the goal of both Generals Eremenko and Vatutin was the expulsion of the Germans from the Don, along with the hope of retaking the Ukraine, thus "precipitating the collapse of not only the German southern flank but [of] the entire German strategic position in the East."

Sadarananda credits Manstein with not only recognizing the threat posed by the Soviet Army's two-pronged counterstroke to the *Wehrmacht's* southern flank, thus repositioning the German forces for a series of successful counterattacks, but also in dealing with Adolf Hitler's 'stand and hold' orders. Sadarananda writes that Hitler complicated the Field Marshal's task by denying Manstein the degree of freedom that would have made his job "considerably less difficult and risky." *Beyond Stalingrad* is structured chronologically in order to effectively illustrate the solutions proposed in order to rescue the besieged garrison at Stalingrad. While faulting Manstein for not sending von Paulus the code word that would have begun the breakout attempt, Sadarananda defends the German *feldmarschall* by restating the official line proposed by Hitler and Zeitzler (OKH Chief of the General Staff), that the Sixth Army was performing a more valuable service by tying down a substantial number of Russians along the Volga. The author also writes that Manstein himself concluded that von Paulus's situation at Stalingrad was, for all practical purposes, hopeless after the Soviets launched *Saturn* and *"Little Saturn"* (14 December), and instead recommended that the Sixth Army remain in the Stalingrad pocket. Disputing this, however, are historians John Erickson and Earl Ziemke, both of whom assert that, as late as 23 December 1942, von Paulus could have initiated an attempt to break out and link up with elements of the 4th Panzer Army that had been sent to assist in the breakout. Manstein instead saw the plight of the Sixth Army as an opportunity to stabilize one sector of the front while redressing the operational-strategic balance by preventing any further Soviet breakthroughs, such as occurred during the winter of 1941-42. Manstein doomed the Sixth Army to its fate, believing that had von Paulus withdrawn, his own forces would become a "magnet" for Chuikov's 62nd Army and Vasilevskiy's Stalingrad Front. Manstein asserted that if properly relieved by air, the Sixth Army could have, in fact, held on at Stalingrad. Manstein's concern instead was centered around Army Group A that was fighting in the Caucasus, rather than on the ever-growing disaster on the Volga. In the end, Sixth Army's fate was sealed by Soviet Generals Rokossovsky's and Chuikov's linkup, which negated any relief effort.

Sadarananda provides an excellent description of the fighting that continued as the garrison inside "Fortress Stalingrad" surrendered (29 January 1943) by vividly describing how the Germans under Manstein fought to hold off the Soviet 5th Shock Army (General M.M. Popov's 'Mobile Group') and the 7th Tank Corps at Nyshne-Chirskaya, which eventually forced the outnumbered German troops out of their vital bridgehead there. Manstein's forces, estimated to be a collection of 10½ divisions faced a Soviet force that consisted of 36 rifle divisions (425,476 men), 1,030 tanks, and almost 5,000 guns and mortars, defending a front encompassing 200 square miles, with mounting casualties and logistical problems. Manstein, forced on the defensive, began demonstrating what Sadarananda calls the German general's "unique" ability to grasp the initiative back from the Russians. This "ability" was aptly demonstrated when, along the Chir Front, Soviet General Bandanov's 24th Tank Corps was mauled by Armeegruppe "Hollidt" when the Germans were able to retake the Tatsinskaya airfield that resupplied the besieged German forces inside Stalingrad.

Sadarananda likewise discusses Manstein's employment of mobile defense operations in order to contain Soviet thrusts against the German positions along the Chir Front, as well as along the Donets River. Defined by historian Timothy Wray in his excellent monograph, *Standing Fast! German Defensive Doctrine on the Russian Front During World War II* (Ft. Leavenworth, 1986), these mobile defense operations or 'fire brigade tactics' were extremely critical in stemming the massive Russian tide during the period immediately after Stalingrad. Both Wray and, to a lesser degree, Sadarananda assert that Manstein's employment of such tactics were in direct contradiction to Hitler's 'No Retreat' and 'Stand Fast' orders, but in the long run, however, saved Army Groups A and B from being cut off and destroyed by the advancing Soviet forces. Manstein's employment of *ad hoc* panzer groups or *kampfgruppes* gave him greater flexibility in dealing with local threats. Despite the presence of such groups, the bulk of Manstein's forces in the Don were, in fact, stationary forces that were employed in a succession of static defenses. Sadarananda writes that these *kampfgruppes* acted as 'fire brigades,' by assisting the infantry as fire support and shock units against local enemy breakthroughs. Sadarananda fails, however, to follow through in describing Manstein's reasoning in employing these tactics, as well as how successful the employment of these mobile formations were against Soviet forces. Sadarananda likewise asserts that, despite the use of mobile groups, the ultimate failure of subsequent German operations in the same area of operations were primarily due to the lack of tactical depth during the retreat from Stalingrad. Construction of such defensive positions came about after Operation ZITADELLE (July 1943), and this only after Hitler reluctantly permitted their formation along the Dnepr River (the *Piranha* and *Panther* positions). Had Manstein possessed such positions in late 1942, the German armies along the Stalingrad Front might not have collapsed as suddenly as they did during the initial stages of *Koltso* and *Saturn*.

Another major omission in Sadarananda's book is the failure to discuss the build up of Soviet forces and their use of 'Maskirovka' (deception) prior to the Stalingrad offensive in November 1942. The author's reliance on German sources clearly reflects the inattention paid to the Soviets' use of deception by the German Army's Eastern Army Intelligence Branch, and once again illustrates how Manstein and his field commanders misread Soviet capabilities and intentions prior to the Stalingrad offensive and later during ZITADELLE. Sadarananda's reliance on German sources, while neglecting even secondary sources on Soviet military strategy during the Second World War, is all too obvious. The author's failure to use similar Soviet accounts of the fighting on the Eastern Front is another serious omission. The wealth of published Soviet memoirs available to scholars in the West would have made *Beyond Stalingrad* a more balanced and better-written book. These memoirs include Marshal of the Soviet Union K. Rokossovsky's *A Soldier's Duty* (Moscow, 1985), and Vladimir Sevruk's *Moscow and Stalingrad 1941/1942* (Moscow, 1978), both of which would have provided a better understanding of the difficulties encountered by the STAVKA after the launching of *Koltso* and *Saturn*. Sadarananda's discounting of the abilities of the Soviet field commanders during this period renders an otherwise excellent book biased and one-sided. All that the author is doing, in fact, is providing the reader with a summarization of the German field reports that reflected the same skepticism and contempt of the Soviet Army's ability to maintain and exploit a major offensive.

By discounting the ability of the Soviet field commanders and soldiers in conducting such a complex set of offensives, Sadarananda has in effect defeated the purpose of his book, and that of course is to illustrate what he terms as "the genius of Manstein." By presenting a more balanced account of the fighting before and after the collapse of the Sixth Army at Stalingrad, Sadarananda would have been better able to illustrate the effectiveness of Manstein's operational prowess instead of giving an extremely biased and poorly balanced version of the failure of the Wehrmacht on the Eastern Front. Despite the last point, however, *Beyond Stalingrad* is an extremely useful book that should be read **only after** reading both John Erickson's *Road to Stalingrad* and *Road to Berlin,* as well as Timothy Wray's *Standing Fast,* in order to gain a better appreciation of at least the German dilemma as the tide of battle slowly began turning in favor of the Soviet Army after the debacle at Stalingrad. Sadarananda's book has, however, provided operational military history with an account that will go a long way in redirecting the focus on an important campaign that, up to now, has been ignored by military historians. *Beyond Stalingrad* is important likewise because of the many operational and tactical lessons Sadarananda has included throughout the book. These lessons serve to illustrate the need for precise operational planning, as well as decisive action on the part of platoon through brigade-level commanders. As Army and Marine Corps armored commanders prepare for another war such as DESERT STORM, *Beyond Stalingrad* is a "must read."

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