EMBEDDED TRAINING
for
ARMORED SYSTEMS MODERNIZATION

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ABSTRACT

In an effort to reduce training costs for sustaining soldier proficiency in deployed units, the U.S. Army Training and Doctrine Command (TRADOC) has identified embedded training as the preferred alternative to be considered for development of training systems used to prepare and sustain future armored vehicle crew members. Prior to full scale development, the demonstration/validation portion of the vehicle acquisition process must investigate the optimum implementation of embedded training for the next generation of armored combat vehicles. This paper reviews the general goals, and some of the challenges involved, for embedded training within the six future vehicle systems planned for the Armored Systems Modernization program; the paper focuses primarily upon the present efforts directed for developing embedded gunnery and tactical simulation into the electronics of two of these vehicles, the Block III tank and the Advanced Field Artillery System (AFAS).

Background

In view of the constantly uncertain and turbulent situations in Europe and Third World Nations, the U.S. Army has initiated the Armored Systems Modernization (ASM) program to ensure the fielding of a competent, combat effective conventional land force able to engage the threats anticipated in the 21st century. This ASM program is intended to take advantage of emerging technological opportunities which will be applied to emphasize commonality of vehicle needs and sustainment costs for the group of vehicle systems.

The ASM program includes the six new vehicles, shown in Fig 1, which are being developed to replace existing armored systems.

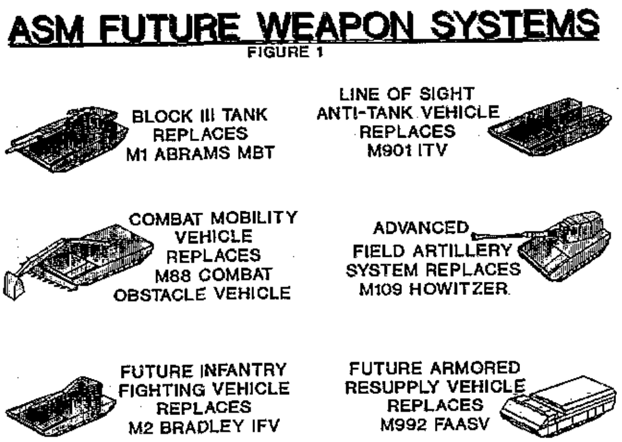

FIGURE 1

Integrated Training Systems Approach

According to the TRADOC vehicle proponents, each ASM vehicle variant requires an Integrated Training system (ITS) consisting of varied combinations of the following kinds of training devices, simulators and simulation (DSS) (see Fig 2):

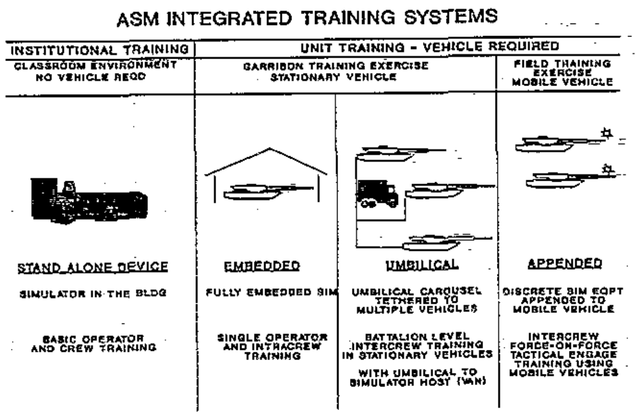

FIGURE 2

Embedded Training System (ETS): The TRADOC definition of embedded training is "Training that is delivered by capabilities built into an operation system in addition to the primary function. The training is made available by components of the equipment that take advantage of the overall system capabilities. It can train individual, operator, crew, functional and force level tasks."

The ETS is envisioned to be tailored to the needs of the respective ASM vehicle crew operation and maintenance tasks. Refer to Fig 3 for a simplistic block diagram of ETS operation.

DETACHED VEHICLE ET MODE
SYSTEM BLOCK DIAGRAM

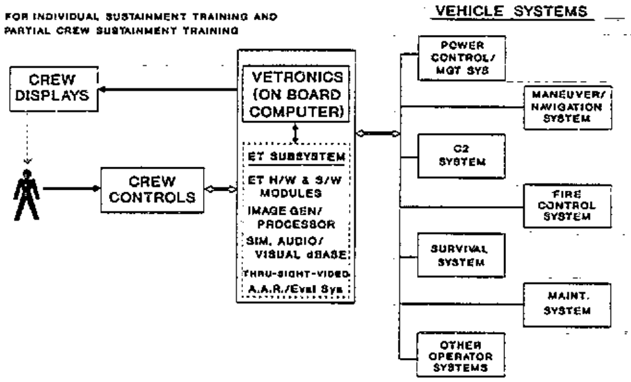

FIGURE 3

Umbilical Carousel Trainer (UCT): External simulation hardware and software equipment that can be connected via an "umbilical" cord to the vehicle ETS. The UCT would have the additional capacities (beyond those of the ETS) to provide some of the desired training features and mission complexities that are not deemed cost effective for embedding in the vehicle. The UCT is conceived as an external simulator device that would provide any individual vehicle crew the capability to collectively train with other individual vehicle crews in battalion-and-below (B2) level of command and control exercises. This UCT would be configured to allow any vehicle of any of the six ASM variants to connect to the UCT, thus providing an opportunity to train complete crews of any ASM vehicle together in a collective team training scenario. UCT could be a mobile, van-type of simulator, complete with separate instructor(s) stations and detailed training data base to address various levels of operator proficiency, (i.e. basic, transition and sustainment). Each UCT is envisioned to be posted to a battalion for use within the garrison (e.g. in the motor-pool area) for ease in coordination of the usage by different types of vehicles. The UCT would accommodate a minimum of 12 vehicles at a time, in a "carousel" fashion. The UCT would have the capability of accessing Simulation Network/Close Combat Tactical Trainer (SIMNET/CCTT) via direct or radio frequency connection.

Appended Training System (ATS): External simulation hardware and software that is attached externally and plugged into the vehicle electronics, or actuated externally, during mobile field training exercises for realistic tactical engagement simulation which includes weapons effectiveness along with the aural/visual ("flash and boom") impact cues of battle explosions. Present-day examples of ATS include the Main Tank Gun/Weapons Effect Signature Simulator (MTG/WESS) and Simulation of Area Weapons Effects (SAWE) type of "non-system" simulation equipment. Currently appended tactical engagement simulations like Multiple Integrated Laser Engagement System (MILES), Tank Weapon Gunnery Simulation System (TWGSS) and Mobile Independent Target System (MITS) are anticipated to be designed into the ETS of the vehicle.

The "external" nature of ATS is conceived to allow actual movement by the "own" vehicle during field exercises at Combat Training Centers, whereas the "external" nature of UCT is to afford the opportunity for multiple stationary vehicles to interconnect for collective team or "task force" training in garrison environments.

Institutional Gunnery Trainer (IGT): Equivalent to current stand alone devices which provide Conduct Of Fire Training (COFT) to the gunner/commander crew operators of tanks and infantry fighting vehicles. IGT is used at the respective vehicle proponent schools primarily to provide basic and transition gunnery training for crew operators. IGT is expected to provide more opportunity than presently available in COFT to train the vehicle driver for vehicle maneuvering during gunnery exercises. Refer to Fig 4 for institutional simulator block diagram.

STAND ALONE DEVICE TRAINING MODE
SYSTEM BLOCK DIAGRAM

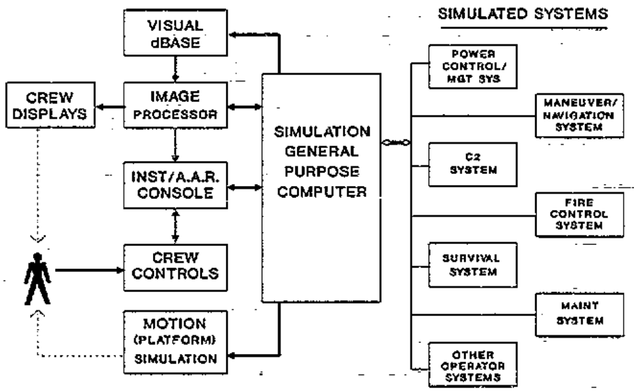

FIGURE 4

Institutional Driver Trainer (IDT): Similar to IGT, except that the proponent school is providing basic and transitional training to the vehicle crew driver. IDT should take advantage of the common driver controls and displays expected to be duplicated across the common chassis design of the ASM vehicles.

Institutional Maintenance Trainer (IMT): Provides an assortment of troubleshooting panels to train maintenance procedures for ASM vehicle engines, transmissions, hull electrical, fire control systems, chassis hydraulics and turret controls. The IMT is envisioned to emphasize the common maintenance design of the ASM common chassis and Vetronics Built-In-Test (BIT) circuitry. The IMT should provide training at the unit and intermediate levels of responsibility.

Close Combat (Crew) Tactical Trainer (CCTT): Provides institutional training, at the basic and transitional level of proficiency, in the combined arms tactical procedures (emphasizing command and control) to be implemented in the future Air Land Battles. The CCTT could serve as the proponent school's version of the UCT collective team training in the garrisoned unit. A mobile configuration of CCTT should be available to meet proponent institutional requirements for "transportable" crew trainers.

Each ITS is required to be Ready for Training (RFT) at various CONUS/OCONUS locations at least one quarter prior to the vehicle Initial Operating Capability (IOC). The ITS requires an Instructional Strategy and Systems Engineering design for all embedded training functions, training related (stand alone) DSS, as well as the Programs of Instruction (POI) and related courses, courseware and courseware development systems (Authoring).

In accordance with the ASM system Operational & Organizational (O&O) Plan, the preferred training capability will be embedded to the maximum practical extent.

A fully tested, validated and verified ETS is required to provide sustainment training and familiarization within the vehicle for crew members assigned to operate and maintain their respective ASM variant vehicle. Let's now focus on some of the specific interface challenges which accompany the desired ETS performance.

Standard Vehicle Electronics Architecture

ASM vehicle technology will emphasize a modular, digital electronic Vehicle Control and Operation System (VCOS) whose configuration has been designed to use the Standard Army Vetronic Architecture (SAVA), presently being developed by the Army Tank Automotive Command (TACOM). SAVA is based upon an assortment of modular electronic processor boards which exchange data across six different buses employing standard interfaces. It is intended that these modular boards and buses will maximize design commonality across the six different vehicles, thus reducing development and sustainment costs for the modernization of this group of vehicles.

The ETS is based on emulating, or alternatively stimulating, the same VCOS electronic signals and data that would normally be cued to each of the vehicle crew members in the course of their assigned duties within the vehicle. The ETS will take advantage of any bus data and interface that is normally processed in the VCOS during combat (non-training) mode. The ETS will stimulate those available VCOS functions and simulate those that are not normally available in the combat mode, but are required during the non combat (training) mode of operation for the vehicle.

The ETS must, therefore, have access to all of the analog and digital signals being communicated on all of the SAVA vehicle buses, including external to Lowest Replaceable Unit (LRU) type:

a. Utility Data (Low Speed) Bus: Power management and control, simple sensor, gauge and actuator monitor and control. Less than 1 MHz.

b. Video Data Bus: Used for imaging and nonimaging sensor video at the crew stations displays.

c. High Speed Data Bus (HSBD): Used for the most complex and high performance vehicle applications having a flow rate exceeding ten megabits throughout (20Mhz).

d. MIL-STD-1553B Medium Speed Data Bus (MSDB): Used for the moderate complexity data performance capability less than ten megabits throughput. (Less than 1 MHz).

Internal to LRU type signals:

e. VETRONICS Test and Maintenance (T&M) Bus: Used for access to, and simulation of, the diagnostic data required to troubleshoot vehicle systems.

f. VME (SAVA) System Backplane (SSB) Bus: for inter-processor/peripheral communications, userdefinable input/output channels and interconnect to all external data buses.

Fig 5 provides a basic diagram of ETS access and function on the SAVA/VETRONICS bus.

ETS ACCESS TO SAVA/VETRONICS BUSES

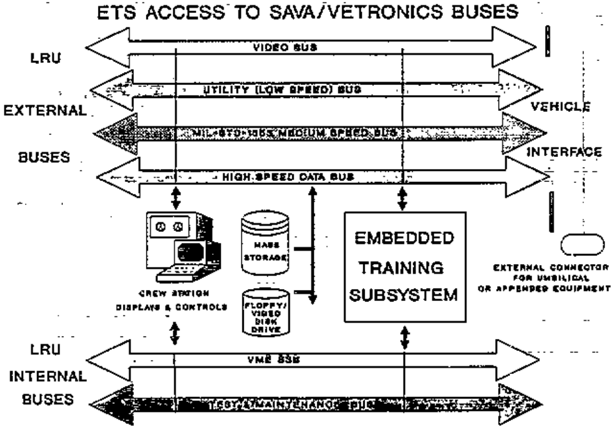

FIGURE 5

Overall Vehicle Mission Performance

The ETS would simulate accepted versions of operational missions, in both normal and degraded modes of vehicle operation. Operational missions would vary for each ASM variant. The operational scenarios for each variant should provide necessary sustainment level of proficiency to individual crew members, both operators and maintainers. Proficiency must include both individual part-task type of training as well as collective team or force-on-force tactical training. The ETS must include the capability of free-running mission scenarios with which the crew member would dynamically respond as dictated by normal combat procedures and doctrine. These scenarios would conclude with an After Action Review (AAR) type of feedback, which provides the student with appropriate guidance and evaluation regarding performance in response to the complete scenario.

The ETS must be designed to endure the same physical environment as the remainder of the vehicle electronics (Vetronics). The ETS must also replicate the threats against which the ASM vehicle must respond. Like the remainder of the VCOS Vetronics, the threats to the ETS are dependent on the mission requirements for the particular type of vehicle system in which it is installed. The most likely and most severe threats are those which ETS would encounter in its employment in tank armored vehicles. The design of ETS shall therefore take into account the requirement that the crew, vetronics subsystems and VCOS subsystems, including ETS, respond effectively to the following enemy threats:

a. Weapons - including anti-vehicle guided weapons, land mines, artillery, tanks, attack aircraft, laser weaponry, and small arms fire.

b. Anti-vehicle obstacles.

c. Electronic Warfare (EW) - including disruption (jamming), deception, destruction of communication nodes, and exploitation of communication information (regarding force strength, locations and intention).

d. Nuclear, Biological and Chemical (NBC) Warfare - including nuclear electromagnetic pulse (EMP).

e. Directed Energy Threat technologies such as laser and High Power Microwave (HPM).

ASM vehicles are expected to use high-mobility tactics and closely-coordinated assaults to improve their combat effectiveness against enemy targets in this threat environment. The enemy arsenal is expected to be used to its fullest to counter the vehicular movement, to disrupt communications used for coordination, and to destroy communication nodes. Thus, radios can expect heavy jamming, and radio transmitters can expect to draw incoming missiles or projectiles. Those emissions that are not jammed and do not draw fire will be the ones from which the enemy can extract tactical information. Optical devices and human eyes will be targets for enemy lasers. Therefore, to minimize the threats, the vehicles must use secure, anti-jam communications which minimize compromising emanations while exposing a low electronic profile. In addition, EMP effects must be controlled and contamination from NBC attack neutralized or accommodated. The ETS must not only survive such threats, but it must also be able to replicate these threats for training and crew preparation purposes.

The vehicle system's ETS shall include an Embedded Technical Help (ETH) capability. ETH will provide operational checklists, automated logbook, parts requisition capabilities, built-in-test, preventive maintenance procedures, automated field manual reference guides, and on-board resource inventories. ETH is conceived to be an automation system which provides labor or material saving procedures that aid crew member performance on the job. While ETH may also serve as a training aid, it is not conceived to be a system of providing sustainment training to ASM vehicle crew operators and maintainers. ETS shall include the capability of training crew personnel in the use of ETH as a tool in their normal duties.

<u>User Desires for ETS Performance</u>

User requirements for the ETS suggest that it will be used both in protected garrison locations and the unprotected environments of actual combat assembly areas, as well as in the harsh environments associated with force-on-force (FOF) training at Combat Training Centers. The vehicle combat laser detector and transmitter may therefore be concurrently used for tactical engagement simulation during FOF training exercises. This embedded feature would then replace the appended nature of present MILES or TWGSS type of laser-based training equipment.

The ETS would simulate realistic combat scenarios which provide proper visual and aural stimulus of, and response to, the complete vehicle crew actions in a manner duplicating the performance expected during actual combat operations. The ETS shall be designed as part of the vetronics and shall be interfaced directly to the crew member controls and displays in order to provide an assortment of readily available combat training scenarios that directly simulate all of the vetronics functions.

The ETS operation must be transparent to the vehicle crew and should not interfere with the crew's normal operational functioning of the vehicle. The ETS design must ensure no inadvertent access to the normal combat mode of fire control operation while conducting training; nor should there be any inadvertent access to the training mode of vehicle operation while conducting actual combat operations. The vehicle operator(s) should be able to access the ETS from the combat (i.e. non-training) mode of operation in less than five minutes.

The ETS design must maximize the use of normally available vetronics resources such as power supply, crew controls and displays, memory, audio and visual generators/processors, disk drives, etc. in order to minimize electronics hardware space claim, with subsequent additional cost, required by the ETS. Maximized use of the normally available resources is also required in order to ensure direct emulation of the typical visual and aural stimuli expected to be provided to the operator during actual combat mode demonstration.

<u>ETS Functions</u>

The ETS would include, as a minimum, the following performance modules or components:

a. Training Menu/Mission Selection Module (TMSM)

b. Crew Station Display Module (CDM)

c. Crew Station Operator Controls Module (COCM)

d. Audio Control Module (ACM)

e. Centralized Data Processor Module (CDPM)

f. Decision/Response Branching Logic Module (DBLM)

g. Performance Monitor/Evaluation Module (PEM)

h. Appended/Umbilical Interface Module (AUIM)

The term "module" is meant to denote a hardware and software unit which is dedicated in design and function to perform the described capability. It may include one or more electronic circuit boards; it may be contained as a part of a single circuit board which is populated by integrated circuits performing various other "module" functions. The software involved may be, for example, a subroutine of higher ordered modules.

Training Menu/Mission Selection Module (TMSM): This module would enable the student or instructor to select and setup the type of training (individual, crew, tactical, level of help, etc.) and particular mission scenario parameters (threats, weather, degraded equipment, etc.) to be simulated. This menu/selection information would be sent via the CDM to the appropriate operator's display(s). Module input comes from the CDM, COCM and CDPM.

Crew Station Display Module (CDM): This module would receive and format the appropriate visual information (video image or graphical symbols or text) to be cued to the respective crew station operator. This information would be output via the CDPM to the high speed digital data bus for viewing at the operator's display(s). Module inputs come from the COCM, TMSM, PEM, DBLM and CDPM.

Crew Station Operator Controls Module (COCM): This module would receive, interpret and translate the digitized data being sent from the operator's controls. This data would provide the input to simulation algorithms that provide movement or action cues to the operator which are commensurate with the perceived operator control. The output of this module would usually be sent to the TMSM, CDM and DBLM for providing the cued visual perception of the operator response. Module inputs come from the CDPM.

Audio Control Module (ACM): This module would enable/disable normal crew audio communication. It would include a synthesized speech voice which could serve for either "missing" crew members, personnel external to the vehicle (e.g. battalion radio operators) or an instructor. Output from this module would usually be sent to crew member headsets via the CDPM, audio couplers and the MDSB. Module inputs come from the CDPM and PEM.

Centralized Data Processor Module (CDPM): As the name suggests, this module would be central monitor ("bus watcher"), interpreter, access path and supervisor of ETS digital data being input or output. This module must access all digital buses, both external and internal. Module outputs go to all ETS modules and to all vetronics buses; module inputs come from all buses and from the TMSM, CDM, ACM, and AUIM.

Decision/Response Branching Logic Module (DBLM): This module would interpret the action taken by the operator versus a series of branching logic trees to provide the appropriate response to the operator. Input comes from the CDPM (decision baseline for comparison purposes) and COCM; outputs go both to the CDM, as well as to the Performance Monitor/Evaluation Module.

Performance Monitor/Evaluation Module (PEM): This module includes an artificial instructor capability that would record the operator's responses to various threats. The record could, as chosen by the operator during the training menu phase, be either:

a. a complete audio and visual record of the free-running scenario just undertaken with summarized audio-visual critique provided at the end of the mission, or

b. step-by-step intervention by the instructor to evaluate or guide each action taken by the operator in response to each obstacle or threat.

To the extent possible, artificial instructor capability must use simple graphics and other easily comprehended formats for presenting feedback to the student(s). This module would also serve as the Integrated Training Management System which provides automated selection of training exercises/scenarios on the basis of predefined instructional strategies and operator/crew past performance. Module inputs come from the CDPM (mission completed, going directly to AAR) and DBLM; outputs go strictly to the CDPM for storage of data record or for the appropriate displayed response to the operator via the CDM/ACM.

Appended/Umbilical Interface Module (AUIM): As the name suggests, this module serves as the central protocol handler of data coming from, and going to, the training simulation equipment which may be either appended to, or actuated by, the chassis during actual moving vehicle, Operational TEMPO (OPTEMPO), exercises or connected via umbilical cabling during stationary "motor-pool" training environments. The module processes both inputs and outputs going between the external training equipment and the CDPM. It is expected that this module would access the external training equipment via an external chassis "umbilical" connector(s).

Physical Characteristics

In order to present the least burden on already taxed vehicle resources, a primary goal of the ETS shall be to minimize weight, volume and power consumption. The ETS design should allow for a modular capability thereby allowing flexibility to install ETS in any selected vehicle, as training is to be conducted.

The ETS design will comply with the SAVA circuit board formfactor construction based on ANSI/IEEE Std 1014-1987 Double Eurocard with VME Backplane (approx 9.5" x 6.3"). Each of these Double Eurocard/VME Backplane circuit cards would utilize through-the-hole Printed Wiring Board (PWB) construction, consume no more than 15 watts of electrical power (dissipation by convection cooling) and should weigh no more than 2 pounds.

The ETS requires a computer generated image generator/processor, which will be compatible with the crew station(s) display technology. The ETS is perceived to require both a mass storage device and a floppy diskette drive device for loading of the various mission scenarios and part-task instruction courseware. The image generation equipment and storage devices may be jointly required for other VCOS functions and not a unique asset solely for the ETS.

Extended Range Gunnery Fire Control Demo

The Armament Research and Development Engineering Center (ARDEC) has initiated the Extended Range Gunnery Fire Control Demonstration System (ERGFCDS) in an effort to examine the potential technological performance expected for the Block III tank fire control.

In this regard, the ERGFCDS contractor (Texas Instruments) will analyze the impact of incorporating the simulation required for embedded gunnery training into the fire control processor functions.

If the analysis suggests acceptable impact, then Texas Instruments shall develop and demonstrate an ETS that is based on simulation hardware and software which is built into the actual fire control electronics. This ETS demonstration is intended not only to assess risk for full scale development of ET in the ASM vehicle, but also to provide a useful tool to assist Government personnel to learn the operational procedures for the proper use of the various vehicle subsystems during eventual test and integration efforts.

Visual Subsystem. This visual subsystem for ET will simulate tactical scenes consisting of European summer (as well as desert) terrain, man-made cultural features and the full gamut of vehicle critical crew operations; (i.e. target engagement for the tank, obstacle elimination for the CMV, etc). Scene content would be variably occulted to realistically simulate day, night and limited visibility (smoke, dust and haze) conditions. The simulated terrain should provide target presentations in various degrees of exposure (full, partial, intermittent or hidden) and aspect angle relative to the view of the own vehicle.

The visual subsystem design should be based on an optimum consideration of state-of-the-art technologies including, but not limited to, CGI (Computer Generated Imagery), CD-ROM (Compact Disk-Read Only Memory), optical disk, and virtual reality. Simulation visual imagery coloration should match that of actual vetronics visuals viewed under combat conditions.

Instructional Subsystem (IS). IS for ET will be menu-driven to provide for the easy selection of desired training exercises in which the crew members interact with each other to perform combat operational procedures. The IS should monitor and evaluate the performance of the student(s), providing a report to the student of past performance, accompanied with complete replay capability of the preceding exercise. Replay of the training exercise may be selectably paused for instructor comment. The performance report should include a comparison of the "acceptable" performance standard for each element versus the actual performance achieved. The performance report will provide constructive criticism intended to remediate student performance. The design of the IS should include artificial intelligence technology.

The IS software is expected to generate menus allowing the crew members to select scenario(s) which provide training at different levels of progressive difficulties. IS would include performance standards and scoring criteria for pass/fail/remedial comment of student performance.

ETS design should demonstrate the capability for modification/updating of training exercises (tutorials and scenarios) by Government personnel in order to ensure fielding of training changes to deployed vehicle units in less than two months.

Scenario content. Scenario content sequence is expected to provide randomization of target(s) or obstacle(s) location(s), target or "own" vehicle routes, mobility status and order of occurrence to prevent the negative training involved with student anticipation of the sequence of previously encountered scenarios. For example, if a student repeats the same exercise with which to train, he should be confronted each time with a different sequence of targets (or obstacles) to be detected, acquired and engaged. Randomization of scenario content should not preclude identification of critical scenario parameters during the AAR for each exercise repetition.

For those vehicles primarily involved with engagement of targets, the ETS would generate at least one simulated combat scenario for each of the following situations:

a. Stationary own vehicle, stationary targets.

b. Stationary own vehicle, stationary and maneuvering targets.

c. Maneuvering own vehicle, stationary targets.

d. Maneuvering own vehicle, stationary and maneuvering targets.

Each scenario containing maneuvering targets should include at least one maneuvering rotary-wing attack aircraft. The simulation software would provide the student with the proper cue of a "killed" target. Likewise, the student shall receive proper cues of hostile targets firing on and "killing" the student, based on improper target engagement by the student. Once the scenario is begun by the student, the crew controls and displays should perform in the same manner of fidelity as that performed during normal combat (i.e. non-training) mode. Selected scenarios might include a wingman vehicle that is visibly maneuvering in the gunnery/tactical exercise. This automated, simulated wingman vehicle will provide the student(s) with identification training of friendly versus hostile targets. An additional benefit will be to provide tactical training for the own vehicle to interact with a simulated mobile wingman which is also engaged with targets.

The ETS scenarios would be based upon simulation of actual combat missions which are expected to be performed by the ASM vehicle. Prior to design of the simulation scenario, Texas Instruments will provide a narrative "storyboard," outlining each proposed mission to be simulated. The storyboard would describe the appropriate crew procedures to be employed, the mix of targets/obstacles to be encountered.

ETS is expected to include the provision of narrative tutorial information to allow the student to selectively review basic crew control functions and operational procedures. This tutorial is intended to get the student prepared on vehicle system operation prior to beginning a simulated combat scenario. This tutorial should also address any diagnostic or maintenance procedures tasked to each crew member (e.g. use of self-test or Built-In-Test-Equipment procedures).

Each scenario would include a Situation Report (SITREP) on the own vehicle status and starting conditions at the beginning of the scenario. The SITREP will include, but not be limited to:

a. Indication of fully operational or degraded equipment on own vehicle.

b. Type and quantity of ammunition available and presently indexed in auto loader.

c. Mobility and defilage/enfilade status.

d. Present selection/state of crew control switches for each crew member, including menus/information being displayed.

e. Present manning of crew positions and designated sectors of responsibility.

f. Intelligence report of possible threats and expected tactics.

g. Visibility and time-of-day conditions.

h. Outline of orders received from echelon commander.

i. Fuel availability.

The SITREP will be preceded by a training exercise outline which describes the type of forthcoming scenario and training exercise to be completed, general description of expected individual and collective crew performance and the standards expected to be attained (e.g. "acceptable" performance). Each outline must provide crew instructions which give the purpose of the respective exercise and discuss specific gunnery and tactical skills to be trained by the respective exercise. The outline is intended to be general in nature and must not allow the student to predict exact location/sequence/mobility of targets to be presented within the subsequent scenario.

Simulated target hits and kills will be based upon the most current probabilities of hit and kill data available for the types of munitions and targets employed in the scenarios.

Scenario content would include exercises which provide specific training in the use of the vehicle Battalion and Below Command and Control (B2C2) system. Proper B2C2 procedures should be incorporated into the scenario(s) to provide comprehensive training of realistic combat requirements for integrated action by the crew member(s) to use B2C2 tactics during target/obstacle engagements.

Advanced Field Artillery System

The Advanced Field Artillery System is one of the six Common Chassis ASM variants. AFAS, with many automated features, will replace the M109 family of howitzers. The Program Manager for the Advanced Field Artillery System (PM AFAS) has initiated an AFAS Advanced Technology Transition Demonstrator (ATTD) contract.

The ATTD phase of the AFAS program precedes the fabrication of a prototype vehicle. The current AFAS ATTD requires definition of the embedded training concept for maintenance and operator tasks. The identification of subsequent training tasks that can be demonstrated in the ATTD or prototype phase is also required.

The AFAS is ideally suited for embedded training. The AFAS, as an indirect fire weapon, will not require the complex embedded visual subsystem anticipated on the direct fire ASM variants, such as the Block III tank. The AFAS crewstations shall include redundant displays and controls. If the analysis by the ATTD contractor warrants, the use of one or more of the onboard crewstations as an instructor station could be demonstrated in the ATTD or prototype. An AFAS crewstation reconfigured as an instructor station, via a training software load or some other means, could control a "closed loop" training simulation. The ability to perform such a "closed loop" training simulation without the need for appended or umbilical devices would demonstrate the utility of fully embedding certain portions of the total training system. The ability to network via an umbilical device, with one AFAS manned by instructors and other AFAS(s) manned by students, could provide platoon and battery level training exercises.

Advanced Technology Transition Demonstrators

Prior to construction of any prototype vehicles, Advanced Technology Transition Demonstrators (ATTD) will be developed to serve as vehicle "test beds" to evaluate the varied technological features being considered for each ASM vehicle.

Each ATTD (Fig 6) will include a crew station "mission module" attached to an actual vehicle functional chassis, which has been designed to incorporate maximum commonality of armored vehicle chassis components (i.e. propulsion system, modular armor, etc.). The ATTD will thus be a mobile evaluation tool, allowing target audience crews to sample the features proposed to be incorporated into the full scale development vehicle.

The ATTD will be preceded by a System Integration Laboratory (SIL) effort which serves as the "hot bench" mockup of the features to be installed within the mission modules.

The Component Advanced Technology Test Bed (CATTB) will serve as the mobile test bed used to evaluate certain technological advances expected for future tanks, such as the ERGFCDS features, including embedded training. CATTB will use an M1

ADVANCED TECHNOLOGY TRANSITION DEMONSTRATOR

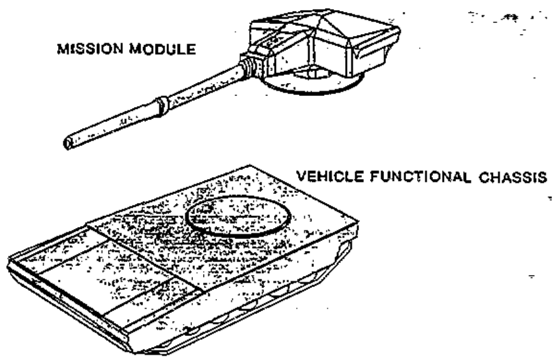

FIGURE 6

Abrams tank chassis which has been modified to reflect SAVA electronic modularity.

Concept Formulation Process

The Project Manager for Training Devices (PM TRADE) is the U.S. Army Material Command agency tasked to investigate the practicality of developing embedded training for ASM vehicles. PM TRADE analysts, logisticians and engineers are reviewing the user requirements for ET, in view of the technological advances expected at the time of vehicle development and in view of feasible approaches which may serve as alternatives to the depth of training desired to be incorporated into the ETS. Fig 7 depicts the "cauldron" of trade-off analysis which is ongoing to consider all of the known information pertinent to embedded training considerations from other DOD programs.

AREAS TO BE INVESTIGATED
for ASM EMBEDDED TRAINING APPLICATIONS

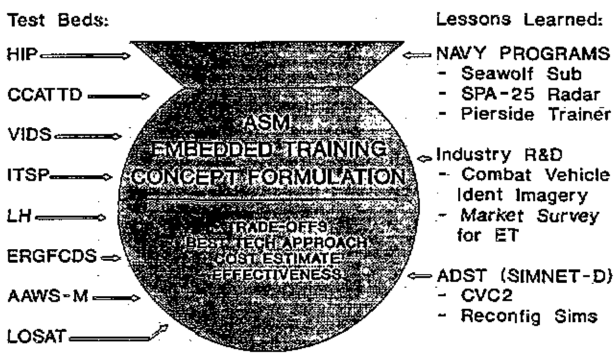

FIGURE 7

PM TRADE's Concept Formulation Process (CFP) will determine and analyze the various alternatives which are deemed feasible for ET and will examine ET as a potential solution to the total ASM integrated training requirement. The resultant analysis to be conducted by TRADOC with PM TRADE will yield answers to such questions as:

a. What are the critical operator tasks and standards to be trained using ET?

b. What impact will ET have on the Reliability, Availability and Maintainability requirements of the crew station controls/displays due to the anticipated increased usage?

c. What amount and type of training can acceptably be stored within the vehicle resources?

d. Should the ET scenarios and database be stored in "soft" drive format (e.g. floppy disc) and loaded into the vehicle computer only when training is about to be conducted?

e. What will vetronic technology provide during the next five years to allow the increased data flow rate and capacities required for the interactive intervehicle crew training desired for user collective training?

f. Should the vehicle laser range finder be jointly used as a range finder and also as an embedded MILES/TWGSS-like transmitter? Should radio frequency techniques replace the present laser-based tactical engagement simulation?

g. Is ET less expensive than our present reliance on stand-alone training devices? How cost effective is ET?

Answers to these and other questions will be pursued during the Concept Formulation Process to determine the wisest assessment of ET for each ASM vehicle system. The advantages and disadvantages displayed in Fig 8 must be evaluated to determine the optimum ET requirements for each ASM variant.

TO EMBED ... OR ... NOT TO EMBED

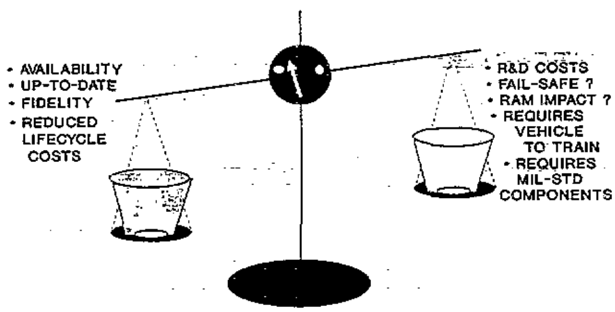

FIGURE 8

Acknowledgments

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