

Development of Embedded Live, Virtual, and Constructive Training: The Imperatives for Successful Implementation of Embedded Training with the System Platform Developer

Cynthia T. Harrison
U.S. Army PEO STRI
Orlando, FL
cynthia.harrison@us.army.mil

Frank Rhinesmith
U.S. Army PEO STRI
Orlando, FL
frank.rhinesmith@us.army.mil

ABSTRACT

Embedded Training (ET) has become the Army's preferred training solution for future weapons/systems development. In the past 10 or so years, training materiel developers have demonstrated stove-piped instances of technical and programmatic appended success unique to one of the Live, Virtual or Constructive training domains with a computing device attached to the vehicle or the system. Historically the training domain and the weapons development domain have each been successful in separately producing systems that meet the Army's requirements. The Future Combat Systems (FCS) Program was the first Army program to require the development of a completely integrated Embedded Training capability as the first choice for training. Despite the numerous ups and downs during the development of FCS, Embedded Training development achieved many successes before the termination of the program. This paper will discuss ten imperatives to ensure successful development of embedded training integrated and concurrent with the development of a new Army system.

The imperatives are broken down into Technical and Programmatic areas. The technical areas addressed in this paper include: Design of a "Safe Mode" for vehicle training; integration with the Vehicle Management System; integration with Mission Command; early dual-use decision for sub-components; designing external power and data ports; definitization of key internal and external interfaces; and early integration of embedded training as part of the Information Assurance (IA) architecture. Programmatically the following areas will be addressed: TRADOC Senior leadership commitment to embedded training; accurate detailed cost and schedule baseline for embedded training; and separate management of training development funds. Details of the implementation will be discussed as well as impacts of not following the imperatives through lessons learned.

ABOUT THE AUTHORS

Ms. Cynthia Harrison is the Chief Engineer for the U.S Army Program Executive Office Simulation, Training and Instrumentation (PEO STRI) Program Manager for Future Force Systems (PM FFS) supporting the development of embedded training for the new platforms being developed for the Army's Brigade Combat Team modernization effort. Since 1985 she has held a wide variety of engineering and program management jobs in the Live, Virtual and Constructive simulation domains for the Navy and Army. Ms. Harrison holds Bachelor and Master of Science degrees in Computer Science from the University of Central Florida.

Mr. Frank Rhinesmith is the Assistant Program Manager for the U.S. Army Program Executive Office Simulation, Training and Instrumentation (PEO STRI) Program Manager for Future Force Systems (PM FFS). He supports the development and fielding of embedded training capabilities for the Army's Brigade Combat Team modernization effort. Since 1994 he has held a wide variety of engineering and program management jobs in the Live, Virtual and Constructive simulation domains for the Army. Mr. Rhinesmith holds a Bachelor of Science degree from the United States Military Academy and a Master of Science in Systems Engineering from George Mason University.

Development of Embedded Live, Virtual, and Constructive Training: The Imperatives for Successful Implementation of Embedded Training with the System Platform Developer

Cynthia T. Harrison
U.S. Army PEO STRI
Orlando, FL
 cynthia.harrison@us.army.mil

Frank Rhinesmith
U.S. Army PEO STRI
Orlando, FL
 frank.rhinesmith@us.army.mil

INTRODUCTION

The Army has pursued numerous initiatives in the past few decades to embed some level of training in the Army's go to war systems but these have primarily been part of the Army's technology base (Rodriguez, A., Eifert, L., & Plamondon, B., 2010). While they have shown significant success in certain areas, primarily embedded virtual training for individual skills, no other Program of Record embraced the concept of Embedded Training (ET) until the Future Combat Systems (FCS) program was established. The FCS Program was the first Army program to require the development of a completely integrated ET capability as the first choice for training. Despite the numerous ups and downs during the development of FCS and its restructure to the Brigade Combat Team Modernization (BCTM) Program, ET development achieved many successes before the termination of the program. This paper will discuss a series of technical and programmatic imperatives (see Table 1) to ensure successful development of ET integrated and concurrent with the development of a new Army system.

ET – Definition

The Army has established the following definition for ET as part of Army Regulation 70-1 Army Acquisition Policy:

“A functional capability hosted in hardware and/or software, integrated into the overall equipment configuration. ET supports training, assessment, and control of exercises on the operational equipment with auxiliary equipment and data sources as necessary.” (Dept of Army AR 70-1, 2003):

While this definition is very broad and allows for ET implementations that make use of appended or otherwise, computing enhanced, operational systems,

the intent of this paper is to address training in a “fully embedded” approach. That is, with no auxiliary devices or attached/appended support.

Table 1. Imperatives for ET

| |
|---|
| <i>Programmatic Imperatives</i> |
| Senior Leader Commitment |
| Cost and Schedule Baseline for ET |
| Separate Management of ET Funding |
| <i>Technical Imperatives</i> |
| Safe Mode |
| ET Integration with Vehicle Management System |
| ET Integration with Mission Command |
| Early Dual Use Hardware Decisions |
| External Power/Data Ports |
| Early Definition of Interfaces |
| ET in the Information Architecture |

ET – The Army's Preferred Solution

ET has been identified as the Army's preferred training solution for future weapons /systems development for the last few decades. In that time, training materiel developers have demonstrated stove-piped instances of technical and programmatic appended success unique to one of the Live, Virtual or Constructive training domains, typically using a computing device attached to the vehicle or the system. Historically the training domain and the weapons development domain have each been successful in separately producing systems that meet the Army's requirements.

ET – Applicability Across Training Environments

The concept of ET can be employed to address training tasks from the individual to the collective level across a wide range and combination of Live, Virtual and Constructive (LVC) environments. To impart the concepts within the paper and to keep it of readable length, the imperatives will be discussed in the context of a number of representative ET use cases. The use cases describe both the current force LVC environments as generic capabilities as well as what the corresponding embedded LVC system must provide to enable an equivalent training capability.

Virtual Individual/Crew Training

Training individual and crew tasks such as vehicle driving, gunnery, fire support, etc. are typically conducted in virtual simulators with the Training Audience interacting with high fidelity replicas/mock ups of the crew station/compartment of the actual platform. Examples of Current Force training systems include the Advanced Gunnery Training System (AGTS), the Common Driver Trainer (CDT), and the Call For Fire Trainer (CFFT). (PEO STRI, 2010). To train individual tasks such as driver training in an embedded environment as part of the actual vehicle, the driver would need to interact with the vehicle gear and steering mechanisms and the accelerator/brake pedals (at a minimum). In response, the ET system would need to provide realistic feedback to the soldier based on their actions, to include visual input (direct view optics, camera, etc.), aural (engine sounds, external fire events, etc.), haptic feedback from vehicle control systems, as well as possible motion based feedback based on driving speed, terrain, etc. Similar interaction and stimulus would be necessary to train gunnery/weapons control/fire support in an embedded environment with the addition of the Soldiers' interaction with the weapon and the appropriate visual, aural, haptic, and motion based feedback. All of this needs to be accomplished such that the Soldier has the appropriate interaction and stimulus to create a realistic training environment without the vehicle actually moving or the weapon firing. This type of training would typically be conducted on a single vehicle, most likely parked in a motor pool or other location, configured to support training.

Virtual Collective Training

The Army trains collective tasks in large virtual environments made up of multiple, high fidelity simulators networked together to provide the required unit support from Platoon up through Brigade. The simulators are supported by other computing assets that provide friendly and opposing Force simulation and

exercise control/After Action Review (AAR) support. The Army's primary virtual collective training system is the Close Combat Tactical Trainer (CCTT). Training collective tasks in an embedded virtual environment would utilize and extend the capabilities used for individual/crew virtual training but requires the participating platforms/vehicles to be networked together (wired or wirelessly) in sufficient quantities to support the training audience participation. To support the exercise without using auxiliary computing systems requires that some number of vehicles or other available operational systems are configured and used for the execution of the role playing, simulation and exercise control, and AAR functions.

Constructive Leader/Command and Staff Training

Training Army Commanders and their Staffs in collective Mission Command (MC) and Intelligence, Surveillance, Reconnaissance (ISR) tasks include exercises that may range in size from a few Company Commanders or Platoon leaders engaging in small scale leader training to multiple echelons of command and staff up through and including Brigade level (Division and Corps level training is not included in this discussion) interacting with each other as part of a large scale collective training event. The Army currently uses federations of simulations such as the Joint Land Component Constructive Training Capability (JLCCTC) to support Command and Staff training exercises. The larger exercises are typically conducted with the training audience in one or more Tactical Operations Centers (TOCs) usually set up near a Military installation's Simulation Center and involve the Training Audience interacting with their organic MC/ISR systems as part of a realistic scenario. The MC/ISR systems are typically interoperating with, or being stimulated by, a constructive simulation. They are frequently supported by a large number of contractor personnel that role play flanking, subordinate, and opposing force units and provide detailed control of the simulated units and entities. Additionally, training in a constructive environment is enhanced by the ability to utilize a scenario that is set in a notional location, date and time with the exercise manager having the ability to set time, start, pause, and resume the exercise, and checkpoint and restore exercise data to revisit or re-enforce particular training objectives. Today's MC systems do not support the execution of mission or scenario/exercise time separate from actual wall clock time so these capabilities are addressed using manual work around procedures. Conducting constructive exercises in a fully ET environment requires that the supporting training simulation and exercise control/AAR capabilities be resident on the organic MC/ISR systems, the training

software is integrated with the MC/ISR software to the extent required to provide realistic stimulation and reaction to Training Audience input, and that the MC/ISR system supports the necessary role playing, simulation and exercise control, and AAR presentation functions.

While the Army continues to increase its MC and ISR capabilities resident in mobile platforms/vehicles, the technical challenges are similar in nature to those identified above and are not addressed as a separate use case.

Live Force on Force (FoF) Training

The Army's Training Strategy requires that every Brigade conduct a live training event at one of the Combat Training Centers (CTCs) prior to deployment. Currently, these exercises use Tactical Engagement Simulation Systems (TESS) (typically from the Multiple Integrated Laser Engagement System (MILES) family) appended to the vehicle which both interface with the vehicle data bus/weapons and the Instrumentation System at the CTC to provide Real Time Casualty Assessment (RTCA), Position/Location Information (PLI) and exercise control. Additionally, these exercises are typically supported with various devices that provide Combat Vehicle Kill Indicators (CVKI) and Weapons Effects. The Instrumentation System at each CTC is responsible for the training network, management and control of the exercise, collection of both tactical and training data, and development and presentation of AARs.

Providing an embedded live training capability may be most appropriately addressed in two phases. First, embedding the TESS and CVKI/Weapons Effects enables the vehicle to participate in what are commonly called "Uninstrumented MILES" exercises. Basically, this is the ability to conduct an exercise with MILES engagements but with no overall exercise control, organic data collection or automated AAR capability when deployed or at a location with no CTC or Homestation Instrumentation Training System (HITS). It would also allow the vehicle to participate in a CTC (or HITS) exercise without the lengthy effort to "MILES Up". Second, when planning live training in a location that does not have a CTC/HITS capability, embedded functionality is provided on additional vehicles configured to support training that would essentially create a mobile instrumentation system that may be used anytime, anywhere, for live training. It requires that some number of vehicles be configured to act as the Instrumentation System by leveraging the tactical network to support the movement of training

data and to perform data collection, exercise control, and AAR functions.

ET – IMPERATIVES AND CONSEQUENCES

The following paragraphs describe a number of key imperatives that must be undertaken to ensure the success of any ET development. The imperatives presented do not represent an all inclusive set but are deemed critical based upon 14 combined years of experience and lessons learned by the authors from the FCS/BCTM program. While the imperatives are loosely based upon the FCS/BCTM design baseline they are presented in terms broadly applicable to any program pursuing an ET capability. (FCS ETF, 2008)

The imperatives are broken down into Technical and Programmatic areas. The technical areas addressed in this paper include: Design of a "Safe Mode" for vehicle training; integration with the Vehicle Management System; integration with Mission Command; early dual-use decision for sub-components; designing external power and data ports; definitization of key internal and external interfaces; and early integration of ET as part of the Information Assurance (IA) architecture. Programmatically the following areas will be addressed: TRADOC Senior leadership commitment to ET; accurate detailed cost and schedule baseline for ET; and separate management of training development funds. Key requirements of the implementation will be discussed as well as impacts of not following the imperatives through lessons learned.

Technical Imperatives

The ability to immerse Soldiers in a realistic fully ET scenario from their organic weapons platforms and MC/ISR systems implies no additional appended training unique systems/capabilities are required. This constraint drives the developer to address a number of technical challenges over and above those addressed by Current Force training systems.

While not discussed separately in the paper, there are a number of general technical approaches that must be undertaken to successfully achieve an ET capability. It goes without saying that you must address the design of your training software/hardware as an integral part of the vehicle, platform, weapons system, or MC/ISR systems architecture and design activities. It should also be assumed that you would utilize every opportunity to use and leverage existing standards from the training community. This both facilitates potential reuse of existing Current Force training capabilities as

well as enables interoperability of the ET system with current training systems as part of larger, collective training exercises. It also allows for training in an environment that includes systems with no ET.

The following technical imperatives provide a key list of challenges for ET developers to address with primary consequences in terms of loss of capability if not addressed.

Design of “Safe Mode”

The requirement to address safety is critical to the acceptance and safety/fielding release for the vehicle. It applies across all ET use cases with examples ranging from individual virtual training for vehicle operations, networking of multiple vehicles to support a command/staff constructive exercise to a large scale Brigade Combat Team (BCT) Force On Force exercise at a live training range such as the National Training Center (NTC).

Embedded Training of many individual, crew and collective tasks as part of a weapons platform/vehicle within the Live, Virtual and Constructive environments requires soldiers to interact with and operate vehicle and weapons controls as well as create, modify and react to operational MC/ISR data. Operation of the vehicle controls must be done in such a fashion as to appropriately replicate their operational use to enable training but also in a safe environment such that Soldier actions do not inadvertently cause the vehicle to move, the weapon to fire, or training scenario data to be incorporated as part of the operational COP. Any of these could easily result in loss of life or limb to the Soldier, damage to the vehicle, or risk to the mission being conducted. To preclude this, it is critical that any ET capability needs to be able to place the vehicle in a “safe mode” such that the illusion of operation is maintained, yet the reality of safety is enforced.

The challenge for ET is not necessarily in the integration of the large number of complex technologies to support the LVC environment (although that is a significant technical issue addressed by later imperatives), but a “safe mode” will ensure the integration of these technologies on a vehicle in a manner that does not place the Soldiers in danger, cause damage to the vehicle, or cause risk to the mission. This requires extensive upfront architecture analysis and development of a sophisticated modes/states solution that enables the Soldier’s use of all operational systems when required by the training objectives and scenario, but precludes actual engagement of the vehicle drive train, weapon, etc. The “safe mode” solution must also ensure the ability

to transition from a training mode back to an operational mode with no loss of capability/data in cases where training is being conducted in a deployed environment and some action forces the immediate return to an operational state.

Any implementation of ET that does not fully address safety issues from the onset will cause unacceptable cost and schedule risk in achieving a vehicle Safety Release and subsequent Materiel Fielding Release.

Integration with Vehicle Management System

Both the Virtual and Live use cases require significant integration of the ET software/hardware with the Vehicle Management System (VMS) and the vehicle electronics (Vetronics) and control systems. Virtual Training of many individual, crew and collective tasks requires full immersion of the Soldiers in the vehicle interacting with the organic vehicle controls, displays and/or the weapons system so that the training scenario appears to be a realistic operational scenario. Live Training requires the vehicle to be fully operational with the primary exception of simulated weapons firing, weapons effects and kill indicators.

Virtual Training exercises require different combinations of real and simulated hardware to stimulate the Soldier depending upon the tasks being trained. Virtual Training exercises typically make extensive use of simulated vehicle subsystems, ownship models, etc., vice use of actual hardware to replicate vehicle systems/dynamics, provide feedback to the Soldier at the Soldier’s touch point (steering, pedals, displays, etc.). It is key that the training software be able to stimulate both real and simulated vehicle systems thru the VMS to provide the required stimulus and response to the Soldier.

In a Live FoF training exercise, most of the vehicle subsystems are operational with primarily those associated with fire control, hit avoidance, and damage assessment functions being simulated. Training unique software is required to coordinate the simulated live fire, for stimulation of the training unique or dual use hardware supporting laser engagements and simulated weapons effects for main gun firing (see dual use hardware discussion), and for simulated hits from incoming rounds. In addition, there is required integration of the ET software/hardware with the VMS/Vetronics to access vehicle data such as position/orientation/location of the vehicle, position and orientation of the hull and turret, gun azimuth and elevation, etc.

Inability to integrate the ET software/hardware with the VMS will significantly limit the type of ET available to the Soldier as availability of key data and stimulation of vehicle control systems will not be feasible.

Integration with Mission Command

Training of Leaders and the Commander and Staff in collective tasks requires the Training Audience to interact with their organic MC/ISR systems, usually in a TOC environment (one or more). To accomplish this in a fully ET environment implies a much tighter integration between the MC/ISR and the training software than any previous implementations. The training software is expected to be resident on and run by the Unit as part of the organic MC/ISR system, without the extensive contractor support required in today's exercises. This necessitates that many of the capabilities addressed by humans and separate computing resources, such as the simulation, translation capabilities, and role player and exercise management functionality, become an inherent part of the integrated MC/ISR/Training software load. This requires significant enhancements and changes to the typical software baselines of both communities and is not a trivial task. A few key examples are provided below.

Current Force MC/ISR capabilities are limited in their ability to portray date/time/location as part of a training scenario that is different than the actual date, wall clock time, and location of the MC systems themselves. Additionally, current MC/ISR systems do not have the abilities to set and control the clock separately from wall clock. This significantly limits the ability to manage a training exercise including control of scenario time and ability to save and restore exercise data to revisit or reinforce particular training objectives.

Current Force Constructive Training capabilities typically require extensive role players and simulation controllers for both blue and red forces to ensure the constructive simulation reflects the required scenario and evolving battlespace based upon the Training Audience's actions. Enhancements are required to the training simulation to interact with plans and orders provided by the Training Audience without the benefit of extensive role players.

Without this level of enhancements and extensions to both MC/ISR and Training software and the tight integration between the two, it is unlikely an embedded simulation capability would be useful in anything other than the simplest of leader exercises.

Dual Use of Platform Hardware

Each of the ET use cases has opportunities to leverage existing vehicle hardware to meet unique training requirements with little/no impact to Size, Weight and Power (SWAP). Most ET capabilities can be provided through a combination of operational software and training software interacting to stimulate and control the organic vehicle hardware systems which provide the user interface and controls to the Soldier in the crew compartment. It should be assumed that the hardware associated with typical Soldier interaction with the vehicle is leveraged for training in lieu of any training unique displays or vehicle controls as well as the organic computing resources on the vehicle. Of greater interest and greater value are some of the vehicle hardware assets that could be used in a dual use capacity to meet some of the more training unique requirements. Examples include use of an onboard laser range finder, laser detector, and laser decoder to meet basic TESS and MILES interoperability requirements, use of vehicle lights in lieu of appended CVKI lights, and development of switchable vision blocks which can provide driver/gunner sights in training modes.

This should be the preferred implementation as any identified training unique hardware will add to the SWAP requirements for the vehicle. It may be viewed as unnecessary by the Project Manager (PM) since it is not critical to meeting the operational requirements and will likely become trade space for higher priority capabilities. It is highly recommended that the developer consider dual use of operational hardware in a training configuration to meet training requirements.

Design of External Power/Data Ports

Training of individual or crew skills in a virtual mode can be accomplished within a single vehicle, as can individual leader training if a MC capability is present. While this standalone training may not require external data, it does require that the necessary vehicle subsystems and computing resources have available and sufficient power to operate. This can be accomplished by keeping the vehicle engine running or by connecting the vehicle to "shore power" in a motor pool or other location (it is assumed the vehicle batteries would not be sufficient to run the vehicle systems required for a stationary training exercise). It is conceivable that the Commander would rather run off "shore power" vice the engine for training exercises for logistical and other reasons. Thus, the availability of an external power source, while not required, is highly beneficial for individual, or networked, virtual and constructive training.

Collective training scenarios, whether virtual or constructive in nature, require the vehicle to be networked with other vehicles or with existing Current Force training systems for the purposes of exchanging training data both for configuration of the exercise as well as during execution. The training network needs to be established, tactical and simulation initialization data needs to be disseminated based on the training scenario and objectives, exercise control commands will be distributed, and training data (e.g., entity state, fire/detonation, etc.) will be published and logged as required during the exercise to support feedback and AAR activities. The ability to support this level of network traffic drives the need for external data ports on the vehicle that are accessible to, and able to be utilized by, the ET software. Failure to provide external data ports on the vehicle would preclude any ability to conduct any training exercises that require multiple vehicles to interact as part of the same exercise.

While it is the intent of this paper to address training from a fully embedded perspective, practically speaking there are valid grounds for providing external ports on the vehicle that are capable of providing power and vehicle data to appended and auxiliary devices as well. While the program may have every intention of achieving a fully ET solution, inclusion of these ports in the initial vehicle design baseline will enable alternative training solutions if cost and schedule priorities cause ET requirements to be diminished.

Design of Internal/External Interfaces

All the ET use cases require the early and upfront identification of both internal interfaces between vehicle, MC/ISR and training software/hardware as well as external interfaces between the vehicle or MC/ISR system with other systems used to conduct training (other ET solutions, Current Force collective training systems, TADSS, etc.). While other sections of this paper tend to promote the concept of tight coupling between the various software components, it's really intended to imply a deeper level of integration than the current implementations which rely primarily on translators to allow disparate systems to interoperate. However, within an integrated vehicle, MC/ISR and training software environment, loose coupling is encouraged to enable autonomy of development within the different domains. Early agreement across the development community on internal interface definitions and data formats will enable this loose coupling and permit developers to pursue implementations to meet requirements while assisting in managing dependencies across the solution space.

External interfaces in support of ET are necessary to enable a distributed ET exercise to be conducted across multiple networked vehicles as well as interoperability of the vehicle's ET with other ET systems and Current Force Training Systems. It is critical to define external interfaces, particularly hardware interfaces, early to ensure the ability of the vehicle developer to make design decisions that meet requirements while staying sensitive to SWAP impacts. Additionally, the software developers need to have an early understanding of the interface requirements associated with a distributed networked exercise as well as for interoperability with other training systems to ensure the appropriate functionality is implemented over time.

Failure to address the internal interfaces will greatly increase the risk that at least one developer will pursue an implementation that does not support, or may even preclude, the ability to meet the overall ET requirements. Failure to address the external interfaces may still allow standalone training to occur in the vehicle but will preclude any interoperability with other ET systems or Current Force training systems. Any efforts to address interfaces late in development will likely be cost prohibitive and result in the ET requirements becoming trade space for other capabilities.

Security Architecture/Information Assurance (IA) Considerations

Consideration of security and information assurance requirements as part of any ET implementation for all use cases is critical in achieving a fieldable solution and impacts all the technical imperatives described in this paper. To date, the implementation of a security architecture that can achieve security accreditation has been the most challenging technical area. It is highly likely that the complex computing environment required to meet broad vehicle and/or MC/ISR needs will include multiple security enclaves with robust guard solutions to manage data flow. Early design of an IA solution that allows for the appropriate interaction between security enclaves is required to enable the required interfaces between any training software and the vehicle and/or MC/ISR software. Additionally, many Current Force Training systems operate at different levels of security than operational systems. The ET implementation needs to address any security constraints or challenges brought on by requirements for interoperability with other training systems.

Vehicle or MC/ISR Security Architectures that do not adequately address and allow for both operational and

training capabilities will not achieve their required Security Accreditation and will likely prohibit the ability to use operational capabilities in a training mode. This will result in the development of appended training unique software/hardware.

Programmatic Imperatives

The Army has committed to the development of ET for soldiers. This requirement has existed for the last few decades but the ability to execute the mission has not been unilaterally embraced across the Army community due to a number of factors. The programmatic imperatives discuss critical areas that singularly do not guarantee the successful development of the breadth of ET. Each of the following programmatic areas below are equally important for the successful implementation of ET in a new system development. The programmatic imperatives combined with the technical imperatives, create a development environment that will explicitly and with due diligence guarantee that ET is properly addressed in terms of cost, schedule and performance.

The following programmatic imperatives provide a key list of areas that need to be addressed for the successful implementation of ET. The consequence of not adhering to the imperatives is reverting back to the status quo of providing separate stand alone training devices.

Army Senior Leader Commitment

TRADOC has incorporated the desire for ET to be the first choice/preferred choice for the development of new training capabilities during the development of a new weapon system or platform. Embedded Training is required by several Army Regulations. (Dept of Army, AR 70-1, 2003) (Dept of Army, AR 350-1, 2009) (Dept of Army, AR 350-38, 1993)

The next step is the incorporation of the ET requirement into the requirements development process and documentation of these requirements in the Joint Capabilities Integration and Development System (JCIDS) Capability Development Document (CDD). The Combat Developer has historically engaged the materiel developer as the requirements have been developed for a weapons system or platform. The development of a training capability has lagged behind the platform development by 1- 3 years. In the past this has been acceptable for the Army but for the success of ET, the requirements and the development have to occur simultaneously with the development of the platform or system capabilities. The user has a responsibility in the future to provide the same level of detail that has gone into the development of measurable

requirements for standalone TADSS devices in the past for the development of Live, Virtual, and Constructive training requirements for the ET capability in weapons platform or system.

Program managers will continue to struggle throughout the development process with cost, schedule and performance. ET, as a new comer to the list of requirements items that a platform PM tracks combined with the old way of building training later, easily becomes trade space for the PM to achieve his milestones.

Without TRADOC Senior Leadership commitment documented as a key performance parameter (KPP), the realization of ET will likely not happen. The detailed documentation of embedded Live, Virtual, and Constructive requirements combined with the elevation of ET as a KPP are essential to the successful delivery of an ET capability on a weapon system or platform.

ET Addressed in POM and Cost/Schedule Baseline

To be successful, PM's have to have a realistic baselined cost and schedule from which to execute their programs. ET as the new comer to the requirements of the system under development has not historically been given the due diligence necessary to take it to completion. The technical aspects will be addressed in other sections of this paper but in the end the PM has to take the technical and programmatic details and put them into a baselined cost and schedule.

The integration of ET into the platform may take the program longer then the historically developed non-ET platform development. Without the details of a well developed and defendable schedule ET easily becomes an area that the PM will recommend as an area that the program needs to trade off to meet either cost or schedule.

The Army training materiel developers now possess sufficient experience in the development of ET that it is realistic to expect a schedule with sufficient detail that matches or exceeds the traditional weapons/platform detailed schedule.

Expectations must be managed on cost. ET is not a cheaper way for the Army to develop training capabilities. Again, Army training developers possess sufficient experience in the development of ET to provide the system PM a detailed cost estimate to match the schedule. The details of the technical imperatives will provide the PM and the user sufficient information if trade off decisions for the program are required.

The development of ET reduces Operations and Support costs and may also reduce the need for “brick and mortar” facilities.

Separate Management of Training Funds

Separate management of Training funds at the program level is a key factor in the successful development of ET. Historically, training development has been buried in a program’s funding management. Previously training capabilities were developed as a stand-alone item and did not directly impact the platform’s technical development process. This worked in the past when funding for training was traded off for higher priority capabilities since training was added back in 1-3 years later.

The development of ET is a software intensive development process. If the funding is not separated and buried under general software development it becomes an easily over looked area that cannot usually recover once development is completed by adding more money to try to fix the shortcoming.

Earned value can also be tracked by program management for the successful realization of ET. As with the program management of cost and schedule, the separation or fencing of ET training funding provides the PM the appropriate visibility and priority to support the user’s requirements.

CONCLUSION

This paper has identified key imperatives necessary for the successful development and implementation of ET along with the consequences and impacts of failing to sufficiently address them (Table 2). Some of the imperatives represent significant paradigm changes that weapons systems and training systems developers have to execute. The implementation of ET does not provide the Army with any significant cost savings but the resulting enhancement to the Soldier’s ability to train is tremendous and the consequence of not adhering to the imperatives is reverting back to the status quo of providing separate stand alone training devices.

Table 2. Imperatives and Consequences/Impacts

| <i>Programmatic Imperatives</i> | <i>Consequences/Impacts*</i> |
|--|---|
| Senior Leader Commitment | No ET Solution. |
| Cost and Schedule Baseline for ET | ET Becomes Trade Space. Late Implementation Cost Prohibitive. |
| Separate Management of ET Funding | ET Becomes Trade Space. Late Implementation Cost Prohibitive. |
| <i>Technical Imperatives</i> | <i>Consequences/Impacts*</i> |
| Design of Safe Mode | Inability to Achieve Safety Release and Field System. |
| ET Integration with Vehicle Management System | No Embedded Live or Virtual Training for Individual, Crew or Collective Tasks. |
| ET Integration with Mission Command | No Embedded Constructive Training for Leader/Collective Tasks. |
| Early Dual Use Hardware Decisions | Increased SWAP Requirements on Vehicle. Appended Training Unique HW/SW Solution. |
| External Power and Data Ports | No Collective Training. No Interoperability with Current Force Systems. No Support for Appended Solutions |
| Early Definition of Interfaces | Limited Embedded LVC Training. No Collective Training. No Interoperability with Current Force Systems. |
| ET in the Information Architecture | No Security Accreditation. Appended Training Unique HW/SW Solution. |
| <i>*All Consequences and Impacts include the development and/or modification of Current Force Training Systems to fully meet the training requirements.</i> | |

ACKNOWLEDGEMENTS

The authors would like to acknowledge and thank the numerous members of the FCS/BCTM Government and Contractor training team for their perseverance, expertise, accomplishments, and contributions made

over the last 9 plus years to the field of Embedded Training.

REFERENCES

Department of the Army Regulation 350-1. (2009). *Army Training and Leader Development*.
Department of the Army Regulation 350-38. (1993). *Training Device Policies and Management*.
Department of the Army Regulation 70-1. (2003). *Army Acquisition Policy*.
Future Combat Systems (FCS) Program. (2008). *Future Combat Systems (FCS) Manned Ground Vehicle*

(MGV) Embedded Training Framework (ETF) Design Note.
Program Executive Office Simulation, Training and Instrumentation (PEO STRI) (2010). *2010 Products and Services Catalog*.
Rodriguez, A., Eifert, L., & Plamondon, B. (2010). *Lessons Learned on Embedded Training Technology Program for Soldier and Platform Centric Training. Proceedings of the Interservice/Industry Training, Simulation, and Education Conference (IITSEC), Orlando FL*.