# Learning to Learn: Reminiscences and Anticipation

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**ABSTRACT**

The author presents his vision of a future strategy for education and training for the armed services that optimizes resources (minimizes cost) while still maintaining or advancing proficiency. The author traces his experiential learning during the decade of the 1970's, when his Army assignments enabled him to influence his service's recovery during the waning years of the war in Southeast Asia, and its aftermath. Then, with readiness for defense of NATO Europe as the strategic objective, Army effectiveness was leveraged upward not only by new weapon systems ($\Delta W$), but also by better ways to train the soldiers who manned those systems ($\Delta P$), and improved methods for developing the command groups that would employ them in battle ($\Delta T$).

While equipment modernization is important, and investments in more proficient crews even more so, both these can be compromised by maladroit leadership. He details use of an analytical approach to training management, based on an experimental discipline, Training Development (TD), a search for cost-effective modes of training and education, a counterpart to combat development, and analyses focused on materiel acquisition. With the end of the war in Southwest Asia in sight, he asserts that full spectrum warfare ought to be the current strategic objective, and argues that there is again a need for TD toward criterion referenced, experiential learning that embodies interactive, well-instrumented live, virtual, and constructive simulations, culminating in vivid after action reviews.

He postulates that technologies available within the next several years ought to make possible field training exercises at or near home station that are fully as effective as the Mission Readiness Exercises (MRE) presently conducted at the Army's Combat Training Centers (CTC). He details seven flaws in current instrumentation of training at the CTCs, but he points out that modern technologies for reconnaissance, surveillance, and target acquisition, combined with soldier PDA's, could enable MRE-like learning experiences anywhere.

## ABOUT THE AUTHOR

In May 1985, General Paul F. Gorman retired from the Army, forty years from the date of his enlistment in the Navy during World War II. In his final assignment, he was Commander-in-Chief, U.S. SOUTHERN COMMAND, 1983-1985. His service included three years of infantry combat in Korea and Vietnam, an assignment with the U.S. delegation to the Paris Talks on Vietnam, with CIA as a National Intelligence Officer, and with the Joint Chiefs of Staff first as J-5, then as Assistant to two successive Chairmen. In 1971-1972, General Gorman was President of the Army's Board for Dynamic Training, and from 1973 to 1977 he served as Deputy Chief of Staff for Training at Headquarters, Training and Doctrine Command, overseeing reforms of the Army's training system. He has been an innovator in the Army's use of information technology, both on active duty and since. In 1995 the Society for Computer Simulation International presented him its Founders Award for Distinguished Service, citing "his many pioneering contributions to the methodology and application of simulation to military defense and preparedness." He has served on Mitre's Army Advisory Board, on the Army-DARPA Advisory Board, and on the Advisory Board of General Atomics. In his spare time, the General works at his farm, *Cardinal Point,* where he and his family operate **Cardinal Point Winery**.

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It is probably jejune in this audience to observe that the United States Army is a **learning organization**. I certainly so believe. But I hasten to add that the task assigned to me for this evening leads me to assert three qualifications:

• *The Army learns less because it <u>wants to</u> than because it <u>has to</u>*

• *The Army's most influential mentors have been its enemies*

• *The Army forgets more rapidly than it learns*

## IMPERATIVES FOR 21ST CENTURY TRAINING

I have been involved with shaping policy for Army training and education at least since 1971, when I was assigned as Assistant Commandant of the Infantry School at Fort Benning. One of my earliest trials was occasioned by a conviction at the Continental Army Command, the senior headquarters then charged with Army learning, that good schools are built upon good libraries, and that to improve learning, the Infantry School needed to expand and to modernize its library. I had just returned from Vietnam, after one year in command of 1st Brigade, 101st Airborne Division, facing a very capable foe while coping with a shortage of experienced NCO's, and conducting on-the-job infantry training for largely ignorant draftees beset with problems of race, drugs, and lack of support from the home front. Fortunately, General Westmoreland (then the Army's Chief of Staff) understood that the Army of that time needed not better libraries, but better ways and means to lend dynamism to Army learning. He tasked me to find ways to enable a commander to tailor training for his unit's needs; training that overcame constraints imposed by lack of funds, personnel shortages, and lack of time; training that the trainer considered as being imaginative, innovative, and professionally stretching; and training that the trainee perceived as a stimulating learning experience, conducive to job satisfaction.[1] I disregarded the library tasking, and focused instead on General Westmoreland's goals, goals that should be foremost in the minds of those designing 21st Century training.

## Enemy Instructors

Cantigny, Kasserine Pass, Buna, Task Force Smith, Ia Drang…the Army learned, but the foe exacted a high price for mentoring. The *mujahideen* of Southwest Asia are but the latest of opponents that use assault rifles (e.g. AK-47), rocket propelled grenades (e.g. RPG-7), and mortars for offense, and improvised explosive devices (IED) for defense. In Vietnam, U.S. infantry units learned, slowly and expensively, to defeat frontal assaults by enemy thus armed from frontal parapet foxholes, with interlocking fires from two-man firing pits with overhead cover. Today it is a rare American infantryman that knows how to build a defense like that. In Afghanistan, Combat Outposts, and Forward Operating Bases have often proved vulnerable to AK-47s and RPGs: e.g. in the attacks at COPs Kahler and Keating, those weapons inflicted the bulk of American casualties. In those two instances, defensive reliance was placed on vertical walls, whereas in Vietnam the Army dug down, covered and concealed. The Army has evidently forgotten that concept, but a full spectrum force, such as the Army aspires to be, will have to relearn it.

## Command =Training Management

The Army has also forgotten much about how to train. Over the past three years, having again been asked to examine Army training, I have recognized problems not unlike those I had to address when the Army was emerging from Vietnam. Lieutenants and sergeants have told me that during the early months of their ARFORGEN reset cycle, training management is poor to non-existent. They were led to believe that during that period they would have a chance to develop individual combat proficiencies and practice battle drills. But higher headquarters do not then take training seriously except for mandatory lectures that have little to do with winning a firefight. Not until the last few months before an upcoming deployment do their battalion and brigade commanders turn toward preparing for a full scale Mission Readiness Exercise (MRE) at a CTC. But then there is little or no time left for leaders at squad or platoon to train and evaluate individuals, or to form cohesive teams. **<u>Training management</u>** is one old issue that urgently requires a modern, "top down" fix for 21st Century training.

## CAN ARMY SCHOOLS MEET THE CHALLENGE?

When I attended the Command and General Staff College (1962) I kept notes (since lost) on the remarkable frequency with which setting up a school figured in student solutions to faculty posed problems. I was documenting a root-level Army proclivity, for one of General Pershing's first initiatives for the Army Expeditionary Force (AEF) was to establish a school in which American officers could be trained on the intricate staff procedures required for interoperability with allies. Ever since, name the problem, then look for the school start-up.

Thirty-five years ago I proposed that Department of the Army formally recognize Training Development (TD) as a military officer specialty, and thereby assure a small, educated, uniformed elite to guide the Army's significantly large investments in the realm of learning. I envisioned TD specialists as counterparts to officers in Combat Developments, engaged with materiel acquisition. The latter were usually Operations Research and Development specialists. The TD training specialty was established, and flourished for a short time, but was eventually sacrificed on the altar of civilianization — apparently the Army's personnel managers deemed it an occupation that could be relegated to civil servants or contractors. Those among you who today detect uncertainty in the Army's approach to requirements for models, simulations, and gaming perceive the results of that shortsighted decision of a generation ago.

While it is true that the Army has over the decades established one of the largest educational systems in the nation —and arguably, in the world— and its schools and centers have been recognized as a benign influence on the nation's general education level, their military worth is debatable. Originally, they were a palliative for the lack of professionalism in the Indian Fighting Army of the latter 19th Century, and subsequently a hedge against mobilization. They probably preserved a modicum of combat effectiveness when the force was distributed in small garrisons engaged with peacetime tedium. Nonetheless, I doubt that the victories of World War II were rooted in Army officer schools. Winston Churchill erred when in 1945 he attributed to them the Army's successes in battle, and his vision for the future was flawed in his advocacy for extending them:[2]

> **I shall always urge that the tendency in the future should be to prolong courses of instruction at the colleges rather than to abridge them…Professional attainment, based on prolonged study, and collective study at colleges, rank by rank, and age by age —those are the title reeds of the commanders of the future armies, and the secret of future victories.**

The late Congressman from Missouri, the Honorable Ike Skelton, agreed with Churchill. In 1987, noting that, with the collapse of the Soviet Union, national military policy would be devised amid strategic uncertainty and domestic fiscal austerity, Ike Skelton persuaded his colleagues on the House Armed Services Committee to conduct an extensive series of hearings to ascertain if the military services could produce the requisite strategists. The hearings were intended to determine if it would be possible that, as "future resources constraints become tighter, better professional military educations can help offset those constraints."[3] They were also to seek an answer to the question "does our military spend so much time studying weapons systems and tactics that there is no room for strategic thinking?"

Skelton opined that the development of strategists of the caliber of George C. Marshall was the proper goal for military education, and he admired Army schools of the 1920's and the 30's because they produced that great American. In 1988, when I was called to testify before the Skelton Panel, I took issue with the Chairman's premises:

> **Professional military education has not in the past done all that is claimed for it… I served as the Assistant Commandant at the Infantry School, as did George Marshall, back in the late 1920s. Now, George Marshall, I believe, is correctly recognized as a great strategist, but George Marshall did not acquire his strategic prowess from his professional military education. To the contrary, George Marshall acted on the military education system as a severe critic and as a reformer. He came to Fort Benning as an individual who was deeply concerned about the formation of officers for the responsibilities of command, and was dismayed to discover that the Army had, in being there, a school dedicated primarily to the production of staff officers capable of producing long written orders of the style that had committed droves of infantrymen to attacks across the barbed wire reaches in front of the trenches in France in 1917 and 1918.**

> **There is a remarkable book that I would commend to you that was produced by the faculty of the Infantry School back in that era. <u>Infantry in Battle</u> repeatedly made the point**

**1930 Mentor**              **1944 Strategist**

Figure 1.  GEN George C. Marshall

**that war eludes rules and formats, and war rewards the inventive mind, war rewards the adaptive commander, war rewards ingenuity and the ability to perceive reality and react to it soundly. War is not a matter that can be left to rules.**

Marshall was a student in an Army school only when he was a junior officer with less than a decade of service. But soon thereafter he began to acquire a reputation for his skill with the operational art. In 1914 no less an authority than Henry H. (Hap) Arnold recognized George C. Marshall as a strategist when the two were still Lieutenants in the Philippines serving on the staff of an Opposing Force (OPFOR) for a major field exercise. The OPFOR commander was an amiable drunk on the eve of retirement, and the OPFOR chief of staff fell ill, so actual command of the force fell to Marshall, who brilliantly directed its maneuvers. Hap Arnold wrote to his wife that he had just seen a future Chief of Staff of the Army in action.[4]

George C. Marshall was indeed a strategist of the first rank. What prepared him for his responsibilities as President Roosevelt's wartime leader of the Army's Ground and Air Forces, and President Truman's Secretary of State and Secretary of Defense, was mainly self-development. Before World War II, he had earned a reputation as a master trainer and tactician. It was well known that he was critical of Army schools, holding that they taught war's grammar, but not its

logic. While he clearly recognized their importance for imparting what Churchill termed "special technical professional knowledge," Marshall also felt that the officer schools of his era encumbered graduates with elaborate theory and time-consuming technique, especially that of producing complex orders so inappropriate for contemporary warfare that these might in fact cause chaos in the opening campaign of a war. [5] Marshall was convinced that military professionalism was best taught by practice, preferably in a realistic tactical setting, which to Marshall meant competing against a thinking opponent in a contest that required improvisation, coping with the unexpected. But Marshall also believed in self-scrutiny. I told the Skelton Panel that:

**George Marshall used to advocate at Benning that every officer ought to take at least an hour a day, put his feet up on the desk, and do nothing but think about who he was, what the profession was all about, and where he thought that he ought to be going within it and how he could change it for the good of the country.**[6]

**FM 100-5**

I also advised the Skelton Panel that in their appraisal they should consider the educational and training value of service in operational units. In 1976 I drafted the opening chapters of Field Manual 100-5, a document the Army considered its doctrinal keystone. I wrote the

introduction to the edition approved and published in that year, a statement of what ought to be, rather than a description of *status quo*:

### WEAPONS AND MEN

**To win, our soldiers will need the best weapons that industry and technology can provide. But weapons, no matter how powerful, are ineffective in the hands of inept, ill-trained, unsure operators. And even proficient crewmen can be rendered impotent if improperly employed by the battle leader. Overall battlefield effectiveness depends on weapons capability, the proficiency of teams or crews, and the tactics or techniques of the commander. Thus, the US Army must obtain powerful weapons, develop fully the proficiency of the men who man them, and train leaders capable of employing weapons and crews to best effect.**

### COMBAT DEVELOPMENT

**US Army combat development seeks to increase the Army's ability to fight decisively by searching combat experience, experiments, tests, and technology for ways to provide better weapon systems, organizations, tactics and techniques. Success in combat developments is vital for our success in battle.**

### DOCTRINE

**Success will also depend on our ability to assess correctly the dynamics of modern battle: to reassess them continually, in pace with the ever-changing nature of the modern battlefield, and to communicate an effective battle doctrine throughout our forces.**

### TRAINING DEVELOPMENT

**The service schools and training centers of the Army constitute a prime resource for readying our soldiers for combat. The service schools are the Army's source of combat development and doctrine, and an important means by which we inculcate leaders and trainers with the tactics and techniques that will contribute to battle success. The service schools express standards for training throughout the Army by the way they teach, by the manuals they write, by tests for evaluating individual skills of soldiers Army-wide, and by the Army Training and Evaluation Program (ARTEP). Training development must provide training standards and techniques matched closely to the realities of the modern battlefield.**

### UNIT TRAINING

**The soldier receives most of his individual training in a unit. It is in his unit where he will have his greatest opportunities to gain confidence —with his weapons, as a member of a team, and by training under conditions approximating battle. Thus, his unit commander plays the preeminent role in developing the resolve and the competence to win outnumbered. The commander must assure each of his officers, noncommissioned officers, and soldiers, the opportunity to improve military proficiency and to prepare mentally and physically for battle. Every unit commander of the US Army is responsible for the progressive professional development of every soldier in his command. Collective training in units should aim at maximum effectiveness with combined arms. Wherever possible, commanders should press beyond ARTEP standards. Consistent with a judicious regard for safety, training must simulate the modern battlefield. Training for battle demands forging effective combined arms teamwork.**

### READINESS

**Since combat developments and doctrine are dynamic, since weapon systems are constantly evolving, and since tactics and techniques are continually changing, training methods must change apace. Readiness for modern battle means training aimed at payoff now. Constant readiness for the early battles changes the presumptions previously governing the US Army training: post-mobilization training, annual cycles, cadre development, and the like. Rather, the commander must manage his training with a sure knowledge of the present state of individual and collective proficiency within his units, and with programs especially designed to bring them up to prescribed individual and unit performance standards. To paraphrase Josephus on Roman training methods, our drills must be "bloodless battles" and our battles "bloody drills." Even in wartime, in the midst of combat, training must continue. Training must be a full-time job for all commanders, regardless of other operations or missions**

### COMMAND OF 8ID

In 1977 I was fortunate enough to be selected for command of the 8th Infantry Division (Mechanized) in Germany, responsible for defense of the Fulda Gap. I commanded the Pathfinders during a time (1977-1979) of severely restrained resources for support of training. To allow you to judge how well I coupled action with my rhetoric in FM 100-5, I want to explain first the concepts I pursued, and then describe some of my training methods.

In July 1977 I arrived at 8ID headquarters in Bad Kreuznach to find that training in USAREUR had not changed significantly from what it had been in 1961, when last I served in Europe: semi-annual trips to the 7th Army Training Center at Grafenwöhr for several weeks of exercises in moving, shooting, and communicating. An annual training program that theoretically progressed echelon by echelon from squad to platoon to company to battalion, but rarely went beyond squad with home station training, given cramped local training areas and the absence of ranges. If ever I needed a reminder that publishing a Field Manual does not create doctrine, I found it there. Doctrine is consensus; it is what most Army leaders believe, and are prepared to enact. As far as the 8ID was concerned, the newly published FM 100-5 had caused few changes.

My first efforts were directed at impressing my 0-6 commanders in the maneuver brigades, division artillery and the support command that I would thereafter expect them to plan for and to conduct multi-echelon training, simultaneously improving all echelons. They were to set aside notions of progressive training echelon, by echelon, and aim instead of readiness now, decentralizing training so that junior commanders and leaders could do likewise.

I would interest myself in training them personally and their battalion commanders, and they were to follow suit, concentrating on subordinate commanders two echelons down. Training goals were to be those set forth in the Army Training Evaluation Program, modified by my headquarters to fit their wartime missions, complete with external evaluations, After Action Reviews, and ameliorative training on identified deficiencies. I expected them to employ simulation to compensate for austere local training facilities, and to increase both periodicity and frequency of critical skill training. And I announced that my Inspector General, per the example of Baron von Steuben, would scrutinize their training management as a matter of command interest.

As far as I was concerned, I told each of them, I would rate his worth to the Army on his unit's demonstrated readiness for battle. Each then ought to start from an operationally useful definition of readiness, establish it as his personal objective, and find practicable ways to advance toward it every day. I pointed out that battle readiness is a function of three factors: materiel, manpower, and technique:  **W** for the in-built effectiveness of weapon systems, **P** for the proficiency of the crews that man and maintain those systems, and **T** for the effectiveness with which those manned systems are employed in battle —including the tactics or techniques of commanders. Readiness for war, **R**, then is a function of these variables: $\mathbf{R} = f(\mathbf{W}, \mathbf{P}, \mathbf{T})$

I did not propose that they devote time or energy to **W** variables —that was what "modernization" was all about, and what industry and the Army acquisition corps, supported by Congress, pursues most avidly. Congressional funds permitting, the Army would provide for improvements: Δ**W**. Nonetheless, **W** is but one readiness variable, and I emphasized that there is strong evidence that usually the others dominate.

Most of what is generally understood to be "training," and certainly the mainstay of most evaluations of "training" for readiness, is related to the **P** factor: manning and training with weapon systems within a given unit. Costs for **P** can be fairly well defined, but **P** effectiveness tends to elude quantification, being driven by a large number of variables, including time and facilities, plus cognitive gains that are difficult to measure. I told them that I was confident that simulation engenders Δ**P**, and that I hoped to insulate them from attempts by zealous accountants to mandate that funds used to purchase simulators for Δ**P** would be withdrawn from accounts that support live training by reducing allocations for fuel, ammunition or other expendables.

I pointed out that the **T** factor is least well understood, supported, or reported. Yet, any readiness advantage that may accrue from high **W** and/or high **P** can easily be offset by tactical ineptitude. For example, a 3700-meter tank-killing missile system (e.g., TOW) employed by an infantry leader thinking about the battlefield in 100-meter increments was dysfunctional, and that leader required remediation.

Obviously, constrained defense budgets and mandated end-strength ceilings would make it more difficult to achieve readiness. It was virtually certain that incremental improvements via Δ**W** would come slowly, but that, nonetheless, I expected that the division would soon be issued infrared equipment for night fighting. Provisions for Δ**P** would have to contend with severe downward pressures on funds, thereby putting a premium on more recourse to simulation. Costs of training would no doubt be targeted for economies and efficiencies, plus reduced allocations for consumables, such as ammunition, replacement parts for vehicles, and fuel, constraints on flying hours, field exercises, and other forms of training that rely on exercising units as they would fight. I promised them that my contribution from 8ID headquarters would be to mitigate the influence of adverse funds.

Ultimately, training management must be consistent

with national strategy. For the United States, a sensible training policy would provide cost-effectively for $\Delta P$ and $\Delta T$ while seeking to find efficiencies that will support at least robust research toward $\Delta W$. Was it reasonable to expect that such a policy could be formulated? I believed that it was. Over the following two years I demonstrated that I was right, and I hope tonight to convince you as well.

In 1977, the 8ID —the Pathfinder Division— had an annual budget of $20 million dollars or so for operations and maintenance of units strewn along the Rhein and Nahe Rivers, comprised of over 20,000 soldiers armed with 400 tanks, hundreds of other major weapon systems, and thousands of other vehicles. Budgetary guidance for the years ahead from superior headquarters —V Corps and U.S. Army Europe (USAREUR)— was "zero growth." Despite expectations that there would be increased training costs attendant to introduction of modernized weapons, that the dollar would fall relative to the deutschemark, and that the costs of ammo and fuel would increase steeply, ZERO GROWTH! Training the division involved three large annual outlays: (1) Over 20% for railroad transportation to the Seventh Army Training Center near the Czech border —payable in deutsche marks, [7] and therefore vulnerable to exchange fluctuations; (2) diesel fuel for tracked and wheeled vehicles; and (3) training ammunition, of which that for tanks and artillery were the principal elements. Ammunition was not paid for directly by the division out of its own operating funds, but the division managed ammunition expenditures by dollar value to meet explicit "zero growth" strictures from corps and army headquarters. If the Pathfinders were to increase readiness, and insure $\Delta P$ and the $\Delta T$ commensurate with the full potential of their weapons, the division would have to operate upon these three major outlays, using markedly different training methods to generate discretionary funds for capital equipment and expendables to support such novel methods.

Payments to the *Bundesbahn* for rail movements to Grafenwöhr were the first, most lucrative target. In fiscal year 1977, the division paid over $4,400,000 to the railroad to move its armored vehicles twice, an average 1600 kilometers of rail moves per battalion. To generate savings for FY 1978, I cut the number of vehicles moved by rail by setting up a divisionally supervised pool of heavy equipment at Grafenwöhr. As soon as it could during that year, the division eliminated all but a few rail shipments to Grafenwöhr, and substituted travel three times each year to Baumholder, a much smaller, but much closer training area under French control, used chiefly by the German Artillery School, but also available to 8ID.[8] Rail travel

was reduced to 400 kilometers per battalion on the average, and divisional rail bills for FY 1978 dropped to $1,800,000 (divisional savings were actually larger than $2,600,000 because the division received a compensatory lump sum in dollars, compensation for losses in previous-year foreign currency transactions). The differential was reprogrammed for upgrading ways and means of training both at home station, and at the training area.

The cost of diesel fuel was also problematic. Between fiscal year 1970 and fiscal year 1978, cost of diesel had risen from 12¢ per gallon to 51¢ per gallon, and auguries were for even more dramatic rises. Nonetheless, during FY 1978 some rail moves to Baumholder were eliminated in favor of marching battalions to that training area over the public highways because diesel costs, though higher per gallon as anticipated, proved somewhat lower than the escalating rail costs. Moreover, since the division's wartime mission entailed deployment over the same roads, the marches contributed to readiness. The training at Baumholder was carefully managed to control consumption of diesel fuel.

As the division began revision of its training plan in 1977, we were aware that between fiscal year 1970 and fiscal year 1978, costs of a round of training ammunition for the 105mm. tank gun rose more than three times. The division had been advised that the per round cost of tank ammunition would increase more than twice as much over the following three years, but that its plan could provide for no increase in the ceiling set for armor training ammunition (TP-T, TPDS-T). USAREUR asserted that $\Delta W$, increasingly accurate sights and improved service ammunition, warranted less practice, and cut training rounds per tank crew from 180 to 71 per annum. This guidance ignored not only a growing armor threat in the Group of Soviet Forces Germany, but also turbulence within 8ID crews, and skill decay over time —all of which had been quantified by TRADOC training developers. Moreover, USAREUR headquarters, responding to TRADOC urgings, had substantially increased its standards for tank gunnery qualification. From fixed targets and single exposures, the goals were raised to engaging moving targets, and to hitting multiple targets with main gun rounds within twenty seconds. For a 50-50 chance of hitting, a WWII tank had to shoot 13 rounds; in '76, one round: Tank guns were larger in caliber, with muzzle velocity ~5000 feet per second, 2.5 times their WWII predecessors. Laser range finders had all but eliminated ranging errors. Taken together, these advances amounted to a ten-fold increase in hit probability, and further $\Delta W$ was in the offing.
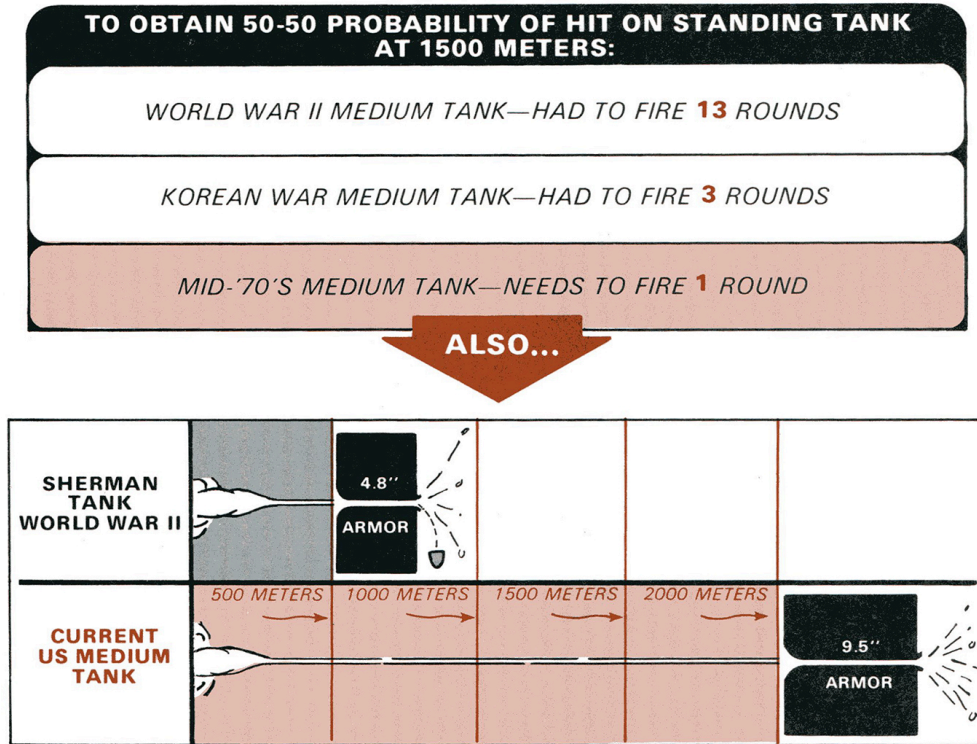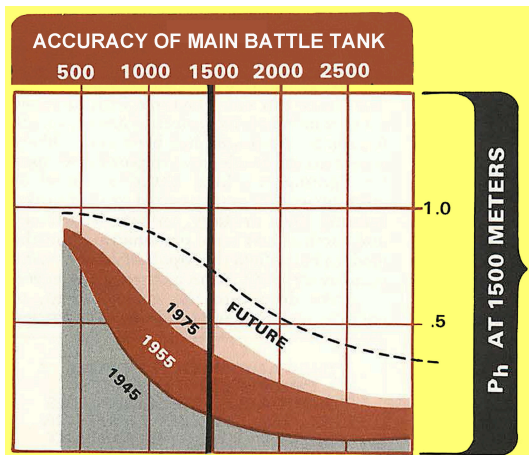
Figure 2. Tank Probability of Hit



Figure 3. Tank Main Gun Accuracy

But I believed that the new USAREUR standards, though demanding, were inadequate for combat readiness. TRADOC training developers had demonstrated, using a digital simulation of combat in the Fulda Gap region, that a U.S. tank company team facing a Soviet breakthrough attack, could confront 60 armored vehicles advancing at 10 kilometers per hour across an average field of fire of 1200 meters, so that the proper criterion for **P** and **T** should be that

"Company Team (twelve tanks) engage and defeat 60 advancing targets within 7.3 minutes." TRADOC pointed out to USAREUR that at peak proficiency its tankers were capable of gunning down such an attack,[9] but that its evaluations showed that three months after a semi-annual tank gunnery "season," **P** would be degraded some 25 percent by skill decay and personnel transfers. At that level of proficiency, winning was unlikely. Beginning in FY 1978, USAREUR required annual qualification on a new range for platoon gunnery, Tank Table IX[10] at Grafenwöhr, to emphasize the requirement for fire control and mutual support among tanks, and enjoined frequent practices throughout the year. It happened that 8ID was the first in USAREUR to use Table IX (autumn 1977), and its tankers were patently not up to it: only 7 percent of its platoons met the new standard. Both to cope with off-season readiness, and to meet the higher "mark on the wall," Pathfinder tankers needed a new training approach.

Among tank crews, ΔP proceeds from repetitive firing practice, and is sensitive, *inter alia*, to both frequency (the number of firing repetitions per training session) and periodicity (the time lapse between sessions, during which **P** tends to decay).[11] But how could the division attain and maintain ΔP in the face of drastic cuts in tank ammunition allowances?
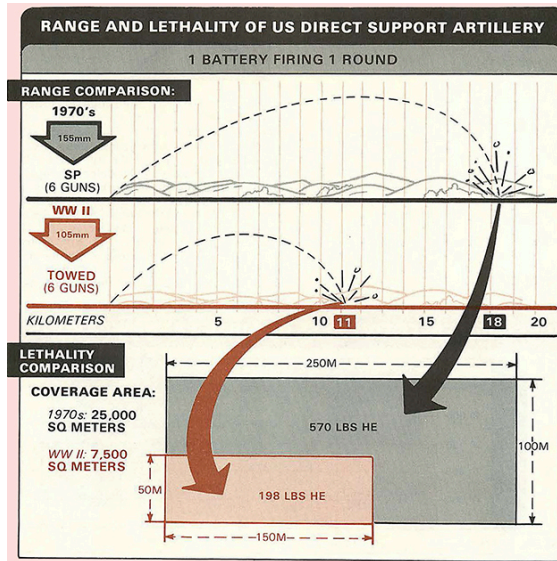
Figure 4.  Artillery Range and Lethality

For FY 1978, I negotiated a tradeoff of <u>artillery</u> ammunition for <u>tank</u> training rounds that kept the full-caliber rounds per tank crew at 100 per year. But this stratagem was coupled with a commitment to invest heavily in sub-caliber firing. For tanks, this meant 8ID's funding manufacture of .50 cal devices.[12] The division also purchased $300,000 worth of portable, radio-controlled targets to align tank-training ranges at Baumholder with the challenges of Table IX. These simulators leveraged upward the utility of home station training areas, and frequent firing became practical. When next the division's tankers fired through Table IX at Grafenwöhr (spring '78) 95 percent of its platoons qualified. Pooling of tanks at Grafenwöhr, rather than detracting from crew proficiency, aided standardization of loading plans within the division, and reduced rounds expended for calibration of the tank sight with the gun tube.

My ammunition trade-off, of course, precipitated a substantial amount of thunder and lightening in the 8ID Division Artillery (DivArty), and rumbles and flashes on the horizon in the direction of V Corps artillery, over what was perceived as an example of blatant racism on my part, favoring tankers over red-legs. Yet artillery **P**, like that of the tank, improves as a function of frequency and periodicity of practice. Δ**W**, range and lethality of DivArty cannons, were significantly improved since WWII, but artillery ammunition costs were also rising, a round of 155mm having increased in cost by a factor of 2.8 from FY 1970 to FY 1978.

Still, the artillery's cost per projectile was only about a quarter the cost of a tank round. I weathered the storm

by offering 8ID artillerymen a trial by shoot-off. Two battalions, both with the same 155 mm self-propelled howitzer, would participate in a 12-month test. **Battalion B** —billeted adjacent to Baumholder's training area, where it could fire almost literally from its motor pool— would be issued, on demand, all the 155 mm rounds it wanted for service practice. **Battalion W**, stationed at Wiesbaden, farthest from Baumholder, had no opportunity at home station to shoot full caliber, and could do so only after a long road march to the training ranges there. Battalion **W** would be provided 70 percent the number of 155 mm rounds Battalion **B** received, but would also receive, again on demand, unlimited 14.5 mm sub-caliber ammunition, which the division could purchase locally. The sub-caliber round was fired on a 1/10th scale range, so that using it, in effect, converted Wiesbaden's unused airfield into an artillery range. At the end of twelve months, both Battalions **B** and **W** would be sent to Grafenwöhr, and there undergo shooting trials judged by impartial evaluators, using only 155mm service practice ammunition. Well, of course, serving units can seldom sustain a pristine experiment of that sort, and training proficiencies early demonstrated by Battalion **W** prompted the Division Artillery Commander to prescribe 14.5mm sub-caliber practice for all his units, including Battalion **B**. Nonetheless, the contest was carried to completion. Over the 12-month test, the competing battalions shot for training the rounds shown in Table 1 below.

Table 1. Rounds Fired, By Type

| Battalion | 155 mm | 14.5 mm | Total |
|---|---|---|---|
| **B** (Full caliber) | 5080 | 2720 | 6800 |
| **W** (Simulation) | 2880 | 4320 | 7200 |

In the end-of-year shoot-off at Grafenwöhr, evaluators concluded that both battalions met the readiness standards established by the Army Training and Evaluation Program and USAREUR, noting no significant differences among the two in ability to deliver fire on target. They did observe that **B** handled its ammunition better, and that **W**'s fire direction centers were faster. From the divisional perspective, this experiment validated that Battalion **W**'s demonstrated readiness had been achieved with 72 percent of the 155mm ammunition cost for Battalion **B**. The Pathfinder's red-legs were converted, and thereafter sub-caliber simulation became central to their training.

The 8th Division was nominally an infantry division, and because of my upbringing, I interested myself in the effectiveness of infantry training even though it was not so weighty an item in Division budgets as artillery or tank training. I was disinclined to accept
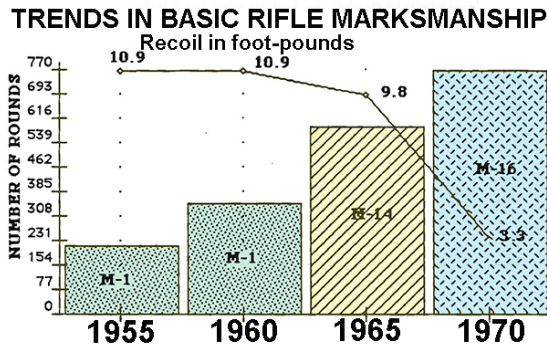
Figure 5. Rifle Marksmanship Trends

prevalent practices. USAREUR standards provided for the firing prescribed by the U.S. Army in its Basic Rifle Marksmanship (BRM) training program. From 1950 through 1975, the Army's standard shoulder arm changed from the M-1 Garand rifle of World War II and Korea, then to the M-14 rifle, and finally to the M-16 rifle.

I sat on the Army Board that recommended adoption of the M-16, and I can attest that one of the reasons the Board supported that weapon was its putative ease of training, occasioned by its low recoil (30% of the M-1's), and its flat trajectory. Yet, the number of rounds prescribed for qualification with the M-16 was eventually raised to more than double the number found adequate for M-1 BRM during the Korean War. I had learned from TRADOC training developers that the number of rounds fired for qualification had little to do with combat effectiveness. Nor, did hours of BRM training. Table 2 (below) provides a summary of the results of experiments with 4400 soldiers, four training programs conducted by expert instructors, of varying length, and varying number of rounds.

Table 2. Rounds Fired per Soldier

| BRM Program | Hours Training | Rounds Fired |
|---|---|---|
| Army Standard | 72 | 778 |
| Alternative 1 | 35 | 334 |
| Alternative 2 | 49 | 262 |
| Alternative 3 | 62 | 560 |

Months later posttests were conducted with previously qualified soldiers to establish probability of hit on standard pop-up targets at ranges between 50 and 300 meters. There were no significant differences among graduates of the four training programs. Conclusion: the quality of BRM training and evaluation counted more than rounds fired.

For 8ID, my dissatisfaction with the Army Standard BRM Program stemmed less from costs than from combat effectiveness. The evaluation method prescribed by USAREUR was the TRAINFIRE range, in which soldiers as individuals rotated among firing positions at the head of defined lanes. At various distances in each lane a target would be raised by electric levers, exposing a flat, head-shoulder silhouette, the plane of which was normal to the firer. The target would remain up for 10-12 seconds, unless earlier hit, but was otherwise static. I knew that tests at the Combat Development Experiment Center (CDEC) showed that TRAINFIRE did not provide realistic combat readiness training for infantry, in that 90 percent of all targets detected by infantrymen in battle move angularly with respect to the observer. CDEC demonstrated that soldiers in foxholes typically see and engage targets across a sector of $140^o$, that usual target-exposure times were less than 6 seconds. Nonetheless, CDEC demonstrated that, after proper practice, infantry teams could be trained to engage and to hit.

I therefore directed that 8ID infantry would use neither the Army standard BRM, nor TRAINFIRE, but rather criteria set forth in a modified divisional ARTEP that required riflemen to engage fleeting, moving targets, and to do so as tactical teams. My purpose went well beyond Marksmanship Badges to Pathfinder combat power.

**Results**

In 1979, in my final report to V Corps, I cited improvements in the mission-dictated tasks as listed in Table 3. Note that effectiveness for only three tasks is described by a numerical value, and even these are dubiously useful as reference criteria. The division had three models of tanks, each with a distinctive fire control system. The division used many different portable, radio-controlled targets, so that often firing conditions varied from range to range, day-to-day. Similarly, sub-caliber ranges reflected wide differences among home station training facilities. Each river crossing tended to be unique, a task performance that varied widely depending on conditions (e.g., location, bank status, state of the river, weather, available crossing means) so that standards were difficult to articulate, and comparisons largely meaningless; nonetheless, the division and supporting German engineers felt significantly more confident of their combined abilities after the exercises than before, and interoperability definitely progressed. Uploading ammunition for war was a task the division could time, and repeat task performance under comparable conditions, but the timing improvement reported represents the differential between what the first battalions achieved and that of the last battalions, there having been significant changes between each iteration

Table 3. Task and Result

| TRAINING TASK | EFFECTIVENESS |
|---|---|
| **Infantry live-fire exercises** | **Marked increase in numbers and difficulty** |
| **Adjustment of artillery on moving targets** | **Regularly practiced from ground and air OPs** |
| **Upload ammunition for war** | **Time per battalion reduced 50%** |
| **Accelerate river crossing techniques** | **Much easier, faster on both Rhein and Main Rivers** |
| **Increase efficiency of road movements** | **Accidents down, deployment time to border 15% less** |
| **Improve maintenance for equipment readiness** | **Operational Readiness rates up and climbing** |
| **Expedite tank zeroing; improve equipment stowage** | **Number of rounds down, speed and accuracy up** |
| **Improve tank and artillery accuracy and speed** | **Sub-caliber widely accepted, frequently practiced** |
| **Meet or exceed USAREUR tank standards** | **95% of 8ID tank platoons qualified** |
| **Improve C3I in battalion task forces and brigades** | **Command groups trained and evaluated** |
| **Develop procedures for building strong points** | **Actual strongpoint built, critiqued, and documented** |
| **Employ antitank mines effectively** | **Repetitive emplacing and recording minefields** |
| **Communicate assuredly and securely** | **Directional antennas for FM fabricated, practiced.** |

based on lessons learned from earlier evaluations. In the road movement case, accidents reported were compared with vehicular miles on German roads; the latter rose sharply when I curtailed rail moves, so the proportionate decrease in accidents must be credited in that light. Moreover, some readiness training tasks were more important than others, but often the more important were those most difficult to measure: $\Delta P$ for tank crews and artillery units was relatively easy to measure and to quantify, but how does a commander train for, let alone measure $\Delta T$? How does he develop the tactics, techniques, and procedures that will win battles at least cost? The answer appears to be well-trained battalion commanders and staffs.

## FIRST BATTLES OF PAST WARS

The first battle of most wars fought by the Army of the United States was a disaster: a costly defeat or a Pyrrhic victory. One American historian, in case studies of ten of these misfortunes, concluded that a fundamental weakness of American arms has been ill-prepared command groups:[13]

**... More glaring than poorly trained troops as a first-battle problem is the weakness of command and control. Virtually every case study emphasizes the lack of realistic large-scale operational exercises before the first battle, exercises that might have taught commanders and staffs the hard, practical side of their wartime business as even the most basic training introduces it to the soldier at the small-unit level. Virtually every case study indicates that the results of confusion, demoralization, and exhaustion at the command and staff level are at best bloody, at worst irremediable--a more crippling defect even than combat units falling apart, because units can often be relieved and replaced in time, headquarters almost never... At least through the First World War, the professional response to the chronic American weakness in command and control was to plan more thoroughly, leaving as little to chance as possible. But thorough planning, with its natural de-emphasis on unexpected situations (beyond the scope of contingency plans), led to rigidity and often-heavy losses. In other words, the command-and-control weakness and its chosen professional remedy were but two aspects of a single larger problem: inadequate preparation of commanders and staffs for the real world of combat ...It is likely that this problem is more acute in America's first battles because the size and structure of the prewar Army, and thus the prewar experience of senior commanders and staff officers are --even today—dictated largely by peacetime needs, not by wartime probabilities. Headquarters in the U.S. Army habitually expend their time and energies on routine administration, seldom pushing training and testing themselves as they push, train, and test their troops. The result too often seems to be that the troops, even when inadequately trained and armed, are readier for war than the men who lead them. The implied lesson is that senior commanders and their staffs might do well to free themselves from the routine busywork of peacetime military life and to plan and carry out frequent, more realistic training exercises for**

**themselves, involving several command levels and arms, that will hone skills th**at **otherwise must be bought with blood and possibly, defeat...**

## BATTLE SIMULATION

One exception to this American training lacuna occurred after the stunning Prussian victories over the French in 1870. The U.S. Army promptly traded the Civil War *kepi* for the *Pickelhaube*, and *Kriegspiel*, or wargaming, gained recognition as a method for training officers for decision-making in battle. In 1879, Livermore's <u>The American Kriegspiel</u>, [14] came into use: an elaborate, map-board, two-sided, manual war game, based on the weapons and tactics of the Civil War. This game was onerously slow and clumsy. Moreover, as weapons advanced —for instance, the introduction of the breech-loading rifle and the machine gun— the Livermore model of war and similar models lost credibility. But the latter nineteenth century seems to have been the only period in which two-sided war games —battle simulations— enriched the peacetime training of U.S. Army command groups for battle, at least until the recent past.

In the early 1970s, the U.S. Army Combat Arms Training Board (CATB) launched a revival of battle simulation for training commanders and staff, fielding both manual (map-board) and computer-driven simulations. "Battle simulation" is a term that describes procedures depicting in real time the results of two-sided, free-play engagements of opposing armed forces. Actual forces need not be employed; rather, the engagement simulation is focused on presenting decision-prompting events, portraying combat-like circumstance for command groups. The term sometimes fits the rubric of "command post exercises" (CPX), yet it is important to note that the terms are not synonymous, in that the conventional CPX is neither two-sided, nor free-play. Battle simulation can involve exercises on terrain, perhaps using just leaders, command groups, or skeletal forces.

By 1976, CATB's prototype board games were in use for both institutional and unit training, and its prototype computer game, the Combined Arms Tactical Training Simulator (CATTS), was being used for training evaluations of line battalion command groups at C&GSC. In 1977, a C&GSC-developed board simulation, FIRST BATTLE, supported the V Corps portion of the annual REFORGER exercise in Europe. The following summer, the 8th Infantry Division incorporated another C&GSC battle simulation, PEGASUS, into field exercise CARDINAL POINT II (CPII), to support a brigade-level, hybrid battle simulation, conducted in part on terrain, and in part on

a map-board. The design of the battle simulation portion of CPII was an outgrowth of Project FORGE, conducted at the Infantry School from 1968-1971[15] and FORGE's lineal descendant, CATTS, which was used first at the Infantry School and later at C&GSC. Moreover, CARDINAL POINT II employed multi-echelon evaluation for both $\Delta$**P** and $\Delta$**T,** seeking to challenge simultaneously both the officers responsible for battalion-level tactical performance through battle simulation, and leaders and soldiers in platoons through small-unit live exercises that required them actually to move, shoot, and communicate.

General "Ace" Collins, one of the modern Army's noted trainers, held that:

> **In a maneuver, or field training exercise (FTX) which is the normal form of large-unit training, the higher the level of the participating units, the poorer the performance of the small units. Exceptions to this generalization are rare. Research indicates that this has been a consistent criticism of large unit training since the Louisiana Maneuvers in 194l...Over the years, observing exercises has led me to the following rule of thumb: the benefits of a field-training exercise extend to units two levels below the highest headquarters participating.**[16]

Collins believed that a brigade-level field exercise could provide meaningful training only for battalion and company commanders, and urged that the "real key to successful training" was emphasis on individual and small-unit performance. He noted that the training of the World War II German Army had "emphasized small-unit training and was done for the most part near home station (Kaserne)." But the Germans did not neglect the training of commanders and battle staffs either, and Collins also advocated command-post exercises (CPX) and what he termed "reduced-distance exercises" for battalion and brigade commanders, remarking that "these forms of training can be done without the cost and loss of troop time involved in large-unit field training exercises."[17]

### CP II: Blended Live, Virtual, and Constructive Simulations

CARDINAL POINT II (CPII) encompassed the 8th Division's FY 1978 ARTEP evaluations, and took place during the summer of 1978, largely on "maneuver-rights" land[18] within the division's garrison region, but using the Baumholder ranges. Seven sequential, evaluated Field Training Exercises (FTX) took place, each extending day and night over ten days, each for a brigade of two battalion Task Forces —one

Table 4. CARDINAL POINT II Events by Day

| DAY | TASKS |
|---|---|
| 1 | Alert<br>Upload as for war*<br>Pre-combat inspection*<br>Movement (by road) to forward assembly area<br>Form combined arms task force<br>Receive Bde OpOrd; conduct troop leading procedures* |
| 2 and 3 | Conduct two-day field exercise in defense*<br>Occupy successive delay positions*<br>Plan fires and maneuver*<br>Maintain security*<br>One company team detached to construct strongpoint (Days 3 thru 8)* |
| 4 through 7 | For Task Force command groups and Company Team commanders:<br>Hybrid battle simulation, 4 missions*<br>For platoons, sections, and TF support elements:<br>FTX, live fire and Tactical Engagement Simulation (TES)*<br>Company Team at strongpoint continues construction* |
| 8 | Reassemble battalions; conduct maintenance<br>Leaders critique strongpoint* |
| 9 | Officers conduct cross-country navigation exercise*<br>NCOs lead battalions on road march to home station<br>After-operation maintenance |
| 10 | Post-exercise inspection* |

* Divisional evaluation

tank battalion and one infantry battalion, both cross-reinforced. To exercise the division's organizational flexibility, the brigade headquarters deployed was usually one other than that to which the battalions were attached in garrison. Division controller teams aided the brigade in portraying the tactical situation, assuring safety, and conducting evaluations. The sequence of key events for CPII is shown in the Table 4.

On Day 1, the unit was required to move to a simulated ammunition storage area built to resemble its wartime depot, and there upload into its vehicles wooden boxes of appropriate markings, cube and weight. This portion of the exercise immediately identified physical improvements possible in the storage bunkers, and more efficient methods among the units drawing the ammunition.

Then followed three operational phases: In the **first phase** the battalions had to cross a major river, and march to an assembly area, cross-reinforce, and then move into position on unfamiliar terrain for two days of occupying successive positions for defense and delay. The diagram in Figure 6 portrays the **second phase**, a four-day period in which the two Task Forces were divided among three different activities: (1) a battle simulation for the two Task Force command groups and their company team commanders, conducted under control of a brigade commander, (2)
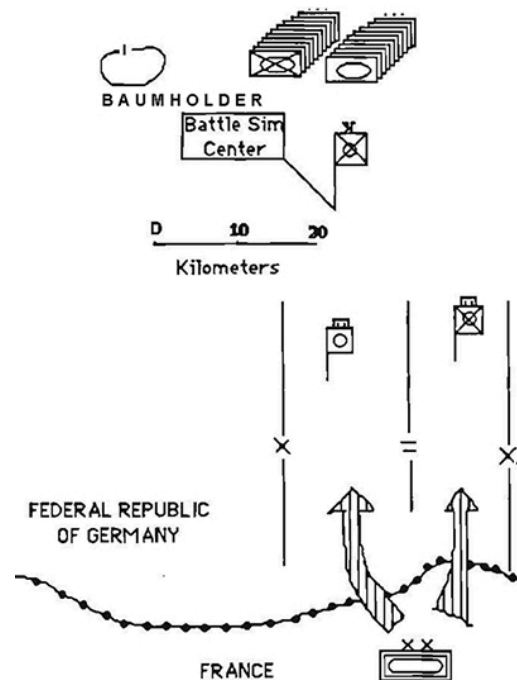


Figure 6. Battle Simulation Scenario, Phase 2

an extensive evaluation of small-unit training, a series of platoon exercises at 20 different locations using both live fire and Tactical Engagement Simulation (TES); and (3) a FTX for a company team actually constructing a strong point. **In the third phase**, units returned to garrison under orders that stressed cohesion and teamwork.

The battle simulation ran continuously for 96 hours, based on a scenario in which an OPFOR division drives north out of France toward an 8ID brigade that has taken up position as covering force for the division.[19] Four battles then ensue, a defense against (1) hasty OPFOR attack, then (2) defense against a deliberate OPFOR attack, followed by (3) U.S. counterattack, and (4) pursuit. The exercise combined use of actual terrain with notional forces on a congruent map board, represented down to individual armor/anti-armor and indirect fire weapons, supporting headquarters and logistic elements.

The Company Team commanders, according to the orders they received from their Task Force command group, positioned and moved friendly elements. Combat outcomes were determined using a division-modified version of PEGASUS on a 1:10,000 scale map. Task Force command posts, all radio nets operational, were deployed within their assigned zone and displaced realistically, fully camouflaged, as they would be in wartime. Within each command post there was one specially trained officer-observer, whose task it was to note intra-staff transactions.[20]

Pre-battle troop leading, including reconnaissance, took place on the ground, but when the company team commanders had received their orders and completed their reconnaissance, they were flown to the Battle Simulation Center where they arrayed elements of their commands, weapon system by weapon system, on the game board. Thereafter, they "fought" a free-play battle against OPFOR. The team commanders were linked to their Task Force command post by radio, reported developments in the situation to their commander, and reacted to his orders. Some Task Force commanders went forward to confer face to face with one or more of their Team commanders during battle, in which case the latter left the board, and flew to rendezvous on the ground.

The timing of battles was left to the Brigade Commander in his role as Exercise Director. Clock time usually equaled exercise time, but the Exercise Director (Brigade Commander) could, at will, advance the situation rapidly. He was allowed to halt action, and even direct a restart if he chose to do so in the interests of more effective training. Moreover, the battles were designed to be of unequal intensity and difficulty for the participants. The controllers themselves rated the first battle the least demanding of the Task Forces, and the third battle the hardest; following are indices of controller-assigned difficulty: **Battle 1: 1.00     Battle 2: 1.44     Battle 3: 1.73     Battle 4: 1.29**

Incorporated in the exercise were a number of U.S. weapons which the division expected to receive in the year ahead, but with which none of the command groups had previous experience: e.g., artillery-delivered mines, and thermal sights for tanks, for anti-armor weapons, and for artillery forward observers. In some instances, command groups had to school themselves on the characteristics and employment possibilities of these novelties, just as they might were the unit to receive a newly fielded system amid an actual battle. (We considered, but rejected in the interests of other training goals, injecting into the simulation an OPFOR Weapon X, unexpected equipment like a new armor suite for main battle tanks, to probe whether the U.S. forces could detect and counter the new materiel.)

After each battle, play was suspended and a hasty after-action review (AAR) was conducted. The Brigade Commander led a discussion for all participants, including the board controllers, asking what went operationally right or wrong in the course of the battle. Then the officer-observer who had been in the Task Force command post privately briefed his Task Force commander on his observations of the functioning of the TF command group. Time was then made available to the Task Force to concert plans for improving their performance in the next battle.

Improve they did. A fairly elaborate evaluation organization was in place to record performance of each participating command group, supervised by a team of scientists from the US Army Research Institute for the Behavioral and Social Sciences (ARI), and the Human Resources Research Organization (HumRRO). These adopted two independent measures of effectiveness (M.E.): one was a military scale (Military M.E.) which rated effectiveness in terms of mission accomplishment, ground area controlled, resources remaining at battle end, and force exchange ratios; the second was an "organizational effectiveness" scale (OE M.E.) which rated the interpersonal relations within the command group in terms of reality testing (sensing, communicating information, and ability to learn from success/failure to modify the process), adaptability (decision-making, coping with changes in the situation, and transmitting decisions, orders, and other implementing directions), and integration (actions to compensate or stabilize for disruptions). As illustrated
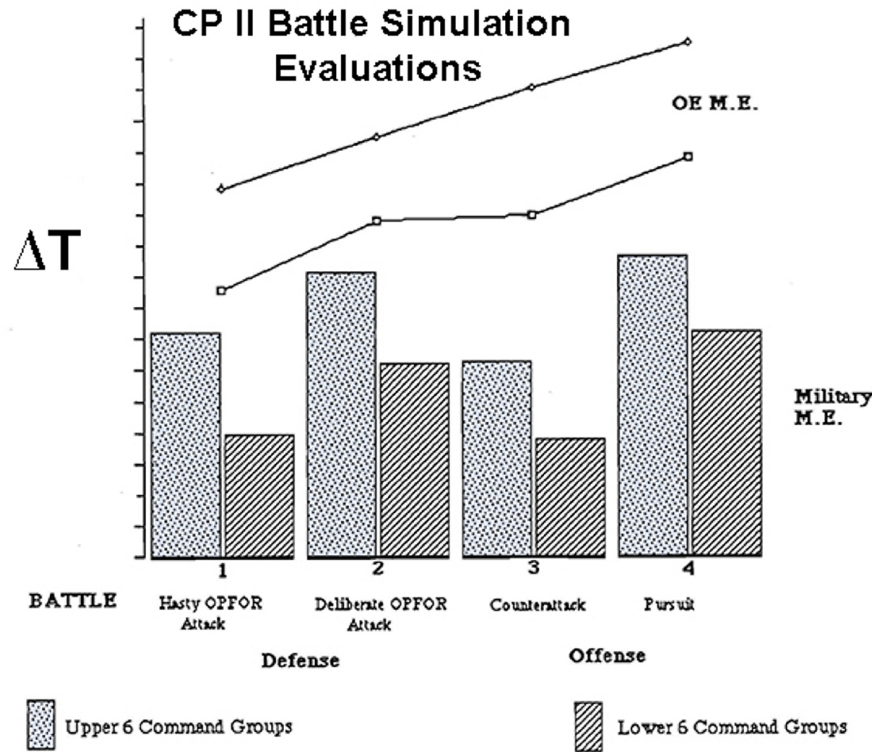
Figure 7. Military M.E. and OE M.E. Changes

in Figure 7, both measures of effectiveness, and judgments of interviewed participants, denoted improvements throughout the four days, from battle to battle. The data were internally consistent: the scores using Military M.E. correlated well with scores using OE M.E., and both moved upwards as the exercise progressed. "Learning curves" were recognizable, and these had evidently not yet reached the point of diminishing return: a fifth battle would probably have produced further improvements. In reporting on outcomes, the battalion command groups, not otherwise identified, were divided into six upper-half performers, and six lower-half performers, using the OE M.E.

These outcomes occasioned some surprise among commanders at brigade and division. In the first place, all the participating battalions had known for at least six months what tasks, conditions, and standards would figure in CARDINAL POINT II.[21] While there were differences among them in organization and equipment, they were all well practiced in cross reinforcing, in training and operating as Task Forces, and in exploiting the potential of each weapon system. Brigade and division both reported them all as having the same high rating in official readiness reports. Moreover, all battalion commanders had been chosen for their assignment by a Department of the Army Command

Selection Board, and their records showed them to be remarkably alike in age, experience, schooling, and previous efficiency ratings. But during the CARDINAL POINT II Battle Simulation, marked differences became evident among those commanders in their ability to lead in battle, and in the effectiveness of their command groups, differences that can fairly be said to reflect Δ**T**.

The scores of battalion command groups for Battle 1, before the first after action review, and before opportunity to rectify egregious error and omission, probably depict their state of readiness as they entered the exercise. The OE M.E. improved fairly steadily from Battle 1 through Battle 4, but the Military M.E. regressed between Battle 2 and Battle 3 as the mission shifted from defense to offense — understandably, since offense had theretofore received little emphasis in divisional training. The change in scores from Battle 1 through Battle 4, reflecting experiential learning, cumulative feedback and remediation, measures the overall Δ**T** from the four days of battle simulation. Table 5 (below) summarizes these results by dividing scores for Battle 4 by those for Battle 1.[22]

Except for the command groups rated by the Military M.E. in the upper half, all ratings show an approximate doubling of Δ**T**. Gains in effectiveness, whether

Table 5. ΔT (Score Battle 4/ Battle 1)

| Military Measures | Upper Half | 1.35 |
|---|---|---|
| | Lower Half | 1.82 |
| O. E. Measures | Upper Half | 1.94 |
| | Lower Half | 3.68 |

measured by the Military or the OE M.E., were much more pronounced for the lower half performers. Nonetheless, the spread among the participants remained significant in that "lower half" command groups finished Battle 4 about where "upper half" command groups finished Battle 1. The largest measured differences among command groups were Military M.E. ratings on Mission Accomplishment, Area Controlled, and Force Exchange Ratio, all performances central to successful implementation of U.S. Army doctrine for winning in battle against numerically superior foes. Command Groups that were rated high by organizational effectiveness measures (OE M.E.), performed well by operational measures (Military M.E.). Being enabled thus to perceive differences in effectiveness among these command groups was, in itself, a signal contribution to the readiness of the division, informing its commanders where and how to act to ameliorate **T** in subsequent training.

I personally had expected the battle simulation to show significant differences in effectiveness among my battalion commanders and their staffs. At TRADOC, I had seen evaluations of over forty battalion command groups of battalions stationed in the United States evaluated by the Combined Arms Tactical Training Simulator (CATTS) at the Command and General Staff College (among whom there had been a substantial spread in effectiveness). One of the statistics I used to cite from that era compared a "qualified command group" with an "unqualified command group" (those labels were my own, not used by the CATTS controllers or C&GSC). Both the command groups had chanced to encounter the same size enemy force on identical terrain. In both instances, the OPFOR had a 4:1 advantage in numbers. The "qualified command group" led its unit to victory in the ensuing battle, emerging with 22 tanks after cutting the OPFOR down to 12; the "unqualified command group" in very similar circumstances found itself withdrawing with just 5 remaining tanks, pursued hotly by 35 OPFOR tanks.

In CARDINAL POINT II, I was the only officer in the Division privy to all unit identifications and ratings. I must confess that I was surprised to find among the lower six command groups one commander I had theretofore regarded highly, and another commander in

the upper six whom I had expected to manifest grave difficulties. In the first instance I had been misled by the commander's personal brilliance and persuasiveness; he had simply not formed a team within his command group, and CPII revealed that he could not carry prolonged action on his own shoulders. In the second, a competent staff carried along a plodding commander, and that team performed along with the very best. Again, the data we collected in all the many evaluations conducted for CP II proved to be indispensible to me as I planned for training my brigades thereafter.

## WHY MULTI-ECHELON TRAINING AND EVALUATION?

Colonel Ardant du Picq, killed in action against the Prussians leading the 10th Regiment of the Line near Metz in 1870, would have endorsed the training methods of CPII that emphasized frank criticism during AAR. That military thinker wrote nearly 150 years ago:[23]

> **The smallest detail, taken from an actual incident in war, is more instructive for me, a soldier, than all the Thiers and Jominis in the world. They speak, no doubt for the heads of states and armies, but they never show me what I wish to know--a battalion, a company, a squad in action ... All these details in a word, enlighten either the material or the moral side of the action, and enable it to be visualized. Certainly one cannot obtain all the details of the same incident. But from a series of true accounts there should emanate an ensemble of characteristic details which in themselves are very apt to show in a striking, irrefutable way what was necessarily and forcibly taking place at such and such a moment of an action in war. Take the estimate of the soldier obtained in this manner to serve at the base for what might possibly be a rational method of fighting. It will put us on guard against a priori and pedantic training methods. Whoever has seen, turns to a method based on his knowledge, his personal experience as a soldier ....**

Like Ardant du Picq, Brigadier General S.L.A. Marshall believed that the ground-truths of war are to be found down where the fight is joined. Of effective military training, SLAM wrote this:[24]

> **... Kant has said: "What one learns the most fixedly and remembers the best is what one learns more or less by oneself." To square training with the reality of war it becomes a**

**necessary part of the young officer's mental equipment for training to instill in him the full realization that in combat many things can and will go wrong without its being anyone's fault in particular. The problem of command in battle is ever to establish a safe margin that will allow for such misadventures. But this much is certain: there is no system of safeguards known to man that can fully eliminate the consequences of accident or mischance in battle. Hence the only final protection is the resiliency and courage of the commander and his subordinates. It therefore follows that the far object of a training system is to prepare the combat officer mentally so that he can cope with the unusual and the unexpected as if it were the altogether normal and give him poise in a situation where all else is in disequilibrium. But how to do it? I would say that the beginning lies in a system of training that puts the emphasis on teaching soldiers how to think rather than what to think ... The test of fitness of command is the ability to think clearly in the face of unexpected contingency or opportunity. Improvisation is the essence of initiative in all combat just as initiative is the outward showing of the power of decision ....**

Both the military sages I have cited are consistent with Clausewitz.[25]

**... We have identified danger, physical exertion, intelligence, and friction as the elements that coalesce to form the atmosphere of war, and turn it into an activity that impedes activity. In their restrictive efforts they can be grouped into a single concept of general friction. Is there any lubricant that will reduce this abrasion? Only one, and a commander and his army will not always have it available: combat experience ...In war the experienced soldier reacts in the same way as the human eye does in the dark: the pupil expands to admit what little light there is, discerning objects by degrees, and finally seeing them indistinctly. By contrast, the novice is plunged into the deepest night. No general can accustom an army to war. Peacetime maneuvers are a feeble substitute for the real thing; but even they can give an army an advantage over others whose training is confined to routine, mechanical drill. To plan maneuvers so that some of the elements of friction are involved, which will train officers' judgment, common sense and resolution is far more worthwhile than inexperienced people might think. It is immensely important that no**

**soldier, whatever his rank, should wait for war to expose him to those aspects of active service that amaze and confuse him when he first comes across them. This is true even of physical effort. Exertions must be practiced, and the mind must be made even more familiar with them than the body. When exceptional efforts are required of him in war, the recruit is apt to think that they result from mistakes, miscalculations, and confusion at the top. In consequence his morale is doubly depressed. If maneuvers prepare him for exertions, this will not occur ...**

For the United States Army, the analytical question comes down to just how close an approximation of combat can we make our TES, our battle simulations, our Combat Training Centers, and other unit simulations? Can these surrogates for battle produce battle-worthy experiential learning?

Note that the data I have presented thus far on training effectiveness is comparative, that is, it describes a differential between one state of training and another. Some anecdotal connections have been made between the training methods described and actual war. Naval aviators have attributed their success in Vietnam to TOP GUN, and both generals and Congressmen have told me that JUST CAUSE, the operation in Panama, fully justified whatever the National Training Center had cost the Army. TRADOC in my era often used models of war, or simulations of war, to prescribe training standards, but TRADOC knew, perhaps better than most, that its models and simulations were pale representations of war itself. There is no analysis that I know of which will resolve the central doubts about the validity of present simulations, or indeed of any training methods, other than actual battle. Always I bear in mind Ardant du Picq's warning from 1868:[26]

**It often happens that those who discuss war, taking the weapon for the starting point, assume unhesitatingly that the man called to serve it will always use it as contemplated and ordered by the regulations. But such a being, throwing off his variable nature to become an impassive pawn, an abstract unit in the combinations of battle is a creature born of the musings of the library, and not a real man ... the human heart, to quote Marshal de Saxe, is then the starting point for all matters pertaining to war. We shall learn ... to distrust mathematics and material dynamics as applied to battle principles. We shall learn to beware of the illusions drawn from the range and the maneuver field. There, experience is with the**

**calm, settled, un-fatigued, attentive, obedient soldier, with an intelligent and tractable man-instrument, and not with the nervous, easily-swayed, troubled, distrait, excited restless being, not even under self-control, who is the fighting man from general to private.**

Still, military professionals must do what they can to prepare soldiers for war--if for no other reason, ***"Si vis pacem, bellum parate."*** I witnessed, beginning 40 years ago in the aftermath of Vietnam, the U.S. Army's restructuring of its military training to infuse realism and combat readiness. Many traditionalists did not welcome the training methods then adopted, such as TES. I think it is fair to say that those methods are still on trial, still unproven in the eyes of some. Tests, analyses, and my own experience have convinced me otherwise. I came to believe firmly in training that efficiently produces both $\Delta$**P** and $\Delta$**T**, and I have no doubt that it is possible today to **double** the effectiveness of training for land combat units.

### A GLIMPSE OF WHAT IS COMING

Like General Westmoreland's refocusing the Army on defense of NATO, the Army's 37th Chief of Staff believed that Army training methods <u>must</u> change to meet the challenges posed by full spectrum warfare in the century ahead, and told me that he would welcome an initiative to actualize such an increase in effectiveness.

In 1991 I presented a paper to the Society for Computer Simulation that argued that most military training could be advantaged by Tactical Engagement Simulation in any or all of its three forms, Constructive, Virtual and Subsistent, and that, ideally, all three forms would be used interactively.[27]

Terms have morphed over time: "subsistent" is now "live,"[28] and Seamless TES has become, in the Army at least, "blended training." I envisioned TRADOC schools participating in Seamless TES: Leavenworth providing the senior Blue headquarters, while the armor school fielded virtual vehicles using the then nascent SIMNET, and the Intelligence School managed constructive models of the OPFOR. In the fielded event, TRADOC's role was confined to the Observer Controller teams. I also depicted a USAF ISR asset being used to instrument subsistent training: "*At subsistent TES sites, the communications problem could be eased by taking advantage of the long-endurance aircraft that are usually present over modern land, sea, or air engagements for the purposes of C3 and intelligence —surveillance systems such as E3A AWACS, the E2A HAWKEYE, and the Joint*

*Surveillance and Target Acquisition Radar System (JSTARS), that proved their value in Southwest Asia."* I gushed on, in the penultimate section of the paper, to assertions that proved more aspirational than predictive:

**Existing instrumentation for subsistent TES, at the sites in the southwest and elsewhere, use fixed communications and buildings for housing staff, processors, and displays. It now appears possible to develop entirely transportable equipment, the key element of which would be a pod for each participant capable of (1) ascertaining precise, three-coordinate position; (2) sensing movement; (3) interacting with fire control systems; (4) processing information; and (5) communicating with other pods .. The postulated pod would be comprised of a high-density parallel processor integrated with micro-electric-mechanical systems, interfaced to the degree feasible with computer(s) integral to the instrumented weapon. All pods might have a miniaturized Global Positioning System component, conceivably supplemented by a local emitter for higher precision. A pod for a dismounted combatant would be small, light and low powered: pocket-size. For a tank, it might be significantly larger, devised to extract substantial data from the tank fire control computer, and to sense where the machine guns were being aimed. For an aircraft, it would include micro-accelerometers. Taken together, these pods would comprise the Joint Tactical Engagement Simulation System (JTESS).**

A score of years have passed: most forms of live TES remain only marginally joint, albeit the National Training Center has done yeoman service in conducting Mission Readiness Exercises (MRE) for units preparing to deploy to Southwest Asia, assisting JIEDDO, and partnering with DARPA. Instrumentation at Fort Irwin, though modernized, remains immobile.

Indeed, most of the funding for the National Training Center has purchased not individual or collective training, but fixed facilities, transportation, and stage setting: the post has been transformed from a decrepit relic of World War II into an splendid oasis in the high Mojave desert; FTX instrumentation to enable AAR is fixed; since the start of the present wars, rotation of training units has accelerated, upping the frequency of arrivals and departures; a replica of one Iraqi village, exact in materials and electronic environment, has been constructed in the training area, and several other lower-fidelity village mockups are inhabited by groups of expatriate Arabs who wear Iraqi or Afghan costumes,

and collaborate with an Army OPFOR similarly costumed.

Nonetheless, there are shortcomings in the TES instrumentation that will constrain future training, particularly with respect to recording individual performance, to staging and controlling 3D battles, and to intelligence in general, so that while the NTC now helps condition soldiers for their forthcoming mission overseas, the foreshortened time they have to spend there attenuates its usefulness, and it can not simulate well the "full spectrum combat" that for the past several years has been the Army's stated desideratum. As an objective, instead of bringing a unit to NTC for an MRE, the Army ought to enable an MRE-quality FTX at home station. General Dempsey agrees.

The most serious lacuna in the instrumentation at Fort Irwin is its inability to track and to record individual performances. E.g. a squad tasked to man an Observation Post will be recorded as an entity, but neither the squad leader nor any of its members are identifiable either for purposes of AAR, or for training records. Tank commanders and gunners, no matter how well they maneuver and shoot, are similarly incognito. The Army should provide each individual a PDA —a smart phone— netted with the instrumentation. The PDA would provide an individual training record for each participant, as well as supporting the collective TES and its AAR.

I learned in Cardinal Point II that battalion command groups may appear alike as peas in a pod, but even under simulated battle stress, there will be major differences among them. Importantly, however, flaws can be detected and ameliorated. The Army owes nothing less than that to a command group preparing for life and death decision making. It is especially important that commanders and staffs learn to manage the constellation of unmanned aerial platforms that will support them in theater, and to integrate the sorts of information that these provide with intelligence from more traditional sources. As an example, the 37th Chief of Staff of the Army designated "The Squad" as one of his nine focus areas for his time in office, yet NTC does not equip squad or platoon leaders with emulations of the Rover handheld linking Predator-class UAVs with leaders on the ground, for there are no such UAS producing video streams. Reconnaissance, Surveillance, and Target Acquisition (RSTA) devices that today enhance the situational awareness of small foot units equipped with the Rover cannot be represented either at the NTC or in home station training.

Observer-Controllers (OC) at the NTC still operate with fire marking teams mounted in HMMWVs to represent the arrival of ballistic projectiles in vicinity of either BLUFOR or OPFOR, and assess casualties with a pistol-like laser designator that disables MILES on a vehicle or on personnel. Neither current audio nor visual cues are likely to prompt proper timely reactions from soldiers in vicinity of the "impact." Yet, more accurate simulation of indirect fire could save lives, for a soldier erect is much more vulnerable than one who has dropped to a prone position, or jumped to cover. In most instances, the cues that prompt such salutary behavior are audio: the sounds of incoming projectiles or of nearby explosions. Hence, a reasonable approach to augmented reality for these circumstances would be small, button-in-ear hearing aids with a wireless blue-tooth connection to the PDA that in turn is notified of the arrival of indirect fire, of calculated casualty effect, and that either "hits" soldiers or gives audio warning. Obviously, if the soldier is in the open, the PDA will have to be informed whether the soldier is erect or prone. The system ought to know, moreover, if he is in a foxhole, or otherwise under cover, a proper function for an OC.

Moreover, the Army plans to issue the XM-25 Counter Defilade Target Engagement System, a shoulder weapon about the size of the current rifle, albeit heavier. According to PEO Soldier, its 700 meters of range and its laser-controlled air-burst 25mm projectile renders the weapon 300 times more effective than any weapon now issued at squad level.[29] There does not seem to have been a training subsystem provided that can interact with either live or virtual TES, but the Army has announced intention to procure 12,500 weapons, one per squad.[30] Nor are sniper weapons well represented in TES.[31] And, of course, strikes from a UAS have to be simulated unrealistically by fire marker teams.

The combat medic is an important member of any small foot unit —a squad operating independently, or as part of a platoon. While current instrumentation does provide some opportunity for medics to practice their battle roles —each person equipped with MILES is issued a card detailing an incapacitating medical event that requires at least first aid, and possibly evacuation as well. The severity and extent of wound is left to the medic's imagination. Realistic depiction on the casualty's PDA of his wound, or a description of his vital signs, could prompt a proper response from the medic, and be recorded. As far as the squad is concerned, when one of its members is "hit," the squad leader faces loss not only of the wounded soldier, but also that of any soldier that stops to render first aid to his buddy, plus, possibly, the two or more required to

get the wounded man out of the line of fire. Therefore, depiction of loss is important to ΔT.

The exigencies of Counter Insurgency have led the CTCs to simulate a civil populace, with specific cultural manifestations, including language, to stimulate appropriate actions by soldiers of the units undergoing training. Each role player —usually an expatriate Arab— is hired and rehearsed in detail to behave consistent with an "identity" pertinent to the tasks selected for the unit being trained. The role players are transported from their homes to the CTC, and sustained there, often living in the "villages," for weeks at a time —an arrangement that is fiscally and administratively onerous. It is, moreover, quite unrealistic for Home Station Training. Therefore, the Army should establish one or more centers for role players, at or near their usual habitats, and there educate them for their role in TES events to which they would be networked and displayed to its participants as avatars in virtual scenes staged indoors, or as a head/shoulder video displayed in the field in a vehicle, or on a mobile manikin, such as might be on a remotely controlled Segway.

Although I am a questionably adept forecaster of technological progress, I remain sanguine that the services can fix all the deficiencies of the CTC noted above, and that we can do so in a way that will provide training at home station even better than current MREs. Last year, at this I/ITSEC event, one of the first two Fellows, Jack Thorpe, observed that technology to support further progress with TES seems at last to be at hand. Allow me to quote from Colonel Thorpe's monograph:[32]

> **We now have a…Joint Training Counter-IED Operations Integration Center (JTCOIC). Information about daily operations from combat zones is screened, looking for new enemy tactics/techniques/procedures, or lessons learned from U.S. or NATO operations (successful or unsuccessful). A selected event is sanitized of classified information, and the event is reconstructed in a gaming environment, currently Virtual Battlespace 2 (VBS2). The reconstruction can be distributed to units equipped with the VBS2 gaming software who can then replay the event. In addition, using the same gaming engine, the event can be replayed and a video of the replay can be recorded, creating a machinama (sic) version. This version can be distributed electronically as with a video on You Tube. A version is published that can also be viewed on a mobile device like a soldier's iPod, iPod Touch, or iPad (MP4 format).**

**The Training Brain**

The JTCOIC has evolved, incorporated into TRADOC, and renamed with an enlarged scope that includes operations other than counter-IED. The re-designated **Training Brain Operations Center** (TBOC) is actively engaged in assisting units with Home Station training exercises. Essentially TBOC scans data from theater (CPOF, TIGR, CIDNE, DCGS_A) looking for events that fit a unit's METL for training. These data are then "bent" and "smudged" to remove classified information, to adapt it to locally available terrain, and to generate a Master Scenario Event List that reflects what happened in the actual event. For a recent BCT operational exercise at Fort Bragg,[33] TBOC provided a database > 60,000 messages, 45 days of historical data, plus 30 days of time-release data drawn from CICNE, TIGR, IIR, HUMINT, etc. Intelligence support included an OPFOR (network, forces) and cultural/character bio sheets for role players.

TBOC is a significant advance in training support, and is demonstrably germane to Home Station training per ARFORGEN for the current war. It economizes on personnel, and enables rapid structuring of realistic collective training events, but its product does not address the infrastructure to collect performance data for individual training records or for collective performance for AAR, UAS management, direct and indirect fires, medical training, or human terrain. Moreover, it has the drawback that it relies on data from the very recent past, on records of encounters with current enemies and current weapons. 21st Century Army training must be full spectrum, and therefore must encompass not only ways and means to defeat present enemies, but also help soldiers to learn both from the instructive past and the speculative future.

Concerning the past, TBOC ought to be brought to bear on leader development through Virtual Staff Rides, in which its machinima present leadership problems for collaborative learning, using the multi-media approach developed by the George C. Marshall Foundation that has been proven successful in the last several ROTC Seminars for Marshall Award winners at Lexington, VA. Consideration might also be given to their building machinima for collaborative seminars for command groups upon NTC records of mid-intensity TES during particularly instructive past rotations, selected by veteran OC's.

As for future full spectrum warfare, TRADOC's Intelligence Support Activity (TRISA) published this year a publication[34] outlining a Full Spectrum Training Environment (FSTE), predicated on hypothetical full

spectrum conflict in the South Caucasus region involving adversaries equipped with armor and air forces. TBOC might try its hand at least on situation setting machinima for FSTE scenarios.

Conceptually, Col. Thorpe's views seem apt for 21st Century training.

> **Where can we expect these interactions between Networking, Instrumentation, and Command and Control to progress? [A SIMNET consultant] observed in 1987 that distributed simulation was a command and control system. We did not have much instrumentation at that point, and just the start of networking. We now see many initiatives in new, low cost, ubiquitous sensors that serve as sources of instrumentation. We can expect these to be proliferated, providing a substantial flow of data about performance. This will lead to a number of innovative developments where MS&G and command and control are viewed as the same. Further, lessons learned in developing advanced, large scale MS&G architectures and applications will be available to assist developers of the next generation of C4I systems in solving tough design, architecture, and implementation problems: many of these problems have already been tackled and solved by the MS&G community.**

I agree with Jack Thorpe: to support military training in the century ahead the services must adapt current and prospective intelligence systems, artfully combined with models, simulations, and games, and drawing adroitly from commercial products. There is likely to be a plethora of effective part task training systems quite capable of criterion-referenced training. However, these must be regarded as prerequisites for an MRE, for there will remain for every combined arms BCT a necessity for one or more holistic field exercises,

conducted at home station, or cost-effectively nearby. If training land and air space is less commodious than at the CTCs, a modernized version of Cardinal Point II offers a solution. Tasks to be trained must be set forth in documents like the ARTEP, simulators or other training facilities made available, and a training regimen established that provides for both individual and collective training for the whole BCT, all units of which are engaged simultaneously in advancing its readiness to deploy.

I anticipate that 21st century training development will be predicated on seven technology interventions :

1. **Mobile Infrastructure for TES**
2. **Soldier PDAs**
3. **UAS Simulation for RSTA**
4. **Augmented Reality for Fire Sim**
5. **MILES for Modern Weapons**
6. **Improved Medical Training**
7. **Off-site role players**

**Mobile TES Infrastructure**

I argue that the services should neither throw away instrumentation useful for Home Station training, nor invest in further attempts to replicate NTC-like instrumentation at Home Station. Instead should they should build integrated advanced Home Station training support around a wireless architecture exploiting a cost-effective version of one or more of the long-dwell aerial platforms that the Army is flying today for RSTA missions. Here are three examples of such UAS, any one of which could contribute to TES instrumentation.

**Gray Eagle.** (Illustrated in Figure 8) The Army's MQ-1C, from the same factory as Predator, is planned for deployment in 2013 to the 160th Special Operations Aviation Regiment, Fort Campbell. This UAS can fly
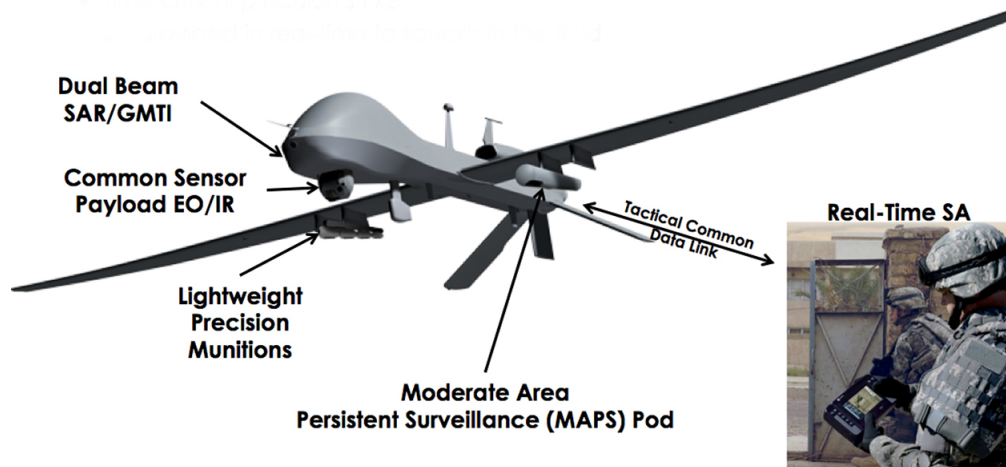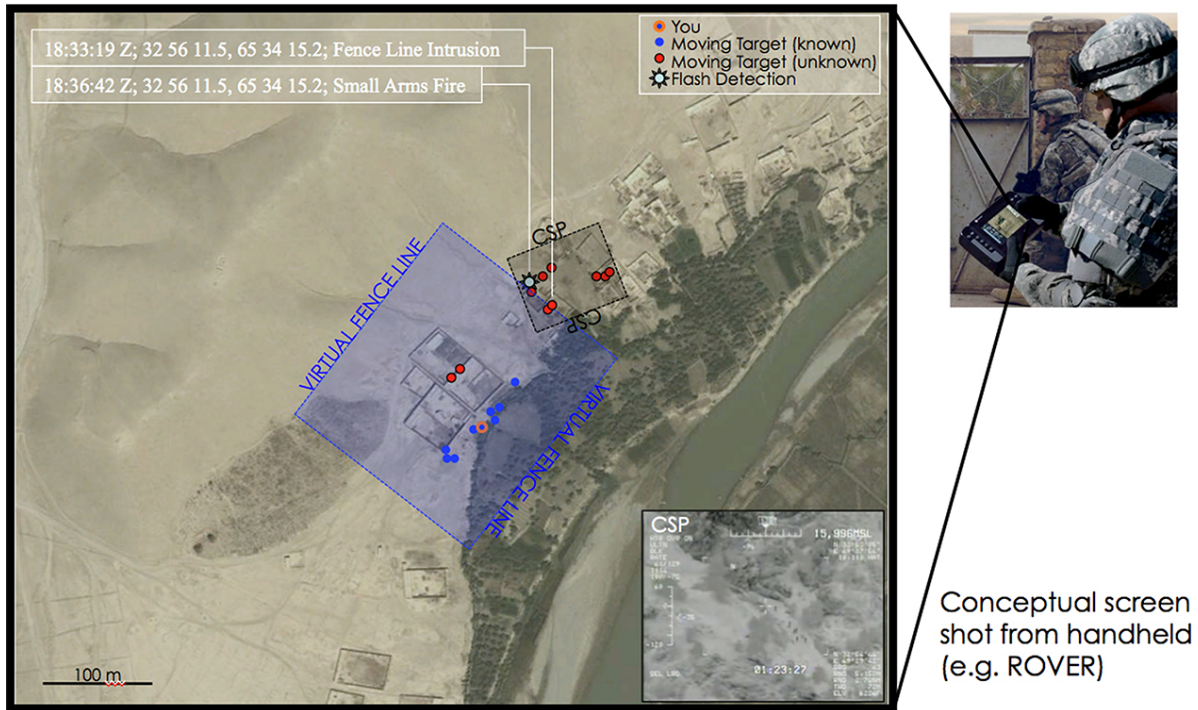


Figure 8.  The Gray Eagle UAV

Figure 9. Hypothetical UAV Information Presented to the Soldier

15 hours above 15k feet, equipped with a 300 lb Moderate Area Persistent Surveillance (MAPS)[35] pod and light-weight precision weapons. That pod is yet to be funded, but its components have all been tested. It could be available by 2013, capable of persistent surveillance over 10km$^2$, furnishing directly to a leader on the ground immediate cues to movement of vehicles or persons, detecting firing events, and delivering precision strike. One CONOPS would be tactical overwatch, under which the UAS would be "tethered" to a small unit on the ground, furnishing its leader useful situation awareness.

Figure 9 illustrates information akin to that the squad leader would access using his handheld. You will note icons posted by the MAPS pod showing known persons (squad members) and unknowns, presumably enemies, because it shows them intruding into the virtual fence that he, the squad leader, had drawn around his area of interest, plus a gun flash detection in their vicinity. All these sensings are recorded and stored for later analyses. All of this seems relevant for training instrumentation. But you should note that the magic is in the MAPS, a 300 pound pod that could be flown on any platform capable of furnishing it electrical power; for a 2013 fielding, MAPS should be started ASAP.

**Aerostat.** (Illustrated in Figure 10) Smaller training areas could use an aerostat, such as the Army Persistent Threat Detection System (PTDS), developed for continuing surveillance to detect and to deter emplacement of Improvised Explosive Devices (IED). Allegedly, such a vehicle could readily lift aloft the MAPS for 30 days at a time, and do so for under $1000 per hour (these costs include personnel to operate and maintain the system).

By comparison, flying a Predator class UAS like Gray Eagle would cost ~$6000 per hour. On the other hand, Gray Eagle coverage from 10k-15k feet would be significantly larger than that of PTDS at 1k feet,



Figure 10. The Aerostat Platform

Figure 11.  The Hybrid Airship

probably necessitating several aerostats to cover a large maneuver area. The PTDS consists of an aerostat, tether, mobile mooring platform, mission payloads, ground control shelter, maintenance and office shelter, power generators and site-handling equipment. The system now operating in OEF has a payload of 1100 pounds.

**Hybrid Airship**. (Illustrated in Figure 11) The Army's Long Endurance Multi-Intelligence Vehicle (LEMV) derives lift from aerostatic lift (cells filled with gas lighter than air), from aerodynamic lift from a hull shaped to act like a conventional aircraft wing, and from four diesel engines.

According to its engineers, the LEMV uses about a quarter of the fuel per payload mile as would a conventional aircraft, and can stay aloft for tens of days. One estimate predicts a 3 week hover over a specific area at 20k feet, carrying a C4ISR payload of 2.5k lb.[36] The manufacturer expects a commercial freighter market to develop if the Army's LEMVs prove to be cost effective. Another of their spokesman further claimed that each of Army's LEMVs could replace 25 fixed wing medium altitude surveillance platforms (otherwise unspecified). But there are other horses in the race for a successful hybrid airship design. In April 2011 the USAF signed an $86 million contract for a design labeled Blue Devil 2 specifically to exploit the wide area coverage proceeding from DARPA wide-area surveillance sensors.

**Soldier PDA's**

Home station training should be but a subset within a larger, 21st Century thrust toward career-long learning that would assure military personnel worldwide wireless training support: books, Service directives, field manuals and technical publications, job aids, and personal records, including and especially, those pertaining to education and training. The interface with

the soldier is not crucial, for it seems that there are already ways and means to transmit masses of information between individuals from central repositories. Nor should security concerns curtail progress, in that it appears possible to create protected informational enclaves and to encrypt transactions with relatively inexpensive means. In the near future there can be recourse to cell phones, pocket storage devices, tablet computers, ebooks, and the like, using media of all types. An aerial platform overhead will facilitate training with these.

In the longer run information technology will almost certainly enable any military service to evolve its learning environments from sporadic schooling to continuous education and skill advancement. Full-spectrum readiness will dictate creative resource to models, simulations and game technology to broaden individual competence to joint, interagency, and coalition service, as well as to enable facile inter-cultural relationships that extend to command of one or more foreign languages.

**UAS Simulation for Teaching RSTA**

The UAS training has been sparse since (1) long range surveillance UAS were scarce, and were needed for operations abroad; (2) FAA objects to UAS operating in or near commercial airline routes; and (3) there is no stated requirement for training RSTA management at the CTCs. In a study of intelligence training [37] conducted in 2006 for the Army's G-2 and his Intelligence and Security Command, four out of five "capability gaps" identified were incapacities in BCT operations/intelligence (ops/intl) teams. The study advocated home station training in collaborative problem-solving involving the commander with the ops/intel team, and with training tasks derived from battlefield data on the area of projected overseas deployment. More than four years later, progress is evident in modifying CTC instruction to reflect the latest intelligence on enemy TTP —TBOC to point— but the absence of ways and means for tasking and exploiting aerial intelligence, in particular for dealing with video streams, has stymied better training for commanders, op/intel teams, and small unit leaders, whether at home station or during an MRE at a CTC.

**A DARPA INTERVENTION?**

DARPA has developed two promising solutions for 3D training instrumentation. One is HART. In March 2011 the Army conducted acceptance tests for a DARPA ISR management program named Heterogeneous Airborne Reconnaissance Team (HART).
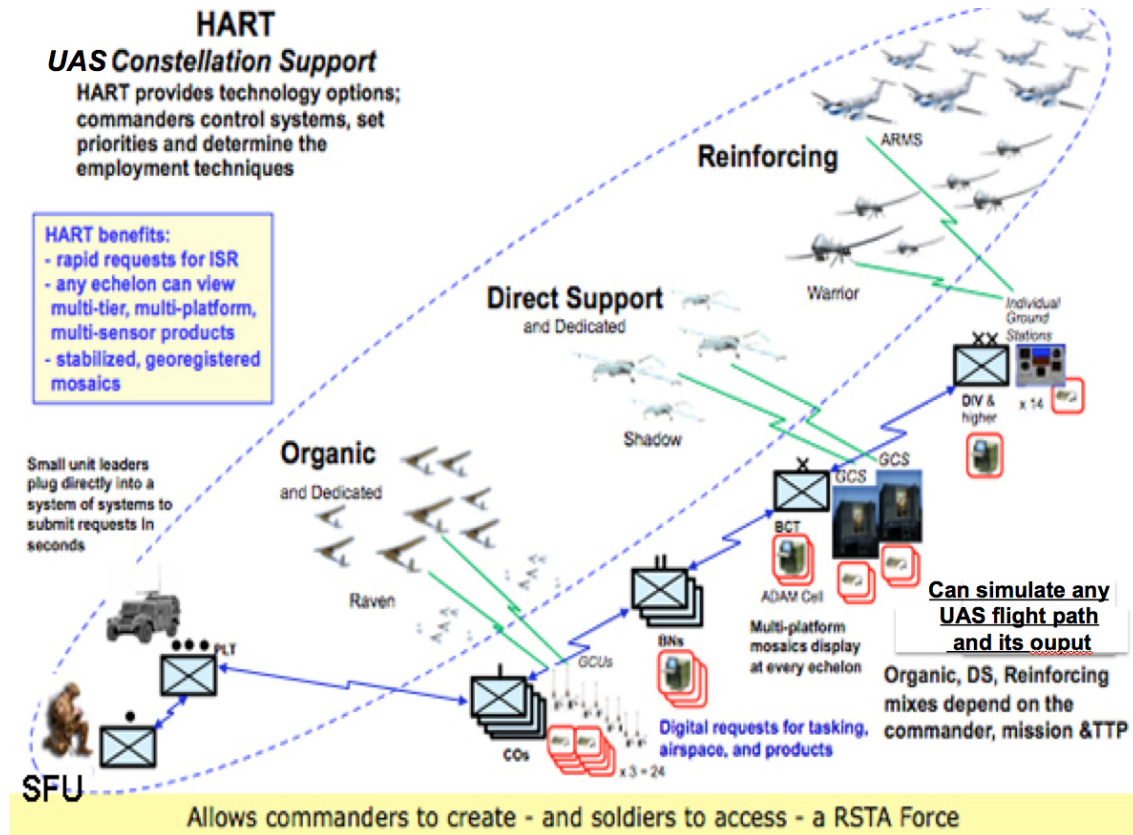
Figure 12.  The Heterogeneous Airborne Reconnaissance Team (HART) Concept

HART was designed to maximize the efficiency of any given constellation of UAS over a BCT by enabling its Op/intel teams to designate areas for surveillance over specified periods of time, for which HART would then task any aircraft within its cognizance. The PM early recognized that it would be impossible to assemble a fleet of UAS sufficiently large to provide a convincing demonstration of system capabilities, so early in the program he required his contractors to insert a capability to simulate the existence of UAS of various types, with different speeds, endurance, operating altitudes, and sensors. At Dugway Proving Ground in

March of this year, HART successfully demonstrated ability to optimize platform control and to downlink video from a constellation of some tens of disparate UAS, only a handful of which were actually flying. The Army accepted, and will deploy HART.

At the same time that DARPA was also bringing to completion a program for USAF entitled "Autonomous Real-time Ground Ubiquitous Surveillance-Imaging System (ARGUS-IS)".
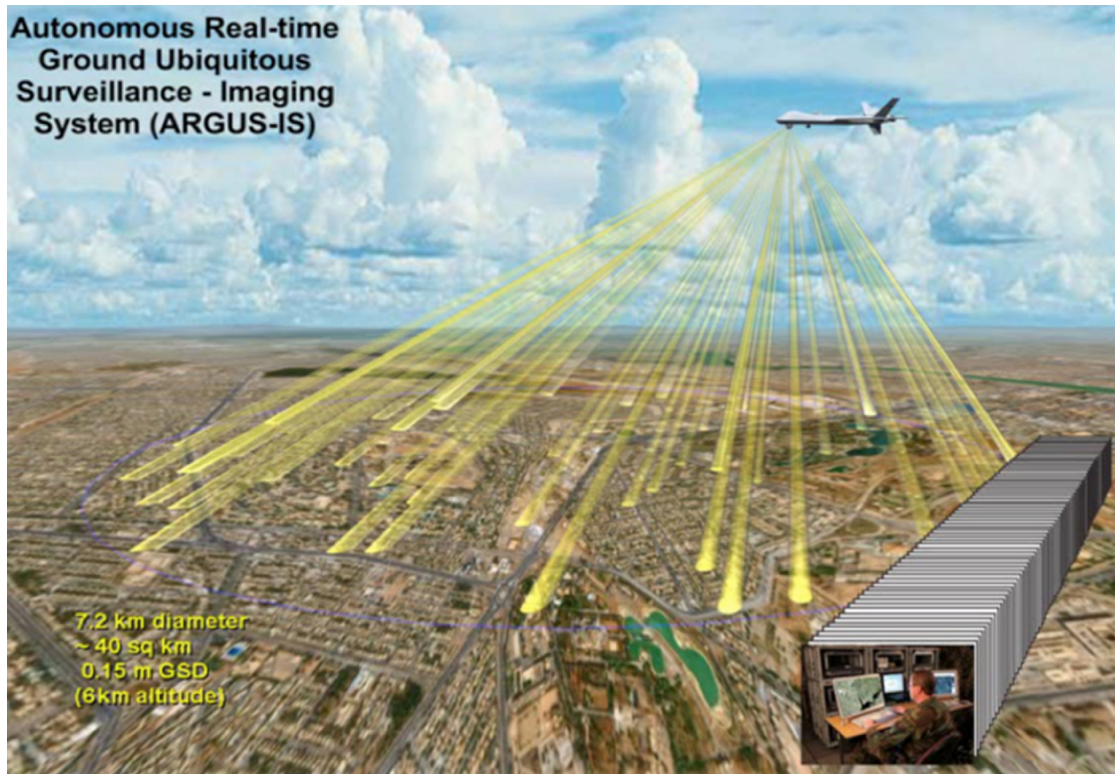
Figure 13.  ARGUS-IS

Named for the mythical many-eyed giant, ARGUS is an ISR force multiplier, an EO MTI system capable of producing multiple high definition video streams that can be "attached" by an operator to a fixed or moving object on the ground, and reliably record and store the resultant imagery. It seems possible to combine ARGUS with HART systems so that video streams from the former can be linked to a simulated UAS responding to tasking from a command group in training.

The cartoon in Figure 13 shows a Predator-class UAS carrying ARGUS in an under-belly pod, transmitting some 60+ compressed video streams to an Air Operations Center via a TCDL. However, almost any aircraft capable of supplying requisite electrical power, including helicopters and aerostats, can carry the pod. ARGUS is one of several emerging Wide Area Motion Video Imagery (WAMI) systems that provide surveillance over a wide area to capture visual imagery of small events. ARGUS parameters are approximately as described in Table 6, below.

Table 6. ARGUS Performance Parameters

| Altitude | Area Coverage | Ground Sensing |
|---|---|---|
| 20 K feet | 15 square miles | 6 inches |
| 30 K feet | 35 square miles | 9 inches |

In 2009 DARPA flew an early version of ARGUS over Quantico, VA, the pod underneath an ancient UH-1H helicopter flying at 17,500 feet AG (pod mounted on Blackhawk pictured in the lower left of Figure 15 below). ARGUS' four focal plane arrays produced the high-density (1.8 gigapixel) mosaic centered in Figure 15. Around it are enlargements designated on the mosaic by yellow dots. These are in sufficiently high resolution to permit an operator to track a particular vehicle and even a specific person moving on foot, visible from overhead. Figure 14, below, is a single frame from a video of five pedestrians, one marked as a High Value Target (HVT). (The other "Peds" are numbered only to show their locations.)



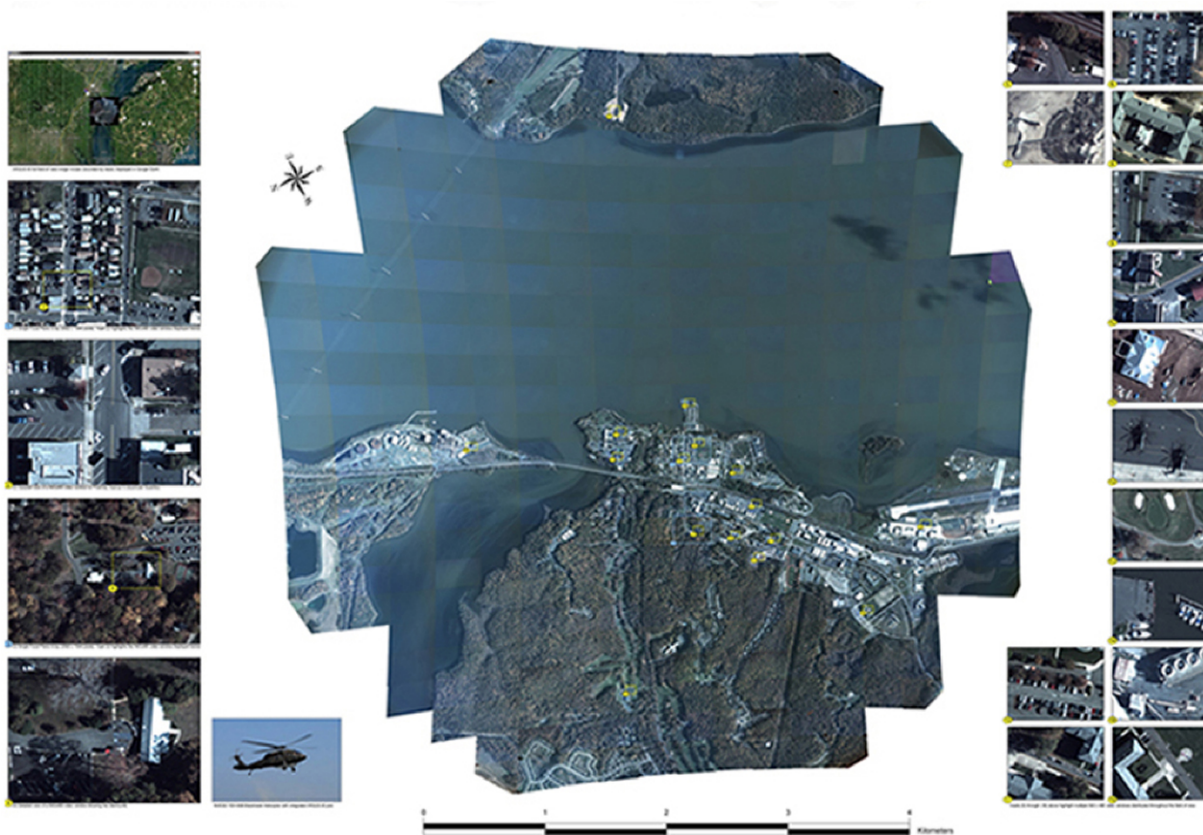Figure 14.  Quantico Pedestrians

Figure 15.  Imagery of Quantico Provided by ARGUS in DARPA Test

In TES all participants are potentially cooperative targets. Were each participant equipped with the PDA described above, the system could identify each of these pedestrians by name. Should the HVT enter a building both MAPS and ARGUS allow an operator to draw a fence around the building that will permit the system automatically to resume track when he reappears. If what happens under cover is important for training, the building would have to be instrumented, for example, by lidar [38] that would automatically lock

> **A long-dwell aerial platform supporting TES equipped with integrated MAPS, ARGUS and HART could furnish video streams connected to any video-producing UAS under HART control, or simulation thereof, and thus down-linked to participants as actual EO imagery: (1) for overwatch of BLUFOR participants, (2) for surveillance of OPFOR, and (3) for support of AAR.**

on the HVT when he entered, and alert when he departed.

## SUMMARY

• The Army will have to find new ways to learn, and must do so conscious always of potential enemy capabilities. It will be imperative to evolve provisions for training soldiers and units anywhere in the world, anytime. I foresee worldwide, wireless training support: 21st Century job-aids, FMs, TCs, and professional books.

• The Army should train the way that it fights. As that way depends heavily on situational awareness, it seems entirely appropriate to center full spectrum training on Mission Command systems that it will use for reconnaissance, surveillance, and target acquisition. I foresee near term and continuing progress toward that end.

• Critical will be the methods the Army uses to develop leaders who expect the unexpected, accustomed to assessing and adapting. These methods must include learning from the past as well as challenging futurities, discovery learning and internalization. I foresee rigorous, cognitive simulations being used for both selection and training.

• The concept of managing training progressively by echelon —squad, platoon, battalion, BCT— is, and always has been dysfunctional. Rather, both training and evaluation should be multi-echelon, and commanders must insure that subordinate leaders have both the facilities and the time to conduct training for their soldiers. I foresee families of criterion-referenced simulators that enable a leader at any echelon to train individuals and teams —especially command groups— to explicit standards preliminary to confirming live evaluations.

• Effective training does not necessarily require large expanses of reserved territory and air

space. The brigade MRE described as Cardinal Point II took place around a military reservation of less than 30,000 acres. I foresee the CTCs exerting seminal influence on Home Station training, and conducting experiments for both combat and training developments.

• The Army should partner with DARPA to develop new instrumentation for conducting live TES. I foresee DARPA's assuming a proactive role in 21st Century Army training.

## ENDNOTES

[1] Letter to the Commanding General, United States Continental Army Command, 17 December 1971, transmitting the Final Report of the Board for Dynamic Training.

[2] Report of the Panel on Military Education of the One Hundredth Congress, Committee on Armed Services, House of Representatives, One Hundred First Congress, First Session, April 21, 1989, U.S. GPO, 1989, p. 12. Hereafter, Skelton Panel Report.

[3] Skelton, Ike. "American Strategy: A Worthy Past, and Uncertain Future." Congressional Record 133 (No. 179, Nov 9, 1987 (No. 179, Nov 9, 1987). See also No. 155, Oct 6, 1987, No. 171, No. 168, Oct 26, 1987, and Oct 29, 1987. The Panel provided the text of a fifth speech entitled "The HASC Panel on Military Education: Focusing the Spotlight," but there was no notation of when it was delivered.

[4] Pogue, F.C. Education of a General. Viking Press, New York, 1963. 120-123.

[5] Cf, my IDA Paper P-2653, The Secret of Future Victories, published by the Combat Studies Institute, Fort Leavenworth, available on its web site.

[6] Skelton Panel Report. 833.

[7] N.B. 8ID was the division of Seventh Army with the longest rail moves; the garrison at Baumholder, consisting of Second Brigade and the bulk of Division Artillery, was 200 miles as the crow flies from Grafenwöhr.

[8] Neither the French forces in Germany nor the German Artillery School were much interested in using Baumholder ranges. 8ID had virtually free access.

[9] In 1976, for an unprecedented training conference at Grafenwöhr, TRADOC trained a USAREUR unit to meet that standard with live firing.

[10] Tables I-VII progressively trained a single tank crew. Table IX required teamwork within a platoon of five tanks for control of movement and fire distribution.

[11] General Creighton Abrams once remarked to me that when he commanded the 34th Tank Battalion, 4thArmored Division in 1944 and 1945 he insisted on gunnery practice every two weeks. He had observed that, even in combat, tank crew timing and precision dropped off sharply in a matter of days. His practice sessions required his crews to reca1ibrate sights, re-sharpen intra-crew gunnery procedures, and demonstrate ability to put steel on target within two rounds. For training techniques relevant to the contemporary

USAREUR environment, see Brown, Maj. Gen, FJ., "The Use of Simulation in Armor Unit Tactical Training," presentation at the NATO Armor School Commanders' Conference, Samur, France, September, 1983. General Brown was one of my Assistant Division Commanders in 8ID.

[12] A heavy machine gun with a bracket to align it atop the tank gun for practice against target arrays at ranges over which the .50 cal. projectile emulated the ballistics of the tank gun.

[13] Shy, J., "First Battles in Retrospect," in Stofft, W., America's First Battles 1776-1965. Lawrence, Kansas University Press, 1986. Pp. 329-331.

[14] Cf., Perla, Peter P. The Art of Wargaming. United States Naval Institute, Annapolis, MD, 1990. Pp. 54-59.

[15] Olmstead, J.A. Christensen, H.E and Lackey, L.L. Components of Organizational Competence: Test of a Conceptual Framework, Alexandria, VA, Human Resources Research Organization, Technical Report 73-19, August 1973. The author became Assistant Commandant at the Infantry School shortly after Project FORGE concluded, and was instrumental in launching its successor, CATTS.

[16] Collins, Jr. Lt. Gen. Arthur S. Common Sense Training, Presidio Press, San Rafael, CA, 1978. Pp. 146-147.

[17] Ibid.

[18] Territory outside of military reservations made available by local German governments under a standing agreement with the USG. Provisions were made to compensate German property owners for any damage occasioned by U.S. forces. Typically this arrangement restricted U.S. vehicles to existing roads or trails, but in at least one instance, 8ID in effect rented unplanted fields for repetitive cross-county maneuver to conduct TES. CPII took place near the French border, in an area that Germany had fortified in the 1930's.

[19] To foreclose a participant unit's preparing detailed plans before the FTX, its zone of action was not revealed until it reached the forward assembly area. My intent was to require each command group to devise a defense on wholly unfamiliar terrain in limited time.

[20] Olmstead, J.A. Elder, B.L. and Forsyth, J.M. Organizational Process and Combat Readiness: Feasibility of Training Organizational Effectiveness Staff officers to Assess Command Group Performance, Human Resources Research Organization, Alexandria, VA, IR-ED-78-13, 1978. Cf. Barber, H.F. and Kaplan, I.T. Battalion Command Group Performance in Simulated Combat, ARI Technical Paper 353,

March, 1979; Barber & Kaplan, Training Battalion Command Groups in Simulated Combat: Identification and Measurement of Critical Performances, ARI Technical Paper 376, June 1979.

[21] Letter, Headquarters, 8th Infantry Division, 9 January 1978, "78 Divisional Evaluations per ARTEP 71-2--CARDINAL POINT II." The FTX name derives from this notion: " ... will serve to orient our professional compasses both over the next six months as we prepare for it, and afterwards, when we can address diagnosed weaknesses in our FY79 training."

[22] At my request, ARI did not release actual scores except to me,, and I have published only the relative data shown to foreclose invidious comparisons among units or commanders.

[23] Ardant du Picq, Col. C.J.J.J. Battle Studies. Military Service Publishing Company, 1958. Pp. 5-8.

[24] Marshall, S.L.A. Men Against Fire. Morrow, New York, 1964. Pp. 116-117.

[25] Von Clausewitz, Carl, On War. Howard, M. and Paret, P. ed. & trans. Princeton, 1976. P. 122

[26] Ardant du Picq. Op.cit. Pp. 39-41. Quoted in Army Training Circular 21-5-7. P. 8

[27] "The Future of Tactical Engagement Simulation." The Proceedings of the 1991 Summer Computer Simulation Conference. The Society for Computer Simulation, San Diego, 1991. 1181-1186.

[28] Reference to Roget's Thesaurus informed me that "Subsistent" was a proper antonym for "Virtual." Both terms were then somewhat esoteric, and I though it expedient to induce recourse to the dictionary. General Larry Welch, President of IDA, thought otherwise, and asserted that we should use "live" vice "subsistent." He was then my employer, so of course, I, then and since, complied.

[29] http://futurefastforward.com/military-intelligence/2822-army-testing-xm-25-smart-weapon-by-lt-col-christopher-lehner-231109 (28 Jun 11). Reported unit cost: <$25k

[30] I suspect the Army will need a simulacrum of appropriate size and weight, capable of firing a blank, and emitting a range finding laser beam at target that simultaneously triggers a casualty signal and sonic signature to the PDA of any person in defilade at that range.

[31] Again, signal to establish locus of target, transmit to PDA of person at that locus either casualty or near miss.

[32] Thorpe, Dr. J. "Trends in Modeling, Simulation, & Gaming." 22ff.

[33] BCT-staged, battalion CPX, with 3 company STX-lane events for one battalion per iteration per day, four days total.

[34] TRISA. Full Spectrum Training. Fort Leavenworth. February, 2011

[35] Moderate Area Persistent Surveillance

[36] http://www.flightglobal.com/blogs/the-dewline/2011/06/meet-the-civvie-lemv.html?utm_source=twitterfeed&utm_medium=twitter 28 Jun 11, The Army's contract for LEMV exceeded $500 million

[37] Military Intelligence Review Team, Outbrief v5.1 October 2006. See Chart 1. The study noted a costly learning curve early in overseas deployments in both casualties and operational successes that seems to stem from intelligence failures., eliminated by on-the-job training in theater.

[38] E.g. http://www.bbn.com/technology/knowledge/lidar