

*T&G original*

## **Experimenting for the Future**

### **Simulation of an Advanced Fire Support System**

**(N.B. there are endnotes)**

For some the word “simulation” connotes “sham,” but among engineers the word is understood to mean “examination of a problem not subject to direct experimentation.”<sup>i</sup> During the summer of 1998 an Army Science Board (ASB) panel exploring technologies for the Army after 2010 wanted to assess the military worth of a novel way to provide direct support fires: containerized, loitering missiles coupled with sensors under the direct control of the maneuver battalion. The ASB panel requested the Simulation Center of the Institute for Defense Analyses (IDA) to “examine engagements in modern combat to gain insights into the utility of boosted non-ballistic missiles, and to ascertain requirements for loitering time.”<sup>ii</sup>: IDA selected two forms of tactical engagement simulation (TES) for its study: first, the virtual TES **Battle of 73 Easting**,<sup>iii</sup> second, records of live TES at the National Training Center, **Operational Test VISualization (OTVIS) Playback of Selected Task Force XXI Missions — March 1967**<sup>iv</sup>.

At issue were new ways to supplement conventional direct-support artillery or mortars. The latter fire ballistic projectiles that make howitzers and mortars vulnerable to counter-fire, so these are usually held separate from, and to the rear of, maneuver units. That necessitates time-consuming inter-unit communications. Requests for fire passed rearward usually consume some eight minutes at each echelon.<sup>v</sup> Hence, ballistic projectiles, whether shells or missiles, have difficulty in hitting moving targets, or in providing close support to swiftly maneuvering friendly forces.

The ASB hypothesized that forward-controlled, non-ballistic missiles able to dwell for a period over a potential target could provide enhanced synchronization and increased lethality. Several concepts being explored by the Defense Advanced Research Projects Agency (DARPA) seemed highly relevant: sensors and sensor-control means, or situation awareness systems (SAS), the Advanced Fire Support System (AFSS). IDA, to test the ASB hypothesis, assumed that SAS and AFSS were organic to the battalion, and devised its two TES experiments as follows:

Experiment 1: examine the potential of AFSS in DARPA's **Battle of 73 Easting**

Experiment 2: assess SAS and AFSS using the Task Force XXI **OTVIS**

Note that in both experiments the simulation provided an analytical framework for evaluating sensors and weapons that will not be available for another decade.<sup>vi</sup>

The AFSS posits deploying small, cheap cruise missiles in a container that functions autonomously on radio command. An AFSS fire-unit could be positioned by parachute, by helicopter, or by ground vehicle, and its control could be assigned to a specific commander. Moreover, each missile once aloft could orbit, seeking targets, then dive, either of its own volition, or on command, to deliver accurately lethal munitions. AFSS was assumed to have these characteristics:

- Range > 20 km
- Lethality > current 155mm cargo round
- Flight profile:
  - Climb to ~ 3 km                      --Can be sent to a specific geographic coordinate
  - Glide/fly to target vicinity        --Can cooperate with sensors to pinpoint target
  - Loiter for 5 to 15 minutes        --Can attack upon "lock-on" or upon command

## **Experiment 1: 73 Easting**

On the third day of DESERT STORM, VII Corps (LtG. Franks) had penetrated deep into Iraq, and had turned eastward thrust to engage divisions of Iraq's elite Republican Guards. The latter, equipped with late-model Soviet armored fighting vehicles (AFV), were in the positions shown as Objectives Norfolk, Dorset and Bonn, screening Iraq's withdrawal from Kuwait.<sup>vii</sup>

### **MAP of IRAQ: 73 Easting**

The 2d Armored Cavalry (Col. Holder) was on the Corp's right (south) flank. Behind the 2d ACR was the 1st Infantry Division (Mechanized) (MG Rahme), racing to pass through the 2d ACR to form on line with the 3d Armored Division (MG Funk) and the 1st Armored Division (MG Griffith). At 1525, passing 65 Easting<sup>viii</sup> (Phase Line Tangerine), the 2d ACR had its 2d Squadron on the north, its 3d in the center, and its 1st in the south. Most of the cavalrymen sensed that the enemy was near. A sandstorm was blowing under a low overcast, often reducing visibility to less than 1000 meters. There was neither air support nor aerial scouts. An order was passed to the lead elements to advance to 70 Easting, and to wait there for further instructions.

At 1553, among the most advanced elements of VII Corps were Ghost and Eagle Troops<sup>ix</sup> of the 2d Squadron, 2d Cavalry, moving abreast at 25-30 miles per hour, approaching 67 Easting. Iron Troop of the Third Squadron was to their southwest, nearing 65 Easting. Eagle's scouts (in Bradley AFV) on the troop's southern flank were echeloned back to keep Iron in sight.

Screen 1553

The diagram is a plan-view screen-capture. The plan-view was chosen for the experiment because it provides a birds-eye view of friendly and enemy positions, records time, and facilitates changing the scale and speed of the action. The solid blue and red icons —scaled up x50 an actual vehicle— mark the positions of AFV; a tank bears a white dot and line to indicate the azimuth of its gun, while an infantry fighting vehicle bears a lesser white line. (In subsequent frames, whitened icons identify vehicles that have been hit and destroyed). The larger, red polygons show Iraqi buildings or other structures.

Minutes later, lead Bradleys of Eagle Troop came under fire from automatic weapons positioned in the building complex shown in the center of the screen (between 68 and 69 Easting). Eagle had driven into the Republican Guard's armor training center. Captain McMaster, commanding Eagle Troop, decided to hit the enemy buildings hard and to bypass the complex to the north. He brought all 9 of his M-1 tanks on line to fire a volley of 120mm HEAT rounds into the complex, suppressing the enemy fire. As Eagle swung past the buildings the troop saw to its front approximately 30 T-72 tanks and a dozen BMP in revetted positions, interconnected by infantry-manned trenches. Without hesitation, McMaster attacked southeasterly, knifing through the enemy defense.

#### Screen 1625

The commander of the enemy brigade, expecting the Americans to advance up the roads to the Training Center, had oriented his force to the southwest. His tankers had set their sights at 1800 meters, the standard Soviet battle range, and presumed that American gun flashes were from halted AFV, whereas the Americans were shooting on the move aided by gun stabilization. Many Iraqis tried to shoot back, but their fire was wildly

inaccurate. Eagle's AFV commanders opened at ranges as great as 2400 meters, consistently fired first, and used their thermal sights and laser range finders for precision gunnery. By 1625, as the diagram shows, all enemy AFV in range were flaming, and Iraqis were surrendering. The Iraqi commander later reported that over the preceding five weeks he had lost only 2 of 39 tanks to air attacks, but that in less than 6 minutes, Eagle troop had annihilated his entire command.

However, McMaster's aggressive attack had crossed into the path of the Iron Troop. Moreover, Eagle could see a much larger enemy force just out of range to the east. The Squadron Commander directed that Eagle turn northeast. McMaster complied, but at 1625, to cover his right flank, he requested artillery fires at "grid 730005." There ensued a classic example of the fog of war (tape-recorded as it happened): the Fire Support Officer, apparently believing that Eagle troop was still short of 70 Easting, the Limit of Advance, responded "Roger, grid 7005." This exchange was repeated twice more. McMaster, fearing that the artillery would shoot into Eagle at "grid 7005," called "Cease Fire!" and moved without supporting fires, traveling for 10-15 minutes vulnerable from the flank.

**Loitering, AFV-killing missiles could have served to secure the exposed flank of the troop on the move, and to confuse and to inflict losses on enemy forces that had been located, but were beyond range of direct fire.**

Screen 1628

Meanwhile, at about the same time, Ghost Troop had advanced to 73 Easting. At 1628 they had closed to within 600-1000 meters of an enemy defensive position. Due to poor visibility, neither side had detected the other, and neither had fired a shot. However, thanks to Ghost Troop's thermal sights, its soldiers spotted their quarry first, detecting as

“hot spots” the very tops of T-72 turrets visible over sand berms thrown up around the enemy vehicles.

Ghost Troop opened fire. The Iraqis returned fire, aiming at the Americans’ gun flashes. The US 120mm SABOT rounds punched through the sand berms, through the T-72 armor, into the rear engine compartment, and in many instances blew the engines completely out the backside of the tanks. The most violent part of the battle lasted only five to ten minutes. Ghost troop emerged from the fight intact.

**Had Ghost Troop been equipped with loitering missiles, they could have used them as “scouts”, seeking out and attacking the enemy from above without requiring Ghost to reveal its position by firing, and searching out beyond the range of direct fire weapons to insure against a lurking counterattack force.**

In the meantime, another threat emerged to the immediate south of Ghost Troop. Ghost had detailed two of its scout vehicles to keep Eagle in sight, but these had been delayed by an enemy minefield, and had dropped behind both Eagle and Ghost. When the firing between Ghost and the Iraqis flared to their front, the scouts moved rapidly to join the fray, but were ordered back to find Eagle. As the two scouts moved south, they ran into a large armored force. Cautiously, they inched forward. As they closed to within 400-500 meters, they could see that they had stumbled upon an enemy battalion.

Screen 1635

The two scout vehicles prudently hunkered down, but succeeded in raising Eagle on the radio to inform them that there was a large enemy force to their north. For the next 15 minutes, they coordinated with Eagle Troop as it turned to face the new foe. When Eagle opened fire, the Ghost scouts fired TOW missiles into the enemy, and withdrew

northward. Within 30 minutes, the entire Iraqi force between Eagle and Ghost was in flames.

**Loitering missiles could have been a genuine force multiplier, enabling the two Ghost scouts to engage the enemy battalion without revealing position. With reliable “blue” situation awareness, they could have collaborated with Eagle, designating precise targets for missile strikes synchronized with Eagle’s attack.**

Screen 1655

At 1655, Eagle Troop had reached 73 Easting and had "circled-up" vicinity 730030 to assess the situation. Visibility was still very poor. Captain McMaster anxiously called each platoon, and was relieved that the troop had no casualties. But he was troubled by the fact that his scouts had lost sight of Iron Troop, which had been hotly engaged some six kilometers to the southwest. Overhearing 2d Squadron ordering Iron to move eastward, McMaster directed Eagle to monitor Iron Troop’s radio net to ensure that Iron did not mistake Eagle for the enemy.

As Eagle paused, some of its tanks and Bradleys fired upon several enemy tanks, personnel carriers, and trucks beyond the 74 grid line. Violent explosions followed, indicating a fuel and ammunition resupply point, and suggesting that Eagle had penetrated into the enemy’s rear. The enemy force to the south vicinity 730005 Easting, which Captain McMaster had sought to attack with artillery, could still be seen positioned across Iron’s axis of advance.

**Loitering missiles could have been used by Eagle to extend its control eastward, and by Iron to attack the enemy force out of range to its front. Collaborative engagement of the latter would have been possible, with Eagle pinpointing enemy vehicles to be attacked by Iron’s missiles.**

Later, just before dark, the enemy attempted to attack around Ghost's north flank. Republican Guard elements had closed to about 1500 meters (the sandstorm continued to have a serious detrimental effect on long range observation) before they were detected and engaged. Even with the blowing sand, thermal sights gave Ghost a significant advantage over the Iraqis. In a sharp 10-minute engagement amid swirling sand, 5 Bradley scouts and 1 Abrams tank from Ghost troop destroyed 16 Iraqi BMPs, and suppressed enemy infantry that dismounted from the BMPs to assault toward Ghost. By 1750 firing had ceased, and Iraqis began surrendering. Ghost had no casualties.

**Had 2d Squadron been equipped with loitering missiles, it could have massed fires from all its troops to meet the threat to Ghost, using the Ghost flank vehicles to target the enemy's forward elements, and searching to the east with the missiles for any following echelons.**

### **Experiment 2: Task Force XXI AWE**

Among the records used to evaluate the Advanced Warfighting Experiment were sequential screen captures of the displays from NTC instrumentation, published in CD-ROM format. IDA used two series: the meeting engagement of 16 March, 1997 to examine the persistence of targets for BFOR missiles, and the OPFOR attack of 20 March, 1997 to examine possible interactions between SAS and AFSS.

BFOR battalions were (hypothetically) equipped with AFSS, plus an organic, robust SAS that included (1) Discoverer II, a LEO constellation of satellites bearing MTI tasked by and displayed to battalion commanders; (2) strewn, linked unattended Ground Sensors (SLUGS); (3) robotic observation posts (ROP) capable of ATR and target designation; and (4) porteed micro aerial vehicles (P-MAV), missile-delivered to potential target areas.

## Map Fort Irwin

The terrain at the NTC is well illustrated on this picto-map: rugged mountains jutting out of the high Mojave Desert dominating deeply eroded valleys; countless defiles that constrain the movement of mounted forces; observation, fields of fire, cover and concealment that vary from one to another of the 1 kilometer grid squares shown. The arrow on the map is 20 kilometers in length, the assumed range of the AFSS missiles.

The Blue Forces (BFOR) were contending with a new command and control system. Moreover, they were conducting operations against the best-trained unit of the U.S. Army, the NTC OPFOR, who knew well how to exploit the terrain at Fort Irwin, and to pose a formidable and continuous challenge.

Screen 075:05:59:14

The date is March 16 (Day 075), and the time is 05:59 in the morning. Reconnaissance elements from both sides have been active throughout the night. The bulk of Blue Force (BFOR) is off the map on the right (east); the main body of Opposing Force (OPFOR) is off the map to the left (west). Both have received orders to attack at 0600, and a meeting engagement on the ground displayed is imminent. The situation depicted shows the disposition of reconnaissance elements. Scouts from both sides have been positioned to overlook BROWN PASS on the western entrance to the valley. Note that OPFOR has inserted observers onto the high ground overlooking IRON TRIANGLE from the south. BFOR has posted a security element northwest of IRON TRIANGLE, designed to preclude OPFOR reconnaissance elements from occupying critical terrain. At 0545 OPFOR fired a persistent nerve agent south and east of RACE TRACK; BFOR has not yet reacted.<sup>x</sup>

The BFOR commander's plan is to advance westward up the valley over RACE TRACK with two battalion Task Forces echeloned to the right [blue arrows 1 and 2]. The lead Task Force is to seize high ground north and south of IRON TRIANGLE, and the following TF will then attack to destroy remaining OPFOR.

OPFOR has prepared four options, the choice among them to be determined when the BFOR plan becomes clear. One of these, Plan FORK is shown: if BFOR attacks up the valley over RACE TRACK, OPFOR Advance Guard is to exit Brown Pass [red arrow 1], hook northeast [red arrow 2] to control IRON TRIANGLE and to facilitate the passage of the massed regiment in an attack along the north edge of the valley [red arrow 3].

Below is the display used for analyses. On the right are various controls and a timer. In the meeting engagement sequence, the data are presented in frames about 30 seconds apart, and these can be displayed frame by frame, or as a "movie," forward or reverse.

Screen 075:07:03:01

An hour has past. BFOR advanced with two task forces in echelon right, and within 45 minutes the lead TF had occupied IRON TRIANGLE and the high ground to its north and south. The rate of advance was about 15 mph (0.4 kilometers per minute). The lead task force sent a team north of IRON TRIANGLE, and the TF (-) occupied high ground to the south.

However, the following BFOR TF had difficulty in pinpointing the location of the persistent nerve agent vicinity RACE TRACK, and was both delayed and disorganized. OPFOR exacerbated the resultant confusion by firing two volleys of FASCAM to extend the obstacle northward, and three lines of non-persistent chemical agents to the southeast of the obstacle so that the northeasterly breeze would drift the gas over forces struggling

with the obstacle. OPFOR elected to execute Plan FORK. The screen portrays the Advance Guard on the west entering the valley from vicinity BROWN PASS. The foremost team of the Advance Guard is making a diversionary attack on the BFOR elements south of IRON TRANGLE, while the remainder turns northeast per plan.

BFOR sought to deny BROWN PASS with a FASCAM volley, but OPFOR quickly moved south of the obstacle via an alternate route (BROWN CUT).

**BROWN PASS and its environs might have been better defended by positioning sensors in the defiles, and using returns from these to cue FASCAM and AFSS.**

Screen 075:07:08:54

The OPFOR Advance Guard moved briskly, at about 30-35 mph (1 kilometer per minute). At grid 3817, OPFOR's lead team encountered a stout BFOR defense, causing the OPFOR column to jam up. The Advance Guard commander ordered his elements to move northeasterly toward the mouth of GRANITE PASS to envelop the BFOR defenders. The screen highlights several grid squares useful for assessing the locus and persistence of the target sets engendered by the OPFOR congestion. [IDA defined lucrative target as ten or more AFV per 1 square km. E.g., grid squares 3616 and 3817 at the time shown.]

**The BFOR defense could have been more effective had loitering missiles been used to extend the range of the M-1 tanks and Bradley Fighting Vehicles. For targets within sight, but out of range, the defenders might have used their laser range finders to pinpoint targets for the missiles.**

The next several screens will show how the situation developed in ten-minute intervals. At 07:18 the OPFOR flanking maneuver is well underway, and the lucrative target sets have moved to grids 3718 and 3819. The obstacles around RACE TRACK

continue to delay and to confuse BFOR. In the meantime, OPFOR is staging a series of demonstrations across the BFOR front, including an ostensible attack from the south.

Screen 075:07:18:15

Screen 075:07:28:22

In reality, the OPFOR main body is pressing at top speed toward BROWN CUT. At 7:28 the OPFOR Advance Guard is fixing the north flank of BFOR, while the lead elements of the OPFOR main body have begun to reinforce.

**Loitering missiles on call of the BLUFOR armor team commander in the north could have extended the reach of his defense, enabled engagement without position-disclosing muzzle flash and blast, and exacted a heavy toll for the enemy's massing his armor on the flank.**

Screen 075:07:38:28

At 7:38 the Advance Guard is attacking southeasterly toward IRON TRIANGLE, rolling up the BFOR flank. Arriving OPFOR units have joined the attack, and more are coming. This screen, and the foregoing three [for 7:08, 7:18, and 7:28] present an interesting tactical narrative of 30 minutes of engagement by the northernmost BFOR TF. Dense target arrays had been presented, but these were usually of short duration:

**Grid**

**Square Start End Persistence**

**3616 7:09 7:14 5 minutes**

**3616 7:24 7:38 14 minutes**

**3717 7:13 7:19 4 minutes**

**3817 7:09 7:19 10 minutes**

**3718 7:12 7:19 7 minutes**

**3819 7:14 7:35 21 minutes**

Of the grid squares examined during this half-hour, 3616 and 3819 offered the greatest potential for BFOR targeting. Over the entire engagement, ten or more AFV of the Advance Guard and the main body were passing through 3616 from 7:49 through 8:29, nearly an hour in all.

**Planning for and synchronization of SAS with AFSS will have to be artful. BFOR should have positioned ground sensors at key defiles such as 3616 and 3819, and as these sensors became active, supplemented them with aerial overwatch. Such arrays could have reported the particularly lucrative target sets in locus and time, and could have cued AFSS.**

An hour after the OPFOR engaged, BFOR north of IRON TRIANGLE have been over-run. By 0821 OPFOR has penetrated beyond IRON TRIANGLE, but has been stopped by a last-ditch BFOR defense, again causing the OPFOR column to close up and to present dense targets.

Screen 075:08:20:42

OPFOR now has the mass to punch through the defenders, albeit at a price. Only by massing fires can BFOR deny the OPFOR its objective.

**In this instance, as in the previous case of the defense northwest of IRON TRIANGLE, the BFOR commander at the scene — the battle captain — ought to have had an opportunity to prepare the battlefield by setting up sensor arrays, and have been furnished sufficient AFSS fire units to destroy the lead OPFOR attackers. With access to additional AFSS assets he could inflict a decisive defeat. It is imperative that the forward commander have direct control of both the sensors and his supporting fires, so that he has the means to maintain full situation awareness no**

**matter what the OPFOR attackers may choose to do, and so that he can respond with fire immediately as targets are presented.**

By 1056 the exercise terminated. OPFOR broke through the BFOR defenses, and was in a position to deliver fires or to maneuver throughout the BFOR rear.

Screen 079:06:01:29

It is 20 March, 1997. In the narrative that follows, the reader is asked to imagine that the action takes place on March 20, 2012, and that DARPA's SAS and AFSS figure directly in the battle.

BFOR had been provided with 48 tanks, 46 Bradleys, and a contingent of light infantry, and assigned the mission of defending the sector shown — largely the ground over which it had attacked on 16 March. The BFOR commander had organized the terrain under three task forces, one in the south assigned to emplace and to defend obstacles in the Valley of Death, and two task forces in the north tasked to defend vicinity IRON TRIANGLE and RACE TRACK.

OPFOR, as the numerous purple icons marking destroyed BFOR vehicles indicate, had been probing the BFOR position from the air and on the ground. The OPFOR commander, with twice the number of AFV available to BFOR, had prepared several attack options. In the light of what his reconnaissance had shown him, he decided to launch the attack diagrammed. His plan called for his Advance Guard to pass through the Brown/ Debnam Passes into the valley [red arrow 1] for a diversionary attack into the BFOR center [red arrow 2]. The OPFOR main attack, however, was to strike southeast through Bicycle Lake Pass and the Valley of Death [red arrow three], and thence into the BFOR left rear.

Screen 079:09:21:35

Throughout the early morning of 20 March, OPFOR conducted a series of demonstrations and hit and run attacks across the BFOR front. In front of the center Task Force, these activities were particularly intense, causing that Task Force commander to request Discoverer II coverage of the Brown/Debnam Passes.

Around 0845, the OPFOR Advance Guard began its passage of defiles leading into center sector, and the Discoverer II MTI reported the movement. At 0900 the center Task Force commander laid down three sensor fields, shown above as A, B, and C, each with a coverage about four kilometers in diameter, to supplement the Discoverer II coverage.

At the time shown, indications were that the OPFOR had committed at least two company-sized OPFOR units, moving at high speed, to attack BFOR's center Task Force.

**Broad area MTI coverage can focus the emplacement of more discriminate sensor fields, and taken together these can produce precise targeting information for AFSS missiles. With the information shown, two sets of ten missiles could be launched, flown to circle over B and C, and then commanded to attack sequentially, missile by missile, every thirty seconds, separated from one another only by an interval necessary for a subsequent missile to confirm that it was locked on a target. The seekers on the missiles act to confirm and to extend the coverage of the sensors.**

Screen 079:09:26:54

Five minutes later few AFV could be detected moving within A, B, or C, but there was clearly an attack underway upon the center Task Force. Ten minutes later, sensor field A reactivated, and the center Task Force reported that OPFOR was trying to envelop their south flank. The TF called for another AFSS strike for A, and summoned attack helicopters to support its south flank company team.

Screen 079:10:00:08

At 1000 all three sensor fields —A, B, and C— were reporting significant activity, but C detected southward, vice eastward movement. This sensing of OPFOR redirection caused the BFOR commander to direct the emplacement of additional sensor fields between the center and south task forces.

Screen 079:10:04:34

Four minutes later the additional sensor fields, D and E, were in place, and confirming that OPFOR AFV were moving rapidly down the road toward Bicycle Pass.

Screen 079:10:12:01

An AFSS strike was launched for D at 10:10, and at 10:14, ten missiles, delivered in rapid succession, struck into the OPFOR column.

By 10:18 it had become clear that OPFOR elements are converging on E, (Bicycle Pass), and another AFSS strike was launched on OPFOR in that area.

Screen 079:10:33:22

At 10:33 additional AFSS strikes of ten missiles each were fired at B, D, and E respectively.

To summarize the firings of 10-missile salvos:

<u>Area</u>	<u>TOT</u>
A	0936
B	0922, 1033
C	0922
D	1010, 1033
E	1021, 1033

**A total of 80 AFV-killing missiles were delivered, flown to precisely located targets, and attacked by diving from above with terminal guidance. Assuming 90% effectiveness, the AFSS eliminated 72 OPFOR AFV.**

In the actual 1997 AWE, the OPFOR had a total of 224 AFV — 63 tanks and 161 BMP. Around 1100 on 20 March the OPFOR succeeded in crashing through the BFOR defenses in the Valley of Death, and turning the BFOR southern flank. But that OPFOR commander's success proceeded from his massing his direct fire weapons, and his accepting 64% attrition: OPFOR emerged from the fight with only 70 AFV. Had he lost 72 AFV forward of the BFOR defensive positions from AFSS strikes, as per above, even before he massed to make the main attack on the BFOR defenses in the Valley of Death, there can be little doubt that the outcome would have been quite different.

**The conclusions of the IDA study were as follows:**

- 1. Direct fire-fights among AFV are usually of short duration: 15 minutes or less.**
- 2. Formations of AFV on the move in NTC terrain present dense target arrays that persist for less than ten minutes.**
- 3. A non-ballistic missile with loiter time of up to 15 minutes would be useful:**
  - a. To extend the control of U.S. AFV (range, lethality) by exploiting their sights, laser range finders, and the Battlefield Combat Identification System.**
  - b. To cover the front, flank, or rear of AFV on the move.**
  - c. To synchronize maneuver with direct and indirect fires.**
  - d. To foreclose having to disclose position by muzzle flash**
  - e. To engage transient targets identified by collaborative sensors.**

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<sup>i</sup> Cf. Webster's New Collegiate Dictionary

<sup>ii</sup> This report was prepared by R.E. Clover, under the direction of L. Neale Cosby, Director of IDA's Simulation Center, and assisted by Major H.R. McMaster, U.S.Army, of the National Training Center, and Generals Funk and Gorman, USA (Retired).

<sup>iii</sup> "The Battle of 73 Easting" is an advanced simulation from the Defense Advanced Research Projects Agency, produced at the request of General Gordon Sullivan, then VCSA. General Sullivan was aware, from the book America's First Battles,<sup>iii</sup> that among "first battles" of all previous wars the only decisive victory had been won by the 2d Cavalry in 1846. Intrigued by reports that the 2d Cavalry had fought and won the "first battle" against the Iraqis in 1991, he ordered teams to begin collecting data in Iraq within hours of the engagement from all available sources, establishing minute-by-minute the positions and

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sequential actions of the U.S. and Iraqi antagonists. DARPA, employing SIMNET semi-automatic forces, then used these data to drive icons within a synthetic battle environment. The result was a vivid, four-dimension representation of every combatant on both sides— by latitude, longitude, altitude, and time. IDA analysts can examine the battle by roaming within that virtual simulation at will, adopting any point of view they wish, with the opponents static or dynamic, shown in real time, fast-forward, or fast-rearward.

<sup>iv</sup> The AWE OTVIS is a CD-ROM of the US Army TRADOC Analysis Center (TRAC) that presents a series of “movies” showing, by successive frames derived from NTC instrumentation, key engagements during the Advanced Warfighting Experiment (AWE) involving the Task Force XXI brigade of the 4<sup>th</sup> Infantry Division (Mechanized). IDA analysts can use the data to ascertain the positions of armored fighting vehicles (AFV) and helicopters of both protagonists at specified times.

<sup>v</sup> Major General Robert H. Scales, Commandant, U.S. Army War College

<sup>vi</sup> This summary displays only frames from the imagery that supported the analyses, but the reader should understand that the analysts viewed these data in motion, and in both cases were able to control the speed of display, to change scale at will, and to record times, to measure ranges and velocity of movement, and to observe the result of firing events.

<sup>vii</sup> Scales, BGen. Robert H. Certain Victory. OCSA, Department of the Army, 1993. P.263.

<sup>viii</sup> In lieu of maps, the cavalymen were navigating with GPS and a numbered grid of one-kilometer squares, the north-south lines of which were referred to as “(number) Easting.”

<sup>ix</sup> The cavalymen used a phonetic name for each troop that began with the troop’s letter designator.

<sup>x</sup> Red icons indicate OPFOR AFV; these turn yellow when hit. Blue icons are for BFOR IFV, which turn purple when hit.