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Collective Training Research Utilizing Returning Combat Aircrews, Lessons Learned

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COLLECTIVE TRAINING RESEARCH UTILIZING RETURNING COMBAT AIRCREWS, LESSONS LEARNED

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This paper describes an experiment to evaluate the effectiveness of the U.S. Army's Aircrew Coordination Training Enhancement (ACTE) program delivered by distance learning. A large-scale experiment was designed and executed using three groups of aircrews that received either electronic classroom-based instruction with instructor facilitation on site, distance learning training using the unit's local Digital Training Facility with the primary instructor off site, or no training. Aircrews with varying levels of experience recently returning from combat were evaluated using event-based scenarios performed in the Aviation Combined Arms Tactical Trainer (AVCATT). Measures were developed within Kirkpatrick's (1998) framework. Execution of the experiment was hampered by a variety of factors. One factor was intermittent weather related power outages which made individual crew stations unavailable for short periods of time. This challenge was addressed within a mission contingency framework. A second factor was the participating aircrews' limited experience with the AVCATT trainer which was installed at the aircrew's home station during the units' deployment to combat. Another factor was crew turbulence related to the supporting units' deployment status. Workarounds for administrative and procedural challenges were devised to maintain the integrity of the experiment to the maximum extent possible; however, the evaluation goals of the experiment were not achieved. Results of this experiment are discussed from the perspective of lessons-learned from conducting field research using operational units in wartime.

Introduction

Aircrew Coordination Training (ACT) and Crew/Cockpit Resource Management (CRM) programs were instituted in the 1980's, first in commercial aviation and later in military aviation, to address adverse mishap rate trends that showed the inability of many aviators to work well together in periods of high stress or workload (Helmreich, Merritt, & Wilhelm, 1999). Minor aircraft malfunctions were resulting in fatal accidents with alarming regularity. While aviators generally displayed excellent knowledge and understanding of aircraft systems, operating procedures, rules and regulations and other technical information, they often displayed a glaring inability to communicate effectively, distribute workload, maintain or regain situational awareness and make sound decisions. Military aviation took note of the success of CRM in the civilian sector and instituted similar training programs (Orlady & Foushee, 1987).

ACT/CRM programs have been structured in various ways and continue to evolve as the perspective changes as to what constitutes effective team coordination training. Most programs include the following basic elements:

- A discussion of the core behaviors or basic skill sets that make up ACT. Each program structures these core behaviors differently, but all contain common elements.
- An examination of the applicability of ACT behaviors in the "real world." This typically takes the form of one or more case studies of real-world incidents or accidents and includes an analysis of where or when proper ACT behaviors could have been employed.
- Some type of role-playing or practice of ACT behaviors in a simulated mission setting, i.e., line-oriented flight training (LOFT) or its equivalent.
- Some form of assessment of the learning or changes in attitudes and behaviors that have taken place as a result of the training, and the evaluation of the training by the students.

Research and Development

ARI worked closely with Army aviation training, evaluation, and safety personnel to develop, validate, and field an ACT Exportable Training Package in 1992. Army ACT program performance methods and measures included:

- ACT behaviors or Basic Qualities evaluated with supporting behaviorally anchored rating scales
- Aircrew Training Manual task performance
- Mission performance of two flight simulator scenarios similar in difficulty in terms of time stress, navigational demands, quantity and capabilities of simulated threat.

Initial ACT products developed were validated using traditional pre and post validation methods (Simon, R., & Grubb, G., 1993) and were fielded using a train the trainer system by the US Army during the period 1994-1998 to all active and reserve component aircrews.

Aircrew Coordination Training Enhancement (ACTE)

Commanders and aircrews alike acknowledged the benefit of the mandatory, one-time training support package (Department of the Army, 1992) that was received by all aviators within the Army aviation community. The initial program did not address sustainment issues and did not package the training in a program that would facilitate such training. Lack of effective aircrew coordination continues to be cited as a definite or suspected contributing factor in aviation flight accidents, and it is a factor limiting attainment of the full mission effectiveness of Army aviation. For example, the Director of Army Safety reported in the December 1999 issue of *Flightfax*, "In fact, FY99 produced Army aviation's worst safety performance since Desert Shield/Desert Storm." The ACT program has not been updated since its original introduction. Currently, ACT is conducted in the classroom (Eight hours of instruction with a two-hour, 50 question, multiple-choice exam) with no follow-on mandatory training periods in either aircraft simulators or in the aircraft. Instructors responsible for evaluating and reinforcing this academic training receive four hours of academic training with no exam to determine competency. Temporary measures such as awareness videos, assistance visits, safety newsletter articles, and a web-based training support package have been ineffective substitutes for focused ACT training.

Approach to Revitalize and Sustain Army ACT

The objective of the research effort to enhance Army ACT is to improve the crew and team coordination effectiveness of Army aircrews in their day-to-day mission planning and flight operations. The enhancement program managed by ARI is a multi-year, multiphase program of applied research structured in three major phases – upgrade and sustain the existing ACT program, refresh and maintain the upgraded ACT program, and deploy advanced ACT applications. ARI's Rotary-Wing Aviation Research Unit convened a working group at Fort Rucker to provide guidance and oversight for Army Aircrew Coordination Training Enhancement (ACTE) program. The group is made up of key personnel from the US Army Aviation Center (USAAVNC) and other subject matter experts who serve as contributors to planning, developing, implementing or evaluating the program.

Phase I of the enhancement effort to upgrade and sustain the current ACT program applied the following general approach:

- Analysis of the current aircrew coordination training program from a total systems perspective to identify conflicts, bottlenecks, and deficiencies in implementing team coordination in daily flying operations.
- Refinement of team evaluation techniques and tools for assessing overall performance along specific behavioral proficiency dimensions.
- Development of prototype focused interventions for training and evaluating team coordination behaviors and for managing risk.
- Validation of prototype team training and evaluation techniques in selected aviation units.
- Field-testing of prototype training, evaluation, and technology products.

Phase II of the enhancement program built on the initial research conducted in Phase I and added the necessary courses and data collection events to implement ACT at all levels of aircrews. These courses include:

- Non rated crew member course (NCM) course, the first Army course that recognizes the specific issues of ACT as seen from the mission crew view point
- Core and Advance Aircraft courses, these courses developed especially for the US Army Aviation Center initial entry training supports a building block approach to initial ACT instruction during the 9 month flight school program
- Train the Trainer Course, This course recognized the need for a standardized training and certification program that not only recognized the ACT behaviors and evaluation system but the need to instruct on courseware delivery, facilitation and courseware management to a target audience that has little or no experience in distance learning delivery.
- Delivery of the Train the Trainer program to include collection of end of course survey data.
- Development of the Crew Team Reporting System (CTRS) an anonymous web hosted ACT incident

reporting system to capture data not currently tracked or reported on in Army aviation.

- Pocket Aircrew Guide, this guide was developed and evaluated to assist aircrews in recognizing correct and incorrect behaviors and debriefing missions to facilitate improvement.

In the final phase of ACT program improvement, Phase III, we utilized the guidance in the ACT Master Plan to focus on deploying advanced ACT applications to complete the enhancement program. The desired results of Phase III were to affect the Army's overall aircrew training and evaluation system, risk management and systems safety processes, and daily flight operations in actual aircraft, system simulator, or while conducting training in distributed interactive simulation environments such as the AVCATT or Longbow Crew Training Systems (LCTS).

Collective Research Project

Phase III research was established to deploy advanced ACT applications that focused on:

- Evaluating the effectiveness of ACTE prototype courseware delivered via Distance Learning delivered training. Of particular importance was to address the persistent question of Distance Learning (DL) effectiveness by capitalizing on our database of interactive multimedia courseware delivery via LAN and the demonstrated DL capability of the prototype ACTE courseware. Evaluating learning interaction (e.g., facilitator-learner, learner-learner), adult learning feedback, courseware content control, and testing results reporting issues.
- ACT event-driven scenarios for multiple aircraft missions in advanced simulators and distributed interactive simulation training exercises development. The development of company and battalion level risk management and team coordination methods and measures to address both crewed systems (aircraft) and organizational (C2) leader-focused team training (e.g., collective training scenarios) effectiveness.
- Evaluating the effectiveness of the enhanced ACT program on the operational mission effectiveness and reduction of crew related errors. Conduct a definitive evaluation of the effect of ACT on operational mission effectiveness and reduction of crew related errors. Conduct behaviorally-anchored rating scale (BARS) reliability and validation testing, develop operational mission effectiveness measures and incident reporting procedures to support comparing a unit with enhanced ACT compared to a unit without. Develop ACT event-driven scenarios for multiple aircraft missions in advanced simulators and distributed interactive simulation training exercises.

Developing Evaluation Tools and Techniques

The second task of ACTE Phase I effort was to develop and implement an evaluation methodology for measuring effective performance of aircrew coordination behaviors. The measurement of aircrew coordination behavior is a critical component of the aircrew coordination program and is central to the training content design and delivery. The product of this task is a set of observable measures of individual and collective behavior, the Behaviorally Anchored Rating System (BARS). The BARS provides a readily usable evaluation tool that trainers and ACT facilitators use to teach aircrew members how to apply the BARS as a fundamental means of evaluating aircrew and team performance of ACT behaviors and skills. The vehicle for documenting these evaluations is the ACT Performance Evaluation Checklist which is based on the 5 Crew Coordination Objectives (CCO) and 13 Basic Qualities (BQ) accepted by the Army as descriptors of aircrew coordination behavior. ACT behaviors and skills are organized by CCO and are rated using a seven-point scale with values ranging from 1 (Below Standards) to 7 (Exceeds Standards). Written descriptions are provided for the ACT behaviors and skills and levels of performance for rating aircrews at the values of 1, 4, and 7. These descriptions serve as behavioral "anchors" and are designed to assist in determining how well an aircrew performs ACT behaviors and skills in relation to a well-defined set of performance criteria. The anchors are used as the standard for evaluating ACT performance. This avoids the trap of norm referencing, i.e., comparing one aircrew's performance with that of another. An aircrew's performance is always rated solely in relation to the "anchors." This has long-term implications for the objective measurement of aircrew coordination improvement. (Appendix A)

Once the crew level evaluation tools such as the BARS system was in place the next level to review in the research was the inter and intra team level coordination. As an additional measure the BARS rating system was to be modified using experience from Battle Command Team Training Behaviors (Grubb, Crump et. al. 2001) into a combined battle staff proficiencies measurement system The base was the ACTE BARS and the Battle Staff Performance Evaluation System Check List

(Appendix B) combined into a initial version or V1 for the research event.

Along with the BARS and Battle Master Instruments, scenario event data collection sheets (Appendix C) were created along with the simulator scenarios. Measurements were established to collect data at various points in the research event and include measurements as shown in Figure 1. The Crew Team Reporting System (CTRS) was developed to support follow on incident data collection.

Measurement Area	Measurement Instruments
Demographic Data	• Data Management System Menu Items
Course Critique Questionnaires	• Data Management System Scalar Critique Items • Data Management System Open-ended Items
ACT Knowledge Test	• Data Management System Multiple Choice Items
ATM Task Performance	• Scenario Worksheets
ACT Behaviors	• Performance Evaluation Checklist • Behaviorally Anchored Rating System (BARS)
Mission Effectiveness	• Scenario Worksheets
Risk Management	• Scenario Worksheets
Crew Team Event Reports	• Web Page Menu Items • Web Page Open-ended Items
Battle Staff Survey	• Questionnaire Scalar and Open-ended Items

Figure 1. *Measurements*

Collective Experiment Coordination

Coordination for experiment participants began in October 2003 with the primary focus on Ft. Hood, Texas. The Army's only fully operational collective trainer, the Longbow Crew Training System (LCTS) was in place and operational training up to 6 aircrews at a time in a device that is certified to conduct individual along with collective tasks. Problems with the units available to evaluate at the collective level were:

- Units in varying levels of readiness training, units were only ready for collective level training during a limited time period in the training program.
- Utilization of the LCTS was high, as a one of a kind device the ability to wire in for individual crew monitoring was not a preferred method.
- Unit command structure was hesitant to put additional tasks on the already overloaded schedule of the support staff
- Units in training had already fallen behind Department of the Army mandated dates for unit deployment.

The preceding factors required a new focus on the unit to be selected for this training. It became apparent that a cohesive unit, full trained, not involved in the war on terror and co-located with a suitable collective training device would be difficult to locate.

Aviation Combined Arms Tactical Trainer (AVCATT)

The AVCATT-A system is a dynamic, alternative instructional concept to train and rehearse, through networked simulation, in a collective and combined arms simulated battlefield environment. It supports institutional, organizational, and sustainment training for Active and Reserve Component aviation units worldwide. Collective and combined arms simulation exercises provide commanders with a capability to conduct unit collective training and rehearsals, the unit's mission essential task list and combined arms wartime mission performance requirements. AVCATT-A is a mobile, transportable, tractor trailer based virtual simulation training system designed to provide aviation the capability to conduct realistic, high intensity, task-loaded collective and combined arms training exercises and mission rehearsals.

The physical layout of AVCATT-A consists of two trailers connected by a raised, covered platform. (Figure 2) One trailer includes three reconfigurable manned modules and an 18-person after action review (AAR) facility with an AAR workstation, three dimensional stealth view, plan view (terrain map), and manned module sensor displays. The second trailer includes three reconfigurable manned modules, a battlemaster control room, and a maintenance room. Included in the battlemaster control (BMC) room are the battlemaster console; semi-automated forces (SAF) workstation; unit observer/controller (OC) position; four unit role player (RP) workstations; and overhead stealth, plan view, and manned module sensor displays. Each manned module is reconfigurable to current Army attack, reconnaissance, cargo, and utility aircraft. Each of the four unit RP workstations can be configured as one of six RP functional areas: fire support, ground maneuver, battle command, close air support, logistics, and engineer.

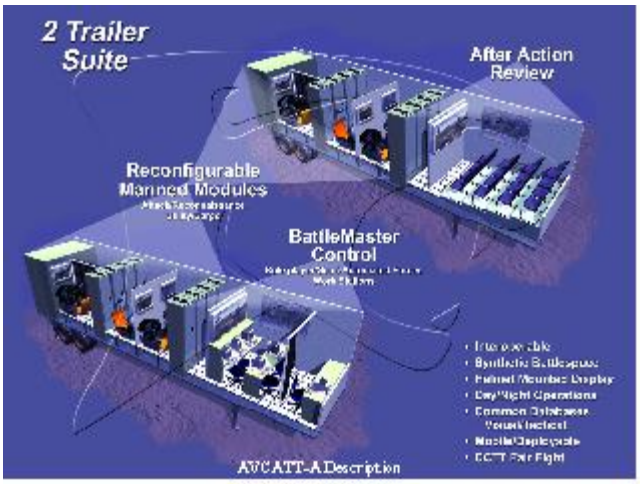

Figure 2. *AVCATT Layout*

The AVCATT was deployed to the final test location in the fall of 2003 and became operational, ready for training in the spring 2004 at the test location. The availability of units returning from the war on terror combined with the operational AVCATT made the selected test location the alternate choice for the conduct of the research data collection.

Available Units

Once the location and collective device was selected the units assigned or in transit back from combat were reviewed. Due to extensive requirements to reacclimatize returning individuals and units and to insure proper reintegration of returning personnel to the local installation time available to conduct the observations of the crews was reduced.

Phase III Collective Experimentation Observer/ Evaluators (OE's) and Battle Master Observers Training

Observer/Evaluator (OE) and Battle Master (BM) training was conducted using US Army Distance Learning Classrooms, contractor instructors presented the Aircrew and Instructor Courses in two-four hour periods. The courses were followed with a training session consisting of the observation of actual crews in simulators followed up by rating using the BARS system to insure inter-rater reliability prior to data collection events. Overall 10 OE/BM were trained and prepared for data collection.

Research Participants

Research participants provided consisted of 12 crews per group for a total of 36 participants. These participants were scheduled for Aircrew ACTE training, pre and post academic testing and pre and post training simulation events.

Lessons Learned

Lesson 1, Ensure all test participants and facilities will be available throughout the course of the entire data collection event.

Test participant availability and status was unknown prior to arrival at the test site. Due to the limited availability of units to participate in research the research director had little room to turn away units who offered to participate. Research participants had been back from overseas combat operations less than 30 days at the start of the research event. During this period research participants were still undergoing mandatory reintegration tasks directed by Department of the Army regulations. During the conduct of the research data collection some participants had mandatory medical appointments and family issues that caused them to miss critical data events. Due to the returning status of many of the installation units, 2 days during the research data collection event the installation was at a minimum manning status, commonly referred to as a "Training Holiday" causing delays in training and support for the research event.

Lesson 2, Crews must be properly trained on simulation devices used to collect research data.

The AVCATT device was a recently fielded system, 12 months prior to research data collection event the Army had begun fielding the system Army wide and less than 90 days at the test location. The device was established as ready for training within 45 days of the beginning of research at the research location. No full scale unit usage of the AVCATT had occurred at the research site prior to this research event. The research participants had not received any training on the AVCATT device and participants needed to be fitted with the helmet mounted visual system and familiarized with both the device and its associated systems just days prior to research data collection. It is important to note that the AVCATT team running the device at the research site worked extended hours and demonstrated professionalism and a get it done attitude that made the best of the situation. Due to the compressed timeline no other training time other than the 1 hour or less familiarization flight was conducted. None of the 36 test participants had any experience on the AVCATT device. During the conduct of the research events it became apparent that the device,

designed as a collective trainer and not certified by the Army as an individual task trainer required some level of familiarization not yet determined to develop proficiency in basic flight maneuvers, to include tactical formation flying. Highly experienced, recent combat crews experienced Controlled Flight Into Terrain (CFIT) accidents due to a lack of flying experience in the research device.

Lesson 3, Time must be made available in the research schedule to allow for adaptation of the simulation device for data collection and to address problems in the device operation.

The AVCATT device is designed to conduct collective training and the research required the monitoring of each individual crew by assigned OE's. The design of the AVCATT utilizes helmet mounted displays which precluded the OE's from observing in the actual cockpit, the AAR facilities built into the device will monitor the video from the 5 cockpits but only provides one voice feed. Although satisfactory for the collective training of a unit at the collective level the device would not allow continuous voice monitoring of each crew by their assigned OE. This limitation required the use of an alternate voice monitoring system with a microphone placed inside the crew's headset. This need to place the system into operation and test prior to each event caused delays in an already restricted schedule.

The AVCATT device is a highly complex device sensitive to power fluctuations and computer settings. During the conduct of the test the final scenarios had only been available to the local AVCATT team for 30 days and had not undergone on site testing.

Weather also played a factor. Although the AVCATT is a durable trailer mounted system the fixed power supply is susceptible to lighting and to error on the side of safety two events were delayed due to electrical storm activity in the area. The device was not the only issue; safety of the research participants required the delay. The AVCATT device is placed in an open field with no overhead protection.

Summary

A research based event requiring the participation of over 40 personnel utilizing complex simulation devices with participants conducting multi aircraft missions requires a level of coordination, participant briefings and time delays that cannot be accomplished without a unrestricted timeline, an extensive device familiarization training program and participants focused on the research event at hand.

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ACT Performance Evaluation Checklist

For use of this form, see the ACT Aircrew Guide

CCO	BQ	Crew Coordination Objectives (CCO)/Basic Qualities (BQ)	Rating
1		Establish and Maintain Team Relationships	
	1	Establish and Maintain Team Leadership and Crew Climate	
2		Mission Planning and Rehearsal	
	2	Pre-mission Planning and Rehearsal Accomplished	
	3	Application of Appropriate Decision Making Techniques	
3		Establish and Maintain Workload Levels	
	4	Prioritize Actions and Distribute Workload	
	5	Management of Unexpected Events	
4		Exchange Mission Information	
	6	Statements and Directives Clear, Timely, Relevant, Complete and Verified	
	7	Maintenance of Situational Awareness	
	8	Decisions and Actions Communicated and Acknowledged	
	9	Supporting Information and Actions Sought from Crew	
5		Cross-Monitor Performance	
	10	Crewmembers Actions Mutually Cross-Monitored	
	11	Supporting Information and Actions Offered by Crew	
	12	Advocacy and Assertion Practiced	
	13	Crew/Flight After-Action Reviews Accomplished	

Remarks: (Use continuation sheet[s] if necessary)

Notes:

Consult the ACT Aircrew Guide evaluation procedures and guidelines. Enter a summary rating (1 – 7) in the rating block for each ACT Crew Coordination Objective (CCO). Refer to the rating scale below.

Below Standards			Meets Standards			Exceeds Standards
1	2	3	4	5	6	7

Appendix A. *ACTE Performance Evaluation Checklist*

Battle Staff Performance Evaluation Checklist

BSO	BSOF	Battle Staff Objectives (BSO)/ Battle Staff Observational Focus (BSOF)	Rating
1		Develop and Maintain Inter and Intra Team Relationships	
	1	Establish Information and Knowledge Management and Exchange Procedures	
2		Mission Planning, Rehearsal, Roles and Responsibilities	
	2	Decision Authority/Capacity	
	3	Decision Strategies/Manage Debate and Communicate Decisions/Assumptions	
3		Establish and Maintain and Workload Levels	
	4	Prioritize and Select Production Strategies	
	5	Maintain Scanning Across Multiple Decision/Action Items	
4		Exchange Mission Information	
	6	Balance Informational Flow Up and Down Chain	
	7	Maintenance of Battle Space Images and Situational Awareness	
	8	Verify Key Information/Employ Risk Management	
	9	Supporting Information and Actions Sought from Crew	
5		Cross-Monitor Performance	
	10	Anticipate and Prepare for Development of Complex Situations	
	11	Manage Task Priority, Task Sequencing and Information Cost	
	12	Manage Process Error during Staff Rotation and Battle Handover	
	13	Practice Continual Self-Critiques and Lessons Learned	

Remarks: (Use continuation sheet[s] if necessary)

Notes: Enter a summary rating (1 – 7) in the rating block for each BCO (BSO). Refer to the rating scale below.

Below Standards			Meets Standards			Exceeds Standards
1	2	3	4	5	6	7

Appendix B. *Battle Staff Performance Evaluation Checklist*

AH-64A AVCATT Scenario Worksheet
PRE / POST Training Mission
Date _____ Period _____ MM # _____

Area Recon Scenario 2
Battle Master Observer/OE _____
Crew # _____

EVENT: Engage Targets with Indirect Fires			
Event Type: Crew Team External		**Event Time:**	**Observed: Y N**
Event Trigger: Team engages targets with indirect fires (SEAD).	Action: Individual crews engage assigned targets with indirect fires in SEAD.		
ATM Tasks:	**Observed?**	**Rating:**	**Related Behaviors:**
1079 Perform Radio Communications	Y N	S+ S S- U	CCO1 CCO2 CCO3 CCO4 CCO5
2007 Perform Aerial Observation	Y N	S+ S S- U	CCO1 CCO2 CCO3 CCO4 CCO5
2020 Call for and Adjust Indirect Fire	Y N	S+ S S- U	CCO1 CCO2 CCO3 CCO4 CCO5
2049 Search for and ID Targets with TADS	Y N	S+ S S- U	CCO1 CCO2 CCO3 CCO4 CCO5
2091 Transmit a Tactical Report	Y N	S+ S S- U	CCO1 CCO2 CCO3 CCO4 CCO5

Performance Measures:

Did the team request indirect fire support? Yes / No (Circle one) # Requests ____

Was indirect fire effective (e.g., targets suppressed or destroyed)? Yes / No (Circle one) # Engagements ____
Targets Destroyed _____

Did the team members share indirect fires target engagement information with other team members? Yes / No (Circle one)

Notes:

Overall Event Rating S+ S S- U CCO1 CCO2 CCO3 CCO4 CCO5 (OPTIONAL)

Appendix C. *Scenario Worksheet*