Spiral Development of Virtual Solutions for Convoy Defense Training

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ABSTRACT

Following initial combat in Afghanistan and Iraq, Army support units, accustomed to neutral or friendly operating environments, were confronted with increasingly sophisticated enemy tactics. Senior leaders identified several gaps in their ability to train Soldiers for these threats: insufficient infrastructure to handle increased convoy live fire exercises; inability to replicate the Contemporary Operational Environment (COE); safety considerations; and insufficient resources such as time, equipment and ammunition. This paper discusses the spiral development process currently underway towards providing an effective convoy training experience.

ABOUT THE AUTHORS

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INTRODUCTION

Prior to recent combat actions, and despite many related lessons from the Vietnam War, many modern military planners assumed convoys would normally operate in neutral or friendly environments. According to Killblane (2005), "The 20th century's concept of the communications zone and safe rear area did not foresee convoys needing force protection assets" (p.76). However, the training experiences of Army Support Forces were slightly different. Units training at Army Combat Training Centers (CTCs) and in Constructive simulations like the Corps Battle Simulation (CBS) were routinely subjected to enemy attacks. Leaders in support units understood they could be enemy targets.

What led to a lack of priority for convoy defense training prior to operations on our current battlefields? Anecdotally, in combined arms training events, attacks on convoys were "training distractions." The interdiction or destruction of supplies or support units doing their real-world missions seriously impacted the ability of combat forces to conduct long duration, combined arms training events. Opposing Force (OPFOR) attacks, or their effects on support forces, were frequently restrained so they did not "impact training." As a result, realistic regular reinforcement of the need for convoy defense and protection was limited or the problem was assumed away.

Following initial combat operations in Afghanistan and Iraq, Army support units, previously accustomed to a neutral or friendly environment, were confronted with increasingly sophisticated enemy offensive tactics. Senior leaders identified several gaps in their ability to train Soldiers for these threats: insufficient infrastructure to handle convoy live fire exercises, inability to replicate the Contemporary Operational Environment (COE), safety considerations, and insufficient resources such as time, equipment and ammunition. For most combat support and service support units, collective convoy defense training was limited to annual Army Training Evaluation Program (ARTEP) events, or CTC rotations.

CONVOY DEFENSE TRAINING PRIOR TO OPERATIONS ENDURING FREEDOM (OEF) AND IRAQI FREEDOM (OIF)

Below is an example of a convoy training approach based on resources available to most Army units. It is provided for illustration only.

Preliminary Marksmanship Training
Mounted/Dismounted Stationary Gunnery with the Multiple Integrated Laser Engagement System (MILES) or Engagement Skills Trainer 2000 (EST 2000)
Mounted/Dismounted Stationary Gunnery with Live Ammunition
Vehicle-borne firing, Stationary and Moving, Using Blank Ammunition/MILES
Marksmanship Single Vehicle Qualification with Live Ammunition
Transition Training from Individual Crews to Serial/March Units Using Blank Ammunition/MILES
Qualification Exercise for Convoy Serial/March Units with Live Ammunition (Battle Drills)
Convoy Blank Fire Exercise Practice
Convoy Live Fire Exercise (LFX) Qualification with Live Ammunition

Figure 1: Typical Convoy Defense Training Path

In the above example, once a unit's Soldiers reach individual weapons and tactics proficiency, crew, squad and platoon level training can begin. This collective training relied on published collective task lists in ARTEP or Mission Training Plans (MTPs) as well as Training Circulars, Smart Cards or publications produced by the Center for Army Lessons Learned (CALL). Leaders were left to resource convoy training as best they could. Due to the difficulty of obtaining ammunition, land, time, trained observers, OPFOR and a release from day-to-day support missions, most Army support units were unable to execute a complete training plan. For most support units, the only opportunity to fully resource convoy training events was during a rotation at one of the CTCs.

OIF and OEF EXPOSE TRAINING GAPS

Increased enemy attacks on convoys and the ensuing media coverage rapidly expanded the Army's focus on combat operations to include protection and defense of convoys. Meetings on topics related to convoy defense and force protection measures were held in 2003 and 2004 and many doctrinal, training and material initiatives were discussed and implemented.

Training gaps and deficiencies discussed earlier, especially in regards to Combat Support (CS) and Combat Service Support (CSS) Soldiers and units, became a key concern. Live fire ranges were upgraded and used for convoy defense gunnery in addition to the traditional mechanized force gunnery tables. Support units received parity or priority for ranges and training land. Significant resources were being expended to incorporate the latest enemy tactics into training and to improve the realism and supply of training devices. The focus on training convoy defense reaped significant benefits, especially for improving proficiency on individual tasks but significant gaps still remained.

Resource Shortfalls Lead to Virtual Solutions

Some resources are finite and no amount of money or effort will rapidly correct problems of insufficient live fire ranges for mounted operations, safety concerns in trying to replicate the COE, an inability to record a training event and provide after action reviews, and performance of repetitive training. A key strength of virtual training is its ability to safely simulate any type of terrain, in a COE setting, provide repetitive training, and play back the event for critique.

Home Grown Solutions

Leaders and trainers realized that some already-fielded simulations and simulators could be modified or used in new ways. Commercial combat action video games partially met the growing requirement. These desktop trainers can support the training of some convoy defense tasks. However, the fidelity of the training and its transferability to the live environment is generally not as high compared with more sophisticated devices. Desktop trainers are a good tool however, as part of a comprehensive unit training strategy.

Training and simulation officers also saw potential in using virtual devices developed for other purposes. For example in 2004, several defense contractors, and Ft Hood's Battle Command Training Center (BCTC) developed a Warrior Skills Trainer (WST). The WST uses an Engagement Skills Trainer 2000 (EST 2000) suite, and a mock-up of a HMMWV. In 2004 the mock-up was placed in front of the flat EST 2000 screen. The HMMWV crew engaged targets on the screen, simulating movement on a route (Gourley, 2004). By 2006 the WST had evolved into a more sophisticated HMMWV mock-up with the ability to move through 180 degrees of virtual terrain from the driver's station.

Figure 2. Warrior Skills Trainer (2004)

Figure 3. Warrior Skills Trainer (2006)

Other units used their imaginations and conducted convoys in the Close Combat Tactical Trainer (CCTT). CCTT is comprised of interactively networked simulators and command, control, and communications workstations replicating the vehicles and weapon systems of a cavalry squadron, mechanized infantry or armor battalion task force. CCTT contains Abrams Tank, Bradley Fighting Vehicles and HMMWV mockups (PEO STRI, 2006). Abrams and Bradley crews can engage and be engaged by a virtual enemy (e.g. semi‑automated forces (SAF)). The CCTT's HMMWV mockup however does not have a weapons engagement capability.

Fort Riley, Kansas and other CCTT sites acknowledged that non mechanized units were asking to use the CCTT for training and rehearsal in many tasks related to convoy operations. CCTT's ability to move in a realistic COE, communicate as crews in a convoy and conduct playback of their movements met many of the requirements for convoy defense training and rehearsals prior to convoy live fire training. However, there are potential negative training lessons when using CCTT as a convoy trainer. Abrams tanks and Bradley Fighting Vehicles have enhanced weaponry, mobility and survivability in comparison to HMMWVs. This may give Soldiers a false picture in regards to their real abilities.

CCTT's Reconfigurable Vehicle Simulator (RVS) Evolves Beyond its Initial Concept and Augments Convoy Training

As far back as 1991 the CCTT program identified a need for wheeled vehicle simulators to operate in conjunction with its Abrams and Bradley modules. RVS simulators would be used for scouts mounted in HMMWVs and support forces driving a variety of trucks or the HMMWV (U.S. Army Training Support Center, 1991).

In 2004 there was a pause in RVS development while options were considered in support of evolving requirements. This pause would later allow CCTT to use the capabilities and shortfalls of other training solutions as starting points for a better RVS solution.

The number of tasks to be performed by the RVS grew as a result of lessons learned in the VCCT acquisition. Lockheed Martin, RVS lead contractor, built upon their VCCT design and included improvements resulting in the current RVS. The capabilities of RVS include two reconfigurable simulators per trailer, the incorporation of the tactical Force XXI Battle Command Brigade and Below (FBCB2) hardware and software, 360 degree horizontal field of view, full recoil on all supported

weapons (M16, M4, M249, M240, M2, Mk19, M9, and AT4), accurate shoot on the move, and reconfiguration to all supported variants in less than two hours.

One drawback which prevents a wider fielding of CCTT's RVS is that its design limits its use to CCTT fixed or mobile facilities. While RVS is transportable it draws some of its simulation power and its After Action Review (AAR) capability from the CCTT site it is associated with. The RVS is considered another manned module in the CCTT system and therefore is controlled by the CCTT Master Control Console (MCC) and uses the Semi-Automated Forces/Computer Generated Forces (SAF/CGF) capabilities provided by CCTT.

Being a part of the CCTT system, the RVS is able to take advantage of the latest CCTT Baghdad database and the COE models that have been incorporated into this database. The capabilities provided in the CCTT Baghdad database allow soldiers to train in a real world urban environment including detecting and evading Improvised Explosive Devices (IED's).

In May 2006 the first RVS developmental unit was fielded to Fort Hood, Texas. The May fielding included two simulators capable of being reconfigured into four vehicle variants, two HMMWV's (M998 and M1026) and two Heavy Expanded Mobility Tactical Trucks (HEMTT M977 and M978). This developmental model has been very popular with the Soldiers and the training community there. Further designs are underway to provide more vehicle types on the RVS platform. RVS production unit fielding will begin early in the 2007 calendar year to include Army and Marine Corps installations.

Figure 4. 2006 Developmental model of RVS with HEMMT variant being used; HMMWV is now to the rear

THE VIRTUAL COMBAT CONVOY TRAINER (VCCT) CONCEPT EMERGES

In 2004 U.S. Army Forces Command (FORSCOM) sent an Operational Needs Statement (ONS) to the Army G3. FORSCOM explained that units, leaders and Soldiers must be proficient in dismounted and HMMWV-mounted combat operations. A virtual training tool, supporting the range of dismounted and motorized operations in urban and complex terrain environments, was nonexistent at that time. (Gourley, 2004)

In this ONS FORSCOM recognized that many of the desired requirements were already contained in the Soldier Combined Arms Tactical Trainer (Soldier-CATT) Operational Requirements Document (ORD). However, as analysis and discussion continued, the Integrated Concept Team (ICT) for Soldier-CATT recognized that an immediate solution needed to focus on mounted operations, specifically patrols and convoys. A new ICT was formed to focus specifically on a virtual solution for mounted operations in a HMMWV. The U.S. Army Transportation School, the Army proponent for Convoy Operations, was given the lead for this effort.

PEO STRI and Industry Blaze an Acquisition Trail

While FORSCOM was drafting its ONS, and the Convoy Defense ICT was finalizing requirements, PEO STRI and its Product Manager for Ground Combat Tactical Trainers (PM-GCTT) began to act. In late February 2004, a convoy trainer procurement was fast-tracked as an "Unusual and Compelling Urgency Procurement". An urgent need to reduce casualties among convoy operations in Iraq enabled PEO STRI to cut through bureaucratic red tape.

Instead of taking the time to issue a rigid list of contract specifications, PM-GCTT asked industry to meet a set of training requirement goals stated in a Request for Information (RFI). In 188 days, PM-GCTT and industry developed a training solution in the form of the Virtual Combat Convoy Trainer (VCCT). Conducting an extremely rapid Source Selection with Training Aids Devices, Simulators, and Simulations (TADSS) contractors, PEO STRI held demonstrations and then issued a Technology Assessment Report. The findings of that report stimulated an Army Strategic Planning Board brief and an eventual decision to fund four VCCT suites utilizing training services contracts.

Two VCCT contractors (Raydon Corporation of Daytona Beach, FL and Lockheed Martin Simulation and Training Systems of Orlando, FL) were selected to provide the suites, splitting the procurement and cutting the delivery time even further. Each training suite would consist of four networked simulated HMMWV vehicles and an Instructor/Operator console which also supports AARs. The acquisition was done with training services contracts and options to procure the residual training material (VCCT Suites) at the end of the training services.

The VCCT is used to train HMMWV crews in a virtual convoy environment on techniques to detect, respond, and avoid IEDs, identify a potential ambush, avoid an ambush, return fire, maneuver, and react appropriately in the COE.

Both VCCT contractors' designs put Soldiers in a realistic virtual environment, but use very different simulation approaches. The Raydon design utilizes head mounted displays for individual combatants riding in virtual HMMWV mockups. It has a complete 360 degree spherical field of view for all but the driver. This provides security around the HMMWV and prevents threats from approaching undetected while moving at realistic highway speeds. The Lockheed Martin design utilizes a 220 degree wrap around screen. It realistically replicates the physical features of the HMMWV and its weapons have realistic recoil and aiming.

In both types of VCCT, trainees use simulated weapons to engage computer generated opposing force combatants and vehicles. Both the VCCT systems are housed in mobile shelters which can be transported to unit locations. In addition, numerous improvements, new capabilities, and functionalities that were not able to be incorporated initially in the time available continue to be added.
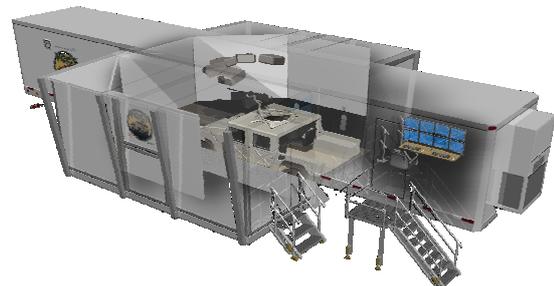

Figure 5. Lockheed Martin's VCCT

Figure 6. Raydon's VCCT

The sense of urgency and cooperation between the contractors and Government team was remarkable and inspiring. Raydon initially delivered their two VCCT mobile training suites within 45 days of contract award. Lockheed Martin delivered their two VCCT mobile training systems within 66 days of contract award. Three additional VCCTs (two Lockheed Martin and one Raydon) were added to the training services contract in 2005 to meet increased demand. The Army requirement was estimated at 27 systems, but funding prevented additional suites from being acquired. In addition to the Army; the Air Force and Marine Corps have also procured VCCT Suites.

Since 7 Aug 2004 over 88,000 Soldiers, Marines and Airmen have received training in the VCCT suites. The suites have moved continually throughout the last two years to meet the demand for training combat convoy operations.

Short Term VCCT Contracts Augment Deployment Training

User acceptance of VCCT has led to increased demand. FORSCOM's policy to move VCCT to different installations based on deployment cycles left many units and installations looking for alternatives. Additionally, there was no opportunity for moving one of the seven VCCTs outside of the continental United States. Several short term (six month) training service contracts have been awarded in addition to the VCCT fieldings described earlier. PEO STRI awarded a contract, funded directly by Fort Hood Texas for VCCT training services from July to December 2005 and another training services contract from June through December 2006. PEO STRI also manages a contract, funded directly by U.S. Army Pacific to provide VCCT training services in Alaska and Hawaii until February 2007.

VCCT Feedback and Analysis Describes Training Shortfalls

When the Army funded the initial VCCT acquisition the Army G3 directed that no additional devices would

be procured until an analysis of the VCCT solution was done. During the initial VCCT training services, PM-GCTT and the contractors collected over 2900 user surveys. These unscientific surveys overwhelmingly indicate that Soldiers like the VCCT and feel it enhances training. However, they also pointed out several shortfalls in each VCCT type which were also validated in formal analysis.

In July and August 2005, the TRADOC Analysis Command at White Sands Missile Range (TRAC-WSMR), with support from many agencies, conducted a formal Training Effectiveness Analysis (TEA) at Fort Lee, Virginia. The analysis used 180 students and Fort Lee cadre split into three groups.

Group 1 was trained, rehearsed and tested using traditional live techniques of lecture, practice on a training lane and testing on a convoy live fire range. The live fire range used blanks, IED and artillery simulators, and pop-up targets activated by weapon mounted lasers.

Group 2 was trained and rehearsed in the Raydon version of VCCT and tested on the same convoy live fire range described for Group 1.

Group 3 was trained and rehearsed in the Lockheed Martin version of VCCT and tested on the same convoy live fire range described for Group 1.

One item worth noting is that over 3,000 man-hours were expended by more than 50 support personnel to set up and run the live training events for Group 1, and the convoy live fire range which validated all training groups. In contrast, less than 100 man-hours were required to set up and run all VCCT portions of the TEA.

The results of the TEA are not final at the time of this paper. Based on preliminary findings briefed to the VCCT IPT some trends are emerging. In the opinion of the Observer Controllers (OCs) for the TEA, VCCTs are fully or partially capable of training two-thirds of the 60 convoy defense tasks that were evaluated. Many of the tasks evaluated as partially or not trained deal with limitations in virtual dismounted operations. Other comments by OCs and TEA participants addressed shortcomings in weapons realism, vertical and horizontal fields of view, and vehicle dynamics. (TRAC-WSMR, 2005)

The Army Purchases VCCT as an Interim Solution for Convoy Defense and Mounted Maneuver Training

In November 2005 the Army decided to purchase the VCCTs currently under training services contract. This was based on the continued demand for the VCCT by commanders in the field and its validation by VCCT users and the TEA. The seven VCCTs are being purchased at the end of their current training service contracts. They will undergo refurbishment to include improvement of some items that currently limit training. VCCTs will remain a viable part of the overall virtual combat convoy and mounted maneuver operations training strategy into the foreseeable future.

The Army Learns From the VCCT and Decides on the Reconfigurable Vehicle Tactical Trainer (RVTT) as the Objective Solution

In late November 2005 a decision was made by the Training and Leader General Officer Steering Committee (TLGOSC) to pursue an objective virtual combat convoy training solution. This solution addresses current VCCT shortfalls and will provide a larger fielding to support mounted maneuver operations in a variety of wheeled vehicles.

The RVTT improves upon capabilities developed in the two years that VCCT has been utilized. It addresses shortfalls in the VCCT such as 360 degree views, vehicle dynamics, and weapons realism. The RVTT concept of reconfigurability is based on the CCTT RVS. RVTT provides commanders a highly tailorable, self-contained, deployable, full-dimension, collective, individual, and combined arms virtual training and mission rehearsal simulator. It will have a robust exercise development sub-system and AAR capability. RVTT operation will be provided by Life Cycle Contactor Support (LCCS) and will not require Soldiers to operate the system.
The RVTT will consist of reconfigurable simulators that replicate the major types of wheeled vehicles used in mounted maneuver operations. RVTT allows, Soldiers, leaders, and vehicle crews to operate in a simulated combat environment. The goal of RVTT training is to allow Soldiers and leaders to practice and achieve a level of proficiency on individual, leader, and collective tasks and subtasks prior to live training. The RVTT will be developed as a component within the CCTT program and be interoperable with CCTT and AVCATT.

PROVIDING A VIRTUAL CONVOY DEFENSE TRAINING CAPABILITY INTO THE FUTURE

As RVS and RVTT are fielded the VCCT will phase out. At the end of all fielding, nine RVS and 27 RVTT suites are projected to be in use throughout the Army.
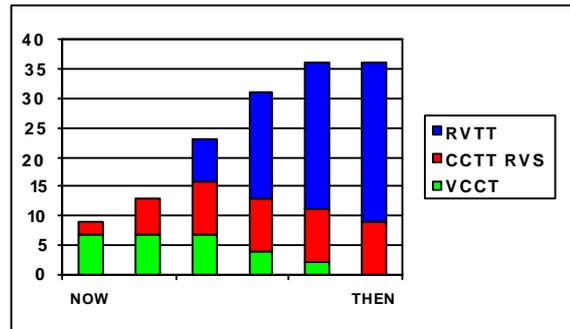

Figure 7. Fielding a Convoy Defense Training Capability based on funding at 100%

Training requirements continue to evolve and grow. The ability of these simulators and others to reinforce training on peripheral equipment and tasks continues to be identified. There is no reason why a crew of Soldiers cannot have a virtual training experience in these devices very similar to that experienced on a live range or at the Combat Training Centers. As was noted during the VCCT TEA, all costs of live training are not always taken into consideration. For example, when a unit visits and trains at a CTC, a huge number of support personnel and equipment is dedicated to making that training as close to war as possible. A reasonable amount of realism and fidelity is achievable in the VCCT, RVS and RVTT with considerably less total expense and greater frequency.

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Figures

Figure 1. From the U.S. Army Combined Arms Support Command. *VCCT Training Strategy, Draft 10a.* 16 February 2005.

Figure 2. Photo provided by: PEO STRI, Assistant Project Manager for Close Combat Tactical Trainers (APM-CCTT).

Figure 3. Photo provided by Cubic Corporation.

Figure 4. Photo provided by: Lockheed Martin Simulation and Training Systems

Figure 5. Artist drawing by Lockheed Martin Simulation and Training Systems, provided by: PEO STRI, Product Manager for Ground Combat Tactical Trainers (PM-GCTT).

Figure 6. Artist drawing by Raydon Corporation, provided by: PEO STRI, Product Manager for Ground Combat Tactical Trainers (PM-GCTT).

Figure 7. Table produced by the authors.