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Structured Simulation-Based Training Program for a Digitized Force: Approach, Design, and Functional Requirements, Volume I

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14. ABSTRACT *(Maximum 200 words)*:

This report describes one of the Army's latest efforts to address the changing training requirements driven by advances in warfighter technologies. The modification of training delivery systems and training programs to incorporate the unique requirements brought about by digital warfighting technologies moves the Army closer to meeting the training challenges of battlefield digitization. The current research effort, the Training for the Digital Battlefield program, also known as the Close Combat Tactical Trainer-Digital (CCTT-D), was designed to ascertain the anticipated requirements associated with using the CCTT (or a similar training delivery system) to conduct training for digitally-equipped platoon through brigade units. The requirements analysis was two-fold. First, it focused on technology capabilities; tactics, techniques, and procedures; scenario design and development; and the structure of training materials specific to the CCTT. Second, it provided a training approach and an analysis of technology requirements that encompass the entire Army. This report spans two volumes. Volume I presents the methods and products of the research effort, featuring an overarching training approach and a training system analysis for delivering digital operations training to Force XXI. Volume II presents the supporting documentation related to this research effort.

15. SUBJECT TERMS

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FOREWORD

The Training for the Digital Battlefield program, also known as the Close Combat Tactical Trainer-Digital (CCTT-D) project, was conducted by the U.S. Army Research Institute (ARI) Armored Forces Research Unit (AFRU) located at Fort Knox, Kentucky. The ARI's research on training requirements and evaluation methods is supported by a Memorandum of Agreement between the U.S. Army Armor Center and ARI entitled Manpower, Personnel, and Training Research, Development, Test, and Evaluation for the Mounted Forces, 16 October 1995. This research was also accomplished through dedicated coordination with the U.S. Army Training and Doctrine Command Systems Manager for Combined Arms Tactical Trainer (CATT).

The CCTT-D project contributes to the Army's major training objectives for Force XXI by evaluating the CCTT's current ability to support the acquisition of skills needed to perform collective tasks during digital operations. The Army has already implemented several of the recommendations presented during in-process reviews and technical briefings. The steps followed to achieve the objectives of the current effort consisted primarily of front-end analysis activities aimed at assessing the training requirements of digital forces not addressed by the CCTT; making specific recommendations for improving the ability of the CCTT to deliver training to digitally-equipped forces; selecting tactical digital operations that would serve as the springboard for actual scenario development; assessing the training support package requirements for digital operations; and developing a training approach and digital operations system requirements that can be molded to fit a wide range of training conditions.

The outcomes of this effort are directed towards trainers, training developers, training managers, Army leaders, and researchers. Included in this report is useful information regarding the CCTT's current ability to support digital operations training; recommendations for CCTT improvements; and scenario designs for movement to contact, defend in sector, and deliberate attack missions. The authors of this report document the methods employed in accomplishing the technical objectives of the program. The report also contains an overarching training approach and a training system functional analysis for delivering digital operations training to Force XXI. Recommendations that address training delivery and system requirements include digitization efforts for the Total Army.

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Technical Director

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The team wishes to acknowledge the contributions of interview personnel who contributed key ideas and insights on training issues concerning Army digitization. Personnel from the 1st Cavalry and 4th Infantry Divisions; the Fort Hood, Texas, Close Combat Tactical Trainer (CCTT) site; the U.S. Army Simulation, Training, and Instrumentation Command; and the U.S. Army Training and Doctrine Command System Manager (TSM) for the Combined Arms Tactical Trainer provided valuable input to this report regarding unit training requirements and CCTT capabilities. The team also interviewed representatives from the Directorate of Training and Doctrine Development for the U.S. Army Armor Center and School and the TSM Force XXI Battle Command Brigade and Below.

This report reflects the efforts of a team of training developers, military subject matter experts, research scientists, and simulation technology experts from three corporations: BDM International, Inc.; Litton PRC Inc.; and Human Resources Research Organization (HumRRO). Mr. Dallas Long, Program Manager (BDM), along with Mr. Michael Flynn (Litton PRC) provided key leadership. Mr. Rich Detrani (HumRRO), Mr. Tim Garth (Litton PRC), Mr. Richard Munoz (BDM), Mr. Bud Dannemiller (Litton PRC) and Mr. Bill Myers (BDM) served as military training design and development subject matter experts. Ms. Beth Long, Mr. George Grammas, Ms. Brenda Smith, Ms. Linda Clark, and Mr. Dave Johnson provided administrative support, all from BDM.

STRUCTURED SIMULATION-BASED TRAINING PROGRAM FOR A DIGITIZED FORCE: APPROACH, DESIGN, AND FUNCTIONAL REQUIREMENTS, VOLUME I

EXECUTIVE SUMMARY

Research Requirement:

Training requirements for the Army are constantly evolving to keep pace with advances in warfighter technologies, to compensate for reductions in fiscal and manpower resources, and to respond to changes in international political and socioeconomic arenas. This report focuses on the impact of battlefield digitization on soldier training requirements, the contributions that simulation-based training can make to further the Army's long-term training objectives, and the research and development that is needed to ensure that new training approaches and delivery systems adequately address the unique training requirements associated with the digitized battlefield. The current effort is a digital battlefield initiative named the Training for the Digital Battlefield program, more commonly known as the Close Combat Tactical Trainer-Digital (CCTT-D) project. The CCTT-D project's mission outlined five major requirements: (a) inventory digital capabilities of the CCTT, (b) devise an approach for exploiting current and future digital capabilities utilized in the CCTT, (c) design a CCTT training program that addresses those capabilities, (d) develop an overarching training approach for the entire Army, and (e) assess the training system functionality requirements associated with implementing the overarching training approach. The U.S. Army Research Institute, Armored Forces Research Unit, located at Fort Knox, Kentucky funded and led this initiative. Program guidance was provided by the U.S. Army Training and Doctrine Command Systems Manager for the Combined Arms Tactical Trainer.

Procedure:

The first major portion of the research program was to provide recommendations for the CCTT that would result in an enhanced ability to train and evaluate digitally-equipped forces in the simulation-based training environment. This portion of the project was completed in three stages. During Stage 1, the CCTT-D Team conducted a quick look assessment to determine the CCTT's ability to train and evaluate digital units and developed a prioritized list of recommended enhancements that addressed each of the major components of the CCTT. Stage 2 consisted of designing structured training scenarios, based on the Experimental Force (EXFOR) scenarios for three platoon through brigade missions: (a) movement to contact, (b) deliberate attack, and (c) defend in sector. The EXFOR exercises were designed under the Force XXI Training Program and were selected as a springboard for the CCTT-D design phase because they were tailored for digital operations. During Stage 3, the CCTT-D Team reviewed the concept of comprehensive training support packages (TSPs) and, with a view to training digitally-equipped units, recommended modifications and enhancements to the concept.

Stages 4 and 5 constituted the second major portion of the project. Stage 4 called for the development of an overarching training approach for units equipped with digital systems while Stage 5 entailed an assessment of the training system functionality required to train a digital

force. This portion of the effort focused on training and system requirements that extend beyond the CCTT environment. Considerations that guided the development of the overarching training approach called for identifying: (a) unique training requirements of tasks resulting from digitization; (b) innovative techniques and methods for both training and evaluation; (c) the training audience in the institution and in the unit, both entry level and professional development; and (d) recommended objectives, approaches, and methods for future training research and development efforts. A front-end analysis provided the basis for proceeding with the training approach development and assessment activities. Using these data, the team developed a training approach that covers a broad spectrum of soldier training requirements for digital operations and a six-stage model that addresses system functionality requirements.

Findings:

Key recommendations from the initial portion of this effort focus on ways to enhance or modify the CCTT to support digital operations training. Other findings underscore the importance of providing digitally-equipped forces a training environment that features a high degree of tactical and equipment fidelity. Training programs should enable unit personnel to acquire proficiency on tasks that support the training objectives. Hence, training programs for digitally-equipped units require specification of the appropriate digital tasks for each training objective. Further, training environments should be equipped to support realistic implementation of the training program and use of the digital equipment. For instance, digital interconnectivity should mirror real world capabilities. That is, a system designed to enhance warfighter capabilities should not require a workaround that is perceived by the training participants as detrimental to task performance. Similarly, training programs and training environments should account for near-term technology changes during the design and equipment acquisition phases. Finally, TSPs developed for the CCTT and digital operations training have unique requirements which should be incorporated into future training development efforts.

Findings from the second portion of this effort provide an overarching training approach that addresses individual and collective training requirements for digitally-equipped forces. Key Army training concepts were folded into an integrated model that addresses unit, institutional, and self-development training. System requirements for digitally-equipped forces are addressed in a six-stage model that considers training requirements analysis, TSPs, training execution, data collection, performance assessment, and feedback as critical system training components.

Utilization of Findings:

The results of this effort provide important information regarding the CCTT's current ability to support digital operations training; ways to improve the CCTT; and scenario designs for movement to contact (MTC), defend in sector (DIS), and deliberate attack (DAK) missions. Frameworks for training approaches and system capabilities that extend beyond CCTT requirements for digital operations are also offered. Army training development and research personnel can use the products and recommendations resulting from this effort to support the design, development, and implementation of training programs focused on digital operations for all of the doctrine, training, leadership, organization, materiel, and soldiers (DTLOMS).

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STRUCTURED SIMULATION-BASED TRAINING PROGRAM FOR A DIGITIZED FORCE: APPROACH, DESIGN, AND FUNCTIONAL REQUIREMENTS, VOLUME I

INTRODUCTION

This report describes research conducted under the digital battlefield initiative known as Training for the Digital Battlefield or the Close Combat Tactical Trainer-Digital (CCTT-D) project. The CCTT-D project's mission outlined five major requirements: (a) inventory digital capabilities of the Close Combat Tactical Trainer (CCTT), (b) devise an approach for exploiting current and future digital capabilities utilized in the CCTT, (c) design a CCTT training program that addresses those capabilities, (d) develop an overarching training approach for the entire Army, and (e) assess the training system functionality requirements associated with implementing the overarching training approach. The project was funded and led by the U.S. Army Research Institute (ARI) for the Armored Forces Research Unit (AFRU) located at Fort Knox, Kentucky. The U.S. Army Training and Doctrine Command Systems Manager for Combined Arms Tactical Trainer (TSM CATT) provided additional guidance. Drawing from an extensive history of research and development geared towards structured simulation-based training (SST) for conventional and digital operations, the training research and development accomplishments of the ARI AFRU provided a solid foundation for accomplishing the objectives of the current effort. The results of this research effort are in two volumes. Volume I, presents the methods and products of the research effort, featuring an overarching training approach and a training system analysis for delivering digital operations training . Volume II presents the supporting documentation related to this research effort. This documentation includes: interview results; training task lists; initial design decisions; and scenarios, sketches, and exercise outlines.

Organization of the Report

This report is intended as a guide for training researchers, training developers, U.S. Army Simulation, Training, and Instrumentation Command (STRICOM) personnel, and Combined Arms Training Strategy (CATS) proponents involved in the development of training programs for digitally-equipped forces. The report also provides recommendations for improving and expanding structured training programs for digitally-equipped forces. Five chapters comprise this report:

1. Introduction. This chapter sets the context for the current effort. It provides an overview of Army training requirements for the 21st Century. It also describes how the Army is addressing those challenges through the use of SST, highlights the historical roots of the current effort, and discusses the Army's progress in providing comprehensive training for digital warfighting.

2. Method. This chapter describes the methodologies followed for the current effort. The first major portion focuses on methodologies specific to addressing the CCTT research issues. The second major portion of the chapter focuses on the development of an overarching training approach and the identification of training system functionality requirements for the Total Army. Intended as a guide for training developers, this chapter will make suggestions for assessing training system capabilities, using effective training development methodologies, and

designing TSPs that support new digital training programs. The approaches followed in each major stage of this research effort are specified in this chapter.

3. Findings and Discussion. This chapter focuses on the research findings for the current effort. Its organization mirrors the Method chapter, focusing on the implications of findings related to training requirements for the CCTT facility, the design of training support packages (TSPs) and structured scenarios, and the Army's need for integrated approaches to training and system design for digitally-equipped forces.

4. Lessons Learned. Future developers and researchers can use this chapter to increase their understanding of issues concerning integrating training requirements and simulation technology, managing training design efforts, and designing training programs for digitally-equipped units.

5. Conclusions and Recommendations. This final chapter offers an analysis of major themes found throughout the report and provides guidance for future research.

Problem Definition

The digitized battlefield will feature more rapid and accurate information distribution, increased situational awareness, increased survivability, parallel operational phases, and on-line decision-making (U.S. Army Digitization Office [ADO], 1995). While digitally-equipped units stand to benefit from new technologies, these benefits also represent major training challenges. Questions related to training issues include: What is the best way to optimize use of new warfighter technologies? What new tasks are introduced by digital equipment? How are tactics, techniques, and procedures (TTPs) affected by battlefield digitization? What feedback innovations are supported by new technologies? Force XXI, an experimental Army initiative for the 21st Century, is confronting these issues by examining how to develop training that keeps pace with warfighter technology advancements and evolving doctrine. To compensate for different rates of technology and doctrine "growth," Army training developers have adopted what is termed a "spiral development" process that strives for timely cross-fertilization of technology and doctrine across the Army's training products (e.g., mission training plans [MTPs] and TSPs). Essentially, spiral development takes the training design procedure specified in TRADOC Regulation 350-70 (U.S. Army Training and Doctrine Command [TRADOC], 1995b) for collective training and makes it a closed-loop process. Evolving technologies and doctrine mean that the training development process contains a constant requirement for training updates.

These issues pose real-world challenges for Army training and materiel developers. As an example, the Army needs an approach that integrates the enhanced capabilities of digital systems and TTPs into the CCTT system for maneuver units (U.S. Army Research Institute for the Behavioral and Social Sciences, 1997). Research is needed to identify the appropriate training aids, devices, simulators, and simulations (TADSS) to use in developing structured training for digital units. Digital training requirements call for research to identify tasks, mission phases, and simulation capabilities that best support digital training. The SST approach (Campbell & Deter, 1997) is one training method currently being utilized by the Army to address changing training requirements for Force XXI. The SST approach provides effective training opportunities that address many of the requirements identified for both conventional and digital battlefield operations. The current CCTT TSPs provide SST for conventional and limited digital unit training (Deatz et al., in preparation; W. T. Holden, personal communication, May 12, 1998). Additional research should examine how to enhance the capabilities of the CCTT to support the training and evaluation of digital units with Force XXI Battle Command Brigade and Below (FBCB2) and eventually all appropriate Army Tactical Command and Control System (ATCCS) components. This research should lead to a broad spectrum training approach and system requirements analysis that addresses individual, unit, and institutional training for digitized forces. Addressing these research issues, the technical objectives for the current research effort were as follows:

1. Conduct a "quick look" assessment of CCTT capabilities and limitations for supporting the training of M1A2 units.

2. Conduct a front-end analysis (FEA) in support of structured training in the CCTT for M1A2 units. Provide one detailed example of a general approach for SST of digital units, focusing on the CCTT and an M1A2 battalion/task force in the 1st Cavalry (CAV) Division at Fort Hood, TX.

3. Provide an overarching training approach and a generalized assessment of the training system functionality requirements to support the training of a digitized force.

Background

Training requirements for the Army are constantly evolving to keep pace with advances in warfighter technologies, to compensate for reductions in fiscal and manpower resources, and to respond to world political and socioeconomic trends. Current TRADOC policy (TRADOC, 1995b) addresses the consequences of the Post-Cold War environment and the requirements of Force XXI by stressing the importance of leveraging technologies to support the use of simulation-based training, electronic task performance databases, and distance learning opportunities. One example of the "push/pull" impact of technology and doctrine on training development is the requirement of digitally-equipped forces to learn smarter ways to acquire, exchange, and employ timely digital information due to advances in warfighter technologies (ADO, 1995). A primary focus of this report is the impact of battlefield digitization on soldier training requirements and the contributions that training simulations, centralized databases, and distance learning technologies can make in addressing the challenges that lie ahead in realizing the Army's long-term training objectives. For instance, a key recommendation offered in this report is the development of a multi-functional automated performance measurement database that complies with the Army's latest simulation technologies such as the High Level Architecture (HLA) (Department of Defense, 1998a), supporting both training and research objectives for Force XXI.

Army Training XXI

A basic premise for the Army of the 21st Century is that the Army's concept for Force XXI promotes the evolution of full-dimensional operations through reorganization and modernization as described in TRADOC Pamphlet 525-5 (TRADOC, 1994). The Army Training (AT) XXI initiative defines the training requirements of Force XXI. It consists of three axes, each with its own focus: (a) Warrior XXI (individual and institutional training), (b) Warfighter XXI (collective training) and (c) WarMod XXI (Army modernization). The Force XXI Training Program (FXXITP), part of the Warfighter XXI axis, directly relates to the current effort since the TTPs and the MTPs for tank platoon through brigade operations developed under the FXXITP for the Army's Experimental Force (EXFOR) served as the foundation for the analysis and design activities of the current effort. (The FXXITP is described in greater detail later in this chapter.) A special mix of training systems and technologies will enable the AT XXI to successfully achieve its objectives. An overview of the major systems that shaped the current effort appears below.

Training Systems

The Systems Approach to Training (SAT) model provides a systematic approach to training development mandated by TRADOC. This five phase model is iterative in nature, featuring analysis, design, development, and implementation as key phases shaped by evaluation activities that proceed throughout the entire training development cycle (TRADOC, 1995b). Also important is the CATS, the Army's overarching strategy for identifying, quantifying, and justifying the training resources required to execute current and future force training. It describes individual and unit training strategies to train the force to standard and identifies the training resources needed to implement the training strategies (TRADOC, 1993). The CATS is most clearly linked to the design and implementation phases of SAT. Together, SAT and CATS provide a solid model for training development that inserts simulation-based training resources and accounts for the three pillars of Army training: institution, unit, and self-development (TRADOC, 1995b).

Relevant to the current effort, the CATS provides the framework for specifying TADSS-based training for the CCTT. The CATT links the training requirements of several functional areas to form a combined arms virtual battlefield. The CCTT is one member of a family of training systems under the CATT program. The CCTT can accommodate combined arms virtual training at crew through battalion/task force levels, using networked simulation technology to provide a cost-effective means of conducting a variety of combined arms and joint operations training (U.S. Army Research Institute for the Behavioral and Social Sciences, 1997).

Warfighting Technology Systems

As the first TADSS-based system under the CATT program, the CCTT addresses the simulation needs of the heavy maneuver force by providing realistic, maneuver-oriented, tactical training for armored, mechanized infantry, and heavy cavalry ground troops in a controlled, virtual environment. The CCTT provides valuable training when used as part of a structured training program. However, it does require unit time and effort to accomplish: (a) home station preparation, (b) observer/controller (O/C) training, (c) workstation training for combat support (CS) and combat service support (CSS) elements, (d) familiarization training on simulators, and (e) rehearsals. The CCTT will eventually be fielded at 10 fixed sites (8 in the continental United States and 2 outside the continental United States) and 12 mobile sites for the Army National

Guard (ARNG). The CCTT, a training technology system, provides the infrastructure for digital training with new warfighting technology systems and prototypes such as the Intervehicular Information System (IVIS), FBCB2, and ATCCS.

The IVIS, FBCB2, and ATCCS systems represent an evolution of brigade and below automated command, control, and communications (C3) systems. Each system enables the exchange of preformatted digital combat reports and graphic overlays between command posts (CPs) and individual combat vehicles in real-time. Enhanced situational awareness of friendly forces through the Position Navigation (POSNAV) feature is provided for each of these systems. While the IVIS provides C3 functions between M1A2s at the battalion and below level, the FBCB2 extends C3 to the brigade, tests a limited number of functional requirements, and provides limited integration with the ATCCS. The current FBCB2 enhances command and control by receiving and updating the Army Battle Command System (ABCS) common battlefield picture/situational awareness via horizontal and vertical linkages between operations centers and between mounted and dismounted platforms. The future FBCB2 will perform C3 functions from brigade to the individual platform level across all Battlefield Functional Areas (BFAs) and provide seamless interface with the ATCCS. Together, these capabilities will result in reduced fratricide and enhanced synchronization of maneuver and fires (TRADOC, 1997b).

The FBCB2 and the ATCCS systems are components of the ABCS that will operate on the Tactical Internet. As a principal component of the ABCS, the FBCB2 will interface with the five ATCCS systems located within the brigade and those systems located within the battalion. Table 1 shows an overview of the five ATCCS subsystems (Program Executive Office for C3 Systems, 1996; TRADOC, 1997b).

Table 1

Overview of the Major ATCCS Subsystems

ATCCS SUBSYSTEM	DESCRIPTION
Maneuver Control System	The primary source for friendly force battle command information. Provides a common battlefield picture, decision aid graphics, overlay capabilities, operation orders, and combat reports.
Advanced Field Artillery Tactical Data System	A fire support system that provides automated support for planning, coordination, control, and execution of close support, counterfire, interdiction, and air defense suppression fires to include joint and combined fires.
Forward Area Air Defense Command, Control, and Intelligence System	An air defense system that integrates air defense fire units, sensors, and command and control centers into a unified system. Provides real-time data for air defense planning and analysis, air battle management activities, and early warning alerts of enemy aircraft.
Combat Service Support Control System	A CSS system at the division and brigade levels providing critical resource information to assist with decision-making, battle planning, and command and control of subordinate CSS organizations.
All Source Analysis System	An intelligence system that provides enemy information to commanders at battalion level and above. Produces ground battle situation displays, disseminates intelligence information, provides target nominations, helps manage intelligence and electronic warfare assets, and aids counterintelligence operations.

To date, the major efforts for the CCTT have focused on the training requirements for conventional forces. Thus, current specifications for the CCTT do not account for the total environment required to support digital training requirements (U.S. Army Research Institute for the Behavioral and Social Sciences, 1997). The CCTT-D project is one of the Army's most recent responses to the training requirements of digital forces. It represents an important effort to train warfighters to effectively use leading edge information-age technologies. The first CCTT site, constructed at Fort Hood, Texas, includes 10 M1A2 tanks with the IVIS. This facility is not equipped with the Army's FBCB2 or the ATCCS. The limited digital systems greatly reduce the training opportunities for digitally-equipped units using TSPs designed for simulation-based training. The Army's current vision, as expressed in the FBCB2 Operational Requirements Document (ORD) (TRADOC, 1997b), is that FBCB2 systems will be interoperable with all current and future simulations conducted in live, virtual, and constructive environments. Further, the ORD states that the FBCB2 requires the ability to exchange data with the ATCCS. Currently, the CCTT only accommodates the conventional unit training requirements specified in the CCTT Training Device Requirement (TDR) document (TSM CATT, 1997).

The remainder of this chapter focuses on the use of simulation-based training to achieve the Army's training objectives for the digital force and the importance of considering the research requirements associated with training for digital operations.

Simulation-Based Training Technologies

Simulation-based technologies support the tactical engagement simulation (TES) paradigm developed by Gorman (1991). The TES paradigm promotes the use of TADSS-based training in the three types of simulation environments: live, constructive, and virtual. Live TES such as the Precision Range Instrumentation Missile Equipment uses instrumented ranges or maneuver areas and simulators mounted on actual military vehicles. Constructive TES incorporates war games (Janus, for example) into computer models that simulate engagements. Virtual TES provides a synthetic environment populated by manned and unmanned simulators that are projected onto a common computer-generated battlefield. Virtual TES is moving from Simulation Networking (SIMNET) and Distributed Interactive Simulation (DIS) technologies to technologies that are fully HLA compliant (Department of Defense, 1998a). This transition will support increased use of seamless TES (i.e., the simultaneous use of multiple simulation domains). The following paragraphs provide an overview of some of the Army's constructive and virtual simulation environments used to train the digital force.

Constructive Simulation

Corps Battle Simulation (CBS). The CBS supports the collective training of commanders and staff officers at the joint, corps, division, and brigade levels. The CBS supports joint force training to theater level (National Simulation Center, 1995).

Brigade/Battalion Battle Simulation (BBS). The BBS is a constructive simulation used to cue staff activities in order to train brigade and battalion commanders and their battle staffs on collective tasks. Designed as a low-cost training simulation, commanders with their battle staffs are able to develop, correlate, and assess large quantities of tactical and logistical data, formulate situational estimates, and make immediate decisions regarding command and control and synchronization of combat, CS, CSS, and aviation assets (National Simulation Center, 1995).

Janus. Janus is an interactive, constructive wargaming simulation used to train company through brigade commanders and staffs to tactically employ friendly forces in combat. Janus models both friendly and enemy weapon systems and provides an automated after action review (AAR) capability that enables trainers to track and replay the battle for the training participants (National Simulation Center, 1995).

Warfighter Simulation (WARSIM) 2000. The WARSIM 2000 will enable CPs at all echelons to train in a realistic, DIS compliant, simulation environment. Still under development, the WARSIM 2000 furthers the Army's goal of exploiting simulation-based training technologies by allowing CPs to interact within the simulation using their table of organization and equipment (TO&E) hardware in the field (National Simulation Center, 1995, 1998). The WARSIM 2000 is designed to replace CBS, BBS, and other constructive simulations. Initial operational capability is scheduled for 2000 and full operational capability is scheduled to be available in 2004 . Eventually, the new technology will interface with virtual (e.g., CCTT) and live training environments. It will also interface with the ABCS (Lockheed Martin, n.d.).

Virtual Simulation

SIMNET. The SIMNET is sponsored by the Defense Advanced Research Projects Agency (DARPA) in partnership with the Army. It is a virtual simulation system that provides a large-scale network of interactive combat simulators, allowing units to fight force-on-force engagements against realistic opposing forces (OPFOR).

CCTT. The CCTT is the follow-on virtual training system to SIMNET. The CCTT is the first link in creating a combined arms virtual battlefield. Using newer, more advanced simulation technology than SIMNET, the CCTT is the first Army simulation system fully compliant with the DIS architecture. The major components found at the Fort Hood CCTT test site are listed in Table 2. The CCTT system supports training of armor, armored cavalry, and mechanized infantry elements particularly at platoon and company/team levels (Program Manager Combined Arms Tactical Trainer, 1994). Through the use of semi-automated forces (SAF), the CCTT can provide training opportunities at the battalion/task force level.

Designed for use by both Active and Reserve forces, the CCTT is currently being fielded in company/team (fixed site) and platoon (mobile) sets. The CCTT fixed sites include enough manned modules for training at the company/team as well as platoon level, with the ability to train up to five units simultaneously. In addition, the fixed sites are capable of simulating battalion/task force level command post exercise (CPX) training. (CPXs in the CCTT are medium-cost, medium overhead exercises that use simulated forces to train battalion/task force staffs.)

Table 2

Major Components Found at the Fort Hood CCTT Test Site

CLASSIFICATION	SYSTEM
Manned Modules	• M1A1 • M1A2 • M2A2 • M3A2 • Dismounted Infantry (DI) (2) • M981 Fire Support Team Vehicle (FIST-V) • M113A3 • High Mobility Multi-purpose Wheeled Vehicle (HMMWV)
SAF Workstations	• Blue Forces (BLUFOR) • OPFOR
Control Consoles	• Master Control Console (MCC) • Maintenance Console (MC) • AAR Workstations
Operations Center Workstations*	• Combat Engineer Support (CES) • Fire Support Element (FSE) • Tactical Air Control Party (TACP) - HMMWV mounted • Combat Trains Command Post (CTCP) • Unit Maintenance Collection Point (UMCP) • Field Artillery Battalion Tactical Operations Center (FABTOC) • Fire Direction Center (FDC)
Digital Devices	• IVIS in M1A2 • Forward Entry Device (FED) in FIST-V • Advanced Field Artillery Tactical Data System (AFATDS) selected capabilities in FABTOC and FSE

Note: Each CCTT site may differ in the amount and type of equipment. Normally, a site is configured in an M1A1, M1A2, or M2A2/M3A2 team combination.

*The Operations Center workstations are located in M577 CP mock-ups.

Each mobile CCTT includes a platoon set of tank (M1A1or M1A2) or infantry/cavalry fighting vehicle (M2A2/M3A2) manned modules and the workstations necessary to emulate OPFOR, friendly combat forces, artillery, and critical CS and CSS assets. In addition, the mobile sets include an AAR workstation which the O/C uses to monitor and control the exercises and review performance. The mobile sets also include other equipment for the control and execution of training.

Structured Simulation-Based Training

SST is the deliberate design of training so that it includes events or cues to prompt the performance of particular tasks, subtasks, or actions in simulation (Campbell, Campbell, Sanders, Flynn & Myers, 1995; Campbell, Deter, & Quinkert, 1997). In general, SST programs are based upon the following principles: (a) task-based and scenario-driven training is effective, (b) the occurrence of events and cues leads to the practice of specified tasks, and (c) immediate feedback maximizes the training experience. Training focuses on specific training objectives in a deliberately constructed training strategy, derived from critical task inventories associated with the tactical situation. Developers of SST programs rely on the application of instructional design principles, coupled with simulation capabilities, to provide training that is both efficient and effective. The defining features and primary advantages of SST, as specified by Campbell et al. (1995), are shown in Table 3.

Table 3

Defining Features and Primary Advantages of Structured Simulation-Based Training

DEFINING FEATURES

- Training exercises implement mission, enemy, terrain, troops, and time available
- Training is conducted in accordance with accepted tasks, conditions, and standards
- Exercises use documented task sources for the selected unit and mission types
- Training fits within the unit's available time and personnel
- Exercises support an appropriate training sequence with regard to tasks and difficulty
- Critical tasks are performed more than once to reinforce learning
- Training support materials result in a turn-key program
- Trained observer/controllers manage the exercises, providing feedback and coaching
- Observer/controllers use observation forms focused on actions dictated by exercise flow
- Training exercises use scripted message traffic and pre-established operation orders
- Subordinate and supporting element activities are controlled within specific guidelines

PRIMARY ADVANTAGES

- Minimizes training development and administration requirements
- Immerses unit in realistic tactical situations
- Supports crawl-walk-run approach to training
- Focuses on critical tasks
- Compresses training time

Campbell et al. (1997) provides the most recent description of the SST methodology applicable to the development of TSPs. Figure 1 illustrates the main design and development phases. This model provided the basis for the design activities of the current effort with the exception that formative evaluation, a methodology for capturing feedback to support revision of training products, was not used in this project. Earlier work by Campbell et al. (1995) provided the foundation for most of the SST efforts described here. The reader who is interested in a full description of the SST methodology should refer to the Campbell et al. (1997) document.

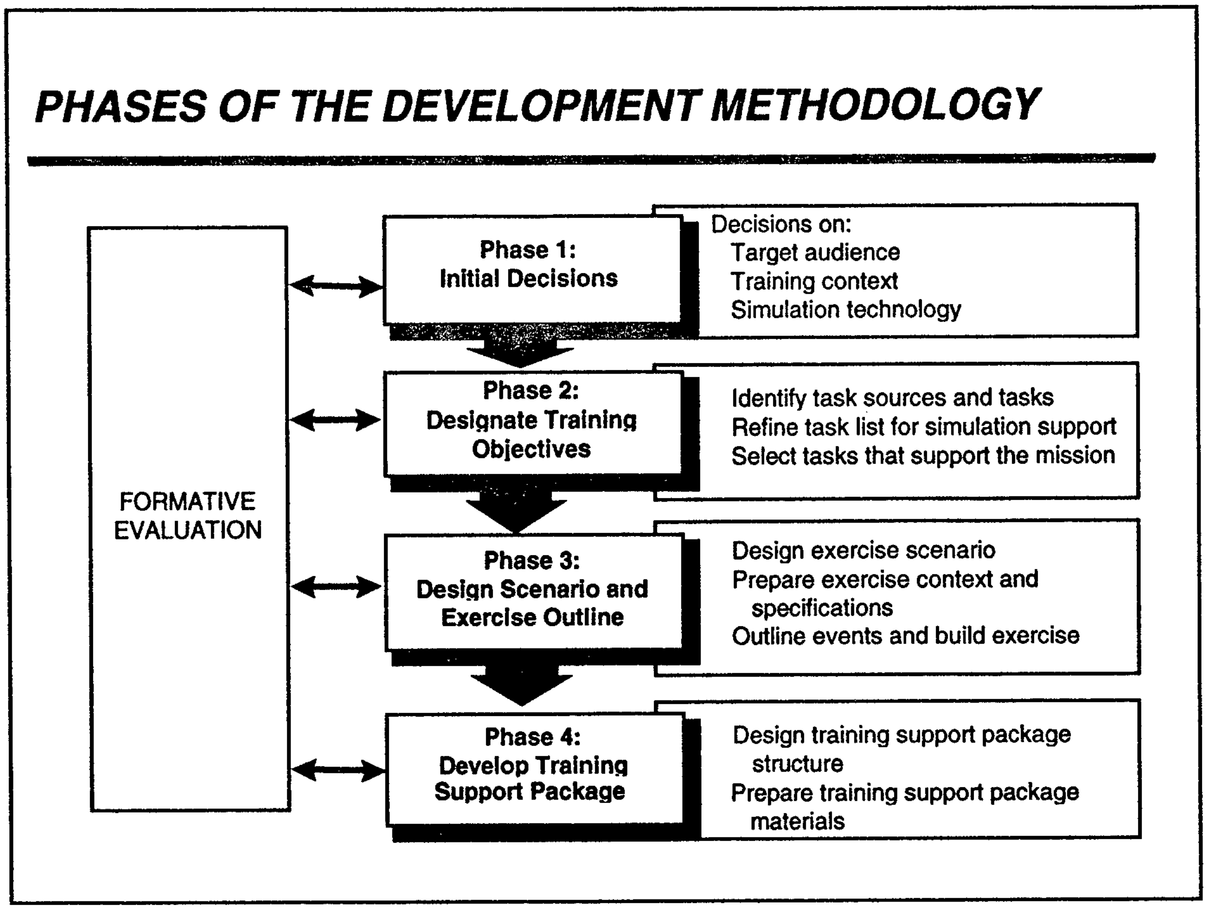

Figure 1. The four phases of structured simulation-based training development (Campbell et al., 1997).

Simulation-Based Training Programs

Training development efforts for conventional and digitally-equipped forces completed by the ARI AFRU and FXXITP provide the cornerstones for the development of simulation-based training programs. The following sections highlight the evolution and interconnections of major ARI AFRU and FXXITP training development efforts at Fort Knox.

Combat Vehicle Command and Control Project

The Combat Vehicle Command and Control (CVCC) project was a research and development effort led by the ARI AFRU (Leibrecht, Meade, Schmidt, Doherty, & Lickteig, 1994). The CVCC project evaluated prototype automated command and control technologies for the M1A2. It was a pioneering effort in terms of system development for the M1A2 and lessons learned for training digitally-equipped forces. Hence, much of the work conducted under the five-year CVCC effort has direct relevance to the Army's current efforts to train Force XXI using simulation-based training methodologies. (The reader interested in a complete review of CVCC training findings should refer to Atwood, Winsch, Sawyer, Ford, & Quinkert, 1994.)

The CVCC program featured experimental versions of the M1A2's POSNAV system and the commander's independent thermal viewer (CITV). A command and control display (CCD) designed to automate C3 functions was an IVIS-like prototype. The CVCC program also featured tactical operations center (TOC) workstations. These workstations had map and message display features similar to the CCD and they could be used to create digital free-text reports and overlays (Atwood, Winsch, Sawyer et al., 1994). The CVCC TOC workstations provided the foundation for the workstations used with the ARI AFRU Staff Group Trainer (SGT) research effort. (A description of the SGT effort appears later in this chapter.) Innovative exercise management tools developed under the CVCC project also served as the foundation for training delivery tools used for the SGT effort. These tools (SEND, LISTEN, and Checkpointing) are described fully in Atwood, Winsch, Quinkert, and Heiden (1994) and are discussed briefly in the Findings and Discussion chapter of this report.

Lessons learned during the implementation of the CVCC project have influenced a majority of the projects described in this section, including the current CCTT-D effort. For instance, results from the CVCC project showed that vast amounts of information must be managed in ways that allow the soldier and commander to discern important information, prioritize it, and integrate it with voice and written information (e.g., Ainslie, Leibrecht, & Atwood, 1991; Atwood, Winsch, Sawyer et al., 1994). In turn, this and other findings have shaped the design of IVIS and FBCB2 features. In fact, much of the CVCC work was incorporated into the FBCB2 User Functional Description (U.S. Army Armor Center [USAARMC], 1997a). Other lessons learned from the CVCC project are reflected in the training design features of the Simulation-Based Multiechelon Training Program for Armor Units (SIMUTA) and EXFOR programs, due in large part to the fact that several of the CVCC research and development team members have played key roles in these other programs. Table 4 features major lessons learned from the CVCC project's final training research effort (Atwood, Winsch,

Table 4

Major Training Lessons Learned from the CVCC Project

TRAINING CATEGORY	LESSON
General	• Use the crawl-walk-run approach to training design • Present demonstrations instead of lectures where appropriate • Include hands-on skill refresher training • Explain software shortcomings early in the training • Emphasize integrated equipment training • Train information systems management • Establish a standard for digital device proficiency
Tactical Training Exercises	• Keep pace and demands low in initial training stage • Use multimedia presentations (e.g., video) during the orders brief to help participants assess the battlefield situation • Establish standing operating procedures for digital reporting
Performance Feedback	• Structure frequent opportunities for timely feedback • Involve training staff in the debriefs

Sawyer, et al., 1994). These lessons highlight basic requirements that should be given high priority during the development and implementation of training programs for digital operations.

Reserve Component Virtual Training Program

The first application of SST occurred with the Reserve Component Virtual Training Program (RCVTP) established in 1993 at Fort Knox, Kentucky. The RCVTP began as a research and development project. Its mission was to develop, evaluate, and implement SST exercises, leveraging SIMNET and Janus technology to maximize weekend drill and annual training time for United States Army Reserve (USAR) and ARNG units. As active units and schoolhouse training managers became interested in using the program, it was broadened to include the active component and became the Virtual Training Program (VTP) in early 1994.

The program included execution-focused exercises for platoon through brigade echelons on the National Training Center (NTC) terrain database (Hoffman, Graves, Koger, Flynn, & Sever, 1995). Exercises were created to support three types of missions based on a common scenario: (a) movement to contact (MTC), (b) defend in sector (DIS) for battalion and below, area defense for brigade and above, and (c) deliberate attack (DAK). The training design included a dedicated O/C team to provide pre-exercise materials, administrative planning, monitoring and controlling of exercise execution, feedback via AARs, and take home packages (THPs) for the training unit. The initial RCVTP contract was the SIMUTA project which provided TSPs at the platoon and company level for SIMNET and at the battalion/task force level for SIMNET and Janus (Hoffman et al., 1995). The TSPs were created for MTC and DIS exercises. The SIMUTA-Battalion (SIMUTA-B) follow-on program refined the original SIMUTA battalion/task force TSPs and created a TSP to support the DAK mission (Graves & Myers, 1997). The Simulation-Based Mounted Brigade Training Program (SIMBART) project created TSPs to support exportable brigade-level training based on the SIMUTA TSPs (Koger et al., 1996). (SIMBART is listed as an RCVTP effort because it was originally intended to support virtual training. Early in the effort, it was determined that the SIMNET facility was not equipped to support brigade-level training. Thus, the SIMBART TSPs were designed for execution in Janus.)

The VTP program implemented at Fort Knox has a dedicated O/C team to support the training. In contrast, programs such as the Combined Arms Operations at Brigade Level, Realistically Achieved through Simulation (COBRAS), SGT, EXFOR, and Structured Training for Units in the Close Combat Tactical Trainer (STRUCCTT), had to design their TSPs for a unit-provided O/C team so that they could be exportable to sites other than Fort Knox. This required more detailed train-the-trainer instructions for the O/C team and the inclusion of site exercise management instructions to supplement the exercise files. Consequently, the COBRAS brigade staff exercise (BSE) TSP included eleven different components compared to the VTP's five. As the TSPs became more complex, detailed instructions were included with the package to form the set actually used by the training participants and support personnel (Campbell & Deter, 1997). A discussion of these expanded programs follows.

Force XXI Training Program

The FXXITP is managed by TRADOC and represents one of the Army's most recent efforts at delivering leading-edge individual, small-group, and integrated staff training to combat forces. The FXXITP consists of a family of programs, four of which are described below because of their connection to the current effort and association with the ARI AFRU.

Innovative Tools and Techniques for Brigade and Below Staff Training (ITTBBST). The ITTBBST program features three projects for individual and collective training of battalion and brigade staff members: (a) the Battlefield Functions (BFs), (b) the BSTS, and (c) the SGT.

The BFs were formerly known as Critical Combat Functions (CCFs) and are the portion of the ITTBBST program that uses the Army's Battlefield Operating Systems (BOSs) established in the Blueprint of the Battlefield (TRADOC, 1991) to create a common list of critical BFs. The BFs assist in structuring individual and unit training programs and assessing training performance (Ford, Mullen, & Keesling, 1997). Function analyses of BFs exist at battalion and brigade levels. For instance, BFs 18, 19, and 20 address the plan, prepare, and execute phases at the brigade level for the command and control BOS.

The BSTS component of the ITTBBST program uses a combination of computer-based and paper-based instruction to train individual brigade and battalion staff members on their respective staff functions (André, Wampler, & Olney, 1997). It includes 28 courses for battalion and brigade commanders and staff members. The SGT project (formerly known as the Commander/Staff Trainer [C/ST]) is the third ITTBBST component. The SGT project focuses on training subsets of brigade and battalion staff and features computers networked together to present tactical reports from a pre-recorded battle to battalion or brigade staffs. The tactical reports prompt the staff members to work together to obtain the necessary information, communicate it to one another (as well as higher and lower) and to use the information to generate recommendations to the commander. The SGT project was designed to serve as a bridge between the individual staff training provided by the BSTS and the COBRAS training exercises designed for the integrated staff. Both the BSTS and SGT use the BFs to structure their training. Analysis of the BFs led to a staff function/task hierarchy that contributes to battle staff training and evaluation for the SGT (Koger et al., 1998).

COBRAS. The Force XXI COBRAS training program features TSPs for brigade and battalion/task forces which cue the staff and maneuver elements to complete conventional MTP-based training tasks (Graves, Campbell, Deter, & Quinkert, 1997). Brigade staff vignettes include planning and preparation-focused exercises that incorporate live simulation and execution-based exercises driven by either Janus or BBS for small groups of brigade staff members. The COBRAS BSE utilizes BBS technology to replicate all stages of a mission from planning through consolidation and reorganization. A brigade and battalion staff exercise (BBSE) integrates staff officers at both echelons in the BBS simulation environment. The Synthetic Theater of War Exercise (STOWEX) is a unique exercise in the COBRAS library designed to harness the interoperability between SIMNET and BBS. It consists of a brigade with one battalion fighting in SIMNET and two battalions fighting in BBS.

SIMUTA-Digital (D). The SIMUTA-D program was designed to augment the Focused Dispatch Advanced Warfighting Experiment (AWE). It converted the SIMUTA battalion/task force TSPs to provide SST for digitally-equipped battalion/task force staffs. The SIMUTA-D program featured separate TSPs for Janus and SIMNET, each designed to support digital force training and incorporate new TTPs envisioned under Force XXI for each of the doctrine, training, leadership, organization, materiel, and soldiers (DTLOMS) components (Winsch, Garth, Ainslie, & Castleberry, 1996). The TSPs were implemented in Janus using a test-fix-test approach. The lessons learned from the SIMUTA-D effort shaped the design and development approach used by the EXFOR TSP Team.

EXFOR TSPs. Under the FXXITP, a series of TSPs for Janus and SIMNET simulations were developed to prepare the Army's digitally-equipped EXFOR for the Task Force XXI AWE. The Janus TSPs support the training of brigade, task force, and company/team elements. The SIMNET TSPs support platoon and company/team training. Both sets were developed to support training on Fort Hood and NTC terrain databases. The TSPs include tasks incorporating the use of Appliqué and other digital systems fielded to the 1st Brigade Combat Team (BCT), 4th Infantry Division (ID), the Army's EXFOR at Fort Hood (Leibrecht & Winsch, 1997).

Close Combat Tactical Trainer Tools

Structured Training for Units in the Close Combat Tactical Trainer (STRUCCTT). This training program provides TSPs which leverage the capabilities of the CCTT technology to train Active Force and ARNG crews, platoons, company/teams, and task forces on conventional, non-digital MTP tasks (Campbell, Flynn, Myers, Holden, & Burnside, 1998). The STRUCCTT program also provides four tables to support digital training for M1A2 platoons in the CCTT. The M1A2 exercises are limited by current lack of CCTT exercise equipment to support digital training. The workaround for the AAR workstation's inability to monitor the IVIS traffic is to put a roleplayer acting as the team commander in an M1A2 and have him send and receive digital messages to and from the manned unit. There is currently no viable workaround for not having SAF capabilities to send digital messages in the CCTT. Therefore, the IVIS platoon cannot see the other armor SAF platoon on its IVIS display, and it receives no digital traffic from other platoons in the company (W. T. Holden, personal communication, May 12, 1998). The STRUCCTT program is based on the SST approach used successfully in the VTP. Unlike the VTP programs described earlier, the STRUCCTT program, as well as the programs described below, were designed to avoid requiring a dedicated O/C team to administer the training. This alternative design requires the unit to provide all O/Cs as well as some of the Operations Center workstation operators.

CCTT-D. The CCTT-D project meets emerging training needs driven by battlefield digitization and provides a foundation for future training developments.

Commander's Integrated Training Tool (CITT). The CITT is designed to integrate the different training tools, techniques, and procedures being developed to support training in the CCTT. The CITT project will achieve this by providing an instructional overview of the available tools, techniques, and procedures. It will also serve as a mechanism for providing commanders and unit trainers access to TSPs and Army training management information systems and databases (e.g., the Standard Army Training System [SATS]) via the World Wide Web (M. R. Flynn, personal communication, May 14, 1998).

One core advantage of many of the simulation-based training programs described above is that they are structured in a way that enables units to conduct training with minimal preparation time and limited external assistance. This is achieved through the organization of training materials into TSPs tailored to specific audiences, missions, and simulation environments. The following paragraphs describe the evolution and current role of the TSP in today's Army training strategy.

Training Support Packages

Since the implementation of the SIMUTA RCVTP program, the Army has delivered specific guidance concerning the contents and structure of TSPs for conventional operations. TRADOC Regulation 350-70 defines a TSP as a "complete, exportable package integrating training products, materials, and/or information necessary to train one-or-more critical tasks" (TRADOC, 1995b, p. V-7-1). The foundation for the development of structured simulation-based TSPs was the Army's training development process, the SAT, which supports the creation of mission-focused, task-based individual and collective training for the Total Army (TRADOC, 1995b). Warfighter TSPs support collective training and include tactical materials, trainer materials, and administrative data. While TRADOC Regulation 350-70 provides direction for Warfighter TSP development, it focuses on conventional operations. An issue cogent to the general objectives of the current effort is how to assemble a TSP that facilitates training digitally-equipped forces using the CCTT or similar systems. Wilkinson (in preparation) provides guidelines for addressing the unique requirements of TSPs designed for the CCTT. The implication of these guidelines, along with the relevance of lessons learned from earlier SST efforts featuring TSPs designed for conventional and digital operations (see below), are explored throughout this report. Taken together, the TSP guidelines and the lessons learned from earlier SST efforts provide a basis for addressing the training requirements of digitally-equipped units using the CCTT.

Overview

The common denominator of most of the past ARI AFRU research is use of the SST methodology supported by TSPs tailored to each effort. Campbell and Deter (1997) recommend a five-part TSP structure based on TRADOC Regulation 350-70 (TRADOC, 1995b). The suggested TSP structure for conventional operations includes: (a) tactical materials, (b) unit materials, (c) train-the-trainer materials, (d) simulation materials, and (e) administrative materials. The following simulation-based training programs feature TSPs containing Campbell and Deter's basic categories of materials: (a) VTP, exercises for platoons, companies, battalions, battalion staffs, and brigades (e.g., SIMUTA, SIMUTA-B, SIMUTA-D, and SIMBART); (b) COBRAS, brigade staff exercises and vignettes; (c) EXFOR, virtual and constructive exercises for platoon through battalion/task force, and (d) STRUCCTT, exercises for platoons, companies, and battalions using the CCTT.

Model for Digital Training Support Packages

A TSP that supports CCTT digital training should provide the training unit, O/Cs, Operations Center workstation operators, and contractor logistics support personnel with the instructions and tools needed to schedule, plan, prepare, and execute training on digital and non-digital tasks in the CCTT. Wilkinson (in preparation) asserts that the Warfighter TSP model does not result in a TSP that trains users how to fully exploit the capabilities of the CCTT system. Wilkinson proposes that a comprehensive TSP for the CCTT should have four parts: (a) a training management and exercise development system, (b) system training packages, (c) training scenarios, and (d) train-the-trainer packages. The U.S. Army Training Support Center (ATSC) supports the TSP concept for digital forces (D. Whiting, personal communication, January 14, 1998). The four TSP components provide an excellent structure for discussing how a TSP should be designed for training and evaluating digital units in the CCTT. The Method and Findings and Discussion chapters of this report further address the application of this model to the CCTT-D effort.

METHOD

A goal of the first three stages of this research effort was to provide recommendations that would improve the CCTT's ability to support the training and evaluation of tactical units equipped with digital systems. This project addressed all of the components of CCTT including: (a) manned modules, (b) command, control, communications, computers and intelligence (C4I), (c) AAR capabilities, (d) workstations, (e) weapons system performance data, (f) terrain databases, (g) SAF, and (h) TSPs.

The initial portion of the effort was completed in three stages consisting of the following: (a) a quick look assessment of CCTT capabilities that led to recommended enhancements, (b) the design of structured training scenarios for the CCTT and recommended future actions, and (c) a review of the CCTT comprehensive TSP concept and recommended modifications.

Assessment of CCTT Capabilities to Train and Evaluate Digital Units

Stage 1 was to determine the CCTT's ability to train and evaluate units equipped with digital systems and to provide prioritized recommended enhancements. A quick look assessment, conducted from June to September 1997, focused on providing enhancements for the April 1998 CCTT Initial Operational Test and Evaluation (IOT&E).

Quick Look Assessment

The purpose of the quick look assessment was to recommend enhancements that would significantly improve the CCTT's ability to train and evaluate M1A2 digital units of the 1st Cavalry (CAV) Division on all phases of the MTC, DAK, and DIS scenarios.[1] The CCTT-D Team used structured interviews, observations of training, and task identification as the primary means of accomplishing the quick look assessment.

Structured Interviews

Structured interviews, tailored to the target audiences, were used to structure data collection with key members representing the following: (a) III Corps Staff; (b) 1st CAV Division–Brigade, Battalion, and Company Commanders, Battalion Executive and Operations Officers, and Platoon Leaders; (c) Fort Hood CCTT Facility Staff; (d) Test and Experimentation Command (TEXCOM) CCTT Test Team; (d) STRUCCTT Training Development Team; (e) TRADOC Systems Manager (TSM) for CATT; (f) STRICOM Program Manager (PM) for CATT; and (g) USAARMC Directorate of Training and Doctrine Development (DTDD).

[1] Although the focus of the research project later shifted to FBCB2, the quick look assessment focused on the 1st CAV Division and M1A2s equipped with IVIS.

The structured interviews were used to identify digital tasks necessary to accomplish various tactical missions, the digital tasks that could and could not be trained in the CCTT, and the strengths and weaknesses of the CCTT to train and evaluate digital tasks. Interview forms were tailored to reflect the role of each interviewee in the CCTT project. Over 60 interviews were conducted from June to September 1997.

The results of each interview were consolidated into the following response groups: (a) platoon and company, (b) battalion/task force and brigade, (c) division and corps, (d) CCTT facility responses, and (e) other organizations. Volume II contains the interview results.

Observation of Training

Military experts from the CCTT-D Team observed training exercises in the Fort Hood CCTT facility during and after the CCTT Limited User Test (LUT). These observations and informal discussions with the 1st CAV and the 4th ID focused on how the unit personnel, trainers, and site staff used the various components of the CCTT to accomplish specific training objectives. Although not equipped with M1A2 IVIS systems, units from the 2nd Brigade of the 4th ID were observed because their organic equipment includes the ATCCS systems.

In group sessions, the CCTT-D Team members considered their own CCTT exercise observations and the outcome of informal discussions with the 1st CAV and 4th ID. The outcome of this process was a list of conclusions and insights regarding the CCTT's ability to support unit training and evaluation on digital tasks. This list supplemented the input obtained from the structured interviews.

Task Identification

The CCTT should be capable of training and evaluating units on all critical tasks associated with their tactical missions. The quick look assessment focused on determining the CCTT capabilities required to train and evaluate M1A2 units on digital tasks and task steps associated with MTC, DAK, and DIS missions.

At the time this work was conducted, the Army had not formally established/approved the digital tasks and task steps for units equipped with IVIS. The team was directed to use the use of the EXFOR MTPs as the basis for the task assessment. To determine the digital tasks and task steps that could and could not be trained and evaluated in the CCTT, the CCTT-D Team reviewed the EXFOR MTPs[2] for the digital tank platoon (Fort Knox Supplemental Material [FKSM] 17-237-(EXFOR)-MTP) and the digital tank and mechanized infantry company/team (FKSM 71-1-1-(EXFOR)-MTP). This review produced a list of digital task steps for each echelon (platoon and company), mission, and task. The team used the CCTT Task Performance Support (TPS) codes (Sherikon, Inc., 1996) and the Operators Manual for the M1A2 tank (U.S. Army Tank-Automotive and Armaments Command, 1995) to determine the CCTT's ability to support unit training and evaluation on the digital tasks and task steps. The product of this process was a list of tasks and task steps that could or could not be trained and evaluated in the CCTT. The tasks and task steps selected for the current effort are contained in Volume II.

[2] The EXFOR MTPs were developed by BDM International, Inc. under the FXXITP and are available from the Commander, U.S. Army Armor Center, ATTN: ATZK-TD, Fort Knox, KY 40121-5000.

Recommended Enhancements to CCTT

The next portion of Stage 1 was to make prioritized recommendations that would improve the CCTT's ability to train and evaluate digital units. These recommendations were based on the findings from the quick look assessment. The first step in this process was to use the quick look assessment findings from the interviews, CCTT exercise observations, and the task lists to establish a non-prioritized set of recommended enhancements for the CCTT. Each member of the CCTT-D Team reviewed the input from the interviews and their own observations to establish a list of recommended enhancements. An integrated list was formed by consolidating the input of the various members. The consolidated list reflected the team's collective judgment regarding the suitability of each recommended enhancement. In the next step, the CCTT-D Team using a group consensus approach established specific prioritization criteria. The criteria used are shown in Table 5.

Recommended enhancements were derived by applying the criteria against the initial recommended enhancements. First, for every recommendation, each member of the CCTT-D Team individually assigned a three-point numeric rating for each of the 13 criteria. Next, these individual ratings were consolidated and averaged for each criterion for every recommendation. Finally, these averaged rating values were summed in order to determine a numeric score for each recommendation. The resulting point values provided the basis for assigning a priority designation to each recommendation. This prioritized list was reviewed and ratings were adjusted by group consensus. A discussion of the final outcome of this process appears in the Findings and Discussion chapter of this report.

Table 5

Enhancement Recommendation Prioritization Criteria

CATEGORY	CRITERIA
Training Benefit to the Unit	Transfer of Training • Fidelity of Emulation • Support for all Mission Phases Training Flexibility • Number of Tasks and Missions Trainable Training Standardization • Procedural Consistency and Control • Repeatability of Training Conditions Effectiveness of Training Feedback • Support for AARs • O/C Assistance • Support for Real-time Evaluation
Feasibility	Technical Risk/Uncertainty/System Stress • Complexity • Sophistication Acceptability to Leaders Probability of Being in Place Near IOT&E
Cost to Implement	Equipment Procurement Software Development Manpower Required to Field
Reduction of Operating Costs	Manpower Savings Operating Tempo (OPTEMPO) Efficiency Ammunition (Live Training Requirements)

Structured Training Scenarios

The second stage of the methodology was to design structured training scenarios for execution by digital units in the CCTT. The methodology for structured training development as described in Campbell et al. (1997) and Campbell and Deter (1997) was followed (see Figure 1). Design responsibilities of the CCTT-D Team were allocated so that one designer was responsible for producing all of the training design products for platoon, company/team, and battalion task force echelons for one of the three missions. The scope of the current effort did not include the development of TSPs. The principal products of this stage included a summary of training design features, task lists for each mission, concept of the operation (sketch) for each mission, scenario specifications package, and an outline of events for each mission. The four phases of the methodology are described below.

Document Initial Decisions-Phase 1

The purpose of Phase 1 was to determine the training requirements, the training audience, and the appropriate training environment of the structured training program. During this initial phase, there were four decision areas that needed to be specified and documented. These decisions (see Volume II) formed the basis for completing the remaining scenario design phases.

Training Audience

The CCTT-D Statement of Work (SOW) (U.S. Army Research Institute for the Behavioral and Social Sciences, 1997) specified that the training program was to accommodate training at the following echelons: armor platoon, armor heavy company/team, and armor heavy battalion/task force (including the commander and staff). These requirements were assessed and the outcome appears in the Findings and Discussion chapter.

Training Context

The training context provides the training "storyline." This includes the following variables: (a) mission type, (b) enemy type, (c) terrain, and (d) unit type.

Mission type. The training program design focused on three tactical missions: (a) MTC, (b) DIS, and (c) DAK.

Enemy type. The scenario features the enemy type typically used at the NTC. Specific details of the enemy type are contained in the Findings and Discussion chapter.

Terrain. The CCTT-D Team considered whether to base the design on Fort Hood or NTC terrain. A design based on Fort Hood terrain would allow 1st CAV Division units to use the CCTT to supplement home station maneuver and gunnery training programs while a design based on NTC terrain would support the unit's NTC preparation program. The CCTT-D Team recommended the NTC terrain since the current Fort Hood CCTT simulation system only has two training environment databases, Central USA/Forest and NTC, with the later being more applicable to the deployment areas of the 1st CAV Division. Basing the design on Fort Hood or Central USA/Forest terrain would not have facilitated rapid scenario development or supported the 1st CAV's most immediate training needs.

Unit type. Focusing on the M1A2 pointed the CCTT-D Team towards accounting for IVIS as the digital command and control system. The team perceived this as a major obstacle because IVIS is a "stove pipe" system that is unable to communicate with most of the other currently fielded digital information systems. Since the M1A2 tank is the only system fielded with IVIS, digital combined arms operations were not possible. Many of those interviewed during the quick look assessment commented about this problem. Essentially, users stated that they were not interested in a digital training program unless it facilitated digital combined arms training. This, along with the Army's tactical doctrine which specifies that maneuver forces usually fight as combined arms organizations, posed a serious design problem. Since IVIS lacked digital connectivity with other digital information systems and none of the other members of the combined arms team (e.g., infantry, artillery, and engineers) were equipped with the IVIS, design of a digital training program for combined arms operations using the IVIS was not feasible.

The CCTT-D Team's recommendation was to design a training program based on the FBCB2 information system. There were two reasons for this recommendation. First, the FBCB2 system supports connectivity with the other fielded information systems and the basis of issue for FBCB2 includes all elements of the combined-arms organization. This would allow a digital communications capability with all combat, CS and CSS elements and would enable design of simulation-based exercises which facilitate digital combined arms operations. The second reason stems from the fact that Fort Hood, Texas is the home of the Army's digitization efforts. All three of Fort Hood's major combat elements (4th ID, 1st CAV, and III Corps Headquarters) have been designated as the first units in the Army to be digitized. The Army's digitization systems are present or slated for fielding at Fort Hood. All Fort Hood units will receive the FBCB2. Consequently, there is a great demand for the CCTT to incorporate an FBCB2 digital capability to facilitate digital unit maneuver training in a virtual simulation environment. Incorporating the FBCB2 into the training design for the current effort addresses this demand.

Another major concern was the organizational structure of the target unit type. This centered around the distinct possibility that, as a result of Task Force XXI redesign initiatives, the combined arms maneuver battalion would be restructured from its current structure of four maneuver companies to a structure with three maneuver companies. A training design based on a four company structure would degrade training development efforts if the Army decided to implement a three company structure.

A key outcome of the Army's Force XXI initiative was a reorganization of the EXFOR's 1st BCT. Two of the most significant changes were the creation of a Brigade Reconnaissance Troop (BRT) which was assigned to the BCT Headquarters and the creation of a Forward Support Company (FSC) which was attached to each maneuver battalion. The CCTT-D Team recognized that these two experimental organizations could have a significant impact on training scenario design since they changed how the brigade and battalion/task forces conduct reconnaissance and sustainment operations. As with the maneuver company issue discussed above, it was likely that the Army would make a decision to adopt the two new BRT and FSC organizations prior to delivery of the CCTT-D design.

After careful consideration, the CCTT-D Team recommended that the training design reflect a four maneuver company organization and that the design not incorporate the BRT or FSC. These recommendations were primarily driven by the concern that the training design for the current effort be exportable to units other than the EXFOR.[3]

[3] Since then, the Army has decided to transition to a conservative heavy division. The conservative heavy division features 15,000 troops and 45 combat platforms in maneuver battalions that are well-equipped with technology (Hartzog & Diehl, 1998).

Simulation Technology

The CCTT-D Team designed the training considering the capabilities the CCTT would have for the IOT&E in April 1998. These capabilities were summarized in the Introduction chapter of this report.

Other Training Considerations

A major concern was whether any of the available SST training programs should be used as a basis for the CCTT-D design. The government expressed a desire for the capability to rapidly develop any training design produced under the current effort. In consideration of this, the CCTT-D Team believed that significant time savings would accrue if a previously developed SST product was adopted as the foundation for the current effort. Two viable candidates for adaptation were the STRUCCTT training program materials (developed by the ARI AFRU) and the EXFOR TSPs (developed by the TSM Force XXI).

The STRUCCTT effort (Campbell et al., 1998) produced 40 structured training exercises developed specifically for use by platoons, company/teams and battalion/task forces while training in the CCTT. The major advantage to using the STRUCCTT materials was that any future development would benefit from existing electronic simulation files. However, at the time the CCTT-D project began, there were no plans to have the STRUCCTT exercises incorporate the use of digital equipment or TTPs. The decision to add four M1A2 platoon tables to the STRUCCTT TSP library was not made until mid-March – too late to be considered for CCTT-D product development.

The EXFOR effort (Leibrecht & Winsch, 1997) produced structured training exercises which facilitated the use of the ATCCS and the Appliqué information system (a predecessor to the FBCB2 system). The EXFOR TSPs were specifically developed to enable platoons, company/teams, battalion/task forces, and BCTs to train on digital TTPs using organic digital equipment while executing MTC, DAK, and defense missions on an NTC terrain database. The simulation drivers for the EXFOR TSPs were Janus and SIMNET. The major advantage to using the EXFOR products was their digital training focus. However, since the EXFOR TSPs were not developed for use in the CCTT, future development efforts could not make use of the electronic simulation files developed specifically to run on the Janus and SIMNET simulations.

The CCTT-D Team ultimately recommended that the CCTT-D design use the EXFOR TSP products as its foundation. Their digital focus provided the best base for the design and rapid development of a digital training program. The team believed that these considerations compensated for the requirement to create new electronic simulation files for the CCTT environment.

The initial decisions were developed and documented using an Initial Decisions Worksheet (Campbell et al., 1997) early in the design process. Once final approval was obtained, the CCTT-D Team proceeded to Phase 2 of the process: designate training objectives.

Designate Training Objectives–Phase 2

The second phase of the scenario design was to determine the training program's tasks. The overall intent was to focus the training on critical tasks and performance standards in support of the training requirements and to ensure that those tasks were supported by the simulation technology. The goals of this phase were to develop a list of tasks that would provide the performance structure around which the scenario would be constructed and define the training objectives for the training audience.

Identify Sources, Tasks and Standards

The source of task lists is normally the most recently approved version of Army MTPs for each unit type and echelon identified as the training audience. The tasks must describe performance procedures, conditions, and standards. Very important to this effort is the identification of the task steps that are performed using digital equipment. A serious constraint identified early in the analysis process was the lack of an approved source for the digital tasks required for the design. The CCTT-D Team encountered several documents that purported to be digital task sources. However, most were found to be inadequate for collective training design purposes since they focused solely at the individual training level. One possible solution was the use of the MTPs developed as part of the EXFOR project. The EXFOR MTP effort modified conventional MTPs for the platoon, company/team, battalion/task force and BCT echelons by incorporating emerging digital TTPs observed during the EXFOR Brigade's AWE train-up. This produced a "hybrid" MTP that contained the same tasks as a conventional MTP with digital performance steps integrated. Although this presented a practical solution, use of the EXFOR MTPs was far from ideal since the digital task steps were based on the Appliqué system, not the FBCB2. More importantly, the Army's doctrine community had not yet approved the MTPs.

Based on the general lack of any other collective digital training task sources, the CCTT-D Team recommended use of the EXFOR MTPs. Although these MTPs were not specifically developed to support training using either the IVIS or FBCB2 information systems, they did provide a source of "generic" (non-system specific) collective digital tasks which the CCTT-D Team could use as a basis for training program design. This issue was resolved when the TSM CATT conditionally approved the use of the EXFOR MTPs for CCTT-D training design purposes.

Since the EXFOR MTPs were based on digital operations using the Appliqué, they were not directly applicable to the CCTT-D design. This led the CCTT-D Team to make some critical assumptions. It was decided that the digital task steps found in the EXFOR MTPs would be considered the foundation for digital operations. For CCTT-D training design purposes, it was assumed that a task supported by Appliqué would also be supported by FBCB2. The key to this assumption was that the FBCB2 system would, at a minimum, encompass all Appliqué features. This established the framework for the development of a task list that contained the tasks and standards to support training evaluation. Based on this, a list was compiled of all tasks contained in the three EXFOR MTPs. This task list inevitably included some tasks that were not supported by the CCTT simulation system. This set the stage for the next Phase 2 activity; refinement of the task list for simulation support.

Refine the Task List for Simulation Support

After extracting the tasks from the three EXFOR MTPs, the CCTT-D Team asked some of the STRUCCTT Team subject matter experts (SMEs) to refine the task lists extracted from the EXFOR MTPs and determine if the digital task steps were executable using the equipment in the CCTT. The methodology used by the SMEs for digital task list refinement was derived from a process developed by Burnside (1990). The approach involved having three SMEs individually rate each task step for support by the CCTT simulation. Once all three SMEs had scored the task steps, they met to obtain consensus on a final overall task score and a score for each of the task steps. The tasks and task steps were scored as: (a) highly supported, (b) partially supported, or (c) not supported in the CCTT. Because the CCTT currently does not have an ATCCS digital communications capability, the SMEs had insufficient experience to produce ratings for the battalion/task force level tasks.

Select Tasks that Support Each Mission

During this activity, tasks were selected, based on their relevance to the selected mission. Once the task list was refined, the CCTT-D Team began the process of task selection. This was a collective process in which the designers selected the tasks to be trained within each echelon for each of the three tactical missions. During this process, the team incorporated all training priority guidance received. The end product was a task list for each echelon and tactical mission. These task lists appear in Volume II. This completed Phase 2 and set the conditions for the CCTT-D Team to proceed to Phase 3.

Design Scenario and Exercise Outlines–Phase 3

The final phase of scenario design was to plan and outline the tactical scenario for the exercises, focusing on only the initial activities of the phase, as defined by Campbell and Deter (1997). During this phase, the intent was to determine the limits of each exercise with respect to mission, enemy, terrain, troops and time available (METT-T); generate the tactical framework for the exercises; and, specify the events within each exercise.

The CCTT-D Team saw the Phase 3 activities as the core of the scenario design. The current method stopped short of building the exercise because that was clearly in the realm of training development and, therefore, beyond the scope of this effort. As before, the team followed a modified Campbell et al. (1997) methodology described below.

Scenario Design

The CCTT-D Team designed scenarios that would place the training audience under conditions requiring the use of organic digital equipment and digital TTPs. This meant structuring the scenarios so that the training audience could receive the training cues needed for digital task execution in a digital format. This required the training audience to navigate using its digital systems, receive and send digital orders and graphic overlays, and receive and send digital reports and requests.

The team members based the scenarios on the EXFOR TSPs. They collaborated to produce draft scenarios that detailed the mission, intent, and concept of the operation for each echelon and tactical mission. Sketches were produced to illustrate each scenario. In developing the scenarios, the team closely followed the initial decisions made in Phase 1 of the design process. The scenarios and sketches were refined and approved. Subsequent decisions included the use of EXFOR scenarios. Detailed outlines of scenarios and sketches appear in Volume II.

Exercise Outlines

Once the scenarios were approved, the CCTT-D Team began the last step in the training design process, developing exercise outlines for each echelon and mission. These outlines were completed in the format provided in Campbell and Deter (1997) and essentially consolidated the information produced as a result of Phases 1-3. The exercise outlines produced for the CCTT-D training design are included in Volume II.

Training Support Packages

The next stage called for recommending the content and format for various training packages or TSPs that need to be revised or produced for digital units using the CCTT. Figure 2 shows the process that the CCTT-D Team followed during this stage.

As a starting point, the CCTT-D Team accepted the TRADOC approved concept of comprehensive CCTT TSPs from the TDR document for the CCTT (TSM CATT, 1997). These TSPs consist of several integrated components: (a) a train-the-trainer module, (b) a library of structured training scenarios including successfully executed examples and AAR materials, (c) an automated training management system, and (d) system operations training. The team also examined Wilkinson's (in preparation) concept for comprehensive TSPs. This concept essentially cross-walks with the CCTT TDR – but provides a detailed description of each TSP module.

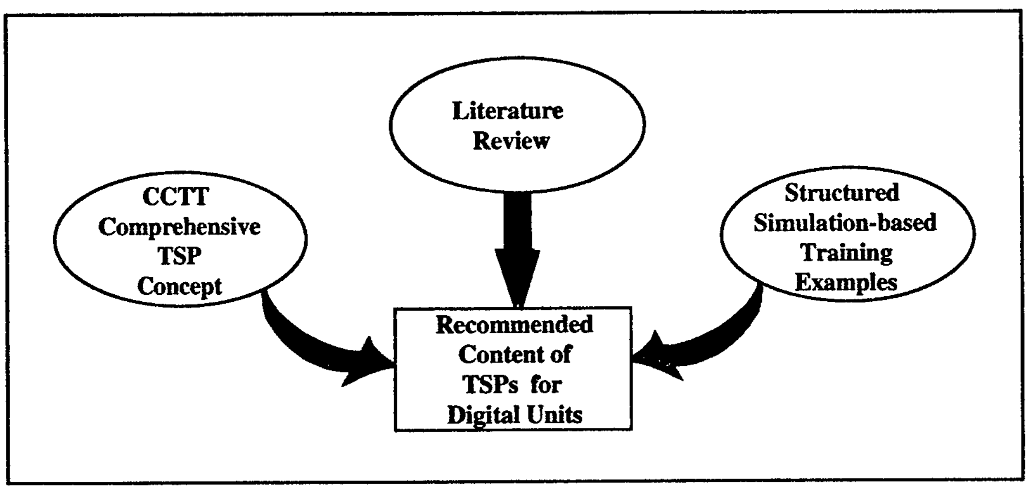

Figure 2. Stage 3 TSP design activities.

The CCTT-D Team also reviewed the ongoing ARI research and development on the CITT for the CCTT. This tool is intended to provide an automated training management and exercise development system for units training in the CCTT. In addition, the team reviewed the VTP (SIMUTA, SIMUTA-B, SIMBART, SIMUTA-D), STRUCCTT, EXFOR, COBRAS, and SGT SST programs. The focus of the review was to assess the content and format of existing training packages or TSPs and determine their suitability for CCTT exercises conducted by digitally-equipped units.

An overview of TSPs as they relate to digital operations training is given in the Introduction chapter while the results of the review process are presented in the Findings and Discussion chapter of this report.

Overarching Training Approach and Training System Functionality

The second major portion of the current effort was organized to develop an overarching training approach for the exploitation of digital systems and provide a generalized assessment of unique training system functionality required to support training a digitized force (U.S. Army Research Institute for the Behavioral and Social Sciences, 1997). An important goal was to provide a training approach and training system models that extend beyond the CCTT-D-based recommendations generated under Stages 1 - 3. The outcomes generated by the quick look assessment and FEA activities completed provided a springboard for this effort. The relationship between the stages is reflected in Figure 3, which also shows the major components of the methodology used to execute Stages 4 and 5.

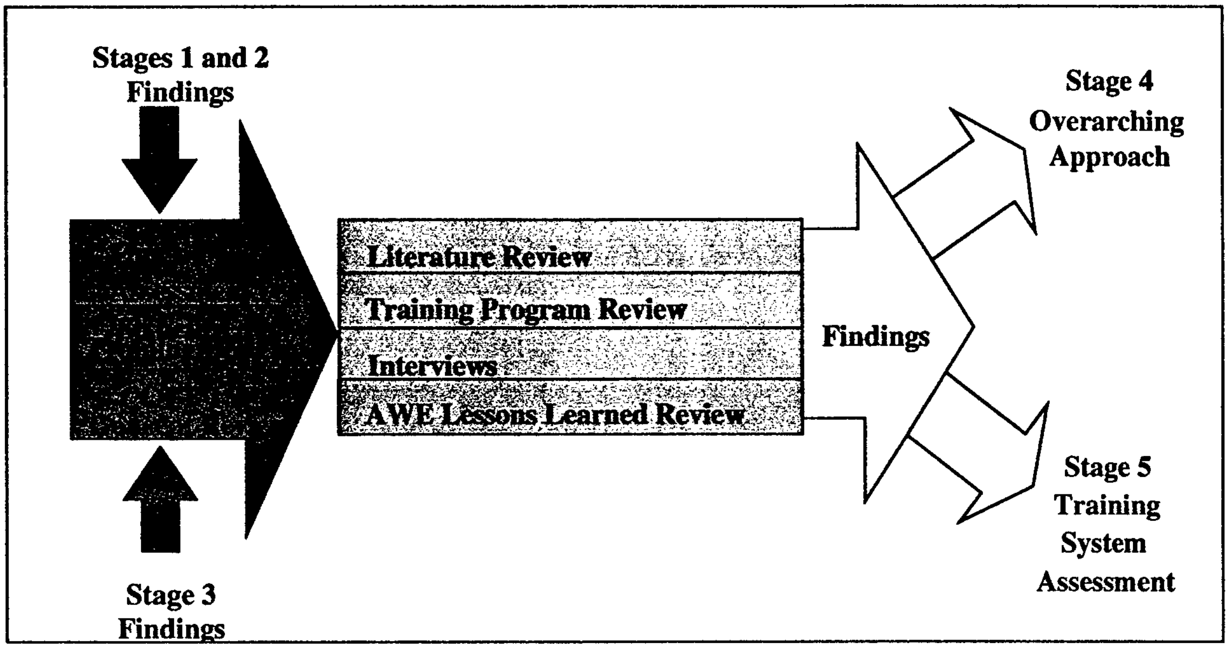

Figure 3. The Stage 4 and 5 methodology.

Primary considerations that guided the development of the overarching training approach (Stage 4) called for identifying the following: (a) unique training requirements of tasks resulting from digitization; (b) innovative techniques and methods for both training and evaluation; (c) training audience in the institution and in the unit, including entry level and professional development; and (d) recommended objectives, approaches, and methods for future training research and development efforts.

A supporting element of the system functionality assessment (Stage 5) was the consideration of how digitization affects the major Army training components. An initial training system framework was developed after reviewing training system assessment models derived from Field Manual (FM) 25-100 (Department of the Army, 1988), the Systems Approach to Training (TRADOC, 1995b), the FXXITP (TRADOC, 1994), and the Army

Training XXI Campaign Plan (TRADOC, 1997a). Together, these existing frameworks provided common elements that shaped the training system model.

Data Collection Procedures

The data collected to support development of the overarching training approach and system functionality assessment came from interviews and review of relevant programs and literature. The methods used to develop the training approach and assess training functionality requirements basically consisted of generating data from the interview and document sources and using a group consensus approach to concept development. Given this commonality, the methods used for each stage are described jointly in this chapter. However, the results of the data collected for each stage provide distinct outcomes. Thus, they are treated separately in the Findings and Discussion chapter.

To facilitate data collection, a template was developed to guide the collection of review and interview data. The purpose of the template was to ensure a consistent focus for each stage. Team members were instructed to structure their interview and review data using the following categories: (a) context of the finding or conclusion, (b) synopsis, (c) practical importance, (d) pertinence to other report elements, and (e) additional notes. These categories were then addressed under each of the elements shown in Table 6.

Table 6

Primary Data Elements for Stages 4 and 5

STAGE	ELEMENT
4 – Overarching Training Approach	• Army XXI Training Challenges • Training the Digital Force Digital Training Concept The Training Spectrum – Army Training XXI Units - Individual, Crew, Collective Battle Command and Staff Training Institutional Training Self-Development
5 – Training System Assessment	• The Training System • Training to Exploit Digital Systems Training Requirements Training Plan/Support Package Development Exercise Execution Data Collection Evaluation AAR Feedback

Team members delivered their reviews to a quality control cell as each was completed. Interview materials underwent the same process. The subsections below describe the procedures in greater detail.

Interviews

Senior military training specialists on the research team conducted interviews. Ordinarily, two SMEs attended each interview, one to serve as the lead interviewer and one to transcribe interview responses (most interviews were also tape-recorded). Interviewees received a review copy of the interview questions at least 48 hours in advance of the actual interview and most interviews lasted approximately 90 minutes. Figure 4 contains the interview questions.

The team sought to interview personnel experienced with Army digitization training issues. A list of interview candidates was generated and approved. The interview audience consisted of representatives from the following organizations: (a) 4ID-Assistant Division Commander for Support (ADC(S)), (b) Chief of Staff, (c) 4ID 1st BCT Commanders (current and previous), (d) 1st Cavalry Division (CD) Chief of Staff, (e) USAARMC DTDD, (f) TSM CATT, (g) TSM FBCB2, and (h) Combined Arms Center.

CCTT-D FOCUSED INTERVIEW QUESTIONS

1. How will digitization impact training requirements?
2. What unique capabilities or characteristics should the following kinds of training systems have to support training a digitized force?
- Virtual simulations
- Constructive simulations
- Live simulations
3. How could we improve the following training components to support training for digital operations?
- Mission Training Plans (MTP)
- Commander's Assessment Tools
- Training Support Packages (TSPs)
- Exercise Execution
- Performance Assessment and Feedback Tools
- Exercise Director's Tools
- Training Program Management Tools
4. What other components are needed to support digitally-focused training? (Example: performance database capabilities)
5. What innovative techniques and methods can the Army exploit to train and evaluate digitally-equipped units?
6. On which of the above areas should the Army focus its training research and development (R&D) efforts to support digital operations?
7. What is your definition of Spiral Development?
8. Follow-up: How does the Army need to modify its spiral approach to training and doctrine development to better meet the training needs of the digital force?

Figure 4. Focused interview questions.

Reviews

The team also conducted an extensive review of relevant literature and programs, all of which were bounded by their practical utility to the current effort. The selected literature and programs dealt with AT XXI and Force XXI concepts, conventional training doctrine, innovative approaches to training and feedback, staff training, and 21st Century Army training technologies. Reviewers were directed to analyze their assigned program or literature, distill information, and synthesize ideas. Reviewers were encouraged to provide "out of the box" ideas or concepts that relate to the broad objectives of Stages 4 and 5. Some literature reviews led reviewers to additional materials and some program reviews were supplemented with informal interviews of program personnel. The Findings and Discussion chapter includes the outcome of all review activities.

Analytic Approach

The data were drawn from interview comments and reviews of relevant literature and program documents. As mentioned earlier, all interview and review data underwent an early quality control process to ensure that the identified data elements had been addressed fully. The subjective nature of the data did not support formal statistical analysis procedures. The basic approach to gleaning results was to initially review summarized data for trends and then adopt an informal content analysis approach to further guide classification of the data into meaningful categories. A discussion of the major findings for each stage appears in the Findings and Discussion chapter.

FINDINGS AND DISCUSSION

Assessment of CCTT Capabilities to Train and Evaluate Digital Units

The CCTT-D Team accomplished a detailed assessment of the CCTT's current and near-term ability to support digital operations training. The team examined the current and expected near-term status of the digital equipment possessed by the 1st CAV Division and the digital equipment contained in the CCTT facility at Fort Hood. It is important to note that while some CCTT capabilities exist at Fort Knox, KY, they are more limited than those at Fort Hood. The Fort Hood CCTT site is a test site and not considered the standard for all future CCTT sites for equipment and capabilities. The concerns in this report that centered on the numbers and types of simulations are based on the limitations of the Fort Hood test site and will not be applicable at final fielding. This section discusses the results of the quick look assessment as well as the recommendations for enhancing the CCTT.

Quick Look Assessment

General Training Issues

Interviews and observations. The leadership of the 1st CAV Division and III Corps overwhelmingly agree that the CCTT is an excellent tactical trainer for platoon and company/team training. The leadership looked forward to being able to use the CCTT on a regular basis and planned to use it to train soldiers on tactical maneuvers and gunnery. The primary concern was availability of the facility. With the number of platoons and company/teams stationed at Fort Hood and the limited resources within the facility, commanders were concerned that their units would be limited in the time they could spend in the CCTT facility.

The leadership expressed interest in using the CCTT for battalion/task force and BCT level training. This interest was tempered by the fact that the facility could not support training an entire battalion down to crew level without using computer-generated SAF. The majority of the leaders indicated a desire to "plug in" their own organic digital systems at battalion/task force level and above to conduct staff and leader training.

Leaders expressed concern about "down-time" in the facility for software and equipment upgrades. Most of the senior leadership were in favor of a "total package fielding" concept whereby the CCTT facility would be upgraded concurrently with the fielding of new equipment to the units and undergo as many changes as possible at one time to minimize down-time. Many supported fielding the new equipment to the CCTT facility first and using it prior to field training portions of new equipment training sessions.

Finally, the leadership discouraged making modifications to the CCTT facility prior to the scheduled IOT&E and did not favor using workarounds in lieu of actual equipment. Most viewed workarounds as a form of negative training. They preferred waiting for a working system to using any form of an artificial training technique.

Status of digital training. The CCTT-D Team examined the training conducted by the 1st CAV units and found that although a large number of digital systems had been or would be fielded to the 1st CAV Division, there was little emphasis on digital training. The 1st CAV Division is expected to be 100 percent M1A2 (five battalions) by the scheduled CCTT IOT&E. However, the digital capabilities of the IVIS systems in those tanks were not used. The primary reason given was that it was impractical to train using a system that would not be used in combat and the current plan is to use pre-positioned stock which includes only M1A1s. Also, during NTC rotations, the 1st CAV Division uses M1A1s since M1A2s are not yet available at the NTC. As a result, units conducting training in the CCTT facility tended to use the M1A1s or ignore the IVIS system on the M1A2s.

A limitation of units equipped with M1A2s is that company/teams do not have the ability to communicate digitally across platforms or to higher echelons because neither the M2A2s nor the battalion/task force TOCs are IVIS-equipped. Rather than do twice the work to pass information both digitally and by frequency modulation (FM) radio, units in the 1st CAV Division trained to the lowest common denominator: FM communication. The only IVIS capability used to any extent by M1A2-equipped units was the POSNAV, which provides the position of other IVIS-equipped platforms in the unit, affording enhanced situational awareness. The 1st CAV Division is equipped with ATCCS systems, such as the Maneuver Control System (MCS), Forward Area Air Defense - Command, Control, Communications, and Intelligence (FAADC3I), AFATDS, and the All Source Analysis System (ASAS), but not to the same degree as the 4th ID and the EXFOR. In many cases, the equipment was not fielded in sufficient numbers to be used effectively in field operations. In cases where they were fully fielded, such as with the FAADC3I and AFATDS, they were used in a stovepiped manner that did not support transfer of digital information to other digital systems.

CCTT Combat Systems

During the LUT, the CCTT-D Team found that the M1A2 simulators were a close replica of the actual tanks that had been fielded to the 1st CAV Division. Soldiers successfully performed mounted navigation using the IVIS POSNAV device, as well as the Driver's Independent Display (DID) "Steer To" indicator. In fact, the navigational assistance provided by the POSNAV was the most popular and most used aspect of the IVIS system in the M1A2s. Other systems used extensively by the crews were the CITV which allowed the tank commander to acquire, engage, and hand-off targets to the tank gunner and the Laser Range Finder (LRF) to obtain grid coordinates.

A major limitation faced by the units training in the CCTT was the small number of M1A2 simulators. The CCTT test site at Fort Hood is currently equipped with only ten M1A2 simulators which precluded training by a pure M1A2 company. The lack of M1A2s in the Fort Hood CCTT facility gave the units participating in the LUT another reason not to fully exploit the digital capabilities of the system.

The CCTT-D Team was particularly concerned about the limited capability to execute digital connectivity. Because there was no digital connectivity between the tank companies and their higher headquarters or between the M1A2s and the M2A2s, the LUT units reverted to FM communication upon first contact. This practice was part of the unit's standing operating procedure (SOP) as it has been since the battalion-level 94-07 AWE. The CCTT does support the current unit M1A2 TTPs and SOPs and will evolve to M1A2 System Enhancement Program (SEP) requirements.

Only one other digital system was available and used at the Fort Hood CCTT facility: the AFATDS system employed by the artillery units. The AFATDS simulator in use at the CCTT facility was not a full-scale version of the system; it allowed the artillery units to send call-for-fire (CFF) messages within the facility but lacked full AFATDS functionality and linkage to other systems such as the IVIS. Although the AFATDS is supposed to link with the IVIS to receive IVIS-generated CFF messages, the version of IVIS in use at the time linked to tactical fire direction systems (TACFIREs), not AFATDS. This capability is expected to be improved with the update of the IVIS software in the Fort Hood CCTT facility.

Overall CCTT Capabilities

Assessing the CCTT facility's overall capability to support digital training was the final topic for the quick look assessment. Because the Fort Hood CCTT facility had some digital equipment installed in the simulators, it was expected that some digital training would be possible. However, the extent of digital training possible and how well it could be evaluated was unclear. To address this concern, the CCTT-D Team interviewed key Fort Hood CCTT facility personnel, observed units conducting training in the facility as part of the CCTT LUT, and compared these findings to the digital training program established for the EXFOR.

The results of the analysis indicated that the Fort Hood CCTT facility was not adequately equipped to support collective digital training. There were not enough M1A2 simulators to train a pure company. The O/Cs could not feed information digitally to the units to encourage digital training. In addition, it was not possible to capture digital traffic between vehicles/echelons. There was no AAR capability to monitor, record, and playback digital traffic to provide feedback to the unit on digital operations.

The facility also suffered other shortfalls with regard to digital training. For instance, at the time of the quick look assessment, TSPs being developed for CCTT training were not designed to address the digital aspects of training or to encourage the use of digital systems. From the unit's perspective there was no digital connectivity and no program to encourage the use of the equipment. Hence, digital training opportunities were severely limited.

The CCTT Team also surfaced the issue of the limited number of databases for the CCTT. The only primary databases that support all the CCTT capabilities are the NTC and Central USA/Forest terrain databases. The NTC terrain database enables units to train on terrain in preparation for NTC rotations; however, they are precluded from training on Fort Hood terrain where they would normally conduct live training. The existence of the Central USA/Forest terrain database does not mitigate this shortcoming.

Recommended Enhancements

The team developed eight recommendations for improving the CCTT's ability to support digital training based on the interview results, observation of training in the CCTT facility, and the team's own EXFOR and STRUCCTT program development experience. Determining whether to upgrade the CCTT to current IVIS or FBCB2 capabilities depends on the current and near-term acquisition plans. The recommendations were then prioritized in order of importance (see Table 7). A major consideration during the development of the list was that almost all of the recommendations were in some way interrelated. For instance, in order to add a digital communication capability to the AAR and SAF workstations, the workstations require the same systems as the simulators. If the FBCB2 were added to the facility, the SAF and Operations Center workstations would also have to be updated to communicate using FBCB2 protocol. To properly conduct and evaluate digital training in the facility, TSPs to support digital training should also be developed. These recommendations need to be incorporated following the rules, model templates, and interface specifications of the HLA (Department of Defense, 1998a).

Table 7

The CCTT-D Prioritized Enhancements List

PRIORITY	CCTT COMPONENT	ENHANCEMENT RECOMMENDATION
1	C4I	Upgrade CCTT with Current IVIS Software and Hardware
2	AAR	Add Digital Exercise Management Tools to AAR Workstations
3	TSP	Develop Structured Training to Ensure Performance of Digital Tasks
4	SAF	Add Digital Communications Capability to SAF
5	C4I	Field CCTT with current FBCB2 Hardware and Software
6	C4I	Field CCTT with current ATCCS Hardware and Software
7	TSP	Modify CCTT and develop TSPs to Support Maneuver Gunnery Training
8	TSP	Expand CCTT to Train Battalion/Task Force and BCT Commanders and Staffs

These priorities reinforce the requirement for total package fielding where training systems must be updated simultaneously with those of the units. Execution in this manner would minimize the overall downtime of the CCTT facility and allow for concurrent system upgrades, as opposed to implementing improvements one component at a time.

It should also be noted that the decision whether to have the CCTT support IVIS or FBCB2 ignores the fact that some training units will have IVIS technology, some will have FBCB2, and some will still be conventional during the upcoming transition period. The CCTT site needs to be able to support these equipment variations. It is also shortsighted to think that FBCB2 will not be quickly followed by a new and improved digital system. Therefore, there is a requirement for unprecedented flexibility in the CCTT system architecture. The CCTT manned modules, SAF, and Operations Center workstations need to be flexible enough to support multiple digital platforms and support conventional operations.

This raises the issue of whether in the near future there will be enough CCTT training systems to support all units. If CCTT cannot be easily reconfigurable to meet these training needs, it is worth considering the reallocation of SIMNET systems to provide support for conventional units while the CCTT supports digital units.

Upgrade the CCTT with Current IVIS Software

The IVIS software used in the CCTT is Version 2.1.2, while the M1A2s fielded to the 1st CAV Division use Version 2.4.3. Thus, the software being used in the CCTT is at least three versions behind the actual equipment. This problem has two significant impacts on soldier training. First, the soldiers reported during the LUT that they had to "train down" to the previous software version in order to function in the CCTT. This caused confusion among soldiers whose IVIS documentation was written for the later version. Secondly, the older version of IVIS lacked some of the functionality of the newer version, specifically in the areas of CFF and logistical reporting. Because of these shortcomings, soldiers were hesitant to use the IVIS system during training.

The recommended and logical fix for this problem is to upgrade the IVIS software in the CCTT with the latest fielded version. To date, Version 2.5 is the most recent version of IVIS and was scheduled to be fielded to the 1st CAV Division between October 1997 and February 1998. This newer version offers a significant increase in capability over the current CCTT version. Specifically, Version 2.5 allows an interface between the M1A2s and the company/team fire support team (FIST) or the task force fire support officer's (FSO's) FED. The FED provides access to the AFATDS devices in the CCTT. When combined, the systems provide the capability to send digital CFFs. Version 2.5 also includes the ability to track vehicle ammunition, send digital situation reports (SITREPs), and send automated ground and air medical evacuation requests.

Updated with the latest version of the IVIS software, units would find an improved training environment within the CCTT and, although lacking needed connectivity, units could train on the same system housed on their vehicles. To maintain this capability, the CCTT would have to be continuously updated as new software releases are fielded to the units. Again, this iterative upgrade fits well into a total package fielding concept to maximize training for the unit. In FY98 CCTT implemented the Abrams Common Software Library (ACSL) system. The ACSL allows CCTT M1A2s (M1A2SEP) to maintain configuration currency with fielded IVIS/Embedded Battle Command (EBC) versions.

Add Digital Exercise Management Tools to AAR Workstations

There is no administrative means to track or send digital information to the players. To provide realistic digital training, the AAR workstation requires the ability to send, receive, and record digital traffic with the exercise unit. This would provide the means to stimulate digital communication and allow the O/Cs to capture and replay digital traffic as part of the AAR.

A digital send, receive, record, and playback ability supported Appliqué training for the EXFOR using the Fort Hood SIMNET facility. There, the exercise controller has the ability to send and receive digital traffic using a personal computer (PC)-based version of the Appliqué system located in the control/AAR cell. To monitor digital traffic, the cell is also equipped with an analog device that simultaneously displays and records individual Appliqué screens in the exercise vehicles. The O/C can use this system to playback the status of each device and show the details of the digital messages sent and received. The mix of analog recording of individual Applique' screens and digital recording of simulation operations precluded integration to support a quality AAR. It is the CCTT-D Team's recommendation that a more advanced capability be added to the AAR workstation in the CCTT. As a minimum, it must allow the O/Cs to stimulate digital training, synchronize display of digital traffic with battlefield operations and assess timeliness and accuracy of digital reporting as part of the AAR process.

Develop Structured Training to Ensure Performance of Digital Tasks

Once a digital communications capability becomes established between the AAR workstations and the exercise unit, the units would require a training program that emphasizes use of the digital systems. Training programs and TSPs that are currently being developed for the CCTT focus on the use of conventional methods to accomplish conventional missions. To encourage units training to use digital devices, structured training needs to be developed that incorporates the use of digital equipment.

Structured training programs have already been developed to train the EXFOR in the Janus and SIMNET environments. These training programs emphasized use of the Appliqué by providing Appliqué-equipped training simulators, incorporating digital traffic as part of the exercises, and requiring the units to send overlays digitally. These programs were well received by the EXFOR, helpful in developing Appliqué SOPs, and instrumental in preparing for the Task Force XXI AWE.

Similarly structured training programs need to be developed for the CCTT to assist units in conducting digital training. These TSPs should emphasize the execution of digital tasks at individual, crew, and collective levels using a stair-step method that utilizes a specific crawl-walk-run progression. The current resource-constrained environment dictates that we develop TSPs designed to evolve SOPs and internalize the TTP required to exploit the full capabilities of the digital systems. These training programs should be developed in concert with improvements to the digital AAR capability and fielded as part of a total package fielding process. One possible starting point is the four M1A2 platoon tables that have recently been added to the STRUCCTT TSP library.

Add Digital Communications Capability to SAF

Another CCTT digital communication shortfall that needs to be addressed is the inability to communicate digitally with the SAF. In many of the company/team and battalion/task force exercises, a portion of the BLUFOR is played by SAF. Operators who are separate from the AAR workstation operators control this force. These SAF operators control a variety of forces ranging from air defense artillery (ADA) forces to unmanned exercise force vehicles. These forces are key to conducting battalion/task force level and above exercises because the facility does not have enough simulators to replicate the entire battalion/task force.

For the SAF operators to perform realistically in a digital environment, they must be able to send and receive digital traffic just like the units they are portraying. These operators must be able to send digital SPOT reports, equipment status, and location information to provide a realistic digital picture to the exercise unit. The Modular SAFOR (ModSAF) Versions 1.5 and higher that are used in SIMNET exercises have the capability to communicate with their tethered M1A2 simulators. Because the CCTT SAF lacks this capability, exercise units that are using SAF forces in the CCTT are unable to receive full digital feeds. To solve this problem, the SAF in the CCTT must have digital capabilities.

Modify CCTT to Support Maneuver Gunnery Training

During the interviews, leaders from the 1st CAV Division expressed the desire to use the CCTT as a maneuver gunnery trainer. They recognized that the CCTT is not a precision gunnery trainer but indicated that it allows enough resolution for units to conduct gunnery rehearsals, as well as platoon and company/team level gunnery training. Inherent in the CCTT is the capability to train crew coordination in areas such as fire commands, terrain driving, target acquisition, target handoff, engagement, and automated CFF. Plus, the CCTT allows for the addition of combined arms multipliers, such as field artillery. To use the CCTT as a gunnery trainer, several modifications are required: (a) enhance the sight reticle to match the one found in the M1A2, (b) change ballistic data in the CCTT to support gunnery task training, and (c) develop data bases for each homestation to allow units to train on home terrain in a virtual environment.

The acquisition of four additional M1A2 simulators, per the current CCTT basis of issue plan (BOIP) will support company pure gunnery. As the Army fields the first digitized division with FBCB2, to support company/team gunnery training, the facility must be upgraded to provide a digital communications capability across the different platforms.

An additional recommendation to support maneuver gunnery training is to implement a structured training program that would use the CCTT as the environment for Gunnery Tables XI and XII. This program would provide turn-key TSPs that could be included in a unit's gunnery training program to augment other training such as the Unit Conduct of Fire Trainer (UCOFT) and the Advanced Gunnery Training System (AGTS).

Expand CCTT to Train Battalion/Task Force and BCT Commanders and Staffs

Although the CCTT is designed and used primarily as a platoon and company/team trainer, its ability to support command-from-simulator (CFS) exercises lends itself to battalion/task force and BCT training. The 1st CAV Division's leadership expressed interest in using the CCTT to train a battalion/task force and/or brigade staff. The CFS capability enables subordinate computer-generated vehicles (i.e., SAF) to be "tethered" to a leader's vehicle (e.g., company commander, platoon leader) so that battalions or brigades can be played with a limited number of manned modules.

To conduct staff training exercises in the CCTT, several modifications must occur. First, the CCTT should be modified so the training unit can use its own organic equipment (e.g., the ATCCS systems, Single Channel Ground and Airborne Radio System [SINCGARS] radios) in a plug and play manner that allows the unit to attach its organic equipment to the CCTT network and operate as in a field environment. The 1st CAV Division leadership also requested the flexibility to organize TOCs either inside using the TOC stations or outside the facility by plugging in to the network.

Another modification to the facility is the addition of two M1A2 simulators to allow for training a balanced task force (two M1A2 company/teams and two M2A2 company/teams) down to platoon level. All vehicles below platoon leader level would be SAF entities controlled in CFS fashion.

In addition, TSPs would be necessary to support the battalion/BCT staff training in turn-key fashion and emphasize the use of unit digital equipment. The exercises should be linked, or nested, to allow maximum training flexibility and reduce TSP development costs.

Field CCTT with Current FBCB2 and ATCCS Hardware and Software

FBCB2. Currently, the simulators in the CCTT allow for digital communication only between M1A2s using the IVIS system. The Army's current focus for digital communication is on the FBCB2 that allows for digital communication between virtually all platforms in the Army and would support digital connectivity across the various platforms in the CCTT. It also has the capability to integrate other ATCCS systems, increasing overall unit connectivity.

Currently, the FBCB2 system is being fielded to the 4th ID. The FBCB2 LUT is scheduled for August 1998 and is to be followed by a Force Development Test and Evaluation (FDTE) in August 1999 and an IOT&E in October 1999. Installing FBCB2 in the CCTT would allow units in the 4th ID to train in the facility. Timely installation of the equipment would help units train for the FDTE and IOT&E. Hence, there is an immediate need for FBCB2 in the CCTT to accommodate training for the 4th ID currently scheduled to begin in March 1999 for the FBCB2 FDTE and IOT&E.

ATCCS. The actual ATCCS systems should be installed in the CCTT concurrent with the FBCB2. The 1st CAV Division units want to conduct exercises using organic digital systems. These include the ATCCS systems which are scheduled to be fielded to all of the 1st CAV Division, as well as the 4th ID. As mentioned earlier, units requested the ability to plug and play their systems into the CCTT network and conduct operations as in the field. The ATCCS systems provide an enhanced capability to visualize and interact on the battlefield. Adding these systems to the CCTT will enable units to train using the full suite of digital communication systems in a virtual environment. Units, especially the commanders and staffs, could use the virtual environment to become proficient in digital tasks prior to the conduct of costly live field exercises.

Structured Training Scenarios

This section provides a summary of the principal scenario design products that include a summary of training design features, task lists for each mission, concept of the operation and sketch for each mission, scenario specifications package, and an outline of events for each mission.

Initial Decisions

This subsection discusses the initial decisions that were made during the design process. The basic decisions are outlined in Volume II. At issue were specifications for the training audience and the appropriate training environment for the structured training program.

Training Audience

Table 8 depicts the training audience for each tactical mission, while Table 9 depicts the training audience within each echelon. Participation in task force exercises is currently limited to CFS exercises that require manning of simulators by commanders and platoon leaders only. This is primarily due to an insufficient number of simulators currently available at the Fort Hood CCTT facility. This problem should be resolved for task force level exercises when a second Fort Hood CCTT facility becomes operational in the second quarter of Fiscal Year 99.

Table 8

Training Audience for Each Tactical Mission

MISSION	TRAINING AUDIENCE
Movement to Contact	Lead Task Force Lead Company/Team of Lead Task Force Lead Platoon of Lead Company/Team in Lead Task Force
Deliberate Attack	Task Force with Mission to Attack Intermediate Objective Assault Team in "Intermediate Objective" Task Force Lead Tank Platoon of Assault Team
Defense	Task Force Defending in Central Corridor Company/Team in Center of Task Force Battle Position Center Platoon in Center Company/Team Battle Position

Table 9

Training Audience within Each Echelon

ECHELON	PRIMARY TRAINING AUDIENCE	SECONDARY TRAINING AUDIENCE
Platoon	Four Tank Crews	NA
Company/ Team	Tank Crews Bradley Fighting Vehicle Crews Company First Sergeant Company Fire Support Team	Field Artillery Battalion TOC Mortar Fire Direction Center Adjacent Units
Task Force	Tank & Bradley Fighting Vehicle Crews to Platoon Leader Level Battle Staff Scout Platoon Leader Mortar Platoon Leader Combat Trains CP Staff Company/Team FIST, Task Force FSO Direct Support Engineer Company Commander Air Defense Platoon Leader	Field Artillery Battalion TOC Mortar Fire Direction Center Air Liaison Officer/Tactical Air Control Party Adjacent Units

Training Context

The context for the CCTT-D training design is depicted in Table 10. For the most part, these variables were either specified in the SOW (U.S. Army Research Institute for the Behavioral and Social Sciences, 1997) or obtained through government guidance during the preliminary training design activities.

Simulation Technology

The simulation technology used for the training design was the CCTT. Although this seemed obvious, there were some questions concerning whether the design should focus on the CCTT's current or projected capabilities that were expected once the system completed its scheduled IOT&E. It was decided that the design should focus on projected capabilities (i.e., FBCB2). Therefore, some of the digital tasks around which the design was based are not supported by the CCTT's current technology.

Other Training Considerations

Several other design variables considered important (Campbell et al., 1997) are described in the following paragraphs.

Table 10

Training Context (NTC Terrain)

MISSION	ECHELON	ENEMY*	TRAINING UNIT (DIGITAL EQUIPMENT)
Movement to Contact	PLT	Krasnovian MRP	Armor PLT (FBCB2)
	CO/TM	Krasnovian MRC	Armor TM (FBCB2)
	BN/TF	Krasnovian MRB	Balanced TF (FBCB2/ATCCS)
Deliberate Attack	PLT	Krasnovian MRP	Armor PLT (FBCB2)
	CO/TM	Krasnovian MRP	Armor TM (FBCB2)
	BN/TF	Krasnovian MRC	Balanced TF (FBCB2/ATCCS)
Defense	PLT	Krasnovian MRC	Armor PLT (FBCB2)
	CO/TM	Krasnovian MRB	Armor TM (FBCB2)
	BN/TF	Krasnovian MRR	Balanced TF (FBCB2/ATCCS)

*Note: PLT, CO, TM, TF, MRP, MRC, MRB, MRR indicate Platoon, Company, Team, Task Force, Motorized Rifle Platoon, Motorized Rifle Company, Motorized Rifle Battalion, and Motorized Rifle Regiment, respectively.

Exercise time. Exercise time refers to the planned duration for a CCTT-D structured exercise or table - with the maximum duration being no more than 1.5 hours for the platoon, 2.5 hours for the company/team and 8 hours for the task force. These durations allow platoons to train and conduct AARs for two exercises in a workday, companies to train and conduct AARs on one exercise daily, and battalions to train and conduct AARs over a two day period. These exercise durations are similar to those adopted by the STRUCCTT effort.

Number and nature of entry points. The CCTT-D training design contains multiple exercise entry points for each of the three tactical missions to provide flexibility. Entry points allow different starting points and break an exercise into segments that can be executed alone, if desired. Table 11 lists the entry points for each of the three missions.

Closely related to the number of entry points is the nature of the entry points. Campbell and Deter (1997) state that entry points should be based on either unit expertise or training emphasis. The entry points used in the CCTT-D training design are all based on training emphasis, also known as "needs based." This means that the entry points focus on different skills or activities that allow units to select the training start point which best fits their training needs.

Table 11

Entry Points for Each Mission

MISSION	ENTRY POINTS
Movement to Contact	Unit Assembly Area Unit Attack Position First Set of Attack by Fire Positions (FSE Engagement)
Defense	Initial Battle Positions (First Echelon Engagements) Initial Battle Positions (Begin Withdrawal) Subsequent Battle Positions (Second Echelon Engagements)
Deliberate Attack	Unit Assembly Area Unit Assault Position Entrance to the Breach Site, Beginning of Assault

Linkages. Early in the program, the CCTT-D Team decided to structure its design so that it facilitated linking the three tactical missions, with one mission setting the stage for the next. This process was simplified because the EXFOR TSPs, which served as the basis for the CCTT-D design, were linked. Linkage allows the three tactical missions to be executed in a logical tactical sequence beginning with the MTC and ending with the DAK. As with the multiple entry points, linkage of exercises was adopted to ensure training flexibility.

Training priority guidance. At the beginning of the training design process, the team received guidance to focus training on the execution of tactical operations using organic digital equipment and emerging digital TTPs. During the design process, the initial guidance was augmented by the addition of two other training priorities. These were to incorporate digital CSS operations into the design and to ensure that the DAK included a requirement for breaching operations. The CSS operations were included in all three missions for each echelon of the training audience. Breaching operations were included as part of the task force DAK exercise. In this instance, a designated breach company/team has the task of breaching the OPFOR defensive belt. Breaching is not required during the company/team and platoon exercises unless the company/team being trained is the task force breach company and the platoon being trained is part of the breach company.

Trainer and other resources. The CCTT-D design was based on the following assumptions concerning trainers and resources: (a) the O/Cs would be provided by the training unit, (b) training would be execution oriented and based on post-IOT&E Fort Hood CCTT facility capabilities, and (c) training program design would incorporate all digital equipment projected to be in the M1A1D-equipped Armor battalion, M2A2D-equipped Mechanized Infantry company and various FBCB2-equipped CS and CSS slice units without regard to actual equipment presently in the Fort Hood CCTT facility.

Training Objectives

The training objectives for each mission and echelon were derived from the list of tasks that could be trained in the CCTT. The tasks that were selected to be trained are shown in Volume II. These tasks formed the basis for the design of the scenarios.

Scenario Design and Exercise Outlines

This section discusses the design of the scenarios for each of the tactical missions. The detailed scenarios (with sketches) and exercise outlines are in Volume II.

Movement to Contact

The MTC scenario places the training audience in the NTC Central Corridor. The exercise maneuver box begins at the East Gate and ends just west of the Brown-Debnam complex. An advance guard main body (AGMB) and MRB from a KRASNOVIAN Motorized Rifle Regiment (MRR) advancing in echelon oppose the training audience.

Defense

The Central Corridor maneuver box begins just east of the Brown-Debnam complex and ends just west of the East Gate. A KRASNOVIAN MRR attacking in echelon opposes the training audience.

Deliberate Attack

The exercise maneuver box begins at the East Gate and ends just west of the Brown-Debnam complex. The training audience is opposed by an MRB from a Krasnovian MRR.

Structured Training Scenario Recommendations

The scenario design products are intended to serve as the basis for future training development efforts. However, a few considerations should be addressed before training development begins. These considerations are summarized in the following paragraphs.

Doctrine for Digital Units

Digital TTPs are changing rapidly. Before attempting to develop TSPs based on the CCTT-D training design, training developers should ensure that they review and incorporate the latest digital doctrine. The CCTT-D training design incorporated the digital TTPs current at the time the training design was produced. However, the TTP manuals used as a basis for the CCTT-D design are currently under revision, the result of an evolutionary process that can be expected to continue.

Unit Organization

The CCTT-D design is based on a four company task force. Since the Army has decided to change its organization to that of a three company task force, training developers will have to modify the task force echelon training design to facilitate training with three company/teams. This will require the incorporation of new digital and conventional TTPs. Closely related to this is the incorporation of some of the experimental organizations like the BRT and the FSC. Because the current plans for the first digital division include these organizations, developers will need to incorporate them into the training program, as they were not included in the CCTT-D training design.

Digital Equipment

As discussed earlier, the CCTT-D design is based on the current capabilities of the FBCB2 and ATCCS digital information systems. Both of these systems are currently undergoing acquisition testing and inevitably will be modified before final fielding. Developers must ensure that they incorporate changes to the systems capabilities into their training program.

Training Support Packages

Although the concept of TSPs was first formally introduced in TRADOC Regulation 350-70 (TRADOC, 1995b), Wilkinson (in preparation) first examined and defined the concept of comprehensive TSPs for the CCTT. The TDR for the CCTT was revised to include this concept (U.S. Army Training Support Center, memorandum titled "Training Device Requirement for the Close Combat Tactical Trainer [CCTT]," dated January 14, 1998). The end result is specification of the following integrated TSP components: (a) system training packages/system orientation training, (b) a library of structured training scenarios including successfully executed examples complete with AAR materials, (c) an automated training management and exercise development system, and (d) train-the-trainer modules/packages.

This section will review each of the components and, based on the introduction of digital systems into the CCTT, recommend modifications to the TSP concept and the training currently being conducted in the CCTT.

System Training Packages

System training packages are instructional materials that train soldiers to operate the manned modules and supporting workstations used in the CCTT. System training for the CCTT is currently provided by videotape, pre-operations checklists, computer-based instruction (CBI), and a variety of progressive practical exercises. Upon arrival at the training site, the training unit and O/C team view a video that briefly introduces the CCTT system, including the safety features, before beginning manned module and workstation training.

Manned Modules

Because the training unit already knows how to operate the actual training vehicles, the focus of the manned module training should be on the differences between the manned modules and the actual vehicles. Videotapes, checklists, and orientation exercises currently provide manned module training in the CCTT. The videotapes explain the different manned module features with a focus on the differences between the actual vehicles and their CCTT manned module counterparts. The site-provided checklists for each crew direct them to conduct pre-operations checks on how to use specific features of the manned modules. Once the crews have completed the activities on the checklists, they execute the mounted and dismounted crew orientation exercises which were created in the STRUCCTT project. The orientation exercises teach crews operating tank and mechanized infantry manned modules the various features of the CCTT, including how to : (a) maneuver on the NTC terrain, including crossing breached obstacles; (b) visually identify computer-generated ground vehicles and aircraft; and (c) handle interactions between unit personnel in manned modules and Operations Center workstation operators. Once the orientation exercises are completed, the STRUCCTT packages for platoon and company/team provide fundamental tables which afford the unit practice in executing various formations in the CCTT. The battalion/task force package provides CFS exercises which allow the manned module participants to gain practice working with the tethered SAF that are necessary at the battalion/task force level in the CCTT.

The installation of digital systems into the manned modules will require modifications to all the current methods used to train soldiers on the operation of the manned modules. These include:

1. Videotape training. Assuming the digital systems in the manned modules replicate the unit's vehicles, these tapes should be modified to train soldiers on the specific differences between the actual vehicle and the manned modules. Digital systems requiring training include the FBCB2, Tactical Internet, Enhanced Position Location Reporting System (EPLRS), and SINCGARS. This training should be converted to CBI available on compact disk-read only memory (CD-ROM) or posted to an Intranet or Internet site. If the systems installed in the manned modules do not replicate the actual systems, additional training would be required.

2. Checklists. The existing pre-operations checklists need to be modified to address the digital tasks and task steps added as a result of new digital systems. These would include any digital pre-operations checks, initializing the FBCB2 system, operating the radio systems, and establishing and entering the Tactical Internet.

3. Practice exercises. The manned module STRUCCTT practice exercises (i.e., the orientation exercises, CFS exercises, and the fundamental tables) will need to be revised to reflect evolving digital operations, digital TTPs, and any new unit organization structure. On the one hand, the addition of digital equipment such as the FBCB2 to the manned modules may mitigate the difficulties that many units have in the CCTT with navigating and maintaining formations. However, at task force and BCT levels, CFS training may become more challenging when the SAF elements are tethered to the platoon leaders or company commanders and communication needs to take place digitally. The challenge is directly related to the BLUFOR

SAF workstations' digital messaging capabilities and to workarounds which must be trained during these CFS exercises to ensure that SAF and manned modules can work effectively together. Thus, CFS training may require additional time.

Workstations

The addition of new digital systems into the CCTT will impact the system training packages that train the operators on the CCTT system's Operations Center and SAF workstations.

Operations Center workstations. The focus of Operations Center workstation training should be on providing the operator with a clear understanding of the system's capability to replicate activities on the CCTT battlefield—particularly CS and CSS. Training on the CCTT site's individual CP workstations (FABTOC, FSE, FDC, CES, CTCP, TACP, and UMCP) is currently provided by the CD-ROM-based training program, "Education of CCTT through Computer Assisted Training Technology" (EDUCCATT, Version 2.0). The FABTOC and FSE training includes instruction on AFATDS. As of Version 2.0, there are also modules on EDUCCATT that train operators how to use HMMWVs and DI modules which are traditionally considered manned modules rather than workstations. When the Operations Center workstation operators arrive at the CCTT site, they complete the appropriate EDUCCATT training program on the site's computers. The EDUCCATT training begins with a tutorial, provides training on plan view displays (PVDs) in general, and then provides workstation-specific training complete with scored practical exercises. Once the workstation operators have completed EDUCCATT individual training, collective training is provided by an orientation exercise for the Operations Center workstation operators.

When additional digital features are added to the CCTT, the EDUCCATT training program and the Operations Center workstation orientation exercise will require modification. The orientation course would require the addition of tasks that incorporate the use of new digital training features. Any procedural or equipment workarounds on the workstations may add training time. Thus, the time needed to complete workstation training when more digital equipment is incorporated into the CCTT may be increased.

SAF and simulation system workstations. The EDUCCATT training program does *not* provide training on the AAR, MCC, BLUFOR, and OPFOR workstations for the contractor logistical support site staff; the site provides this training. The current on-the-job training (OJT) provided by the site does not support using CBI to train SAF, MCC, and AAR workstation operation.

The BLUFOR and AAR workstations are likely to become more complex if digital support capabilities are added (e.g., digital message generation, digital data capture, processing, and feedback). The contractor logistical support workstation operators would benefit from having standardized CBI available when learning the new workstation features. Using CBI on the AAR, MCC, and SAF workstations also means that training could be exportable in case deployed units have to operate these workstations rather than contractor logistical support personnel in the future.

The prospect of increased system training time conflicts with the Warfighter XXI ideal of one day of train-up for three days of training (TRADOC, 1997a). The time allotted on the STRUCCTT TSP calendar for non-digital CCTT system training (including the training for the manned modules and CP workstations) is approximately 12 hours on-site for units that have not trained in the CCTT within the last 180 days. The STRUCCTT TSP does not extend the train-up time for manned modules and CP workstations in its M1A2 digital exercise tables. However, that is because the equipment to support those digital tables is the same as that to support the non-digital tables (W. T. Holden, personal communication, May 12, 1998). Adding FBCB2 to the manned modules will likely lead to expanding the system training time. Potential impacts include new ATCCS equipment additions in the TOC and modifications to AAR and SAF workstations. To keep from extending the system training time needed when digital-support equipment is added, the individual workstation on-site system training could be shifted to off-site training. For example, manned module videotape training could be converted to CD-ROM which along with the revised EDUCCATT would be accessible via the Internet or personal computer. Also, familiarization with the features of the CCTT system (e.g., the identification of OPFOR and BLUFOR vehicles, the appearance of artillery bursts) could be addressed by the creation of a CD-ROM based program that could also be accessed via the CITT.

Structured Training Scenarios

Wilkinson (in preparation) defines the structured training scenarios as the "materials and information required to load, execute, and AAR a specific scenario built within the task-based structured framework as defined in TRADOC Regulation 350-70" (p. 8). These materials include operation orders (OPORDs), overlays, event guides, observation forms, execution guidelines for workstation operators, and task lists. These are the standard tools that have been used in structured simulation-based TSPs since the VTP and are still present in the STRUCCTT TSPs. Unlike scenarios designed for conventional operations, scenarios used for digital training require both digital and non-digital tasks and task steps. As doctrine and TTPs evolve for digital units, the corresponding training scenarios (including the execution guidelines for the BLUFOR and OPFOR and tactical materials like OPORDs and maps) will require modification.

AAR packages. A major component of structured training scenarios is the AAR package. An AAR system similar to the SIMNET-based Unit Performance Assessment System (UPAS) is needed to collect data in the CCTT for presentation in summary graphs and tables. (For a description of the UPAS, see Leibrecht, 1996.) A system similar in concept to the SIMNET, the CCTT system has a data analysis and reporting (DAR) window on the AAR workstation which provides reports of cumulative data for measures such as number of kills, field of view (line of sight), and ammunition expenditure. The STRUCCTT Team found that the DAR reports were data-intensive and technical in nature and therefore did not provide useful information to the training unit (Deatz et al., in preparation). Thus, the DAR requires modification to collect and present meaningful information for conventional and digital operations training.

A wide range of performance and system diagnostic data were collected during the CVCC effort. The DAR developers should consider some of the CVCC measures that provided the units feedback on mission performance and on their use of the CCD (Leibrecht et al., 1994). In the SGT program (Quensel et al., in preparation), feedback on timeliness, accuracy, and relevance of information is provided via an automated performance profile (which evaluates staff actions with mission-critical information) and the "window of opportunity" (which portrays whether the actions took place in a timely fashion). Although the CCTT training is not scripted like the SGT instruction, it is structured by scripted messages from higher and lower that indicate OPFOR activity. In digital CCTT training, these key OPFOR messages could be flagged as they are sent out by the system to open the so-called window of opportunity. Objective measures related to timeliness, accuracy, and relevance could be collected and presented via charts and graphs to be used in the AARs. The SGT AAR module charts and graphs could serve as prototypes for effectively presenting digital performance data.

The structured training scenarios component of the comprehensive TSP also includes observation forms and events lists. Observation forms in SST programs are typically paper-based and separate from the events list. A lesson learned for both the SGT (Koger et al., 1998) and the STRUCCTT (Deatz et al., in preparation) programs is that users want the events list and observation form combined. The STRUCCTT Team found that combining the events list and observation form was too difficult to implement on paper. However, the use of computers in developing observation forms to support digital exercises greatly increases the possibility of combining the observation forms (e.g., via pull-down menus) with the events lists.

The SGT program piloted the use of a data collection form on a hand-held personal data assistant (PDA) for the observers (Koger et al., 1998). The PDA readily downloaded the observation form data into the personal computer that was used for data capture and analysis, making the data available for AARs and THPs in 15 minutes or less (K. Fergus, personal communication, February 5, 1998). This coincides with the STRUCCTT requirement for 15 minutes to prepare for company/team and staff section AARs. In a digital CCTT TSP, computerized data collection tools could be linked to the AAR workstation's DAR for downloading and presentation. Without the use of technologically advanced ways to capture, process, and present data, it is likely that the preparation time for AARs will expand when feedback is required on digital as well as non-digital task steps.

Take home packages (THPs). One area not addressed by Wilkinson (in preparation) is the THP (called the post-exercise report in the STRUCCTT project). In the VTP and EXFOR projects, the THPs largely consisted of copies of completed observation forms and lists of tasks to be sustained or improved that were sent out days or weeks later (if at all) by the O/C team. However, expecting a unit-provided O/C team to follow through with the creation and delivery of a THP without the aid of an automated system may be unrealistic.

One of the lessons learned from the SGT program's field interviews (Quensel et al., in preparation) was that the standard THP was ineffective because it took too long to be received and it did not contain an action plan. In the 16 January 1998 CCTT-D in-process review (IPR), the comment was voiced that THPs are seldom used and thus merit low priority (B. C. Leibrecht, personal communication, January 19, 1998). However, the SGT interview results suggest that the unit might find a THP useful if it were distributed to the unit prior to leaving and it included an action plan to help the unit sustain and improve task performance. Thus, the SGT program provides a THP, called a Commander's Staff Profile, to the commander before his departure from the training site (Quensel et al., in preparation). Likewise, a THP for digital CCTT training needs to be given to the unit immediately following completion of training. The THP should provide a focused action plan for sustaining and improving the performance of digital and non-digital tasks. Determining the contents of the action plan and the fastest production process requires further investigation. However, computerizing the tools to collect data and provide feedback is a good place to start. A potential window for conducting research on this issue is during the development of the TSPs for digital training in the CCTT.

Demonstrations. Demonstrations are another component of structured scenario packages that have been included in past SST projects. Demonstration videotapes were created in the initial SIMUTA project that showed platoons, companies, and battalions successfully executing selected tasks from the exercises. These videotapes were designed to help prepare units for training and were not used in AARs (Koger et al., 1996). As discussed earlier, the STRUCCTT CD-ROM demonstrations of performance accomplish the following: (a) introduce the table, (b) provide an overview of the table, and (c) discuss each exercise event individually while a simulated unit executes the tasks in the table (Campbell et al., 1998). These demonstrations are very task-focused, providing an effective introduction to the tasks for each table. However, like the SIMUTA demonstrations, the STRUCCTT demonstrations were not developed to support AARs due to the inability of the AAR workstations to support the playback of the CD-ROM during the AAR (Campbell et al., 1998) and the lack of adequate time to make the necessary modifications (R. C. Deatz, personal communication, February 12, 1998).

The CCTT training packages to train digital skills should also include CD-ROM demonstrations of performance that show digital units successfully executing the tables and exercises in the CCTT. The CD-ROM format is easier to modify than the videotapes produced for SIMUTA. This is an important consideration because as the digital TTPs evolve, the demonstrations of performance will require frequent modification. Another advantage is that CD-ROM demonstrations of successful performance using digital equipment can be accessed via the CITT Internet site before the unit arrives on-site for training.

Training Management and Exercise Development Systems

The CITT is a training management and exercise development system for conventional and digital CCTT training currently under development. The CITT will provide access to the available exercises, existing TSPs, train-the-trainer materials, and available operator courseware. Access will be via stand-alone computer systems and the Internet for the training unit, contractor logistical support personnel, and the O/C team (Commander's Integrated Training Tool Team, 1997). The CITT will provide templates that guide the user step-by-step through modifying an existing exercise or creating a new training exercise for the CCTT. The STRUCCTT TSPs will be accessed via CITT to support the development of conventional training exercises for the CCTT. Any TSPs developed to support digital training in the CCTT should also be integrated into the CITT for easy access to the unit for selection and modification. Once the exercises are selected, modified, or created, users can print the necessary TSP materials. Materials available will include the instructions, job aids, and tactical materials necessary to execute a CCTT exercise (M. R. Flynn, personal communication, January 15, 1998).

Train-the-Trainer Packages

The train-the-trainer component of digital training in the CCTT should focus on the TTPs required to support digital training exercises and it should instruct the trainers on the use of the other portions of the comprehensive TSP, such as the structured training scenarios and system training material (Wilkinson, in preparation). Train-the-trainer packages are needed for digital CCTT training at four echelons: (a) platoon, (b) company/team, (c) battalion/task force, and (d) BCT. Each package should include instructions that support MTC, DAK, and DIS missions and NTC and Fort Hood terrain databases. Trainers include the: (a) unit commander, (b) O/C team, (c) Operations Center workstation operators, and (d) contractor logistical support personnel. Table 12 shows train-the-trainer package components and some examples of topics to be addressed.

Table 12

Components of a Generic Train-the-Trainer Package

TRAIN-THE-TRAINER COMPONENTS	TOPIC EXAMPLES
TSP Package Contents and Instructions	Listing of components Who needs which components Description of how to use the components
Program Description	Benefit to the unit Echelon(s) supported Portion of the training unit included Digital equipment supported in CCTT Available missions Exercises available within those missions Tasks trained Length of the exercises
Selecting Exercises	How to select exercises Execution examples provided Recommended order of execution Exercise modification guidelines
Support Personnel Needed	Organization of the O/C team O/C team member qualifications (to include digital equipment experience) Contractor logistical support site personnel Requirements Unit support workstation operator requirements (including qualifications)
Activities to Support the Training	(See Table 13)

The roles and responsibilities of personnel involved in providing digital training in the CCTT will differ from those as described in STRUCCTT. As FBCB2 and new digital exercise support equipment are added, new instructions will need to be created for the unit leaders, O/C team, Operations Center workstation operators, and contractor logistical support site personnel. The instructions should be tailored by role to explain the responsibilities in these training phases: (a) pre-exercise preparation, (b) on-site exercise preparation, (c) execution, (d) post-exercise, and (e) post-exercise report. Some examples of exercise activities and teaching points addressed in a generic train-the-trainer package are shown in Table 13.

Table 13

Example CCTT-D Train-the-Trainer Exercise Activities and Teaching Points

PHASE	START/END POINTS	TEACHING POINT EXAMPLES
Pre-Exercise Preparation	Starts when the task force decides to conduct the CCTT training. Ends when the task force arrives at the training site.	O/C and training unit coordination Training unit and site coordination Site preparation O/C preparation Training materials review
On-Site Exercise Preparation	Starts when the task force arrives at the training site. Ends with the start of exercise execution.	On-site rehearsals Practice exercises available Site exercise initialization procedures Digital equipment Initialization SOPs Exercise preview instructions
Exercise Execution	Starts when the task force reports REDCON 1. Ends with end of exercise.	Capturing digital performance data Completing observation forms Using event guides Workarounds Contingency rules for equipment malfunctions Coaching guidelines
Post-Exercise	Starts when the task force reports for the AAR. Ends when the task force completes the AAR.	Description of digital AARs AAR Timeline Preparing for AARs Presenting AARs AAR slides
Post-Exercise Report	Starts when the task force completes its training period. Ends when the post-exercise report is delivered to the task force commander.	Contents of the post-exercise report Creating the post-exercise report Delivering the post-exercise report

Some train-the-trainer program components will be addressed by the CITT in its instructional overviews. The CITT program plan states that as digital TTPs become available for the CCTT, they will be incorporated into the CITT's "CCTT Senior Leader's Training Overview" for brigade commanders and above and the "CCTT Unit Leader's Training Overview and Guide" for commanders and unit trainers at platoon through brigade echelons (Commander's Integrated Training Tool Team, 1997). The other train-the-trainer components will have to be developed during a training program development effort focused on training digital units in the CCTT. For instance, the description of the roles and responsibilities for support personnel will require that training objectives be identified for each role so that tailored train-the-trainer packages, including instructions and tools, can be created from those training objectives.

One lesson learned from previous efforts such as the STRUCCTT project is that the training support personnel, including the O/C team and contractor logistical support personnel, do not tend to read the pre-exercise materials (Deatz et al., in preparation). The packages are often unread for a myriad of reasons including: (a) packages are too thick with unnecessary "nice to know" information, (b) read-ahead materials and tools are combined and difficult to read, and (c) support personnel are convinced that they already know enough about filling their roles in the CCTT training program without reading the package. When digital train-the-trainer packages are developed for CCTT, research should address the possibility of developing the roles and responsibilities descriptions in CBI rather than traditional paper-based instruction. While it would be expensive to develop multimedia CBI for each role, it is likely that the CBI format would be more acceptable to the users. Putting the roles and responsibilities instructions into CBI also supports making the train-the-trainer instruction computer-based.

Besides the instructional overview portion of the CITT, computer based instruction for leaders, O/Cs, CLS personnel and workstation personnel must be integrated into the scenario development tools and provided with the digital scenario execution materials. The CITT, if expanded to include digital force training tools, may provide the medium for interactive online instruction for all participants in CCTT training. The CITT tools must be firmly rooted in the structured based approach to training and provide a means to mentor users, to include CLS personnel, in the application of structured training techniques for digital force training. The digital force enhancements to CITT should include:

- Wizards and tools that permit users to easily navigate through training on the digital capabilities in CCTT (SAF, AAR, Command, Control, Communications, Computers, and Intelligence (C4I) systems, TOCs, Synthetic Theater of War (STOW) Links) and instruction on how one can integrate and exploit those capabilities.
- Explanation of techniques and rationale for using structured training to support digital force scenario development and execution.
- Digital scenario development and modification tools with wizards that assist in explaining issues, TTP and rationale specific to digital force training requirements. Such tools should not force all users to traverse every step but permit a range of scenario development approaches that extend from "quick and dirty" to complete packages suitable for use as Exercise Evaluations (EXEVALS).
- The scenario modification tools should permit quick modification to existing scenarios based on a selection of tunable tactical conditions appropriate for either analog or digital

units. Unit performance will rarely stagnate and changing scenarios to challenge units based on improvements or problems in specific aspects of digital force operations is imperative.

- The tasks to be trained, the mission type selected and the extent to which all battlefield combat resources are included will determine the data available for the AAR. The CITT should permit the scenario developer to identify the specific performance information desired, the key events or sets of conditions for which to collect data and an initial set of AAR presentation templates.

Media

Once the TSP components that support the use of the CCTT for digital training are completed, they will be accessible via the updated CITT. The user will identify his role and what exercise(s) will be supported. A blueprint of the needed TSP components and instructions for accessing them will be received. The TSP components can then be viewed and any necessary tools materials printed.

The CITT should be developed and integrated into the Army's SATS program. This will ensure seamless extension from the Army's training management system into detailed instruction on how to exploit training systems and assistance in structured scenario development for each of these systems. The CITT is being developed for delivery in both a stand-alone computer-based training environment as well as a web-based distributed system. This coincides with the expectations for the Army SATS and supports long term integration of these two training support systems.

Overarching Training Approach

The initial portion of this research effort was completed in three stages that focused on training digital units in the CCTT. This final portion of the research was completed in two stages, moving beyond the CCTT to all aspects of training the digital force. First, Stage 4 conceptualizes an overarching approach to training the digitized force. Second, Stage 5 recommends new functions, characteristics, or capabilities that are required to train a digital force for each component of the Army training system. Additionally, new and innovative methods to train the digital force along with recommended areas for further research are addressed.

Since the early 1990's, there have been numerous experiments and studies conducted on digital systems, units, and command and control. As described in the Method chapter, an extensive review of literature and training programs was conducted to complete the final portion of this research. This review included both digital and non-digital programs and events including the AWEs (e.g., Desert Hammer, Warrior Focus, Focused Dispatch, and Task Force XXI). Interviews with selected individuals possessing extensive and recent experience in digital force training were conducted to gain new insights, glean key information, and capture innovative ideas. The Army has used the results of the AWEs to determine organization, systems, and doctrine for the future (TRADOC, 1994). Determining the training approach and system for the force of the future should receive equal consideration. The Army must transition to and develop effective individual, collective, and institutional training for a digital force equipped with new systems, new organizations, and emerging warfighting doctrine while faced with challenges associated with new missions, personnel turbulence, downsizing, and reduced resources.

Overview of Key Issues

The Army will face numerous challenges as it evolves to a digital force. The introduction of digital combat and information systems combined with Force XXI doctrine and organizations will have a dramatic impact throughout the Army. As training soldiers and units to proficiency for wartime mission remains a priority, current training systems, programs, and processes will need to evolve. This evolution, referred to as the 2nd training revolution by Dubik (1997) and Brown (1996), will impact the design, development, execution, and evaluation activities across unit, institutional, and self-development training. Warfare in the "information age" will require additional skills that focus on using digital tools to synchronize and integrate multiple BOS in time and space to achieve the commander's intent to ensure warfighting success (Brown, 1996).

Digital Systems and Operations

A digital force is much more than an Army equipped with digital systems. The areas of command and control, situational awareness, target acquisition and identification, and improved system lethality have been affected and influenced by information technology (ADO, 1995). Digitization has been defined by the ADO (1995) as the acquisition, exchange, and employment of digital information throughout the battlespace in a way that is tailored to the needs of each user and driven by technology. Digitization positively impacts planning and execution by providing an accurate vision of a common battlespace.

Combat units will be equipped with digitally capable systems such as the M1A2, M1A2SEP, M2A2ODS-D, M1A1-D, M2A3, command and control vehicle (C2V), battle command vehicle (BCV), Paladin, Kiowa Warrior, and Longbow Apaches (U.S. Army Training and Doctrine Command Analysis Center, 1998). These combat systems possess capabilities that allow an unprecedented sharing of information and situational awareness. This allows units to fight using a broader range of tactics, move dispersed, mass to fight, avoid the enemy, and dominate a larger battlespace. Commanders and staffs located in more mobile CPs will be equipped with each of the ATCCS and have access to friendly and enemy information from a variety of systems to include unmanned aerial vehicles (UAVs) and the Joint Surveillance Target Attack Radar System (JSTARS).

Digital forces, equipped with information age systems, both combat and information, will fight differently. Although the doctrine and TTPs for the digital force are embryonic in development, the concepts are espoused in TRADOC Pamphlet 525-5, Force XXI Operations (TRADOC, 1994). A short summary of the characteristics of Force XXI Operations and the Patterns of Operations will provide insights into digital operations. Force XXI Operations are characterized by:

1. An extended battlespace that goes beyond the traditional physical dimensions of width, depth, and height. It also includes the electro-magnetic spectrum.
2. Precise and synchronized attacks throughout the battlespace.
3. Non-linear operations where tasks are executed across the entire battlespace.
4. Distributed operations where emerging capabilities, operations, and functions are executed throughout the depth, width, and height of the battlespace.
5. Simultaneous operations across the battlespace.

Force XXI operations will be executed through deliberate patterns of operations that emphasize force projection and protection, information dominance, shaping of the battlespace, decisive operations, and a sustained force.

Training Strategy Considerations

Considerations or parameters relevant to a digital training strategy were determined from the extensive literature and program reviews and from the interviews of leaders involved with training soldiers and units on digital systems and operations. The analysis resulted in the following categories: (a) audience, (b) training locations, (c) training technology, and (d) training requirements.

Training Audience

Digitization will eventually impact the Total Army: Active, National Guard, and Reserve. The overarching training approach must address all soldiers and cover all career positions. Additionally, small groups, crews, sections, cells, and staffs will require training. Finally, collective training at levels from platoon through corps will be required.

Training Locations

The Army has traditionally conducted institutional, unit, and self-development training. Training for digital operations will see these three areas merge into a more seamless, integrated approach. Technology will facilitate the use of training packages in institutions, units, or as part of self-development. For example, soldiers needing training before going to a digitally-equipped unit should be able to obtain it from the institution through self-development programs via distance learning or as part of the unit's training material. Distance learning, one of the Warrior XXI initiatives, is a concept for the delivery of training to the soldier where and when it is needed (TRADOC, 1996). Additionally, training developed for the fielding of new digital systems should be used for initial entry training and self-development in the institutions.

Lessons learned from Desert Hammer, NTC 94-07, the Task Force and the Division XXI AWEs (TRADOC, 1998a) emphasized the need to incorporate digital training into institutional, operational, and self-development instruction and also that the operational, institutional, and self-development training needs to replicate the digitized command and control (C2) environment.

Training Technology

The overarching training approach must be developed within the framework and concepts of AT XXI. The AT XXI (U.S. Training and Doctrine Command, 1997a) is the application of key enabling technologies to enhance the execution of Army training by exploiting new technologies in information systems and training methods. This concept addresses individual training, collective training, and Army modernization training. The AT XXI will be applied across the training system from tools to training development and training methods, all in an open system capable of continuous improvement through the infusion of emerging technologies and functional requirements.

The goal of AT XXI is to effectively apply to the proposed training system enabling technologies that allow soldiers to better plan, prepare, execute, and manage collective training and revolutionize individual and institutional training. The AT XXI concept integrates the numerous ongoing initiatives and future development efforts to produce a coherent, integrated training system and strategy for Force XXI. These efforts include embedded training and distance learning.

Numerous experiments and research studies have proven the advantages of using simulators and simulations in training. A lesson learned from the Division XXI AWE is that leaders and staff need extensive staff training to be able to fully exploit digital capabilities (U.S. Army Training and Doctrine Command Analysis Center, 1998). To add support to this argument, Dubik (1997) presents four principal advantages of simulation-based training: (a) units can use live training time more effectively; (b) units can develop and maintain complex skills; (c) units can train tasks not feasible in live exercises; and (d) units at different geographic locations can participate in combined exercises using live, virtual, and constructive domains. Clearly, approaches to training digital units need to stress use of simulations.

Training Requirements

The overarching training approach must be responsive to the ongoing evolution resulting from Force XXI and the Army After Next. As new combat and information systems are fielded and units reorganized, doctrine, TTP, and tasks to be trained will change. Training products must be easily modified and readily accessible to the entire training audience to account for these changes. Desert Hammer highlighted the need to identify new or modified tasks and for training programs designed for digital operations to include staff functions and troop leading procedures (Quinkert & Black, 1994).

The software for digital information systems is constantly being upgraded to increase capabilities. Training products should be revised to account for these changes. These revised training products should meet two requirements. First, they will be needed for new equipment training for units not yet trained. Second, the training must address the "delta" training requirement, the difference between the old and new software versions. Soldiers previously trained on the old version of software need this training. The proposed training approach needs to account for both new equipment training and version update training.

As the Army transitions to a totally digital force, the requirement remains to provide training on analog tasks. As the AWEs demonstrated, digital units must still work with non-digital units (e.g., reserve component) and operate when the digital systems fail. Units must develop and ingrain procedures to coordinate with non-digital units and accommodate limitations of the hardware and software. Related to this is the need for "back-up training." With the introduction of digitization, there has been a tendency to think of changes in training only in terms of how to operate new digital systems (Campbell, Ford, Shaler & Cobb, 1998). Equipment reliability and the prospect of operating with mixed forces dictate a training requirement for back-up skills. Back-up skills for a force that is fully immersed in digital capabilities and TTP do not and should not necessarily mean reverting to analog techniques circa 1980. We expect to find in the evolving digital units, and it is obvious from home and industry use of technology today, that when the system degrades or fails, the operator instinctively works through the problem with remaining capabilities. Operators share with other users whose systems are operational, reprioritize tasks, and reboot the system. In the tactical environment those who first learn on digital systems will also work through degradations or failures in ways we may not expect today. For example:

- Combat platform. A combat platform with an inoperative digital system will partner with a combat platform whose systems are operational and exchange leaders if required.
- Staff section. The staff section with an inoperative device will obtain the needed information using another digital system or share with other staff section by multi-tasking on their system.
- Leaders. The leaders of the future may carry PDAs with wireless links to their main data systems – these PDAs will update critical information automatically and be available as backup. Further, as capabilities and technologies change, training requirements will also evolve from manual back-up techniques to redundant digital systems.

Additionally, when confronted with the challenges of operating in a mix of digital and analog environments the media for the exchange of the information may remain the same: acetate, paper orders, FM communications. However, the information contained on the media will evolve and resemble closely the more concise digital formats. For example, digital units already build operational graphics consisting almost entirely of TIRS (Terrain Index Reference System). Digital units should not be expected to provide information in unique formats for analog counterparts.

Leaders and soldiers of tomorrow will develop far more innovative backup techniques than we can articulate today given we are hampered by our underlying base of analog techniques of execution.

The proposed training approach needs to be sequential. Individuals should be trained to proficiency prior to conducting training as a crew or staff group and prior to training collectively. The FXXITP has espoused sequential training through the use of the BSTS to train individuals prior to training staff groups and CPs using COBRAS. Inherent in sequential training is the requirement to ensure that tasks are "threaded" from individual to collective. Training on requirement to ensure that tasks are "threaded" from individual to collective. Training on individual tasks must support the follow on training on collective tasks. To accomplish this goal, the overarching approach must be designed within the concept of the CATS (U.S. Training and Doctrine Command, 1993), the Army's overarching strategy for the current and future training of the force.

The overarching approach needs to incorporate a progressive methodology where training is repeated under increasing difficulty. Training packages that were used during the training for Focused Dispatch and the Task Force XXI AWEs incorporated the "crawl, walk, run" progression to prepare for the AWE. During Army Experiment 5, a three-step approach (Brown, 1996) was used to train digital battle command and staff groups. Step One is proficiency in the basic skills and knowledge necessary to succeed in an analog environment. Step Two is proficiency on both the digital hardware and software in execution of tactical warfighting scenarios. Step Three focuses on the development of highly adaptive, hyper-proficient individuals, small teams, leaders and units competent and confident to perform current and likely Force XXI missions (TRADOC, 1998a).

Tied closely to software training is the training required to overcome the perishability of digital skills. The simple principle of repetition is most important in digital training. The key is to incorporate and use digital equipment during each workday at similar, if not the actual, digital workstations. As one of the previous battalion commanders in the EXFOR stated, "use of digital systems must be integrated into soldier and unit day-to-day operations in garrison and in the field." Integration into day-to-day operations will help prevent the loss of digital skills.

Training must overcome a new challenge that digitization presents, the management of large amounts of information from various sources. Commanders and staffs need to learn to process and analyze huge amounts of information effectively and make decisions quickly based on that information. Numerous interviewees commented that the more experienced the commander or staff officer, the more he/she could effectively deal with and sort through the clutter. However, effective information management training would help offset a lack of experience. Leader decision-making on a digitized battlefield requires an understanding of system architecture, capabilities, and limitations of the entire spectrum of assets available. This has been evident in the Division and Task Force AWEs. A leader's capability to prioritize and focus is increasingly important in the digitized environment.

The remainder of this chapter describes the key findings from the interviews and reviews of literature and programs. Discussions relate to developing an overarching training approach for the digitally equipped Army (Stage 4) and identifying the training system functional requirements for training delivery (Stage 5).

Overarching Approach to Train the Digital Force

A key finding of this effort was that the Army has many sound and useful "parts" in its training spectrum, that, when combined, provide the bulk of the structure for an overarching training approach. An example is the AT XXI concept (TRADOC, 1997a) which provides the foundation for the overarching training approach.

The Army is currently adopting the concepts and framework of AT XXI as the means and methods to train and sustain the force. This emerging concept incorporates three axes: (a) WarMod XXI focuses on Army modernization training, (b) Warfighter XXI focuses on unit training to train battle staff and collective tasks, and (c) Warrior XXI focuses on institutional and self-development training (TRADOC, 1997a). The overarching approach to train the digital force will be described within the context of these three mutually supporting axes.

WarMod XXI-Army Modernization Training

The WarMod XXI is frequently referred to as New Equipment Training (NET). Though it is training for soldiers on new equipment, WarMod XXI should evolve under the AT XXI concept to be much more than the current NET. The TSPs designed and developed for new equipment training will form the basis of individual and collective unit sustainment training and institutional training. The WarMod XXI will begin the training development process that will eventually provide training products for use in institutions, units, and self-development. This is a significant change from the way training development is done today but certainly an efficient way to accomplish it under the constrained resources and high turmoil associated with the digitization of the Army. It should be noted that this is a maturing concept and that wide divergence exists in actual compliance with the AT XXI concept.

The process should begin with TRADOC Systems Managers (TSM) documenting the training requirements for each digital system in their System Training Plan (STRAP) and ORD. In accordance with these documents, the Material Developer resources and executes the training. This process is what numerous senior leaders desired in the total package fielding concept discussed earlier in this report.

The FBCB2 ORD (USAARMC, 1997a) and STRAP (USAARMC, 1997b) capture much of what is needed to move digital training along the correct path. The FBCB2 ORD follows the WarMod XXI concept and states that the PM will develop a series of system training products, conduct initial and key personnel training, and NET. These training products will be used as the basis for institutional training development, unit sustainment training, and rapid train-up of replacement personnel in support of contingency operations. The FBCB2 ORD captures the essence of WarMod XXI.

The FBCB2 documents, however, are not alone in providing guidance on digital systems NET. The recent ABCS Capstone Requirements Document (CRD) states that training will consist of individual battlefield automated systems training and collective "horizontal integration" training that will provide operators with the skills required for sending and receiving messages and database exchanges from other battlefield automated systems (TRADOC, 1998a). Additionally, collective training must be conducted so that ABCS operators and maintainers can operate and maintain the total system. The combat service support communication system (CSSCS) ORD (TRADOC, 1998b) states that initial CSSCS fielding to a unit will be performed by on-site NET teams. Training will include operational and maintenance training for instructor and key personnel. The current MCS ORD states that initial training for operators, supervisors, staff users, and commanders will be conducted by NET teams (TRADOC, 1995a). The ORDs from the ABCS systems also address multimedia embedded training as a method to conduct initial and sustainment training. The CRD states that ABCS Systems will develop embedded training requirements in accordance with their respective system ORDs and appropriate TRADOC policy. Embedded training will include the ability to train collectively with the other ABCS systems and conduct horizontal integration within the ABCS. The CSSCS ORD states that the training concept for the CSSCS includes embedded training. The MCS ORD states that operator sustainment training and new operator OJT will be facilitated by an embedded training program built into the operational system software.

Materiel developers, in accordance with the documents now approved by TRADOC, are trying to resource and execute the training detailed in the guidance. However, training conducted for new digital systems usually consists of NET Teams that primarily focus on individual training using the traditional classroom method. Additionally, a variety of NET classes have been created for each component of the ABCS with very little similarity in strategy, concept, or format.

Sound digital training development guidance is available; however, it cannot be found in any one document. Clearly, a standard model for digital policy and/or guidance is needed. Figure 5 illustrates a recommended approach for training a digital force. Individual and collective training designed, developed, and used during NET should be the basis of unit, institutional, and self-development training. A goal of WarMod XXI is to minimize isolated stove-pipe training development for individual systems (TRADOC, 1997a). The STRAP and ORD approval process was instituted to ensure coordination between training development efforts.

The current acquisition process addresses the functionality, manufacturability, sustainability, suitability and end state training only *after* the design is determined and fixed. What is missing in this process however, is the early consideration of trainability and usability. If we consider *First Generation* digital systems to be those of the 1980s such as TACFIRE and MCS, we see good examples of stovepiped standalone systems. These systems were not easily operated nor easily trained and therefore were slow to become reliable warfighting tools for the commander. As we now develop the *Second Generation* digital systems, we are repeatedly finding that many of the systems are still difficult to use, hard to train and by logical extension result in a rapid loss of user expertise. It is a direct result of the lack of focus on trainability and usability early in the concept design phase of the acquisition process.

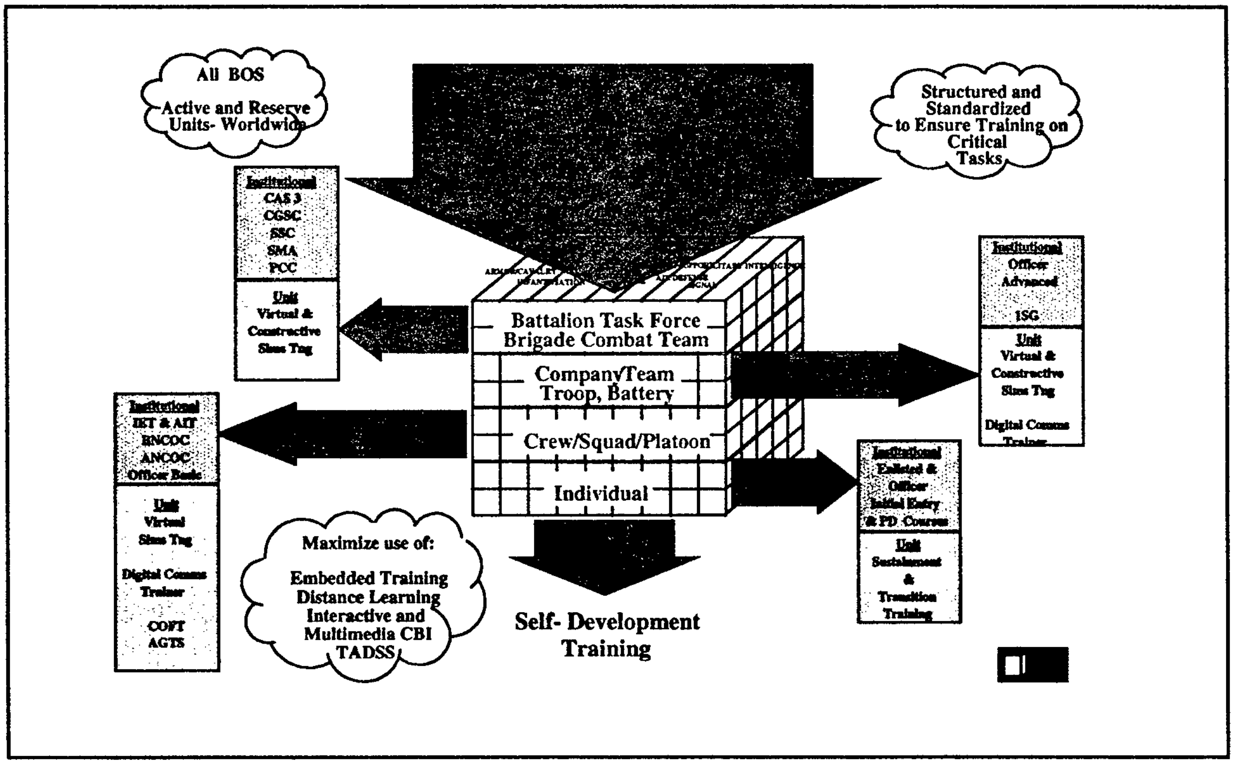

Figure 5. Training development model for WarMod XXI digital units.

In Figure 6 one can see a representation of the development path that brings most of the critical players into the process early. However, bringing the doctrine developers and training development team on board after the design is set eliminates the flexibility required to maximize the potential capability of the system. This is especially true in today's environment where a "system" is really just a component of a system of systems. Doctrine and training developers should concern themselves with more than just a stovepiped view of Tactics, Techniques and Procedures (TTP) for a new system or how to train soldiers to operate a new system. Their focus must be on the integration of the new system into the combined arms force and changes in the TTP to ensure full exploitation of that capability. Trainers must be able to develop tools and techniques for training these capabilities in the context of the combined arms environment. Neither of these requirements can be met, much less optimized, if these two concerns are not addressed at the same level of importance and at the same time as the concept evolves.

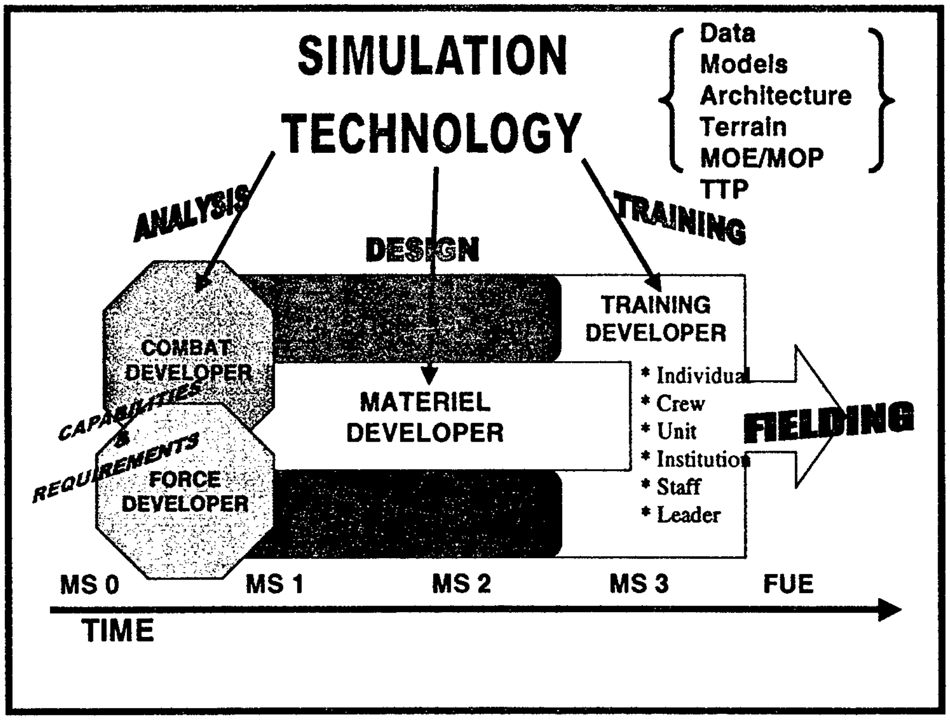

Figure 6. Model for integrating critical players in the development process.

Developers are increasingly using simulation-based tools to assist in the development of these new digital systems. Engineering logistics and design simulation tools can assist developers and ensure improvements are made in the areas of functionality, manufacturability and sustainability. However, in the areas of trainability and usability developers are not using this same technology to the extent now possible. Under recent changes in acquisitions policies and techniques the developers are increasing the use of Integrated Process Teams and "User Juries" that include members of TRADOC in the design process. This increases the potential for TRADOC to buy-in to the process and the resulting design but does not adequately address the shortcomings. Analysis shows that these new digital systems should provide explicit increases in combat effectiveness. However, in each of the field trials or AWEs of the new digital systems the units rarely met the expected mark by any measure. This may be the result of computer wargame analysis that assumes soldiers can exploit the systems to their potential and units are not provided with systems that can be easily learned, easily trained or easily integrated into the combined arms battlefield. The fact remains, the new systems are still difficult to use and hard to train. The result is a steep skill degradation curve that requires frequent use in the field environment as adequate simulation-based collective training tools have not been provided.

Efforts to shape the historical processes to meet the challenges inherent in the acquisition of the Force XXI – AAN system of systems forces us to confront the requirements-capabilities paradox. This paradox has remained well hidden in the legacy single system development. This requirements-capabilities paradox is best understood by a set of circular logic questions. As we move toward Force XXI-AAN can we:

1. Identify the operational effectiveness of a system if we haven't determined if soldiers can physically operate the system at its potential?

2. Identify if soldiers can operate the system at its potential if we haven't trained soldiers to exploit it?
3. Train soldiers to exploit it if we haven't developed the Training Support Packages (TSPs)?
4. Develop the TSPs if we haven't developed the Tactics, Techniques and Procedures (TTP)?
5. Develop the TTP if we haven't operated the system on the combined arms battlefield in the "most" operationally effective manner?

The use of Advanced Distributed Simulation starting in the early stages of system design and continuing through to fielding may provide an answer. Simulation based acquisition concepts must be expanded to include explicit use of soldier in the loop combined arms simulation environments to proof MANPRINT design, develop and proof crew and unit TTPs as well as develop and confirm the effectiveness of system and non-system training devices. Technology of today supports such a concept however Army policies and organization structures do not. In this era of digitization we find the training and TTP development process comes too late in the acquisition cycle. It is time to break the barriers and integrate all aspects of system development into the process shown in Figure 7 . The current challenges confronted by trainers coming in at the last stage of development are thus far insurmountable and will remain so if the process does not change.

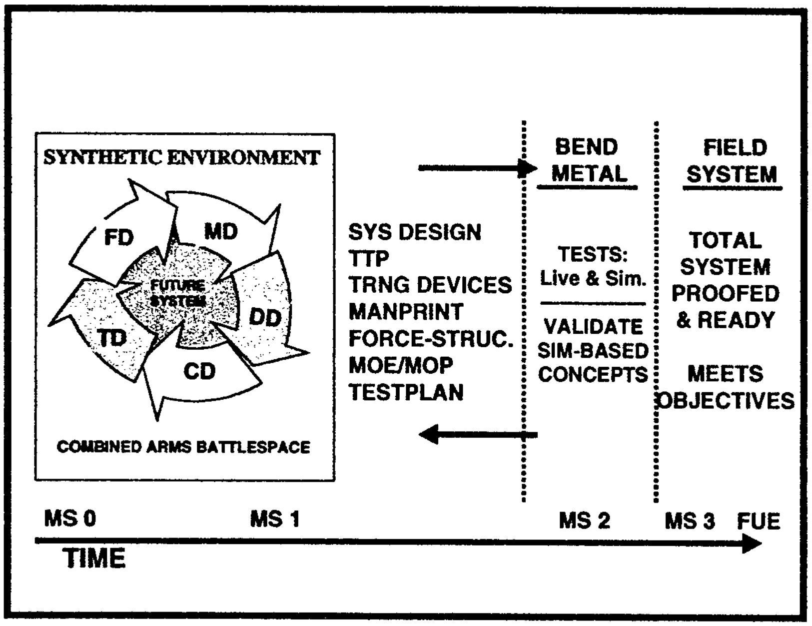

Figure 7. Breaking barriers and integrating all of the aspects of system development.

Individual Training

The design, development, and fielding of individual training products for digital systems during fielding is crucial to the success of the entire overarching approach for training a digital force. If properly developed, these training products can be used in institutions, units, and in self-development throughout the Total Army. The Army has started to adopt this concept as evidenced in the WarMod XXI concept (TRADOC, 1997a) and the recent ABCS CRD (TRADOC, 1998a).

Training and material developers should adopt the emerging WARMOD XXI concept. The CRDs, STRAPS, and ORDs for digital systems need to incorporate these concepts. One of the goals of WarMod XXI is to develop TSPs that consist of fully digitized multimedia, multipurpose products for use during initial unit and institutional training. The WarMod XXI concept needs to be modified to state that these products can be used for self-development. The TSPs produced for individual training need to be developed using the technologies specified in AT XXI to include embedded training, distance learning, CBI and Warrior XXI TSPs (i.e., Total Army Training System [TATS] courses). These multimedia-based TSPs should be made available via CD-ROM, the Internet, Intranets at various locations, and in digital learning centers or universities. Courses can be modified as software is upgraded and as TTPs change and can easily be distributed using the technology from AT XXI. Training provided during fielding should move away from platform classes to multimedia based interactive training. As much as possible, the format and content of the courses on digital systems need to be standardized. This will facilitate use of these courses. For example, individual training for each system could include an Overview/Leaders Course, Operators Course, Maintainers Course, and a Staff Officer/NCO Course. Additionally an Overview Course needs to be developed that addresses all of the digital systems. This overview course should be executed throughout TRADOC immediately. Courses developed for individual training should teach the use of digital systems within the context of how battles are fought–training focused only on the mechanics of equipment operation is not sufficient.

Collective Training

The design, development, and fielding of collective training products for digital systems is also crucial to the success of the entire overarching approach for training a digital force. If properly developed, these training products can be used in institutions and units throughout the Army.

Training on collective tasks has not been emphasized during fielding nor adopted in the ABCS CRD or ORDs, with the exception of FBCB2. The ABCS CRD (TRADOC, 1998a) defines collective training as "horizontal training" that will provide operators with the skills required for sending and receiving messages and database exchanges from other battlefield automated systems. This horizontal training is being provided to units at Fort Hood throughout the Central Technical Support Facility (CTSF) and is an important aspect of the overarching training approach but does not follow the commonly accepted definition of collective training for units. The FBCB2 ORD states that collective TSPs must provide training tailored to specific mission and contingency scenarios so that units can practice, rehearse, and train under expected mission conditions (TRADOC, 1997b). The Army needs to incorporate collective training into the WarMod XXI concept and the recent ABCS CRD.

The WarMod XXI concept (TRADOC, 1997a) and the ABCS CRD should be modified to include training units on collective tasks using digital systems. The TRADOC agency responsible for WarMod XXI should review system ORDs and the corresponding SOW to ensure the integration of training programs. The concept of collective training from the FBCB2 ORD needs to be reviewed for use in the WarMod XXI and the ABCS CRD. Further, it is highly suggested that the concept of embedded training be further explored as a means of conducting collective training of C4I tasks.

Warfighter XXI-Unit, Individual, and Collective Training

Individual and collective training on digital systems plays an important part in the overarching approach. Warfighter XXI encompasses individual training in the unit, battle staff training, and unit collective training (TRADOC, 1997a).

Figure 8 illustrates the recommended overarching training approach as applied to a battalion/task force. Its methodology and concepts are applicable to BCTs, divisions, and corps. The right axis, Battle Command/Staff training, will be discussed prior to crew, platoon, and company training. This training approach should be incorporated into the Warfighter XXI Campaign Plan (TRADOC, 1997a) in order to ensure that training product development is coordinated and integrated. The sequential training levels within each axis shown in Figure 8 are described below.

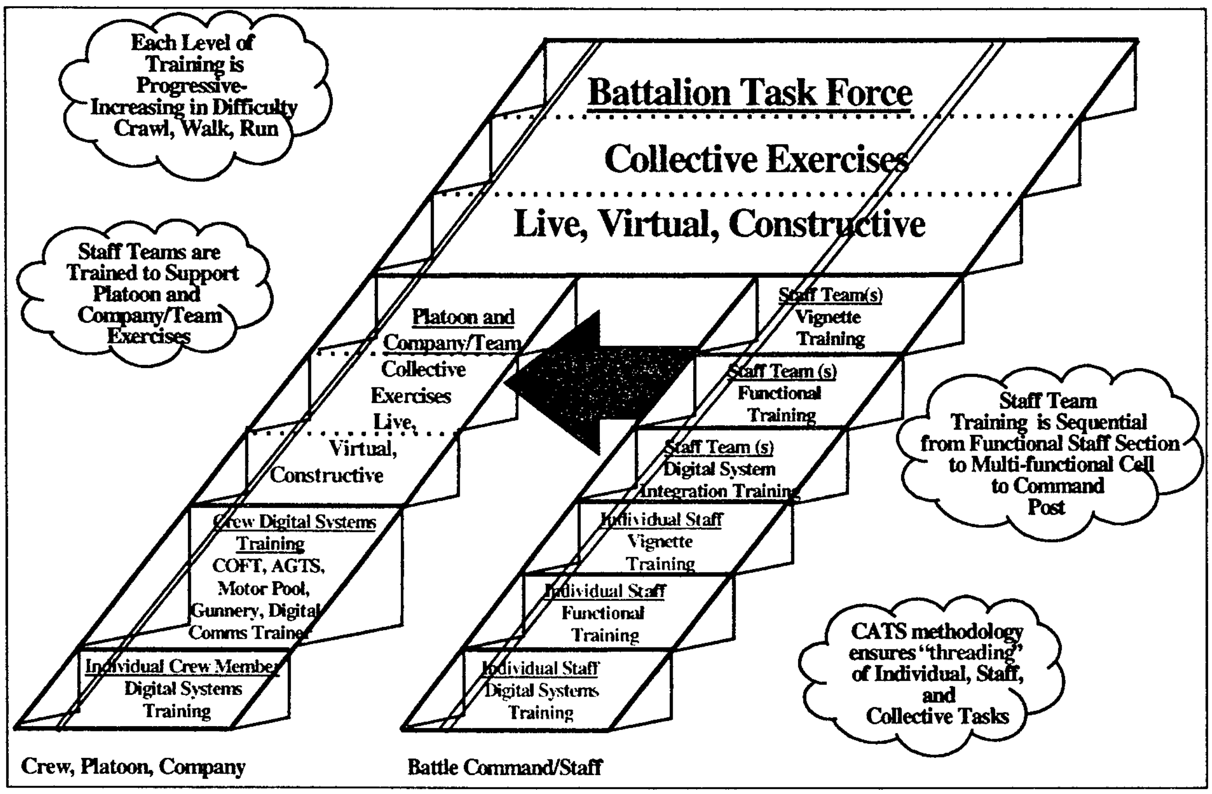

Figure 8. Training model for Warfighter XXI digital units – individual, unit, and collective training.

Individual Staff Digital Systems Training

Staff personnel throughout the Total Army at all echelons, in all units, and in every BOS, require an in-depth knowledge of the digital systems applicable to their staff section. Although this training is provided during systems fielding, personnel turbulence, changes in system software, changes in TTPs, and digital skill decay require that this training be constantly updated, readily accessible, and part of the day-to-day activities in units.

The training concept for the CSSCS includes unit sustainment training based on an embedded training capability. This embedded training capability should be the primary means of training in units. The PM should develop and distribute training materials for the life of the system. The CSSCS computer should support all operator and maintenance training for new equipment and sustainment training.

The MCS ORD states that initial training for operators, supervisors, staff users, and commanders is achieved through OJT conducted within units by master operators or by attendance at local troop schools (TRADOC, 1995a). Development of exportable training materials and programs of instruction (POIs) will facilitate operator sustainment training and new operator OJT for installation level training. Not providing these exportable training materials misplaces the burden of developing digital training on the unit.

The FBCB2 ORD (TRADOC, 1997b) states that the unit commander will be responsible for system proficiency through sustainment and transition training and will ensure that training time and assets are available to train the required skills to standard. Fortunately, the PM is tasked to develop a series of system training products for use during new systems training. These training products will be used as the basis for unit sustainment training and rapid train-up of replacement personnel in support of contingency operations.

Training for individual staff members on digital systems is an important part of the overarching training approach. This is easy to accomplish if the multimedia, interactive training products developed during system fielding are constantly modified and provided to staff members in units via CD-ROM, the Internet, local Intranets, and are embedded on the systems. These CD-ROMs can be issued and web based internet should be made accessible to allow use in varying environments (e.g. workplace, home, armories). Individual staff members will gain and maintain proficiency by repetitive training using these products. As noted by a previous commander in the EXFOR, routine use of digital systems must be integrated into daily garrison operations.

Individual Staff Functional Training

Once individual staff members become proficient on operation of the digital system the next level of training is functional training. Evaluation of staff training by a number of sources and studies revealed glaring deficiencies in brigade and battalion level battle command and staff training. For instance, observations of the Task Force and Division AWEs indicate the need for structured individual training for commanders and staff within and across all BOS (U.S. Army Training and Doctrine Command Analysis Center, 1998a). The object of functional training is to train staff members to accomplish their individual staff tasks using the applicable digital system.

The BSTS, a multimedia CBI training program, trains non-digital maneuver brigade and battalion commanders and staff officers and has been proven to be a very effective staff-training tool (André et al., 1997). The use of interactive, multimedia courseware that applies the latest technology is an important tool for digital training. Digital BSTS TSPs need to be developed as Warrior XXI TSPs using the technologies specified in AT XXI. This individual-level staff trainer will then be available for use in units, institutions, and for self-development.

Individual Staff Vignettes Training

The next level of training for individual staff members addresses a new digital challenge, the management of large amounts of information from multiple sources. Staff members need to be trained and evaluated on information management, critical thinking, and decision-making skills. Prior to proceeding to staff group training, it is necessary to teach individual members how to process and disseminate information and digital messages. The CVCC Information Management Exercise (IMEX), Staff Training in Information Management (STIM) research, and the Digital Leaders Reaction Course (DLRC) at Fort Leavenworth are examples of training that address this need.

The CVCC program introduced the use of computer-driven message processing vignettes to train information processing and information management (Winsch et al., 1994). The training was designed for individual company commanders. During the CVCC IMEX training, individuals received pre-scripted digital message traffic via a SEND utility which the participants processed and disseminated as required. Each student completed multiple vignettes that became increasingly difficult by reducing the intervals between message transmissions and increasing the number of messages. Participants received feedback via a computerized AAR module on how well or poorly they processed the message traffic compared to an SME; the ability to determine whether the information was relevant (i.e., pertinent to one's own unit) versus irrelevant (pertinent to another unit) and to determine information criticality were key factors in performance (Winsch et al., 1994).

The STIM (Freeman, Cohen, Serfaty, Thompson, & Bresnick, 1997) also used a computer-driven message stream (sent out via a simple e-mail application) to help staff officers improve their digital information management and to help them avoid information overload. The STIM is a system designed to address: (a) making and interpreting assessment updates, (b) applying critical thinking skills, (c) discerning when to exercise critical thinking skills, and (d) deciding when to apply rapid recognition responses to teach individual staff members to think critically and make better tactical decisions. In operation, each participant acted as the battalion S3 as they processed pre-scripted messages. The message stream was halted intermittently so that a notional commander could send pre-scripted questions for the participants to answer. The participants had to provide answers, defend their answers, and indicate actions that they would take next using a node-linked graph. The results were later evaluated by an SME.

The DLRC is an on-going project at the Command and General Staff College (CGSC) at Fort Leavenworth, Kansas. It is primarily a tool for training leaders to exploit situational awareness and to achieve a high level of proficiency in automation-assisted decision-making. Although currently focused to train brigade commanders, the concept is applicable to individual staff officers. The goal is for the commander to make four to five decisions per hour. The brigade commander resides in a Command and Control Vehicle (C2V) surrogate with role-players as staff officers, battalion commanders, and division commander/staff. The brigade commander arrives with a "received" situation-order already issued and the brigade deployed and in action. Role-players include an intelligence (Intel) officer, an operations officer, and an FSO. Other role-players available by radio also act as the XO, other staff, and the battalion commanders. The brigade commander sees the division commander and adjacent commanders (all role-players) on a small screen in the C2V. The outcome of all decisions and orders are captured for the AAR.

The three programs (CVCC IMEX, STIM, and the DLRC) should be researched in greater depth with the best ideas from each combined to form the basis for a training program focused on staff officers and leaders using the ABCS systems in tactical scenarios. For example, the DLRC program should be examined to see whether using a computerized message script to drive much of the training could eliminate many of the role-players. Multiple versions of the message scripts could be available to support the various decisions that the commander might make. The SGT Team designed but did not develop branching exercises that supported various courses of action that the staff could take. A similar tack could be taken for the DLRC to train leaders on decision-making. Furthermore, the automated objective feedback provided by IMEX on how well messages were processed could be supplemented by feedback on decision-making based on that information such as is provided in the STIM or DLRC. Using technology that is currently available, an SME could provide on-line feedback on the viability of the decision made via e-mail, instant messaging, or pre-scripted feedback if the decision had a multiple choice format.

All staff officers need to be trained and evaluated on the processing, synthesis, and dissemination of information received through digital systems in a tactical operation. Based on this information, they make staff estimates and recommendations to commanders. One of the lessons learned from the AWEs is that information management training needs to be embedded (Quinkert & Black, 1994). Following one of the design considerations for the overarching training approach, these digital vignette TSPs should be developed using the technologies specified in AT XXI to include embedded training, distance learning, and CBI. This individual staff vignette trainer will then be available for use in units, institutions, and for self-development.

Staff Teams-Section, Cell, and Command Post Performance

Structured training for staff sections, cells, and CPs was repeatedly identified as needed during the various AWEs and in interviews with commanders and staff officers at Fort Hood. This training deficiency affects digital and non-digital staffs. The training challenge is increased as tactical operations on a Force XXI battlefield require more rapid and more extensive staff coordination and synchronization. The staff teams' training is highlighted in the three top blocks on the right "leg" of Figure 8. Prior to discussing the training for staff teams, it is appropriate to specify the following:

1. Staff section personnel are from the same staff section such as the S-1 or G-4.

2. Staff cell training personnel are from different staff sections that are organized to accomplish a specific function. Examples of staff cells are the Planning Cell, Deep Operations Cell, Targeting Cell, or Reconstitution Cell.

3. Command post training groups the staff sections and multiple cells that make up a CP. Examples of CPs are Division Main, Corps Assault, Battalion Main, and Division Rear.

Staff Teams Digital System Integration Training

All staffs at every echelon need to understand the capabilities provided through the integration of all digital systems and the information available via multiple means. The recent ABCS Capstone Requirements Document (TRADOC, 1998a) states that initial training will consist of "horizontal integration" to provide operators the skills required for sending and receiving messages and database exchanges from other battlefield automated systems. The CRD also requires that all ABCS components develop embedded training that includes the ability to train collectively with other ABCS components and conduct horizontal integration within the ABCS. Digital systems integration training is being conducted at the Fort Hood CTSF. The horizontal digital training course conducted on the ABCS systems connected via a local area network (LAN) includes: (a) training on the individual capabilities of the ABCS systems and the synergy resulting when used together; (b) training on client/server operations to include products available from all the ABCS systems; and (c) battle skill training which teaches the skills necessary to operate in a digital environment.

Digital system integration training is required for students in every institution. Structured Warfighter XXI TSPs need to be developed to ensure the accomplishment of training objectives. The Staff Leader Guides currently being developed by the Combined Arms Center can be used to establish procedures and standards. These training packages need to be flexible to train the numerous sections, cells, and CPs. Training needs to occur in garrison in daily operations, in digital learning centers at unit locations, in standardized reconfigurable TOCs at institutions, and through embedded training.

Staff Team Functional Training

After achieving proficiency on the horizontal integration of digital systems, the next sequential level of staff team training is teaching collective tasks using digital systems, including the management of large amounts of information from various sources. Staff members need to be collectively trained and evaluated on information management and decision-making skills. Although no digital trainer exists at this time to meet this need, the SGT project has the potential to train staff teams how to execute their staff functions.

The SGT project developed a computer-driven, structured staff training program designed to train staff processes during execution only; it bridged the gap between the training of individual staff member skills using BSTS and the collective training of commanders and staffs in the Janus and BBS environments in COBRAS (Quensel et al., in preparation). SGT was designed to train conventional maneuver brigades and battalions and is organized into three levels of tables:

1. The Staff Transition table that trains internal staff sections.
2. The Staff Integration table that trains staff sections to work together.

3. The Command Post table that trains the full command post to work together synergistically.

Like the IMEX exercises discussed earlier, SGT uses prescripted message traffic to drive the exercises. The SGT also incorporates a multimedia presentation for exercise preparation and feedback, as well as a multi-dimensional evaluation and feedback system. The SGT trains basic skills and techniques in the execution of staff team tasks. These skills are expressed in a set of learning objectives that address the following staff functions: (a) monitor, (b) process, (c) analyze, (d) communicate, (e) coordinate, (f) integrate, (g) recommend, (h) disseminate, and (i) synchronize. The SGT methodology provides a standardized approach for use in the training of any battle staff (Quensel et al., in preparation).

Staff Team Vignette Training

Lessons learned from the AWEs support using operational vignettes to focus on training objectives (Quinkert & Black, 1994). Although this level of training has not been developed for a digital force, the COBRAS vignettes provide a good starting point (Graves et al., 1997). Like SGT, the COBRAS program provides structured, simulation-based training on basic staff skills for conventional forces; however, unlike SGT, COBRAS is not solely execution-focused. Further, COBRAS training is not pre-scripted like SGT but is driven by constructive and live simulations. In the crawl-walk-run spectrum, SGT is more of a crawl-level staff trainer than COBRAS, but its pre-scripted nature is important to achieving its training goals and allows more detailed automated feedback than would be possible without pre-scripting. The 24 COBRAS vignettes provide walk-level staff training; they are small group, structured exercises that train two or more members of the brigade staff on specific training events. Some are planning and preparation-focused exercises that incorporate live simulation as well as execution-based exercises driven by either Janus or BBS for small groups of brigade staff members. Examples of vignettes include developing courses of action, reconnaissance and surveillance plans, plans for dislocated civilians, and plans for NBC defense operations. Vignette type training needs to be developed for the digital force as a portion of the overarching approach.

COBRAS also provides higher-level staff-only training in the form of the BSE and BBSE. (See the Introduction chapter of this report for more detailed descriptions of BSE and BBSE.) Unlike the vignettes which are primarily planning and preparation-based, the BSE and BBSE cover the planning, preparation, execution, and consolidation and reorganization phases of the missions. The BSE and the BBSE use BBS technology to drive the exercises for the brigade staff and the brigade and battalion staff, respectively. Feedback for the COBRAS vignettes and the COBRAS exercises is provided via conventional AARs. This training product can be used to train staffs in digital learning centers or standardized reconfigurable TOCs either at unit locations or in the institutions.

The SGT and COBRAS were designed and developed to train non-digital staffs on collective tasks in scenario-based tactical operations. Both could be converted to train staffs equipped with digital systems. Some thought should be given as to how the two programs could be integrated to train all phases of the mission and to train at both the crawl and walk levels. For example, the SGT's computer-driven nature lends itself to training digital information processing, so its platform could become the basis for a product. For the crawl-level training, the current SGT could be expanded to include planning, preparation, and consolidation and reorganization exercises as well as execution-focused pre-scripted exercises. Automated feedback could be provided on planning products such as OPORDs, decision support templates, etc. To represent walk-level training, the SGT system could be enhanced to permit non-prescripted messages to be sent by a BBS or Janus that has been converted to send digital messages.

Pre-scripting exercises for the SGT would be much easier if the Janus or BBS exercise fed messages that could be saved in the form of scripts with actual time intervals. When used at the walk-level, the highly detailed automated feedback system currently provided by the SGT system would not be possible; however, having a non-prescripted option would allow for decisions to be made by the participants and then acted upon. As previously discussed, another way to enhance SGT for staff team training is to provide branching exercises for the SGT if the Janus or BBS technologies cannot be easily linked to the SGT. One approach is to explore the extent to which artificial intelligence (AI) systems can support SGT training exercises, data collection, and AAR preparation activities.

Run-level staff training occurs when the staffs team up with the remainder of their unit and conduct collective exercises in live, virtual, and constructive simulations. A discussion of this follows the individual and crew training sections below.

When considering training for staff sections, staff cells, and command posts, the ideal would be one staff trainer for digital units' internal staff sections, functional staff cells, and multi-functional command posts. In various interviews at Fort Hood, commanders voiced concern over the lack of time available to train their staffs and expressed their desire for one training system. An important element of the overarching training approach is a digital staff trainer. To design and develop this staff trainer, the following recommendations are offered:

1. Review and combine the SGT and COBRAS programs and the Horizontal System Training being conducted at Fort Hood into a single digital staff trainer. This digital staff trainer can be used to train staffs in digital learning centers at unit locations, and in standardized reconfigurable TOCs developed at institutions, via embedded training.

2. Develop Warfighter XXI TSPs to ensure the accomplishment of training objectives.

<u>Individual Crew Member Digital Systems Training</u>

Individual crewmember proficiency is an important aspect of the overarching approach. Individual crewmembers must be proficient in operations of their digital systems and all members must be cross-trained on the individual skills required to operate the systems. Furthermore, it is also possible that the introduction of digital equipment may mean that some crewmembers take on unprecedented levels of responsibility. For example, because of his proximity to the IVIS or FBCB2 digital screens, it has been suggested that the loader is in a better position to take immediate charge of the tank (including use of the IVIS or FBCB2) than the gunner in the event that the tank commander is incapacitated (R. Gray, personal communication, May 8, 1998). Regardless, each crewmember, from the loader to the tank commander, must be cross-trained on the digital equipment so that they can better support the other members in their use of their equipment. The training products that were developed for initial systems training must become the foundation for this training. Training products for individual crewmembers must be updated by the system PM. They must be embedded in the actual system, loaded onto the system for training, or made available via distance learning such as CBI that emulates the actual system.

Crew Digital Systems Training

The FBCB2 ORD (TRADOC, 1997b) states that embedded training programs must address crew collective training tasks to be performed in both garrison and field environments. Embedded training may be resident on the system or loaded onto the system for training. Previous EXFOR battalion commanders felt that training on crew level tasks must be incorporated into all aspects of maintenance and training. As examples, they recommended that situational awareness be replicated in the UCOFT to train crew tasks, that digital training be incorporated into live gunnery exercises, and that crew training be conducted in the motor pools, during 'information coordination exercises'.

There are numerous ways to meet this training requirement. First, TSPs designed for embedded training need to follow the applicable system ORD. Second, all crew level simulators such as the UCOFT and AGTS need to be modified to incorporate digital systems. Finally, digital ranges or home station instrumentation need to be developed and fielded at unit locations.

Platoon, Company/Team, Battalion/Task Force and Brigade Combat Team Collective Exercises

The next level of SST training is collective training at the platoon level and higher. This addresses the uppermost portion of the crew, platoon, and company "leg" of Figure 8 as well as the top portion where crews and above train with the commanders and staffs. There are good examples of SST for non-digital forces to include SIMUTA, SIMUTA-B, SIMBART, and STRUCCTT. Structured training developed for digital forces includes SIMUTA-D, EXFOR, and the recent development of STRUCCTT tables for digital elements. The success of each of these programs is generally accepted.

One limitation of the previously developed SST exercises is that they have harnessed only one simulation platform at a time (e.g., SIMNET, BBS, or Janus), and separate TSPs were written to train on those different platforms. The exercises were limited by the capabilities of the single simulation platform. The COBRAS STOWEX is the first to create exercises for interoperable simulation platforms. The COBRAS STOWEX demonstrates how SIMNET and BBS connectivity can be used to train a larger portion of the brigade than previously possible (N. Jenkins, personal communication, July 23, 1998). In the STOWEX, one battalion is fighting in SIMNET (including the battalion staff), providing training down to crew-level. In BBS, two battalion staffs fight the battle. Other options should also be explored. According to the Functional Specification for SIMNET/Janus Interconnection, SIMNET and Janus should be interoperable (Fraser & Crooks, 1992). This capability has been tested with some success and has potential to expand the scope of simulation-based training to higher echelons. Further, the

CCTT is supposed to be interoperable with WARSIM 2000 (B. Danemiller, personal communication, July 23, 1998). Ultimately, all potential gateways between virtual and constructive simulations (including between the CCTT and available constructive simulations) should be explored. The Army is evolving to a federation of simulations, the HLA (Department of Defense, 1998a). As computer simulations, manned simulators, and supporting utilities are interfaced, the rules, specifications, and templates of the architecture must be followed. Compliance with the HLA requirements should reduce many of the interoperability issues.

As previously mentioned, the ABCS CRD and system ORDs (with the exception of the FBCB2 ORD) do not fully address the requirement for collective training. The FBCB2 ORD states that collective TSPs must be developed by the PM as part of system development and will be designed to support effective training for operators, maintainers, tacticians, unit commanders, staff officers, battle captains, and units to include combat, CS, and CSS. For collective training, FBCB2 TSPs must provide training programs tailored to specific mission and contingency scenarios so units can practice, rehearse, and train under expected mission conditions.

Collective training is an important aspect of the overarching approach to training a digital force. Units must be able to conduct structured training under realistic conditions in virtual, constructive, and live environments. This training must emphasize use of digital systems and operations. To provide this training, Warfighter XXI TSPs must be designed and developed to train digital units in the CCTT and WARSIM 2000.

Warrior XXI-Institutional, Individual, Collective, and Self-Development Training

Training on individual, staff, and collective digital tasks must be incorporated into all levels of education systems at TRADOC service schools. This training must be tailored for each level to develop leaders for utilization at specific organizational levels. As stated in TRADOC Regulation 351-10 (TRADOC, 1997b), training and education usually precedes significant and new levels of operational assignments. Training individual, staff, and collective digital skills and digital concepts (the science and the art) in every TRADOC service school is a critical aspect of the overarching approach. Digital training must begin with initial entry training, continue throughout the TRADOC institutional education and training programs, and culminate with the highest levels of professional development.

The ABCS CRD and ORDs recognize this training requirement. The ABCS CRD (TRADOC, 1998a) states that ABCS familiarization will be integrated into the C2 programs of instruction at TRADOC service schools and will, at a minimum, address applicable doctrines, capabilities and operational employment in accordance with the ABCS and subsystem STRAP. Each battlefield automated system is responsible for providing training for use in the core curriculum. Additionally, initial training is to be conducted by a combination of professional development training and institutional operator/maintainer training courses.

The CSSCS ORD states that the training concept for the CSSCS includes institutional training (TRADOC, 1998b). Training for CSSCS will be prepared for three categories of personnel: operator/unit level maintainer, supervisor/manager and programmer/analyst. The TRADOC will provide orientation on CSSCS in professional development courses. The MCS

ORD states that MCS familiarization training will be integrated into the POIs at TRADOC Service Schools (officer basic course [OBC], officer advanced course [OAC], combined arms service support school [CAS3], CGSC, basic non-commissioned officer course [BNCOC], advanced non-commissioned officer course [ANCOC], and Sergeant Major Academy [SMA]) and will, as a minimum, address capabilities and operational employment (TRADOC, 1995b).

The FBCB2 ORD states that institutions will train systems familiarization and/or operation to initial entry officer and enlisted personnel and professional development course attendees (TRADOC, 1997c). The PM will develop a series of system training products and conduct initial and key personnel training and NET to be used as the basis for institutional training.

Again, it appears that numerous approaches have been identified. All contain good concepts that would partially support digital training and self-development activities. Figure 9 is a model that was developed by consolidating key ideas from the various ORDs, STRAP, and the ABCS CRD combined with concepts from training research.

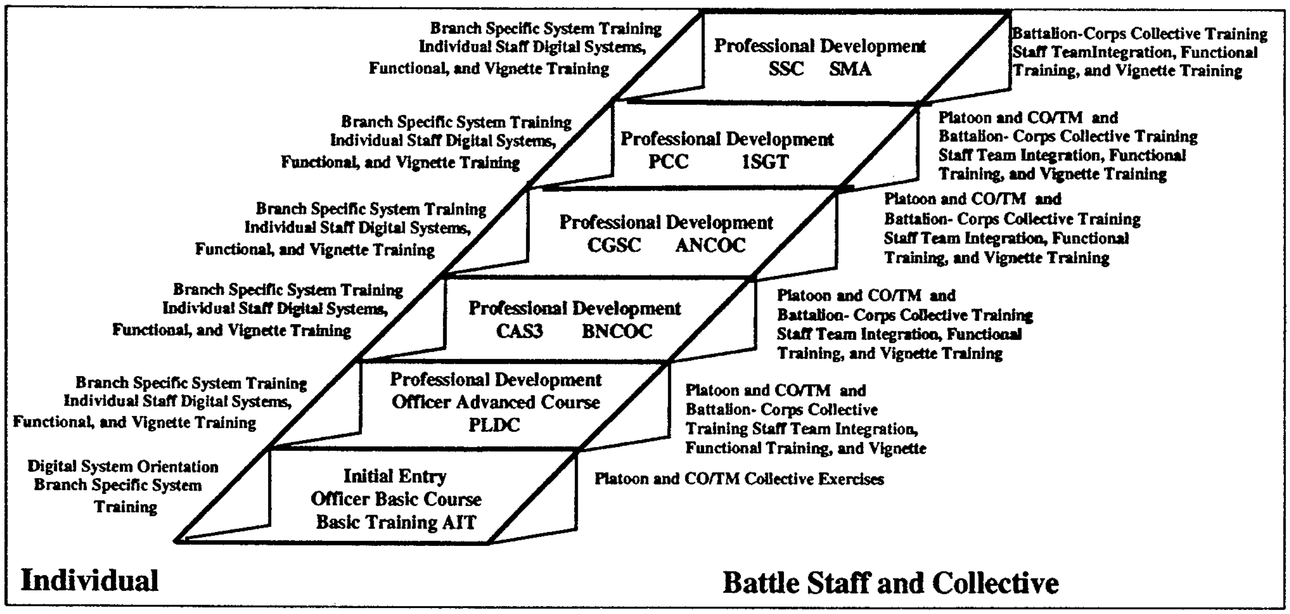

Figure 9. Model for Warrior XXI – institutional, individual, collective training and self-development.

Individual Training in the Institution

Individual training on digital systems and digital concepts must be incorporated into all levels of the educational system. This training must be tailored to specific professional development levels and address performance shortfalls due to digital skill decay, changing system software, and doctrinal changes. The training products developed for the initial training conducted during fielding should be used as the basis for this training. Individuals must be trained on their branch specific systems and receive the specified digital commander and staff training.

Initial Entry Training (IET) provides an example of the concept described above. As part of fielding, the PM (through the contractor) will execute individual training for the system during NET. This training should be task-based, multimedia CBI or capable of use on a LAN, Internet, and/or Intranet. It should be continuously updated and embedded into the actual hardware. When this is accomplished, the transfer of this training into the institution will be a straightforward process.

Professional development courses should follow the same model. Officers during their OAC would receive individual staff digital systems, functional, and vignette training. This same training would be ongoing in the units receiving their NET from the contractor. When the system has been fielded to the Army and NET is complete, the training would require only minor changes which would be made by the proponents.

Collective Training in the Institution

As with individual training, collective training on digital systems must be incorporated into all levels of the educational system. Also, the training products developed for the initial training conducted during fielding should be used. For example, TSPs used to support EXFOR training for AWEs at the platoon through brigade level should be incorporated into professional development courses during institutional training. Instruction ongoing in the Fort Hood CTSF on the ATCCS will mature as we increase our expertise on digital TTP and evolve digital TSPs. These digital products should migrate into the TRADOC institutions, as they become available.

Individual Training - Self-Development

A major effort is needed to enhance self-development digital training. The training audience for the Total Army is varied and dispersed. The frequency of changes in software and doctrine exacerbate digital skill decay. The spiral development ongoing in all of the DTLOMS domains keeps training developers scrambling to maintain training that is current. Historically, the Army has allocated fewer resources for self-development. With the information highway a reality, the Army needs to focus on self-development as a way for soldiers to keep pace with digital requirements.

The numerous individual training products being developed for digital systems, staff functional training, and staff vignette training need to be developed following the concepts in AT XXI. Courses must be made available via distance learning technology such as TATS courses on CD-ROM or accessible via the Internet. Individuals need to have the capability to maintain proficiency on digital systems. An improved self-development capability is essential to any digital training strategy.

Training System

The Army has developed a multitude of training systems, processes, cycles, and strategies that address training requirements. These systems differ in their focus but share common features. The first step in specifying the training system functional requirements for a digitally-equipped force is to recommend a training system that accommodates a digitized force.

Once the system has been designed, the next step is to determine the capabilities or functions for each component of the training system.

Army Training Systems, Processes, Strategies, and Cycles

The Army does not have a common definition of an Army training system. In determining the structure and components of the training system to be used for this research report four different sources were referenced. These were the Training Management Cycle from FM 25-100 (Department of the Army, 1988); the Systems Approach to Training (TRADOC, 1995b); the Force XXI Training Strategy (TRADOC, 1994); and the Training System from Army Training XXI Concepts (TRADOC, 1997a). Although these vary in their structure and serve different purposes, their concepts are very similar. Figure 10 illustrates the similarities.

Training management cycle from FM 25-100. The capstone doctrinal training manual for Army training is FM 25-100 (Department of the Army, 1988) which describes the Army training management cycle. It is used by units to train to standard in mission essential tasks. The process begins with identification of the unit wartime mission and establishment of the Mission Essential Task List (METL) prior to the initiation of the cycle that has four steps: (a) prepare a training assessment, (b) prepare training plans, (c) execute the training, and (d) evaluate the training.

Systems Approach to Training. The Army currently uses the SAT process outlined in TRADOC Regulation, 350-70 (U.S. Army Training and Doctrine, 1995b) to develop, manage, and assure the quality of individual, collective, and self-development training for the Army. The SAT describes the Army's training development process and is primarily focused towards training developers in TRADOC Schools. The SAT, described as a disciplined and logical approach, involves four training-related sequential phases: (a) analysis, (b) design, (c) development, and (d) implementation. The evaluation of training products occurs during each phase.

Force XXI training strategy. Since 1995, the Force XXI Training Program has been developing the foundation for future methods in Army training. The BSTS, COBRAS, and SGT training products were produced as part of research and development efforts. The Force XXI training strategy was used during these efforts. This strategy (TRADOC, 1994), which is similar to the FM 25-100 Training Cycle, starts with determination of wartime mission and unit METL. This is followed by a commander's assessment, development of training plans, execution and data collection, and finally an AAR.

Army Training XXI training system concepts. The AT XXI campaign plan (TRADOC, 1997a) describes a training system that is capable of continuous improvement through the infusion of emerging technologies and functional requirements. Implementation of this system will provide: (a) integrated and distributed information and training management support, (b) comprehensive, configurable, content-rich training products and media, and (c) synthetic training tools and devices. The objective training system is intended to provide a full range of responsive training support capabilities using go-to-war and standard hardware systems for trainers, training managers, and trainees at home station, deployed, or en route to operational missions. Each of the three axes has different components that can be grouped into five categories: (a) FEA, (b) training documentation, (c) support tools, (d) evaluation, and (e) archive.

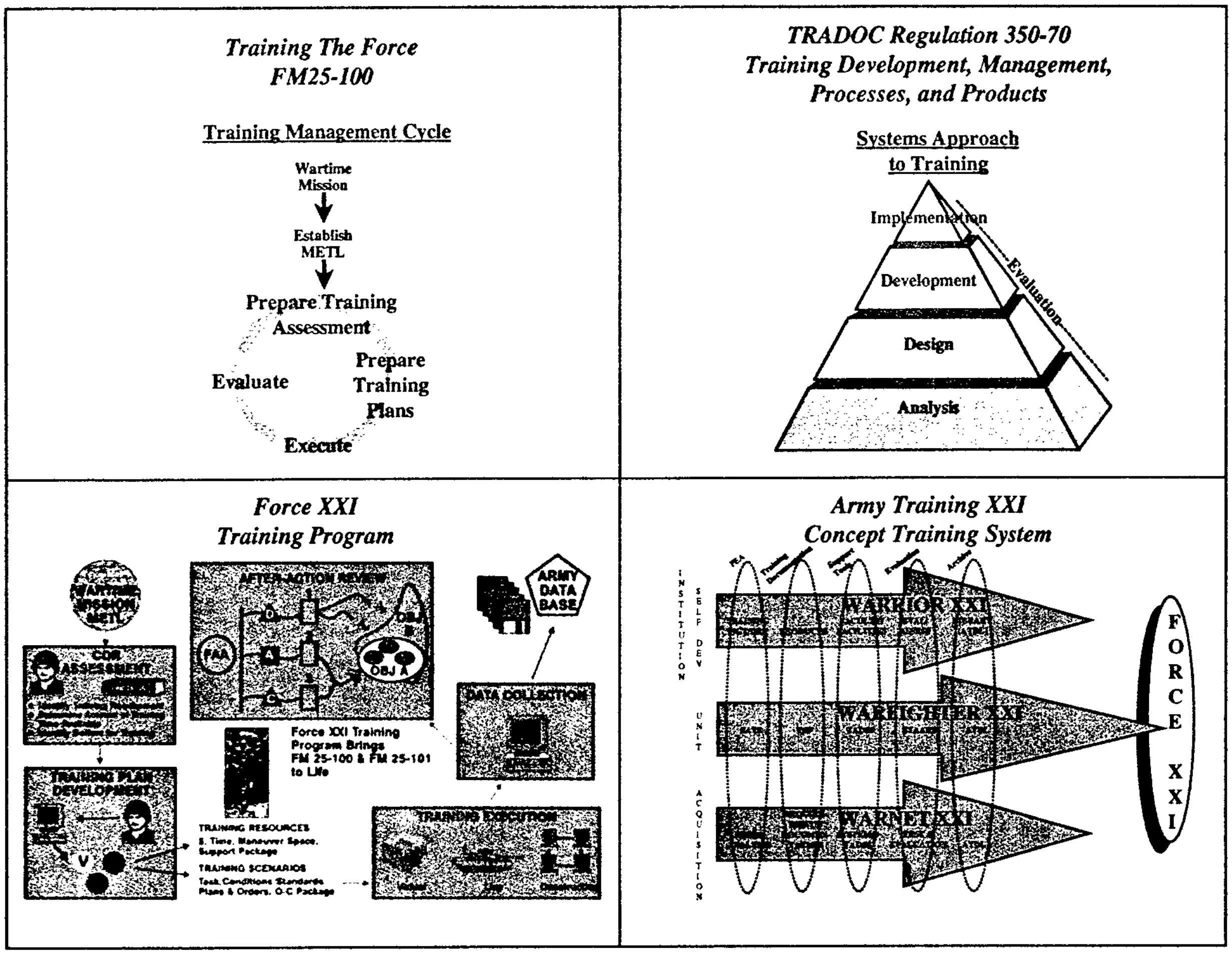

Figure 10. Army training systems, processes, strategies, and cycles.

Digital Training System

The previous systems, cycles, and strategies provide a good foundation for building the training system for the digital force (see Figure 11). This system includes the following six components: (a) training requirements analysis, (b) training plan and support package development, (c) training execution, (d) data collection, (e) assessment, and (f) feedback. This system could provide a foundation to revise models in FM 25-100 (Department of the Army, 1988), TRADOC Regulation 350-70 (TRADOC, 1995b) and the AT XXI Campaign Plan (TRADOC, 1995a). These references should be revised to assign responsibilities for implementation and coordination. The following discussion will show how digitization affects these training components and provide recommendations for further development.

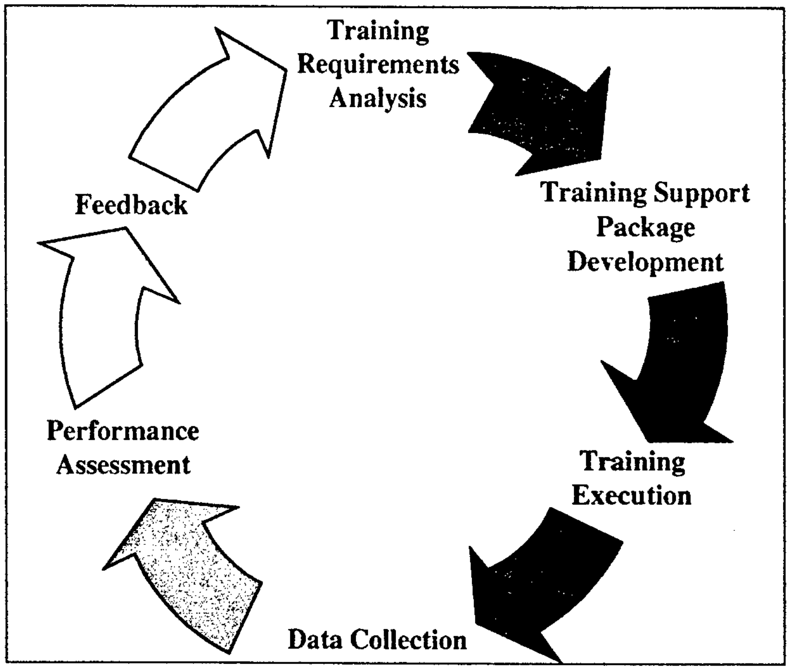

Figure 11. A digital training system mode.

Training Requirements Analysis

Although the reviewed systems use different terminology, all training management and development systems have an analysis component. The basis of all training is the determination of the tasks, conditions, and standards for the training audience to execute. Training a digitized force is no different.

Lessons learned and observations from all of the AWEs have identified this as an important first step to training. An insight from Desert Hammer stressed the need to identify new or modified tasks required for digitization (Mounted Maneuver Battlespace Battle Lab, n.d.). It was noted almost four years later during the Division XXI AWE that a detailed job analysis to determine tasks, conditions, and standards was needed for corps, division, and brigade staff positions in a digitized force (TRADOC, 1998a).

To make battle command and staff training effective, the tasks, conditions, and standards for training commanders and staffs must be better defined (Brown, 1996). These staff training objectives are incomplete and require immediate analysis and codifying. The analysis of staff tasks, conditions, and standards must include the vertical integration of higher cross-BOS functional headquarters as well as lower level functional units such as engineers, ADA, or CSS elements. The BFs that were completed for analog battalion and brigade staffs should be revised for digital units. As noted by Dubik (1997), warfare in the information age will require additional skills in concert with those previously attained in the industrial age Army. These skills involve the synchronization and integration of effort of multiple BOSs in time and space to achieve the commander's intent.

Comments from previous EXFOR commanders validate these studies and lessons learned (U.S. Army Training and Doctrine Command EXFOR Working Group, n.d.). All felt that digital tasks were additive to the old analog tasks and one commander reported that the training requirement doubled. They also indicate that the Army has not identified new digital tasks but has merely digitized old analog tasks.

As the Army slowly evolves to a totally digital force the requirement to provide training to perform tasks on digital and manual systems remains. The reliability of digital systems, the lack of digital back-up/redundant systems, and the digital/non-digital mix of systems dictate this requirement. The need to train and evaluate both automated/digital and manual/analog tasks affects all components of the training system. This is further complicated by the automation of many individual and collective tasks. Units will continue to face this challenge until the Army includes adequate redundancy measures in its digitization effort.

Determining the tasks, conditions, and standards required to train a digital force is a tough but achievable and necessary goal. It should be approached in two ways. First, conduct a comprehensive, coordinated, and integrated FEA to determine the tasks. Second, develop an automated assessment and feedback system for digitized units that has the ability to revise training objectives. A discussion of such an assessment and feedback tool appears later in this chapter.

Since the evolution to digitization began, doctrine writers from every TRADOC school have been revising the TTPs for digital units based on observations of exercises. These are quickly outdated as digital tasks are "living tasks" that require revision as system capabilities change and units identify better ways of doing business. Under the Warrior-T Program (TRADOC, 1998a), a TRADOC cell is to be established at Fort Hood to observe units and capture digital training objectives for every BOS. This FEA is required to establish a foundation for the training system and should assist the Army in solidifying its doctrine for fighting the digital force. The TRADOC Force XXI Operations pamphlet (TRADOC, 1994) is four years old and has not been updated to reflect the results of the AWEs. The FM 100-5 (Department of the Army, 1993) is currently under revision but needs to be finalized prior to determination of digital tasks. The independent observers must capture the processes while individuals, staffs, and units are conducting the training or exercises. Also, observers must be present for long periods of time to observe both failures and successes. Horizontal and cross-BOS tasks and processes must be captured. The BFs should be revised and modified for digital forces. Finally, "back-up" tasks must be captured and incorporated into TTPs.

Earlier we addressed the potential for early development in initial crew and unit collective tasks for a new system by using an advanced distributed simulation environment. The same is true for developing staff and leader TTP as digital systems are developed. However, the rapid change in digital system capabilities as they evolve requires a more real-time approach, rather than attaching observers to units to record what happens as the unit attempts to use the systems in training exercises. An explicit system with a low cost environment must be established that permits unit staffs and leaders to step through tactical situations first very slowly and then more and more rapidly as observers/mentors assist and track actions each step in the process.

If one can agree that the only major difference between an environment that supports TTP development, training, mission rehearsal and course of action analysis is the speed with which the tactical simulation driver runs, then one can envision a single system that could be used to support the entire process. Thus far, such a system does not exist but should be the objective capability the Army seeks. Lacking such a system, one could use something as simple as a "board-based" or terrain model wargame to support the development of staff and commander TTP development.

A board game approach would have the commander and his battle team separated from each of his operations centers. Each operations center would be manned and separate from the others. Each of the C4I systems would be present as appropriate and linked to the simulation driver, or in this board game approach, linked to a reciprocal system that can manually feed it input. Each C4I system would be manned by the appropriate staff member and an SME on that particular system would be in direct support. Each surrogate operations center would be manned appropriately to include the Battle Captain. Qualified mentors would be assigned as a minimum to the Commander, each Battle Captain and the C4I stimulation cell. The method consists of stepping through each phase of the commander and battlestaff process for each type of mission. The commander, staff members and TOC Battle Captains state, as required, their information expectations/desires and the staff with C4I SMEs and mentors attempt to satisfy these requirements by appropriate use of the C4I systems and integration of information. The C4I system SMEs and Battle Captain mentors ensure that the full capabilities of the C4I systems are used to provide the information. In all aspects of staff immediate action, future planning and decision making such a process can be used to work through issues, identify executable TTP and identify shortcomings in the C4I systems and processes. Once an initial, clear, executable Battle Command and staff TTP is defined then the simulation/stimulation driver can be executed at faster tempos under varying conditions to refine the processes. This is just a brief explanation of a detailed concept to show that rapid development of staff and commander TTP can be done relatively quickly and with reasonable overhead. It should not require a long-term data collection effort that relies on the hope that the units will eventually adopt a good process that the Army wants to record and provide to the rest of the force.

Training Support Package Development

A limited number of structured TSPs have been developed to train non-digital system (e.g., SIMUTA, SIMBART, and STRUCCTT). Initial efforts for digital forces (e.g., SIMUTA-D and EXFOR) were based on existing TTP and force structure circa 1994-95. Training packages were designed to train units from platoon to BCT in virtual and constructive simulation environments using scenario-based exercises for various missions.

Warfighter XXI TSPs are intended to provide unit tailored scenarios for live, virtual, and constructive simulation training (TRADOC, 1997a). These TSPs: (a) provide training execution support materials, evaluation materials, and references; (b) are capable of modification to meet specific unit and individual needs; (c) support the planning and resourcing execution of the training event; (d) are digitally stored and retrieved through the Army Digital Training Library; and (e) are designed and modified with the automated systems approach to training and accessible by units using SAT. The concepts and capabilities of Warfighter XXI TSPs provide a basis for digital units but need to be expanded.

Any future TSPs for the digital force must replicate evolving Force XXI operations and emphasize simultaneous operations, precise and synchronized attacks across an extended battlespace, and non-linear operations. Missions and scenarios must be designed around the deliberate patterns of operations that emphasize force projection and protection, information dominance, shaping of the battlespace, decisive operations, and sustaining the force. During the train-up of Task Force XXI for the AWE, training was drawn from the principles contained in TRADOC Pamphlet 525-5 (TRADOC, 1994). These should be reviewed and used as a start for developing digital force TSPs.

The training execution support and evaluation materials need to include digital products for the ABCS systems such as digitized overlays and databases that can populate the digital systems, and files for the simulation system. The training evaluation materials should provide tailored observation sheets and address automated data collection requirements.

The concept of progressive training must account for requirements specific to digitization. Current TSPs focus on friendly/enemy force ratios as the primary method to increase difficulty. The results of STIM suggest ways to increase difficulty that include increasing and varying the number of digital messages received in a particular time, adding messages that provide more ambiguity to the enemy situation, and adding "noise" via faulty messages (Freeman et al., 1997). Forcing the training audience to use back-up analog tasks is another method for increasing difficulty.

An important feature of the Warfighter XXI TSP is the ability of commanders to modify the TSP based on training objectives. Digitization brings with it complexity that requires research in the ability to modify digital TSPs. These modifications may be based on a requirement to focus on operational conditions that include degradation of digital systems, mixed analog/digital units, information warfare, breadth of battlespace, as well as the proficiency of the unit. A CITT-like "wizard" system needs to be developed that provides commanders the ability to modify TSPs and provides the needed training execution and evaluation materials. The speed with which the TTPs for the Force XXI Division units are evolving dictate that TSPs and TSP development tools enable rapid change in the exercise packages.

Training Execution

Digital units will execute training in live, virtual, and constructive (L-V-C) environments. To create realistic digital training conditions, information should be fed to the training audience from multiple sources. To achieve this, the training environment must recreate the entire information network. A review of the CVCC research (e.g., Atwood et al., 1994), SGT project (e.g., Koger et al., 1998), AWEs (e.g., TRADOC, 1998), and the Brown, Nordyke, Gerlock, Begley and Meliza (1997) work provides insights to these unique requirements. As these evolving L-V-C digital training environments are interconnected, developers must adhere to the elements of the HLA that were established to create a common framework.

To train digital units, the exercise controller needs the capability to send or "push" digital information such as ABCS databases and reports, UAV video feeds, and JSTARS moving target indicator (MTI) data to support the exercise. In the CVCC project, a SEND utility was used to send pre-created digital reports to the vehicle simulators and to the TOC workstations. Reports could be sent individually or in vignettes, at preset times or with preset intervals between the messages. The SEND utility was particularly useful in training individuals and small staff sections in a highly structured scripted training environment like the SGT. The research by Brown, Nordyke et al. (1997) reinforced the need for a send, receive, and process capability for exercise control. These utilities enable the push of information to include voice and digital communications, orders, overlays, warnings, reports, enemy situation updates, and targeting data.

In a tactical environment, digital units have the capability to "pull" digital information from higher, adjacent, or subordinate units. The ABCS system, using the client/server architecture, has the capability to access databases or information. Exercise control must provide connections to other sensors and collection systems and must manage and ensure the flow of targeting and intelligence information (Brown, Wilkinson, et al., 1997). This finding was echoed in an earlier recommendation that semi-automated forces in CCTT must be able to automatically send digital information such as positions or reports to the training audience.

In summary, the digital training audience should have the capability to push and pull digital information from higher, lower and adjacent units as in the real world. This same capability is required for the trainers using AAR systems and training facilitators who are emulating notional elements. These capabilities permit the trainer to set the conditions to ensure execution of the intended tasks. Setting the conditions for task-based training is a defining feature of the structured training approach.

Data Collection

An important aspect of training is the collection of data. Many of the efforts described earlier provide insights to the unique data collection requirements of digital units. The basic requirement is that adequate data needs to be collected to assess the degree to which the training objectives have been met. The following paragraphs highlight some data collection recommendations and give examples of existing data collection tools.

Monitoring, listening, and recording information from digital and non-digital systems are important data collection features. In the CVCC project, the LISTEN utility was a companion tool to the SEND function. The LISTEN utility showed all digital reports sent out on the net. The messages were printed for immediate review and archived to a disk file for later review. Checkpointing, another CVCC utility, provided the capability to capture a snapshot of a training exercise at a selected point in time. It essentially allows an exercise to be frozen and saved for future use. Checkpointing saves the status of all the manned simulators and workstations (including the digital equipment being used [overlays, messages, etc.]) and records the date and time that the checkpoint occurred. If restarted, all systems initialize to the point in time that the checkpoint occurred. Related, the ability to monitor and record information from up to six Applique' screens from the manned modules was achieved in SIMNET during the EXFOR training exercises. These recordings could be marked for later use in the AAR (Winsch et al., 1994).

Embedded data collection procedures offer a powerful approach to collecting data in complex environments. For example, the SGT utilizes embedded data collection procedures by capturing system-generated performance data, standardized unit self-assessment, and automated data processor observer tools for higher function data collection. The instrumentation data focuses on the performance of tasks for the lower level learning objectives. The observers collect data concerning the higher level objectives by recording the actions of staff members in intra-staff actions both within the CP and with elements outside the CP.

Accounting for the impact of C4I systems on exercise control, Brown, Nordyke, et al. (1997) suggested collecting automated data on the following:

1. Digital communications (OPORDs, overlays, requests, reports, etc.)
2. Situational awareness
3. Collection assets requested
4. Commander's information requirements
5. Discrepancies between ground truth and perceived truth, and their effects
6. Player access to external information sources
7. Information "pushed" by higher and "pulled" by players (cross-walk with mission information requirements)

Brown, Nordkye, et al. (1997) also offer a host of recommendations for improving analog data collection that would be beneficial to digital training. These include examples of capabilities to facilitate performance of key O/C and analyst data collection. These included automating battlefield damage assessment results, collecting data on line of sight misses, and providing O/Cs a mobile workstation/laptop to observe activities. The authors also point to the following important areas of observation for O/Cs:

1. Command and staff interactions during decision-making process (wargaming, course of action development/selection, and intelligence processing)
2. Effectiveness of briefbacks (who attends, apparent understanding of plan, changes to the plan)
3. Effectiveness of rehearsals (rehearsal type and process, apparent understanding of plan, changes to the plan)
4. Information sources accessed
5. Command and control actions during mission execution

The Unit Performance Assessment System (UPAS) is a software system that collects network data from the SIMNET system and converts the raw data into map displays, graphs, and tables showing how well a unit performed (BDM International, Inc, 1995). The major capabilities of UPAS are data collection, replays of battles, snapshots, and reports. Data collection can be accomplished with UPAS using a highly structured approach for producing AARs and THPs or a second option that allows the data collected to be customized and filtered. The Automated Training Analysis and Feedback System (ATAFS) was a follow-on to UPAS that addressed limitations of UPAS such as an inability to collect radio communications synched to visual display data and the excessive time required to analyze UPAS data (Brown, Wilkinson, et al., 1997).

There are ongoing research efforts to develop capabilities that allow trainers to identify significant tactical events (e.g. initial enemy contact, digital dissemination of locations of contaminated areas, high payoff targets located by UAVs) during scenario development. As these events occur the training system then automatically collects and stores required data, formats initial AAR presentation materials and inserts appropriate doctrinal guidance. These types of data include: disposition of forces, digital and voice messages leading up to and immediately following the event, and friendly picture from the threat perspective. These automatically generated materials are then available to the trainers in time sequenced order for use in rapid construction of the AAR. Such tools permit the trainer to focus on the conduct of the exercise and unique events rather than being distracted by the capture of standard information. These tools have been considered in the C4I Training and Analysis Feedback System (CTAFS) and the CCTT XXI development efforts.

Systems designed to train digital units need to incorporate both automated and manual data collection mechanisms. This need is demonstrated by the research in previous stages of this report and the systems described above. These efforts need to be used as a foundation for further research aimed at specifying the design and development requirements of a complete data collection tool that will significantly contribute to training.

Performance Assessment

The next component of the training system is the assessment of performance data. This requirement is more difficult in a digital environment. An automated system should compare performance, information provided or available, and expanded digital tasks. One of the conceptual components of Warfighter XXI is the Standard AAR System (STAARS) (TRADOC, 1997a). It calls for all current and future AAR systems to provide the trainer, training developer, and combat developer with DTLOMS-based information and feedback on performance of systems, students, and units. The STAARS is intended to provide the following:

1. Quick look assessment of unit performance during execution of training.
2. Immediate AAR feedback to the training unit using a standardized, automated, task-based approach.
3. Reduced AAR preparation time and improved quality of products.
4. Software tools to enable user tailoring of AAR products to meet local needs.
5. Quick, visual displays of critical exercise events portraying data to the trainer and analyst along with recording data.
6. Data to be used in assessment of a unit's training status.
7. Modification of the unit's training plan.
8. Expert system guidance for users to capitalize on feedback from events.
9. An ability to translate lessons learned from the Center for Army Lessons Learned, Battle Lab experiments, CTC rotations and unit training events into leader development and collective training concepts, methods, and strategies.

10. An ability to produce revised doctrine or TTPs.
11. Interface with current and future simulations and simulators.

The ATAFS database (Brown, Wilkinson, et al., 1997) is an example of a system that trainers could use to determine if a unit performed a specific task to standard. Although geared for analog units training in the SIMNET environment, ATAFS could be modified to gauge the impact of digitization on unit performance. It contains over 5000 MTP standards for the tank platoon, company team, and battalion task force. The database specifies the types of data required to measure unit performance: network data (electronically collected), radio communications, direct observations of leader/soldier behaviors, planning products (orders, overlays, etc.), and terrain information. For digital training exercises, electronically collected and analyzed data is required to support assessment.

Systems designed to train digital units need to incorporate an automated tool to support the trainers' assessments of unit performance. The data collection and performance assessment efforts described in this chapter provide a reasonable direction for the development of such a tool set.

Feedback

The final component of the training system is feedback to the training audience. This feedback is through AARs and THPs. This feedback needs to be tailorable, automated, and designed following the STAARS concept of a three tiered AAR system (TRADOC, 1997a). Tier 1 provides automated, standard products connected to the commander's training tasks. Tier 2 provides automated AAR products with a menu to select from for advanced or additional analysis. Tier 3 provides the user the ability to build customized AAR products. An automated feedback system has never been developed for digital units. The ATAFS (Brown, Wilkinson, et al., 1997) and SGT (Quensel et al., in preparation) are the only examples of automated AAR systems.

The ATAFS study (Brown, Wilkinson, et al., 1997) called for an AAR system that automatically generates AAR displays for specific combat tasks. The ATAFS system supports the STAARS concept for AARs by providing a menu of AAR aids at the end of an exercise. Further, it contains an AI engine or knowledge database that guides the automatic generation of AAR aids. It also supports the Tier 3 concept by enabling users to create their own aids.

The SGT AAR provides automated AAR displays on objective measures of staff performance. Computer screen displays provide feedback on timeliness, accuracy, and relevance of information via an automated performance profile (which evaluates staff actions with mission-critical information) and the "window of opportunity" (which portrays whether the actions took place in a timely fashion). The staff section also performs a computer-based self-analysis for use in the Exercise AAR and receives an individual-level remediation plan that includes references to BSTS modules. The SGT AAR module charts and graphs could serve as prototypes for effectively presenting objective digital performance data. The SGT Exercise AAR is computer-driven but involves the commander in its presentation and allows the staff to assess their performance as a whole. Because the SGT Exercise AAR is computer-aided, it helps walk the trainer or commander through the AAR and focuses on tasks rather than tactical outcomes; it is a learning tool on *how* to present AARs.

The SGT also provides an example of how to create a useful THP. Because the SGT's Commander's Staff Profile information is downloaded from the SGT workstations and PDAs, the THP can be given to the commander 20 minutes following completion of the exercise rather than the usual several weeks after an exercise (Quensel et al., in preparation). Computerizing the tools to collect digital and non-digital performance data and to provide feedback means that useful THPs will be that much easier to create in the future.

A key finding of this effort is that systems designed to train digital units need to include a capability to automatically create an AAR. The research findings contained in this report should be used as a foundation for further research aimed at developing an integrated automated assessment and feedback tool. This brings us back full cycle to the Training Requirements Analysis component shown in Figure 11.

Cycle Number II – Training Requirements Analysis

Current simulation technology permits the trainer to have unprecedented control of the conditions under which tasks are trained. This permits the trainer to tailor both the exercise conditions and performance standards to the unit's capabilities. Upon completion of the first cycle, feedback is available to determine the unit's level of performance and permit the trainer to revise the conditions and performance measures under which the tasks will be trained in the next cycle.

In addition this documentation of the evolution in task, conditions and standards sets the conditions for identification of the required modifications to digital TTP. As we cycle through the training process and capture the data across all units, we will be able to more rapidly and accurately learn how to exploit existing Force XXI capabilities and provide the force with updated 'how to fight' manuals. The obvious next step is to use this data to clearly identify shortcomings in usability and trainability of existing digital systems. This could feed directly into what *should* be the evolving simulation-based acquisition process (John Hopkins University Applied Physics Laboratory, 1998).

LESSONS LEARNED

This chapter distills the major lessons learned for the current effort. Some lessons learned are specific to the CCTT environment, most apply to the entire Army training spectrum. All lessons are addressed to Army trainers, training developers, training managers, leaders, decision-makers, and researchers involved in the design, development, and implementation of training programs for digitally-equipped units. Many of the lessons learned throughout this chapter relate to the challenges presented by the spiral training development approach currently embraced by the Army. Spiral development calls for soldier-in-the-loop "train as you fight" development and has significantly modified traditional, controlled training development and implementation approaches. Further, spiral development appears to be a long-term training development approach. Thus, getting a handle on the best way to train in a dynamic, changing environment is imperative. This chapter illustrates many of the specific hurdles faced by training developers working within the parameters of a spiral environment and are offered to further the Army's progress in delivering training to its digitally-equipped forces. It is organized around the following topics:

1. Integration of training requirements and simulation technologies
2. Training program design and development for digitally-equipped units

Integration of Training Requirements and Simulation Technologies

Training programs designed for digitally-equipped forces must adequately account for new training requirements brought about by the introduction of advanced warfighter technologies in a way that ensures that the training environment will support the desired training. One significant factor regarding the marriage of training requirements and simulation technology is the required fidelity of both the training devices and the training environment (see Table 14).

Table 14

Training and Simulation Integration Lessons Learned

CATEGORY	LESSON
Training Fidelity	• Training development and technology advancements are synergistic • Simulation and live TOC assets require integration • Compromising digital connectivity adversely affects training
Facility Requirements	• The number of digital platforms must support the selected training echelon • Installing an automated AAR capability will have a high pay-off • The total package fielding concept can expedite facility upgrades
Workarounds	• Workarounds should not increase a unit's resource requirements • Workarounds should not result in negative training • Workarounds should focus on functions not considered combat critical • Leaders need to be informed about the advantage of workarounds

Very early in the training design process, decision makers must determine how closely the training environment (simulation or live) must match the operational environment to achieve the desired training results. The results of the current effort highlight several important considerations regarding the issue of training fidelity. This section of the report illustrates key lessons learned regarding training fidelity requirements and two other closely related factors, facility equipment requirements and the use of workarounds.

Training Fidelity

The "train as you fight" model forces Army decision makers to constantly forecast the expected training requirements and technologies for tomorrow's forces to ensure the relevance and utility of current training development efforts. Training and technology requirements are often interrelated, as demonstrated by the proposed CCTT enhancement recommendations discussed earlier in this report (see the Findings and Discussion chapter). For instance, adding a digital capability to the AAR and SAF workstations also requires simulator modifications. Adding new digital capabilities is expected to impact requirements for training material development (e.g., require the development of TSPs tailored to digital operations). Additionally, the 1st CAV Division leadership prefers having actual TOC elements located outside of the simulation facility. This highlights the need to consider linkages to non-CCTT assets and procedures for integrating simulation technologies and live assets.

An important training fidelity requirement relates to the degree to which communication systems (e.g., IVIS, FBCB2, ATCCS) found in the CCTT mirror the vertical and horizontal communication linkages found in the field. Additionally, the number of simulators must be sufficient to support the training audience. The AFATDS, the only ABCS system in use at the CCTT facility, was not a full-scale version of the system and could be linked only to IVIS. In contrast, the POSNAV component of IVIS and the CITV (with its laser range finder) were designed for high fidelity and were frequently used during the CCTT LUT. The major lesson learned is that there is a strong need to provide a high degree of realism to unit personnel and leaders, especially with regard to the integration of higher assets and the configuration of digital devices. The CCTT XXI program will address these issues and ensure the integration of ABCS into CCTT.

Facility Requirements

The CCTT facility needs to be adequately equipped to support collective digital training. For example the initial test fielding of CCTT at Fort Hood, TX only included 10 M1A2 simulators which was shown to be insufficient to train a M1A2 company. Further consideration should be given to integrating the ATCCS into the CCTT facility TOCs and providing trainers and workstation operators with digital equipment to communicate and feed digital traffic to the unit. Finally, the CCTT facility requires automated equipment to monitor, record, and playback digital traffic that can be used to support the delivery of digital (and conventional) AARs. During the FBCB2 LUT, the training audience will require similar FBCB2 capabilities. Whether the system is IVIS or FBCB2, the underlying principle is the same. The training facility must be equipped in a manner that facilitates realistic training on the selected systems.

To incorporate these changes and the other enhancement recommendations, significant downtime will occur in the CCTT training schedule. Total package fielding should be applied to minimize facility downtime. This concept calls for concurrent system and unit upgrades. For example, any new C4I system installation and software updates should take place in parallel within the training facility. Essentially, a training facility's infrastructure, including procedures for incorporating system/facility changes, should accommodate sustainment, maintenance, and update activities without incurring significant lost opportunities to the training units.

Workarounds

The issue of whether to use workarounds to provide training participants the opportunity to "experience" a device feature is complex. Unit personnel dislike workarounds because they are frequently perceived as contributing to negative training as well as increasing internal support requirements. However, PMs often see workarounds as constructive and even innovative options for leveraging training device capabilities. For this research effort, workarounds were sought to advance the concept of training tools, techniques, and procedures. There is a difference in perspective regarding the value of workarounds between unit personnel and the CCTT-D project leadership. Though we were asked to explore possible workarounds to support digital training, unit leaders wanted fire support, engineer, CTCP, air defense, and other CS/CSS players to participate in simulators rather than at workstations to get more realistic battle "friction". In many ways, adding personnel at the CS and CSS workstations represents an innovative approach to broadening the training audience for simulation-based exercises and provides a training option when more realistic alternatives are not available. However, unit personnel were not in favor of tradeoffs that degrade realism even to this level.

As indicated above, designing workaround procedures that prevent training participants from getting "close enough" replications of fielded equipment is frequently perceived by unit personnel as unacceptable. Clearly, workarounds that are complex and/or do not replicate the fielded equipment are seen as providing negative training. Training developers must carefully weigh the potential tradeoffs when training programs are designed to require the training audience to use workarounds. This is especially true if the workaround centers on a device feature that is frequently used and is considered combat critical. Under these conditions, soldiers will often attempt the standard method for completing a task rather than learning and employing a training workaround. If this happens, the validity of the training is threatened.

To minimize workaround requirements for units, leaders suggested a plug-and-play training capability. This is achieved through importing digital equipment into a training facility that supports seamless implementation of the equipment's features. Another alternative is to ensure that the equipment in the training environment replicates the organic equipment in critical ways and that workarounds are required only for activities that are infrequent or arguably inconsequential to the overall training objectives of the unit. For instance, initialization procedures for a system, if well documented and trained, could vary from the fielded device. In most cases, this would not detract from a unit's training objectives. Training developers should strive to develop workarounds that do not increase the unit's resource burden and to educate leaders/trainers about the potential value of required workarounds. Workarounds should be employed to limit the use of soldiers as "training aids". To eliminate current use of workarounds in ways that negatively impact training, the Army should integrate both the crew and collective simulation training requirements into the acquisition of every system.

Designing and Developing Training Programs for Digitally-Equipped Units

The major lessons learned for training design and development are shown in Table 15.

Table 15

Design and Development Lessons Learned

CATEGORY	LESSON
Training Program Design	• Determine training program foundation early • Base design requirements on system acquisition milestones • Tailor SST templates to specific project • Document design parameters and changes • Use most current doctrine/tactics for digital operations • Use most current task lists for digital operations
TSP Development	• Tailor training materials to digital audience • Follow Wilkinson's (in preparation) recommendations for TSP structure • Structure training development efforts to support "design, develop, implement, and revise" approach • Use test bed for early stages of program development

Training Program Design

Most of the lessons learned for the design phase of the current effort underscore the importance of determining key design foundation parameters early in the life cycle of a training development effort. Critical foundation decisions involved determining whether an existing training program should serve as the springboard for new development activities. There are inherent advantages to using existing programs to feed new training program development activities. Common elements from existing programs are modified to fit current requirements. These advantages must be weighed against the disadvantages – including the risk that modifying existing materials (e.g. task lists) limits innovative approaches that fully realize the potential of new technologies. Equally important is determining which digital platforms the training program will address. Since these design issues are deceptively subtle, they are discussed in greater detail below.

One major design issue concerned the selection of a training program to use as the foundation for the design and development of the CCTT-D scenarios. Based on cumulative expertise and a review of available FXXITP efforts, the CCTT-D Team determined that the two most reasonable candidates for the current effort were the STRUCCTT and EXFOR scenarios. It was recognized that use of the materials from either program would involve tradeoffs. For instance, the STRUCCTT scenarios supported only conventional training in the CCTT environment while the EXFOR scenarios supported digital training in the SIMNET and Janus environments. The team had to determine which was more important in terms of achieving the objectives of the current effort: (a) starting the design effort with scenario materials that cross-walked with the training environment but fell short on digital TTPs, or (b) using scenario materials that already accounted for at least some form of digital TTPs but fell short on addressing the CCTT.

Training development efforts must incorporate the anticipated technology and doctrinal changes expected to impact future training requirements. This is a significant challenge since there is no Army mechanism that synchronizes training program development and system acquisition cycles. For example, the current program's efforts would have been significantly facilitated had the STRUCCTT program addressed digital operations early in the project rather than toward the end or at least incorporated "digital hooks" for future development efforts. Further, the installation of FBCB2 and ATCCS into the CCTT will introduce new training requirements beyond those already identified in the M1A2 STRUCCTT effort .

Strategies for developing training programs that address both current and future technologies are needed. For instance, an important lesson learned from the current effort relates to the decision of whether to base CCTT-D design on the current IVIS or the projected FBCB2/ATCCS systems. In this case, the next two major acquisition milestones for the CCTT involve installation of the FBCB2, beginning with LUT conducted in August of 1998. Hence, training designs focused on the IVIS will be soon outdated. Ensuring that a training program will offer significant training value upon its completion may require approaches for TSP development that result in generic training materials that can be tailored to a variety of units and equipment platforms. Design decisions should accommodate the fact that changes are occurring and will continue to occur in both fielded digital systems and their respective TTP. This issue will continue to challenge training developers as the Army proceeds with the digitization process.

Future CCTT training development efforts can follow the methodology specified in this report. However, training developers must account for any new training requirements associated with the addition of new platforms (e.g., M1A2SEP, M2A3, and Paladin). The team added some items to Phase 1 of the SST methodology by incorporating battlefield conditions, training objectives/tasks, AAR approach, and exercise control approach to the SST templates. This demonstrates that developers using training development models must consider how the models should be tailored to accommodate a program's specific objectives.

The documentation of design parameters and changes is a critical component of any training development effort (Campbell et al., 1997) and is particularly important to the collection of lessons learned that can benefit future design and development efforts. In cases where assumptions are no longer valid, implications should be analyzed and new assumptions generated. Assumptions made during this effort concerning unit organization are no longer valid. Follow-ons to this effort must update these and other assumptions and document changes in an audit trail fashion.

The lack of established doctrine/tactics for digitally-equipped units was a concern of the CCTT-D Team from the outset. Ideally, the team would have used established task lists for digital operations rather than building on the EXFOR Draft MTPs. To the extent that research and development efforts should push the doctrine envelope, using the EXFOR Draft MTPs was acceptable. Training development efforts for the digital force require thinking "out of the box," especially when it comes to digital tasks and task steps. Still, the design process would have been bolstered by an initial Army-approved digital task list.

Current digital TTPs and MTPs are based on conventional force structure. They will change with the fielding of new organizations (e.g., three companies per battalion, the FSC, and the BRT). This calls for effective coordination between doctrine development and training development efforts and raises the issue of whether the Army needs a different model for developing digital doctrine and training materials. The cyclic approach proposed in the Training Systems section of this report specifically addresses this issue.

Training Support Package Development

It was not within the scope of the current effort to develop specific TSPs. Still, lessons were learned that apply to future TSP design and development activities. The quick look assessment of the current effort resulted in eight major enhancement recommendations that will be discussed in detail in a subsequent section of this report. Nearly all of these enhancements identify and argue the need to account for the unique training requirements associated with digital operations.

Comprehensive TSPs designed and developed for digital operations will be a powerful training tool for Force XXI. The factors that result in a comprehensive TSP for the CCTT are accounted for by Wilkinson's (in preparation) model which includes the following components: (a) system training packages, (b) structured training scenarios, (c) training management and exercise development systems, and (d) train-the-trainer packages. Wilkinson's comprehensive TSP model provides a structure for presenting comprehensive digital training in the CCTT that should be considered for future developments. While the Wilkinson model addresses development, an evaluation component related to the unique challenges of digital training needs to be considered.

As noted in the SIMUTA-D research report (Winsch et al., 1996), training evaluation efforts stand to benefit from the use of commonly accepted research methodologies. The SIMUTA program (Hoffman et al., 1995) leveraged simulation capabilities to ensure that the scenarios and TSPs were adequately structured to support the training objectives for each mission before the materials were used for actual unit training. The systematic design, development, and implementation approach followed under the SIMUTA effort is difficult to execute in a spiral environment. The CCTT-D effort was aimed at improving future training programs for digitally-equipped forces. The CCTT-D Team's ability to oversee the implementation of training events using controlled research methods was limited due to its piggyback nature (which is also a byproduct of spiral development). Winsch et al (1996) proposed that new training programs should undergo a develop-test-revise cycle before being distributed to a unit demanding a training benefit. However, in this digital environment training developers might be better served with a more flexible approach that could be captured as a design, develop, implement, and revise model addressed in the Training Systems section of this report.

The next chapter, Conclusions and Recommendations, summarizes the major findings, lessons learned and offers final recommendations.

CONCLUSIONS AND RECOMMENDATIONS

The outcomes of the CCTT-D effort provide recommendations to Army personnel involved in the specification of system infrastructure requirements and the development of digital operations training for the CCTT facilities. The scope of the current effort was addressed in two portions. The first portion featured an assessment of CCTT capabilities and limitations, an analysis of structured training in the CCTT environment, and a determination of the design requirements for delivering training to digitally-equipped units using the CCTT facility. The second portion moved beyond the CCTT environment, resulting in an overarching training approach for digitally-equipped forces as well as a model of the training system functionality required for digital training. This chapter presents the major conclusions from the current effort and provides suggestions for follow-on research and development. The organization of this chapter contains conclusions and recommendations specific to the CCTT first, followed by a more broad-band discussion of Army training and system requirements.

Impact of Digitization Environment

The Army has made a conscious decision to transition to a digital force more rapidly than its normal modernization process would accommodate (TRADOC, 1997a). The logic behind the decision is clear. The Army wants to reduce the time currently required to get products in the hands of soldiers and units and reduce the cost of materiel acquisition. The result is an environment of dramatic and rapid change in nearly every aspect of modernization – especially the doctrine, training, organization, and materiel domains of the DTLOMS. This dynamic environment is not new. Constructive and virtual soldier-in-the-loop experimentation beginning with the Combat Vehicle Command and Control Program initiated in 1989, followed by the Battlefield Synchronization Demonstration (Courtright et al., 1993) and the Horizontal Integration Experiment (Sawyer et al., 1994) fueled preparation for Desert Hammer -- the first digital battalion level AWE. Today the change continues with the EXFOR. The complexity of training and the amount of required changes increase substantially as the focus of training rises to higher echelons. Areas impacted include training strategy, tasks to be trained, TADSS, training programs, structured TSPs, institutional training, and the basic training development process.

Training developers accustomed to applying the Army's training development process for relatively stable jobs and units with correspondingly stable tasks find an ever more challenging environment where the "spiral development" of increasingly complex digital materiel (TRADOC, 1997a) is outpacing the stable training development process. The materiel development process involves a series of iterative steps. At each step the most current TTPs and MTPs should be analyzed for tasks that then become the basis for accelerated training development. This would produce a version of the most appropriate training products which units then use to train for the next event in the digitization process. Experience with the EXFOR shows clearly that this spiral development of digital equipment significantly complicates training development (Leibrecht & Winsch, 1997). Time available to produce training materials is minimal. Organizations change from event to event. The TTPs for digital operations are evolving and require constant updates. Digitization hardware and software change often. Soldier turbulence is high. Nevertheless, soldiers, leaders and units require training to be proficient for the major digitization milestones. Consequently, training developers must develop a new model that includes a more flexible approach that is synchronized with the materiel development process.

In addition to the challenges noted above, training developers must be sensitive to the changes technology brings to the TADSS arena (e.g., the HLA requirements). As new digital hardware/software is fielded to units, it must be incorporated into the TADSS in a timely fashion. An example is the rapid fielding of FBCB2 and the need to incorporate it into the Army's close combat heavy collective training environment (CCTT). As units evolve and mature the TTP for digital operations, the Army's training developers must capture, assess and publish this progress to ensure a rapid transition from the use of analog operations and digital equipment to conducting training using digital operations and digital equipment. Much of this effort to capture, assess and publish evolving TTP can be conducted in simulation training facilities such as the CCTT once it is modified to support digital operations.

CCTT Facility Enhancements

At the present, the CCTT does not provide all of the capabilities required to adequately train and evaluate units equipped with digital systems. Table 16 summarizes the specific conclusions and recommendations from this research effort related to CCTT facility enhancements.

Table 16

Conclusions and Recommendations Regarding Facility Enhancements

CONCLUSION	RECOMMENDATION
• The CCTT facility cannot adequately evaluate units performance of digital tasks and task steps	• Add digital exercise management tools and digital capabilities to AAR workstations
• The CCTT facility is not fully equipped with digital systems	• Upgrade CCTT manned modules with digital C4I systems required by existing force • Field CCTT operations centers/command posts with digital systems to replicate actual TOCs • Establish capability to link CCTT digital systems with live TOCs • Develop a systematic procedure to upgrade current software versions to digital systems
• Computer-generated forces require the capability to communicate digitally with manned modules	• Add digital system capability to SAF and Operations Center workstations

(table continues)

Table 16 (continued)

CONCLUSION	RECOMMENDATION
• The CCTT is focused to train platoons and company teams but has the potential to train digital battalion/task forces and BCTs	• Expand the CCTT to train battalion/task force and BCT commanders and staffs
• The CCTT's two terrain databases (NTC and Central Germany) do not allow units to train on home station or deployment terrain	• Develop additional terrain databases (e.g., CCTT home station locations, Southwest Asia, Korea)
• The CCTT could, but does not, train units on gunnery skills	• Modify the CCTT to allow for maneuver gunnery, to include appropriate weapon system performance data sets

The CCTT facility enhancements will impact training design to the extent that they will change the CCTT's infrastructure, leading to training improvements and affecting how certain tasks are performed. All of these impacts must be accounted for in the TSPs developed for digitally-equipped units.

Comprehensive Training Support Packages

Training packages for digitally-equipped units should be designed to meet the units' specific training needs. Although the STRUCCTT exercise library now includes four M1A2 exercise tables that will be included in the CITT, existing TSPs were not designed to adequately train and evaluate units equipped with FBCB2 digital systems. The CITT project, with input from the STRUCCTT Team, will provide guidelines on translating conventional exercises to digital using TSP formats from STRUCCTT. However, the CITT will not provide directions on modifying those exercises tactically. Furthermore, as is their charter, the CITT prototype will only include the equipment already available at the CCTT site. The FBCB2 will not be included in the CITT prototype because it will not be fielded until the fall of 1998. However, FBCB2 will be included in the CITT design documentation, and the CCTT-D scenarios, once developed, will ultimately be incorporated into the CITT (M. R. Flynn, personal communication, May 14, 1998). Thus, the CITT provides a good tool for customization of digital exercises provided that its guidelines expand to include FBCB2 task steps and any yet-to-be-fielded exercise support equipment such as digital capabilities for SAF. Table 17 summarizes the specific conclusions and recommendations related to digitally-focused TSPs.

The recommendations shown in Tables 16 and 17 provide a blueprint for future efforts by building on the lessons learned from the current effort and pointing to ways to address the limitations currently faced by training developers focusing on digital operations. Many of these recommendations introduce complex issues and noteworthy challenges. For instance, expanding the CCTT to support brigade level training is a significant undertaking that would require major additions to the CCTT facility. However, research is needed to ascertain the impact of digital operations at the brigade level.

Table 17

Conclusions and Recommendations Regarding Comprehensive Training Support Packages

CONCLUSION	RECOMMENDATION
• Structured TSPs have not been developed for the CCTT to train and evaluate FBCB2-equipped digital units	• Develop structured training to ensure performance of digital tasks and task steps for FBCB2 • Use CCTT-D and STRUCCTT M1A2 TSP design work as a foundation for TSP development
• Existing TSPs do not meet the full spectrum of unit training requirements	• Develop TSPs based on new force structures (e.g., 3 company battalion, FSC, and BRT) • Develop TSPs for new terrain databases • Develop TSPs to support maneuver gunnery training
• Current system training packages and train-the-trainer packages do not focus on digital considerations other than the M1A2	• Extend existing CCTT-specific TSPs and expand the CITT to include digital requirements for units with FBCB2
• Training management and exercise development systems need to consider unique digital system requirements	• Ensure the CITT is updated as needed to support units with emerging digital systems and equipment fielded in the CCTT beyond December 1998

A global conclusion related to TSP development is that initial program design and development activities should take place in a test bed environment that supports an iterative, design, develop, implement and revise methodology. This is especially true for programs designed to train digital operations because of the lack of established doctrine and the current trend to develop doctrine and training for digital operations in parallel. Using an iterative approach in a controlled test bed will afford training and doctrine developers multiple opportunities to "grow and extend" TSPs, MTPs, and TTPs designed for digital operations.

The CCTT-based recommendations listed in Tables 16 and 17 suggest areas where additional work is needed. For instance, the utility of the recommended CCTT enhancements should be examined with warfighters in the loop. The enhancement recommendations were generated from subjective data and should be verified in a controlled manner. Wilkinson's (in preparation) model for TSP design provides an excellent opportunity to validate an Army-accepted approach to packaging training materials. Further research is needed to establish key parameters for developing TSPs for digitally-equipped units. There are still many unanswered questions regarding the impact of battlefield digitization on system requirements, organization, missions, TTPs, and tasks. For instance, how will tasks change now that the Army has adopted a three-company force structure? How will responsibilities be redistributed within the company? How will the organization of higher and lower echelons be affected? What are the implications for digital operations? How can the CCTT be structured to support training and address these research questions?

Overarching Training Approach and Training System Functionality

The CCTT-D Team set out to develop innovative models for the Army's training approach and training system for digitally equipped forces. However, the outcome of the literature review and interviews pointed the team in a different direction. The front-end analysis revealed that the Army already has specified many of the "pieces" required to support the training requirements of digitally equipped forces. The challenge lies in connecting the pieces currently scattered throughout Army literature. No one existing model provides the solution to the broad range of digital training challenges, but the integration of several existing models covers significant ground. In response, this report offers three complementary training models one each for WARRIOR, WARFIGHTER, and WARMOD. Additionally, this report provides a training system model for the Army's digitally equipped forces. These complementary models provide one with a comprehensive approach to training (see the Findings and Discussion chapter).

The conclusions shown in Table 18 highlight the importance of exploiting training technologies; adopting a flexible training model that maintains currency across doctrine, tactics, and systems; and conducting the research needed to answer the outstanding questions related to back-up training requirements, training approaches, and information management skills. For instance, digital equipment complicates the notion of progressive training to the extent that it must now incorporate an additional dimension: digital training requirements. The "crawl" stage of training no longer is limited to the conventional arena. Further, the goal of progressive training has evolved to a "run" stage that integrates conventional and digital training requirements. An important related issue concerns the degree to which back-up skills for degraded operations need to be trained. The issue of back-up training is complex and calls for research before it can be fully understood. Direction for addressing training system requirements for digitally equipped forces appears in Table 19. The first step in developing a training system is conducting a front-end analysis of the requirements linked to digitization.

Digitization also means that training products developed for Force XXI will remain dynamic (i.e., high maintenance) as long as materiel, doctrine, and organizations continue to evolve. Accounting for the impact of digitization must include more than renaming analog tasks. A continuous analysis is required to identify and evolve the new tasks, conditions, and standards for digital operations. The TTPs for the digital force are integral to the specification of the proper tasks, conditions, and standards. Significant and steady progress on solidifying doctrine will facilitate digital force training in fully achieving its objectives.

Table 18

Conclusions and Recommendations Regarding Overarching Training Approach

CONCLUSION	RECOMMENDATION
• Parts of an overarching training strategy are currently scattered throughout the Army literature	• Use the WarMod XXI concept and build a template against which training and system development proposals will be judged to ensure integration between individual, self-development, and unit training • Develop an integrated training system and strategy that includes embedded training, simulation-based training, and distance learning
• Training approaches must accommodate the rapidly evolving digitization environment	• Produce training products that are easily modified and accessible to the entire training audience • Maintain currency of training products to reflect evolving doctrine; TTPs; task, conditions, and standards; and system changes
• Training must be sequential with threads between individual and collective approaches	• Develop CATS for digital units
• Training must be progressive and employ innovative techniques	• Adopt a repetitive "crawl, walk, run" methodology (using BSTS, SGT, and vignette training), striving for hyper-proficiency • Exploit technology capabilities (especially Internet)
• The WarMod XXI concept modification does not account for unit training on collective tasks	• Modify WarMod XXI to include unit training on collective tasks using digital systems
• Digitization does not remove the requirement to train conventional and back-up skills	• Conduct research to investigate what constitutes conventional and back-up training • Conduct research to determine the proper mix of conventional, back-up, and digital training required for Force XXI
• Information management presents a special training challenge for digitally equipped forces	• Conduct further research on building a staff trainer that improves commander and staff decision-making processes within a digital environment

Table 19

Conclusions and Recommendations Regarding Training System Functionality

CONCLUSION	RECOMMENDATION
• The Army does not have a common definition of a training system	• Integrate the existing models into one comprehensive Army training system model applicable to digital training requirements
• Training requirements analysis, TSPs, training execution, data collection, performance assessment, and feedback are the key system training components	• Conduct a comprehensive, front-end task analysis followed by the development of an automated assessment and feedback system that supports training for digital units • Develop TSPs to replicate Force XXI operations • Incorporate a progressive training approach in TSPs • Include a CITT-like wizard system that provides the ability to modify TSPs and generates training execution and evaluation materials • Build training environment to recreate entire information network with proper "push/pulls" • Address the unique requirements of digital training in data collection • Account for overlapping requirements of exercise control and data collection

The identification of TTPs for the digital force requires new tools for trainers to observe and measure the use of digital equipment, expanding the scope of TSPs to include equipment specific training, and developing TSPs that are easily accessible and updated. Further, SST approaches may need to allow the commander multiple options regarding the degree of structure imposed during training. For instance, highly structured training approaches may suit early stages of progressive training, while initial training exercises designed to flesh out new doctrine and TTPs for digital operations may call for more of a battle book approach to training execution (Leibrecht & Winsch, 1997). All of these complexities increase the workload of those involved in developing and implementing digital training.

System requirements for training the digital force must provide for full horizontal and vertical integration of digital platforms and communication devices. Anything less equals degraded operations. Training tools that assist with exercise control offer substantial benefits in the areas of training delivery and research.

Training a digitally equipped force introduces new data collection, performance assessment, and feedback requirements. Data collection requirements for digitally equipped forces become increasingly complex as the training audience grows, new warfighting technologies are added, and TTPs evolve. Training developers, observers, and researchers need automated tools and new approaches for data collection. Utilities and assessment systems already exist that provide the basis for developing capabilities to address these requirements. Performance assessment requirements relate to the process of translating the data collected into AAR products and construction of databases that support TTP and doctrine revisions. System developers should fold performance assessment requirements into one system. The STAARS concept defines the requirements for an automated AAR feedback system. Assessment systems already exist that at least partially fulfill the STAARS concept. The integration of existing systems into one automated data collection, assessment, and feedback tool would represent significant progress to the training challenges currently faced by the Army for digitally-equipped forces. Thus, a major recommendation resulting from the current effort is to conduct further research to support the development of a digital unit collection, assessment, and feedback system.

A common finding that shaped the development of the overarching training approach and system functional requirements models is the need to integrate already existing Army guidelines into standardized, usable formats. Operating under a system that contains a multitude of models to achieve the same objective (i.e., training) is cumbersome, especially when it is clear that changes are needed to accommodate new processes such as spiral development. The outcomes of this effort provide two corresponding models for Army training that address digitization requirements. The next step is to build a bridge between the overarching training approach and training system models that will synchronize training and materiel development efforts. Clearly, the Army training and materiel development communities would profit from a mechanism designed to ensure the compatibility between training and materiel development efforts. The ORDs and STRAPs provide the conceptual basis for developing such a mechanism. What is needed are ORD and STRAP guides developed for TRADOC to use in evaluating system development proposals. The Deputy Chief of Staff for Training (DCST) would use the guides to ensure the integration of training and materiel development requirements. New system requirement documents should not go forward unless they meet the training integration guidelines established by the DCST.

Summary

The results of this project constitute valuable input to the Army's sweeping initiatives to meet the training challenges of the 21st Century. This report contributes to the Army's understanding of how the CCTT can be improved to support training for digital operations. Further, this report provides guidance for developing training for digitally equipped forces that extends beyond CCTT considerations. Overarching training approach and training system models provide an important first step in codifying the requirements for training digitally equipped forces. Information contained in this report provides training developers a jumpstart on creating TSPs designed for digitally equipped units. Training developers will not change the dynamic environment; they must learn to operate within it. The "absolute" requirement for success in digitization is proficient soldiers, leaders, and units. Because of today's highly dynamic environment, meeting this requirement demands more than just an adjustment to the current training development process as proposed in this report. It requires changes to the Army's Acquisition Process. In the acquisition arena, the Army has aggressively modified the process of getting new materiel into the hands of soldiers (TRADOC, 1994), however that process must be changed to consider a more holistic view that addresses more than just the issues of lethality, survivability, tempo, suitability and maintainability. The full scope of doctrine and training development requirements must be integrated into the acquisition process.

Recommendations for future research point to further investigation of the cyclic training and training development model for digitally equipped forces. This model could significantly change and synchronize the doctrine, TTP and TSP development. These recommendations include the need for a broader look at policies, methods and tools for integrating training and doctrine developers into the acquisition process.

Training and doctrine developers using warfighter-in-the-loop tools, such as simulation, early in the concept exploration phases can provide the key to addressing the lack of synchronization between material fielding and training products. The digitization effort is clearly an effort to field a system of systems that require seamless interaction across systems to get to expected levels of increased force effectiveness. Training and doctrine developers must have a set of tools that allow them to examine the issues of trainability, usability and fightability in an environment that includes all of the emerging systems and capabilities – across proponents. With such tools one can develop the TTP, doctrine and training materials in concert with the evolution of the new materiel systems. This will ensure that a total system capability is fielded.

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APPENDIX A

ACRONYMS AND ABBREVIATIONS

NOTE: This list includes acronyms from the appendices.

1SG	First Sergeant
AAR	After Action Review
ABCS	Army Battle Command System
ABF	Attack By Fire
AC	Active Component
ACSL	Abrams Common Software Library
ADA	Air Defense Artillery
ADC (S)	Assistant Division Commander for Support
ADO	Army Digitization Office
AFATDS	Advanced Field Artillery Tactical Data System
AFRU	Armored Forces Research Unit
AFV	Armored Fighting Vehicle
AGMB	Advance Guard Main Body
AGTS	Advanced Gunnery Training System
AI	Artificial Intelligence
AIT	Advanced Individual Training
ALSP	Aggregate Level Simulation Protocol
AMSAA	U.S. Army Materiel Systems Analysis Activity
ANCOC	Advanced Non-Commissioned Officer Course
AOAC	Armor Officer Advanced Course
AOBC	Armor Officer Basic Course
AR	Armor
ARI	U.S. Army Research Institute for the Behavioral and Social Sciences
ARNG	Army National Guard
ARTEP	Army Training and Evaluation Program
ASAS	All Source Analysis System
ASCL	Additional Skill Classification
ASLT	Assault
ATAFS	Automated Training Analysis Feedback System
ATCCS	Army Tactical Command and Control System
ATK	Attack
ATSC	U.S. Army Training Support Center
AT XXI	Army Training XXI
AUTL	Army Universal Task List
Avn	Aviation
AWE	Advanced Warfighting Experiment
BBS	Brigade/Battalion Battle Simulation
BBSE	Brigade and Battalion Staff Exercise
BCST	Battle Command Support Team/Battle Command/Staff Training
BCT	Brigade Combat Team
BCV	Battle Command Vehicle
Bde	Brigade
BF	Battlefield Function
BFA	Battlefield Functional Area

BFV	Bradley Fighting Vehicle
BLUFOR	Blue Force
BMP	Opposing Force Infantry Fighting Vehicle
Bn	Battalion
BNCOC	Basic Non-Commissioned Officer Course
BOIP	Basis of Issue Plan
BOS	Battlefield Operating System
BP	Battle Position
BRT	Brigade Reconnaissance Troop
BSE	Brigade Staff Exercise
BSFV	Bradley Stinger Fighting Vehicle
BSTS	Battle Staff Training System
BT	Battle Tank
C/ST	Commander/Staff Trainer
C2	Command and Control
C2V	Command and Control Vehicle
C3	Command, Control, and Communications
C4I	Command, Control, Communications, Computers, and Intelligence
CAA	Combined Arms Armies
CAB	Combat Aviation Brigade
CALFEX	Combined Arms Live Fire Exercise
CAS3	Combined Arms Service Support School
CATS	Combined Arms Training Strategy
CATT	Combined Arms Tactical Trainer
CAV	Cavalry
CBI	Computer-Based Instruction
CBS	Corps Battle Simulation
CCD	Command and Control Display
CCF	Critical Combat Function
CCTT	Close Combat Tactical Trainer
CCTT-D	Close Combat Tactical Trainer-Digital
CD	Cavalry Division
CDR	Commander
CD-ROM	Compact Disk-Read Only Memory
CDU	Commander's Display Unit
CES	Combat Engineer Support
CFF	Call for Fire
CFS	Command from Simulator
CFX	Command Field Exercise
CGF	Computer-Generated Forces
CGSC	Command and General Staff College
CID	Commander's Integrated Display
CITT	Commander's Integrated Training Tool
CITV	Commander's Independent Thermal Viewer
CLS	Contractor Logistical Support

CO	Company
COBRAS	Combined Arms Operations at Brigade Level, Realistically Achieved through Simulation
COFT	Conduct of Fire Trainer
COR	Contracting Officer's Representative
Co/Tm	Company/Team
COTR	Contracting Officer's Technical Representative
COTS	Commercial Off-the-Shelf
CP	Command Post
CPT	Captain
CRD	Capstone Requirements Document
CPX	Command Post Exercise
CRP	Combat Reconnaissance Patrol
CS	Combat Support
CSS	Combat Service Support
CSSCS	Combat Service Support Communication System
CTAFS	C4I Training and Feedback System
CTC	Combat Training Center
CTCP	Combat Trains Command Post
CTSF	Central Technical Support Facility
CVC	Combat Vehicle Crewman
CVCC	Combat Vehicle Command and Control
DAK	Deliberate Attack
DAR	Data Analysis and Reporting
DARPA	Defense Advanced Research Projects Agency
DB	Database
DBCS	Digital Battle Command System
DCA	Data Collection and Analysis
DCST	Deputy Chief of Staff for Training
DI	Dismounted Infantry
DID	Driver's Independent Display
DIS	Defend in Sector/Distributed Interactive Simulation
Div	Division
DLRC	Digital Leaders Reaction Course
DocTTP	Documented Tactics, Techniques, and Procedures
DRB	Division Reaction Brigade/Battalion
DS	Direct Support
DTDD	Directorate of Training and Doctrine Development
DTLOMS	Doctrine, Training, Leadership, Organization, Materiel, and Soldiers
E&S	Electronic and Surveillance
EA	Engagement Area
EBC	Embedded Battle Command
EDUCCATT	Education of CCTT through Computer Assisted Training Technology
EXEVALS	Exercise Evaluations

EPLRS	Enhanced Position Location and Reporting System
EXFOR	Experimental Force
FA	Field Artillery
FAADC3I	Forward Area Air Defense-Command, Control, Communications, and Intelligence
FABTOC	Field Artillery Battalion Tactical Operations Center
FBCB2	Force XXI Battle Command Brigade and Below
FDC	Fire Direction Center
FDTE	Force Development Test and Evaluation
FEA	Front End Analysis
FED	Forward Entry Device
FIST	Fire Support Team
FIST-V	Fire Support Team Vehicle
FKSM	Fort Knox Supplemental Material
FM	Field Manual/Frequency Modulation
FPOL	Forward Passage of Lines
FRAGO	Fragmentary Order
FSB	Forward Support Battalion
FSC	Forward Support Company
FSE	Fire Support Element/Forward Security Element
FSO	Fire Support Officer
FTX	Field Training Exercise
FXXITP	Force XXI Training Program
G4	Division/Corps Logistics Officer
GDLS	Ground Designated Laser Sensor
GPS	Gunner's Primary Site
GSR	Ground Surveillance Radar
HEMTT	Heavy Expanded Mobility Tactical Truck
HLA	High Level Architecture
HMMWV	High Mobility Multi-purpose Wheeled Vehicle
HQ	Headquarters
HSI	Home Station Instrument
HumRRO	Human Resources Research Organization
IB	International Border
ID	Identification
ID	Infantry Division
IET	Initial Entry Training
IFV	Infantry Fighting Vehicle
IMBC	Improved Mortar Ballistic Computer
IMEX	Information Management Exercise
IN	Infantry
info	information

intel	intelligence
IOT&E	Initial Operational Test and Evaluation
IPR	In-Process Review
ITTBBST	Innovative Tools and Techniques for Brigade and Below Staff Training
IVIS	Intervehicular Information System
JSTARS	Joint Surveillance Target Attack Radar System
LAN	Local Area Network
LD	Line of Departure
Ldr	Leader
LRF	Laser Range Finder
LUT	Limited User Test
L-V-C	live, virtual, and constructive
MBC	Mortar Ballistic Computer
MC	Maintenance Console
MCC	Master Control Console
MCS	Maneuver Control System
Mech	Mechanized
MEDEVAC	Medical Evacuation
METL	Mission Essential Task List
METT-T	Mission, Enemy, Terrain, Troops, and Time available
ModSAF	Modular Semi-Automated Forces
MOE	Measure of Effectiveness
MOP	Measure of Performance
MRB	Motorized Rifle Battalion
MRC	Motorized Rifle Company
MRD	Motorized Rifle Division
MRP	Motorized Rifle Platoon
MRR	Motorized Rifle Regiment
MRS	Muzzle Reference System
MTC	Movement to Contact
MTI	Moving Target Indicator
MTP	Mission Training Plan
N/A	Not Applicable
NCO	Non-Commissioned Officer
NET	New Equipment Training
NLT	No Later Than
NTC	National Training Center
O/C	Observer/Controller
O/O	On Order
OAC	Officer Advanced Course
OBC	Officer Basic Course

OBJ	Objective
OJT	On the Job Training
OneSAF	One Semi-Automated Force
OP	Observation Post
OPFOR	Opposing Forces
OPORD	Operation Order
ops	operations
OPTEMPO	Operating Tempo
ORD	Operational Requirements Document
org	organization
PC	Personal Computer
PCI	Pre-Combat Inspection
PCC	Pre-Command Course
PDA	Personal Digital Assistant
PDSS	Post Deployment Software Support
PL	Phase Line
PLDC	Primary Leadership Development Course
PLT	Platoon
PM CATT	Program Manager for Combined Arms Tactical Trainer
PM	Program Manager
POI	Program of Instruction
POSNAV	Position Navigation
PSN	Position
PVD	Plan View Display
R&D	Research and Development
RC	Reserve Component
RCVTP	Reserve Component Virtual Training Program
Recon	Reconnaissance
REDCON	Readiness Condition
RMB	Regimental Main Body
S1	Personnel Officer
SA	Situational Awareness
SAF	Semi-Automated Forces
SAT	Systems Approach to Training
SATS	Standard Army Training System
SBF	Support By Fire
SEP	System Enhancement Program
SGT	Staff Group Trainer
SIF	Selective Identification Feature
SIMBART	Simulation-Based Mounted Brigade Training Program
SIMNET	Simulation Networking
sims	simulations
SIMUTA	Simulation-Based Multiechelon Training Program for Armor Units

SIMUTA-B	Simulation-Based Multiechelon Training Program for Armor Units-Battalion
SIMUTA-D	Simulation-Based Multiechelon Training Program for Armor Units-Digital
SINCGARS	Single Channel Ground and Airborne Radio System
SITREP	Situation Report
SMA	Sergeant Major Academy
SME	Subject Matter Expert
SOP	Standing Operating Procedure
SOW	Statement of Work
SPOTREP	Spot Report
SSC	Special Staff Course
SST	Structured Simulation-Based Training
STAARS	Standard AAR System
STAFFEX	Staff Exercise
STIM	Staff Training in Information Management
STOW	Synthetic Theater of War
STOWEX	Synthetic Theater of War Exercise
STRAP	System Training Plan
STRICOM	U.S. Army Simulation, Training, and Instrumentation Command
STRUCCTT	Structured Training for Units in the Close Combat Tactical Trainer
STX	Situational Training Exercise
TACFIRE	Tactical Fire Direction System
TACP	Tactical Air Control Party
TADSS	Training Aids, Devices, Simulators, and Simulations
TATS	Total Army Training System
TB	Tank Battalion
TC	Tank Company
TD	Tank Division
TDA	Table of Distribution and Allowances
TDR	Training Device Requirement
TES	Tactical Engagement Simulation
TEXCOM	U.S. Army Test and Experimentation Command
TF	Task Force
THP	Take Home Package
TIRS	Terrain Index Reference System
TM	Team
TO&E	Table of Organization and Equipment
TOC	Tactical Operations Center
TPS	Task Performance Support
TR	Trouble Report
TRADOC	U.S. Army Training and Doctrine Command
TRP	Target Reference Point
TSIM	Tactical Simulation
TSM	U.S. Army TRADOC Systems Manager
TSP	Training Support Package

TSup	Tactical Support
TT	Tank Table
TTP	Tactics, Techniques, and Procedures
TUD	Training Unit Designator
UAV	Unmanned Aerial Vehicle
UCOFT	Unit Conduct of Fire Trainer
UMCP	Unit Maintenance Collection Point
UPAS	Unit Performance Assessment System
USAARMC	U.S. Army Armor Center
USAR	U.S. Army Reserve
VTP	Virtual Training Program
WARNORDS	Warning Orders
WARSIM	Warfighter Simulation
WOG	Warning Order Group
XO	Executive Officer