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Systems for an Interservice Exercise Measurement and Feedback System: Performance Measurement Index

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13. ABSTRACT *(Maximum 200 words)*

This report presents a research concept for developing and applying methods for collecting measures of performance for close air support aircraft equipped with hardware to integrate with the Air-Ground Training Feedback System at the National Training Center. This paper, discusses background, development of an outcome collection method, data collection hardware, and proposes a data collection method for examining the effects of close air support systems on the battlefield. This report is part of a complete package of hardware, battle planning tasks, and outcome measures. These products will assist commanders and their units training at the National Training Center, as well as analysts studying trends in training and operations.

The Air-Ground Training Feedback System is a promising addition to the training at the National Training Center. However, the capability of the system to produce the outcome measures discussed above is dependent upon instrumentation and availablity of trained observers/controllers.

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Multiple Integrated Laser Engagement System (MILES), Air Warrior Measurement and Debriefing System (AWMDS), Theater Air Control System (TACS), Control and Computation Subsystem (CCS)

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Introduction

This report presents a research concept for developing and applying methods for collecting measures of performance for close air support aircraft equipped with hardware to integrate with the Air-Ground Training Feedback System at the National Training Center. This paper, discusses background, development of an outcome collection method, data collection hardware, and proposes a data collection method for examining the effects of close air support systems on the battlefield. This report is part of a complete package of hardware, battle planning tasks (see "Integrated Task List for the Air-Ground Training Feedback System," J. Root, 1994), and outcome measures. Figure 1 is a model of the Air-Ground Training Feedback System. These products will assist commanders and their units training at the National Training Center, as well as analysts studying trends in training and operations.

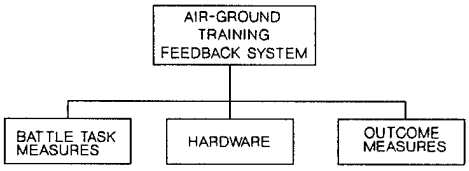

Figure 1: Air Ground Training Feedback System

Current Army tactics and doctrine have commanders synchronizing many weapons systems to mass combat power at a critical point to achieve victory. Training must accurately replicate the weapon systems that commanders use on the battlefield so they understand systems effects and the tasks necessary to synchronize them.

The Air-Ground Training Feedback System is an effort to identify the critical aspects of close air support employment and provide a training mechanism which assesses how these factors are operationalized in the combat training center environment. Today, while close air support is employed at the National Training Center, the training value, for both the Air Force and the Army, is not maximized. Rules of engagement cover the use of close air support and require subjective opinions from observer/controllers and a chance element (a roll of the dice) to decide an outcome for a close air support attack. Training would be much improved if the aircraft were

equipped with a system comparable to the Multiple Integrated Laser Engagement System (MILES).

The MILES system is used to record outcomes for ground-force engagements. When hit by an enemy weapon system laser, a vehicle's MILES system will record the hit and disable the vehicle. These systems are used at a unit's home station for training as well as the National Training Center. The Air-Ground Training Feedback System will provide an assessment tool for MILES type outcomes at the NTC for air-to-ground attacks.

The Air-Ground Training Feedback System is based on a new instrumentation system, which integrates air and ground components, and will provide an enhanced tactical engagement simulation capability (See Section 3, "National Training Center/Air Warrior Measurement and Debriefing System" for information on the hardware and software package). The Air-Ground Training Feedback System will improve the training of air crews and planning staffs through observer/controller evaluation of battle tasks and outcome measures, producing lessons learned and items for discussion during after action reviews.

SECTION 2

DEVELOPING OUTCOME MEASURES FOR THE AIR-GROUND TRAINING FEEDBACK SYSTEM

Outcome measures examine the effects of some activity. At the National Training Center, outcome measures show the results of the employment of combat systems on the battlefield. Outcome measures for the Air-Ground Training Feedback System must specifically capture the effects of close air support aircraft and ground air defense weapons on the National Training Center battlefield.

A system for studying outcomes for ground combat was developed that gives a direction for a system to measure outcomes for close air support. The ground system is based upon the mnemonic used by ground forces to analyze missions, METT-T. A ground commander uses these factors in developing his plan to accomplish a mission.

- **Mission**: The task that the unit is to accomplish.
- **Enemy**: A description of the enemy, his size, and capabilities.
- **Terrain**: The advantages and disadvantages of the terrain and weather (forecasted) and how they will affect both friendly and enemy operations.
- **Troops**: Number, equipment, location, and capabilities of friendly forces.
- **Time**: The amount of time available for planning, movement, and the time of execution.

These factors were reviewed in developing outcome measures to characterize the performance of ground combat units in regard to their mission statement. The mission statement defines the nature of the performance and consists of defend, attack, or movement to contact missions. Defend missions are to hold on to territory by destroying enemy attackers; attack missions are to gain control of territory or to destroy certain elements of the enemy force. Movement to contact is to locate and destroy enemy forces.

Within the context identified by the mission, the factors of troops, terrain, and enemy were examined to develop specific performance measures. For example, on a defend mission the

factors could be measured in the following way:

- **Terrain**: The degree that the enemy penetrated into the rear area, as measured by the number of enemy combat systems in that area at change of mission.
- **Enemy Forces:** The percentage of enemy combat systems starting the engagement that was still present at change of mission.
- **Friendly Forces**: The percentage of friendly combat systems starting the engagement that was still present at change of mission.
- **Time:** This is considered a scenario-driven constant and is not factored into the outcome measurement. Use of time for planning and preparation is considered in the measurement of process task performance.

The factors of mission, enemy, troops, terrain, and time are not only important for the successful planning and execution of a ground mission, but also for air missions that support ground forces. Therefore, when examining outcomes for close air support using the Air-Ground Training Feedback System, we can use these same factors.

Methodology

The outcomes for the Air-Ground Training Feedback System are the physical actions and effects of close air support at the National Training Center. Close air support is defined in JCS Pub. 1 as: "Air action against hostile targets which are in close proximity to friendly forces and which require detailed integration of each air mission with the fire and movement of those forces."[1] Execution of a close air support mission is the performance of physical actions against hostile targets. The outcome of a close air support mission is the effect of those actions on the target.

There are two controlling factors in measuring outcomes of training at the Combat Training Centers. First, the outcome measurement process must not intrude on the actions of the people being trained. Second, the data collected must be useful to observer controllers in identifying training strengths and weaknesses. Operationally, this means the information that the observer/controllers gather will help in the debriefing of the participants during After Action

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[1] Joint Chiefs of Staff, Department of Defense Dictionary of Military and Associated Terms, JCS Publication 1 (Washington, D.C.: U.S. Government Printing Office, 1 January 1986), p. 70.

Reviews and increase the value of the training.

Engagements at the National Training Center replicate reality. The outcome measures reflect the fidelity of that replication. However, they are not completely true indications of what outcomes would occur in war. These measures are derived in a training environment (using electronics instead of actual weapons) where safety and learning predominate. They are training tools to be used by Army and Air Force commanders.

The outcome measures are intended to serve several different purposes. Outcomes indicate training performance of close air support aircraft aircrews and their controllers (air component). They serve as a limited measure of performance for air and ground elements that plan, control, and coordinate an attack (close air support team), and they will provide data for analysis. They can be used to assist unit training managers and, more, importantly, identify systemic issues and provide focus on many DOTML (Doctrine, Organization, Training, Material, and Leadership) arenas. Figure 2 lists components and purpose for outcome measures.

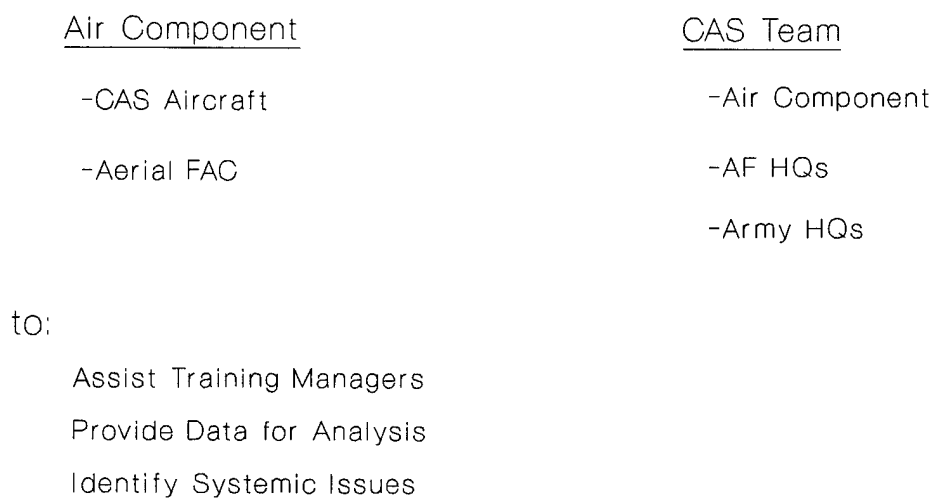


Figure 2: Components and Purpose for Outcome Measures

Air Component Performance: The outcome measure will gauge the performance of the air component in its ability to find the correct target, attack it, and survive. It gives commanders training and tactics information not otherwise available.

Close Air Support Team Performance: The outcome measure must gauge the effects of the coordination between the air component and the ground component just prior to and during

an attack by the air component. This measure is not one of planning, which is covered in detail by a separate measure of performance based upon a task list developed by BDM Federal ("Integrated Task List for the Air-Ground Training Feedback System", J. Root, 1994), but a measure of the air component's contribution to the ground component's mission. Team performance will not be a separate measurement of the outcome of the battle. It is part of the outcome measure, yet analysts may separate it from the physical results of an attack to study why something occurred: What happened -vs.- why it happened.

In collecting outcome measures we will want to observe the contributions of close air support aircraft. Outcomes are the physical results of a close air support mission and as such, collection of empirical data is limited to the results of the attack by close air support aircraft. These results can be quantified by the numbers of killed enemy vehicles and the number of friendly aircraft that survive the attack. However, this does not limit the measure to the fighters making the attack. A subjective measure of contribution can be collected by observer/controllers that observe a close air support attack. Observer/controllers can make a subjective observation of tactics used and support given, to the ground force, by the close air support aircraft. While the raw air component performance data will consist of enemy vehicles killed and friendly aircraft destroyed, the team performance data will add contributions and enable the observer/controller, and the analyst, to see the dynamics of command and control over the close air support aircraft. An example of such a contribution is the attack by close air support aircraft acheives the results, in regard to the the enemy, that a ground commander desired.

Outcome Measurement System

The collection of objective outcome measures is dependent upon the collection system, the National Training Center Air Warrior Measurement and Debriefing System. The Measurement and Debriefing System is designed to provide all commanders with accurate depictions of simulated ordinance expended by tactical aircraft, and a reasonable estimation (based upon the Joint Munitions Effectiveness Manual, JMEM) of their effects. The Measurement and Debriefing System also simulates the use of surface-to-air missiles used by ground forces to counter the attack by tactical aircraft.

The Measurement and Debriefing System will be automatically integrated into the Army After Action Review and Debriefings as visual (video) and hard copy printouts of the air actions. Integrating the system's data into the training of the commanders, aircrews, and air defense elements will require further study, in that an enormous volume of data will have to be condensed into a format directly applicable to the learning experience of the participants.

SECTION 3

NATIONAL TRAINING CENTER
AIR WARRIOR
MEASUREMENT AND DEBRIEFING SYSTEM

The National Training Center/Air Warrior Measurement and Debriefing System (AWMDS) is an advanced training facility developed to improve combat proficiency and provide AirLand Battle training to the US Army National Training Center (NTC) with TACAIR and Theater Air Control System (TACS) elements. The AWMDS supports real-time training for Army/Air Force combat elements and Air Force aircrews in a realistic simulated combat environment at the maneuver area in Fort Irwin, California. The Air Force aircrews operate from Nellis AFB, Nevada.

The Measurement and Debriefing System (AWMDWS) is the hardware portion of the Air-Ground Training Feedback System (see Figure 3). The AWMDS provides position, velocity, attitude, air mass parameters, and weapons data for up to 36 high-activity (AIS pod equipped) aircraft for the purpose of monitoring and evaluating pilot performance in a tactical air combat scenario. The AWMDS accepts position data for up to 100 low-activity aircraft, and position and weapons engagement data and battlefield management information for up to 700 NTC-IS (Information System) participants. The AWMDS supports up to 50 simultaneous weapons simulations plus up to 22 unguided bombs for each high-activity aircraft, their effects (bomb damage assessment, BDA; and probability of kill, P_K), and Army air defense weapons effects. All maneuvers of aircraft and instrumented ground players in the NTC maneuver area is recorded and can be displayed, as they occur, on the Display and Debriefing Subsystem (DDS). There are Display and Debriefing Subsystems located at the Tactical Operations Center, Fort Irwin, and at

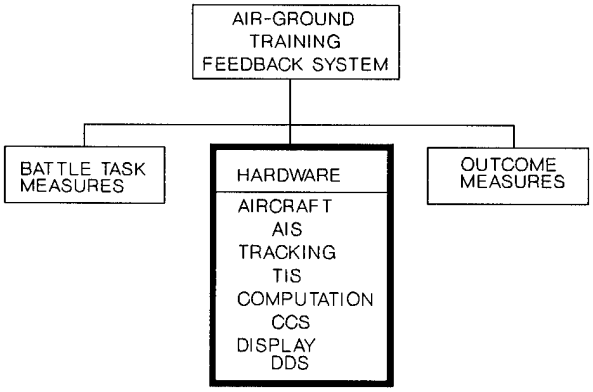


Figure 3: Air Ground Training Feedback System

the Air Warrior Operations Center, Nellis AFB. (See Figure 4 for diagram of system.)

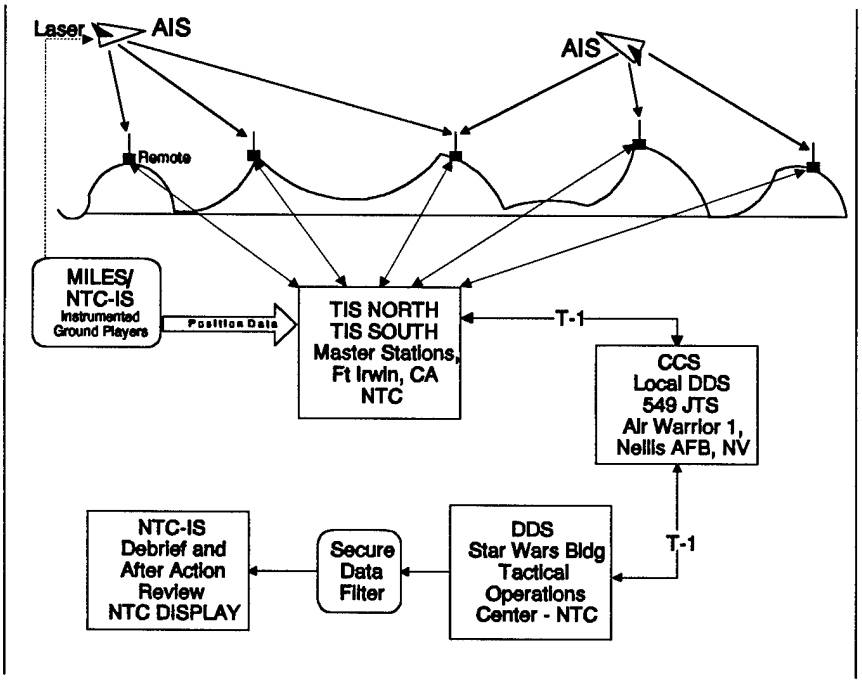


Figure 4: Display and Debriefing Subsystem

Pilot and air defense element initiated and system-validated weapons fires result in the simulation of the selected weapons against a computer or controller selected target. The system accommodates the combined activities of air combat maneuvering (ACM), no-drop weapons scoring (NDWS), anti-radiation missile (ARM) training, and air defense element training with their respective weapon simulations, as well as supporting three simultaneous missions. The system supports two types of scenarios which are called exercise modes. The Training Exercise Mode provides an iterative type of scenario in which participants are allowed unlimited practice of weapon deliveries. The Tactical Exercise Mode provides a combat scenario in which participants are allocated limited and expendable weapon inventories, participants are scored as dead or alive, and probable rates of failure are applied to weapon launches, deliveries, and impacts.

Without requiring the use of live weapons, the system enables commanders to recognize weapons envelope boundaries, observe the results of weapons firing/delivery techniques, obtain accurate BDA, determine air defense effectiveness, and practice air-to-ground and ground-to-air tactics —— all in the context of a realistically simulated combat environment.

Specialized training support includes:

- **No-Drop Weapons Scoring Activities** -- Training in air-to-ground missile and ballistic weapons delivery, the associated aircraft flight attitudes and dynamics, and the computed BDA against an NTC-IS instrumented point target or set of targets.

- **Air Defense Artillery Activities** -- Training in simulated surface-to-air missiles/weapons employment against adversary forces under realistic but controlled engagement conditions. Trains aircrews in realistic surface-to-air missile/antiaircraft artillery (SAM/AAA) evasion techniques.

These activities can be exercised in individual training missions or in combined missions to provide fully integrated tactical training in advanced combat operations under realistic conditions.

Physically, the AWMDS consists of four major subsystems. The Aircraft Instrumentation Subsystem (AIS), carried by each participating aircraft, interfaces with the aircraft. It provides digital and range data to the rest of the system via the Tracking Instrumentation Subsystem (TIS). The TIS includes remote stations and dual unmanned masters which, together, gather data from each AIS, and relay the information to the Control and Computational Subsystem (CCS). The TIS also accepts data from the CCS for transfer to the AIS. Aircraft and range data received at the CCS are processed there to provide required AWMDS information, which is then sent to the Display and Debriefing Subsystem (DDS). At the NTC DDS the CCS-to-DDS data are split. One path goes to the DDS, the other goes to a secure data filter (SDF) where only unclassified data are sent to the NTC-IS.

These subsystems track aircraft movements, collect data on employment of simulated air-to-air, air-to-surface, and surface-to-air weapons, and calculate simulated weapons trajectories. When integrated with the NTC-IS, which tracks all instrumented ground players, the AWMDS will determine ground targets within the P_K range of air delivered weapons, estimate BDA, and display all of the listed information at the DDS consoles for monitoring and control of the live mission while simultaneously recording it for debrief replay.

System Description

The AWMDS encompasses an approximate 30x21 nautical mile area of the Fort Irwin range. (Figure 5 shows AWMDS range view.) The system can track aircraft from 100 ft AGL to 60,000 ft. and provides weapons simulations and full state vector tracking for up to 36 aircraft, including position, velocity, acceleration, attitude, true airspeed, angles of attack and sideslip, and other airmass parameters. The aircraft must carry an AIS pod to obtain these data.

AWMDS audio functions enable monitoring of up to twelve UHF/VHF channels and

selective transmission of weapons tones. It supports up to 50 simultaneous missile simulations plus up to 22 unguided bomb simulations for each aircraft.

All mission data--digital, audio, and video--are recorded and available for replay during debrief.

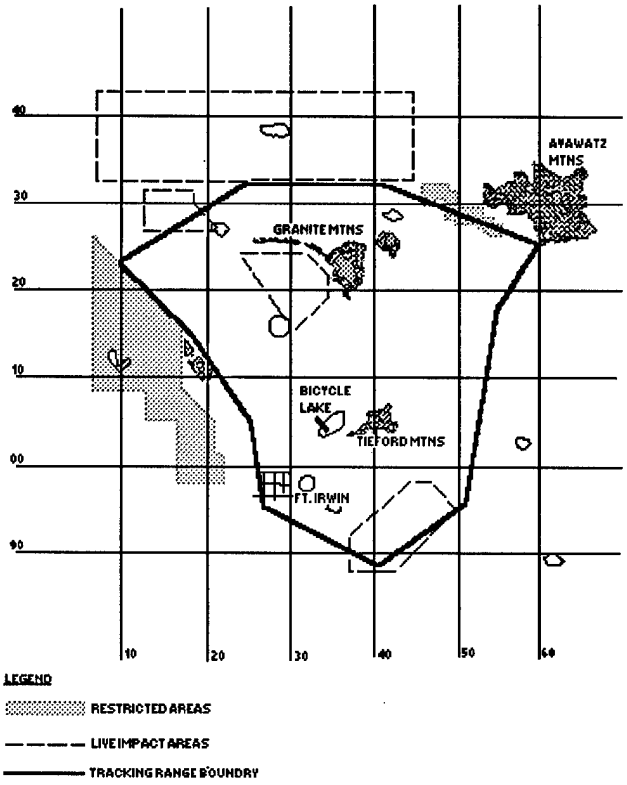


Figure 5: AWMDS Plan View

The AWMDS supports training in basic bomb/missile delivery for all properly interfaced high-activity aircraft. Using the attacking aircraft's state vector information and the pilot-initiated weapon release "Pickle" pulse, combined with weapons type, ballistics and fuse characteristics, the AWMDS predicts ground impact points. Weapons effects and probability-of-kill (P_K) calculations will predict bomb damage on targeted ground targets. AWMDS simulates various bomb and missile types for various delivery profiles. The DDS displays designated ground targets, weapon Pickle and result messages, release condition data, and ordnance impact points. The AWMDS supports aircrew training in the use of guided air-to-surface missiles, including the AGM-65D and -65G (Maverick). This capability is available for aircraft equipped with the proper interfaces and a captive AGM.

Using the aircraft and captive AGM data, the AWMDS calculates and displays P_K contour footprints or real-time simulation results, including P_K values or reasons for miss.

System Elements

Aircraft Instrumentation Subsystem (AIS)

The AIS is a five-inch-diameter pod physically similar to the Sidewinder (AIM-9) missile, and is mounted externally on the aircraft. It contains a transponder, a digital interface unit, a radar altimeter, an inertial reference unit (gyros, accelerometers, and data processor), an air data sensor unit, and a Multiple Integrated Laser Engagement System (MILES) receiver. The AIS operates from standard aircraft power available from an aircraft suspension unit.

The AIS measures aircraft flight data (attitude, velocity, acceleration, angular rate, and differential air pressures) from the aircraft's flight systems, and obtains weapons status data from the aircraft weapon system. It also receives laser energy from ADA assets aimed at the aircraft. Via the ground-based TIS, the AIS communicates these data to the CCS and receives tracking data corrections and operational commands over a bi-directional radio link. AIS-TIS data communications are synchronized to allow real-time processing of functional weapon simulations and multilateral tracking of aircraft position. Figure 6 depicts a P4AW AIS and its several components.

Tracking Instrumentation Subsystem (TIS)

The TIS enables synchronized data exchange between the ground-based CCS and the airborne AIS. The TIS consists of two unmanned master stations (north and south) and a total of 18 ground interrogator stations ("remotes").

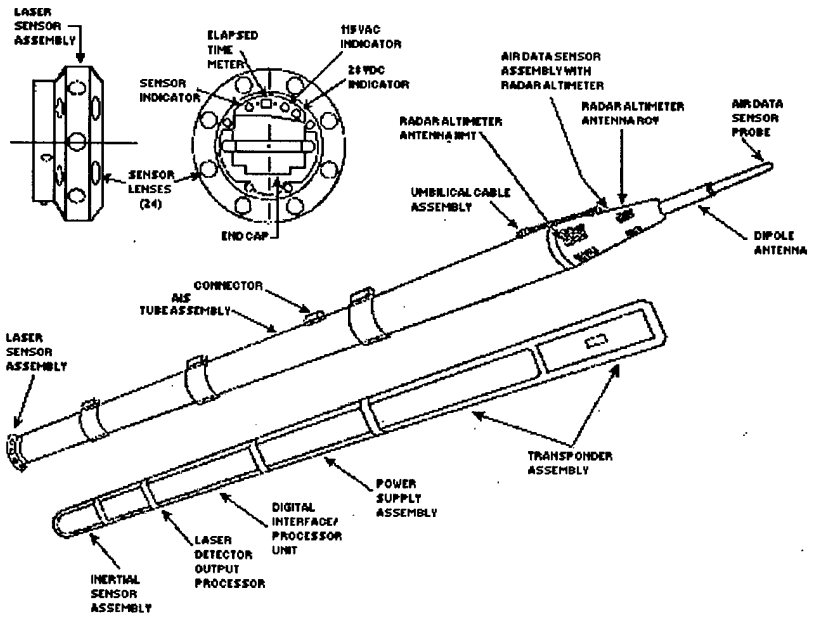


Figure 6: AIS P4AW

The remotes are located throughout the NTC exercise range to maximize multilateral tracking geometries for on-range aircraft. The remote interrogator stations consist of ground-to-air-to-ground and ground-to-ground receiver/transmitters powered by batteries, which in turn are typically charged by solar panels. The remote stations relay master station transmissions to as many as 36 AIS-equipped aircraft on the range and, in turn, relay AIS air-to-ground transmissions back to one of the master stations. The corresponding master station then transmits the data via full-duplex microwave link to the CCS. In reverse sequence, CCS-generated tracking data corrections and operational commands are transmitted to the AIS.

Each master station consists of a computer for processing communications and measuring ranges, microwave datalink equipment for communications with the CCS, and UHF/VHF equipment for voice communications with the aircraft. A calibration transponder similar to an AIS is installed as part of each master station to enable AWMDS calibration and performance checks to be conducted without aircraft in the area. Figure 7 shows a typical TIS remote station.

Control and Computation Subsystem (CCS)

The CCS is the primary processor for the AWMDS, performing the major computational and control functions for the system. As an executive system, the CCS supports communications between the AWMDS subsystems; it also records system and mission data in real time. It is located in Air Warrior Operations at Nellis AFB.

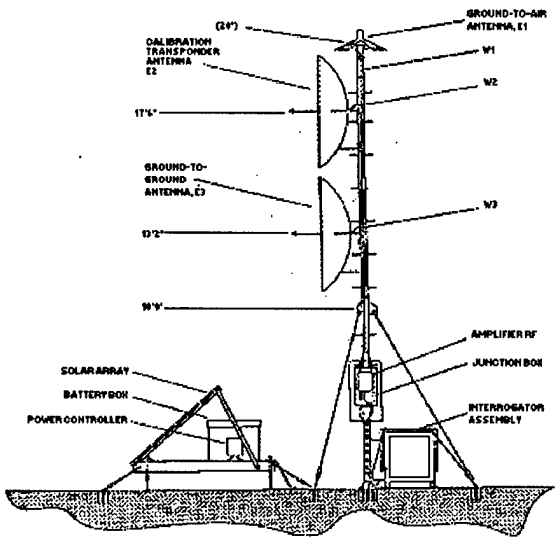


Figure 7: Remote Station Assembly

The CCS computes the aircraft state vector and airmass parameters of aircraft by processing the range measurements from the TIS and attitude, velocity, and air pressure data from the AIS. The CCS real-time tracking filter generates corrections to attitude and velocity measurements and formulates an uplink message for the AIS. These corrections are used to update the AIS, TIS, and CCS. Maneuvering aircraft are monitored to determine whether they exceed preset limits for acceleration, descent rate, angle of attack, or airspeed.

The CCS processes aircraft weapons system data to compute simulated weapons trajectories and results and to supplement internal system data; ground data from NTC-IS equipped devices are also processed for weapon ID and kill parameters. All weapons simulations are computed within the CCS; all aircraft tracking data, weapons trajectory data, and results are transmitted to the DDS in real time.

System Operator's console (SOC)--Interfaced to the CCS computers is the System Operator's Console (SOC), the primary operator interface to the CCS. The SOC is used to enter and change mission data, create and maintain mission data files, and generally control CCS operation. This function resides in a personal computer, permitting an off-line capability to create and maintain mission data files as well as an on-line capability to start, stop, and control the mission. The SOC terminal is located with the master DDS console and interfaced to the CCS.

Display and Debriefing Subsystem (DDS) The DDS records all data received from the CCS during live operations on magnetic disk for post-flight analysis. The data can be displayed such that aircrew and aircraft performance can be reviewed during live missions or post-mission debriefings. For debriefing, each DDS console is used as a stand-alone unit; thus, previous missions can be replayed at one console while an ongoing live mission is controlled and recorded at another.

There are two DDS consoles in the AWMDS: one at Air Warrior (Nellis) and one in the NTC Tactical Operations Center at the Star Wars Building. Each DDS console contains three, full-color CRT monitors for presenting digital alphanumeric and graphic or solid-fill raster displays. With the controls on the DDS console, which includes a collocated PC keyboard, the user can select and modify these displays as well as enable audio communications, control disk functions, and operate a hard copy printer/plotter. Because missile parameters are classified, a software filter (Secure Data Filter, SDF) is incorporated at NTC which removes the classified data and then forwards it for display on the Army Sun workstations. This data is recorded, which allows the After Action Review to be unclassified.

Twelve UHF/VHF radio channels are provided so that the console operator can communicate with aircraft approaching and operating in the arena. Radio and telephone communications are also available so that DDS personnel can coordinate with personnel located at a remote DDS, the CCS, the TIS master stations, or the flight control tower.

System Operations

The recording and replay capabilities of the AWMDS enable participants to see the exercise from various viewpoints, allowing them to supplement their own experience with that of other exercise participants and to obtain an overall perspective of the development of the entire exercise. Emphasis is placed on reviewing the overall battle scenario and unit performance rather than on individual performance evaluation.

When an exercise is about to be conducted on the AWMDS, the system operator initializes the system and inputs the participant data necessary to monitor and record the exercise's activities. The DDS recording consoles also display the exercise for monitoring and general viewing. The system allows viewing the action with either latitude/longitude or UTM grids displayed.

On exercise completion, several levels of after action review (AAR) or debriefing can occur, as desired. First, individual combat elements/aircrew flights can be debriefed. Full replay of air and ground action is available, including computed BDA. Secondly, separate AAR/debriefs for aircrews and soldiers can be held. These AAR/debriefs concentrate on the performance of the air and ground packages as a whole, with individual personnel or subgroup performances receiving attention only if they significantly affected the overall package performance. These package AAR/debriefs typically include replay of pertinent AWMDS recorded data to provide

an overview of the exercise's development, along with discussion and review of the Red and Blue plans, individual element reviews, and BDA summaries. Third, the top level summary AAR/debrief includes all participants. It is a top level summary of the exercise and covers lessons learned.

Following the mass AAR/debrief, AWMDS support can be scheduled on request for debrief of individual personnel, elements, subgroups, etc. These debriefs can be used to concentrate on specific exercise segments, drawing on the range of AWMDS replay capabilities to review specific aspects of the exercise from various perspectives of interest.

At the conclusion of each exercise rotation, one final mass debrief for all exercise participants is conducted. All briefing products, e.g., analysis summaries and composite video recordings, are made available to each participating unit to use for later review and analysis.

Exercise Modes

The AWMDS accommodates two basic modes of operation: Training and Tactical. The primary difference between these modes is the level of realism invoked by the system in simulating and depicting weapons firing and their results. That is, Tactical Mode is used to simulate the actual combat situation as realistically as possible, while Training Mode may sacrifice certain realism aspects to meet a specific training need.

Training Mode

Training Mode supports an iterative type of scenario that allows participants unlimited practice of weapon deliveries. In Training Mode, missiles and other ordnance expended by an aircraft are not subtracted from the aircraft's weapons inventory, and aircraft that are "killed" by simulated attacks remain active to fire or be fired upon.

Tactical Mode

Tactical Mode supports realistic combat scenarios in which participants are allocated limited and expendable weapon inventories; they are scored as dead or alive; and probable rates of failure are applied to weapons launches-deliveries- impacts. Unlike Training Mode, Tactical Mode prevents aircraft that have expended all of their weapons stores from firing again and excludes "dead" aircraft from continued participation in the exercise. However, Tactical Mode does permit DDS console operators to "rearm" or "rebirth" aircraft, thus allowing them continued weapons interaction in the exercise if desired by the Exercise Controller.

SECTION 4

OUTCOME MEASURES

DESCRIPTION AND COLLECTION

In Section 2, the outcomes desired were listed as a combination of objective outcomes (that describe the achievements of the air component against ground targets and its losses from air defense) and subjective outcomes (coordination of the close air support team and the ability of the air component to fulfill the ground commanders intent). The hardware and software packages described in Section 3 are capable of providing observer/controllers and analysts with the objective data necessary to make assessments on the attacks made by close air support aircraft. Subjective judgements can be made using information gleaned from printouts, observation of graphics displays, gun camera video, and direct observation.

Description of the Outcome Measures

The outcome measures consists of the Lethality Component Measure, the Survivability Component Measure, and the Contribution Component Measure. The Lethality Component and Survivability Component Measures are objective; the Contribution Component Measure is subjective (see Figure 8).

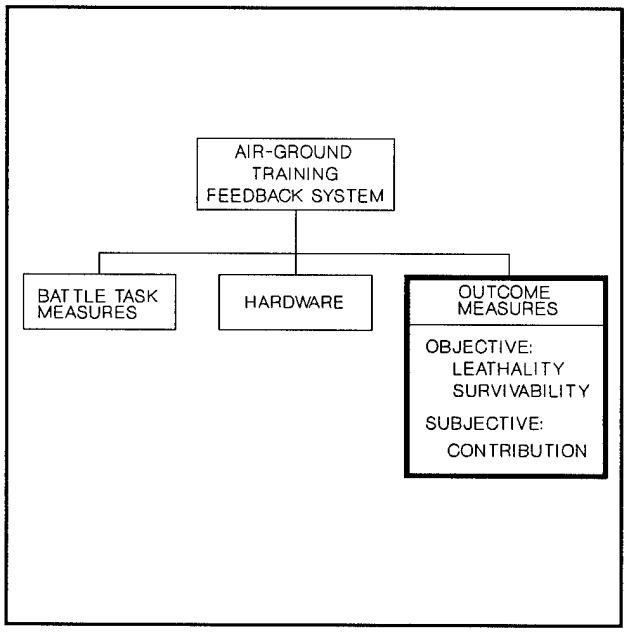


Figure 8: Outcome Measures

The Lethality Component Measure (LCM) is a measure of collective success achieved by the air platforms against ground targets. The LCM measures the performance of all the air crews in a given mission. LCM is not concerned with what target is attacked, whether it is the correct target or not; it is only concerned with the physical outcome of a given attack. Differentiating between targets is part of the Contribution Component Measure.

The LCM consists of a ratio for each mission. The LCM ratio is derived from the number of kills made for the number of air-to-surface weapons used. The number of kills, and the number of air-to-surface weapons used is obtained from the Display and Debrief Subsystem (DDS, the DDS is described in Section 3) printouts. These printouts list the aircraft, weapons used, and result.

The National Training Center/Air Warrior Measurement and Debriefing System gathers weapons release data, determines the probability of kill for those weapons, and then determines a battle damage assessment for each attack. This information is then sent to a Display and Debriefing Subsystem (DDS) where it is collected and a printout lists the aircraft, weapons used and the results. For the LCM, both the ratio and the raw numbers of weapons and kills are collected.

The Survivability Component Measure (SCM) is a ratio of surviving aircraft at the end of a mission to the aircraft that were at the beginning of the mission. The SCM is not concerned with why an aircraft is killed, or how it was killed (surface-to-air missile, combined arms air defense fires, or whether it is a fratricide). SCM only measures the percentage of surviving aircraft against total aircraft committed. The SCM is collected and reported in the same manner as the LCM.

The Contribution Component Measure (CCM) is a collective measure based upon the plan, coordination, and attack. The CCM is a subjective analysis of how well the ground and air components planned and coordinated an attack. The CCM is collected as a series of observations made by observer/controllers. Observer/controllers will make these observations as part of their critique of the elements participating in training. Observer/controllers will gather CCM data at the same time they observe training by watching operations directly, observing near-real-time output from the Debriefing Subsystem (DDS), and/or reviewing video-gun-camera tapes from the aircraft after the aircraft have returned to base. The framework for the analysis lies in the Army's METT-T (mission, enemy, troops, terrain, and time) method for mission analysis. This mnemonic fits the type of information needed to be gathered in determining contribution. Figure 9 lists the CCM.

The CCM (as well as the LCM and SCM) does not answer why something was successful or was not successful. Outcome measures are not measures of why a unit or close air support attack was successful. They are the basis for developing empirical relationships among various observations about employment of close air support. The observer/controllers must analyze this, and other, data to determine why a particular battle had a particular outcome. The commander determines the degree of success of that outcome, and of the training.

The CCM is series of yes or no questions used to indicate whether the portions of the CCM were accomplished. The CCM provides observer controllers, trainers, and analysts the basis for answering why, and helps them determine how performance can be improved.

Mission: The mission is the result that the ground commander wants to achieve from the close air support sorties. During planning, the ground commander has determined that the combat power of the close air support sorties will accomplish some action that will help the ground forces accomplish their mission. Examples are, the close air support destroys an enemy unit, close air support attacks delay enemy units, or the close air support attacks allow friendly units to maneuver.

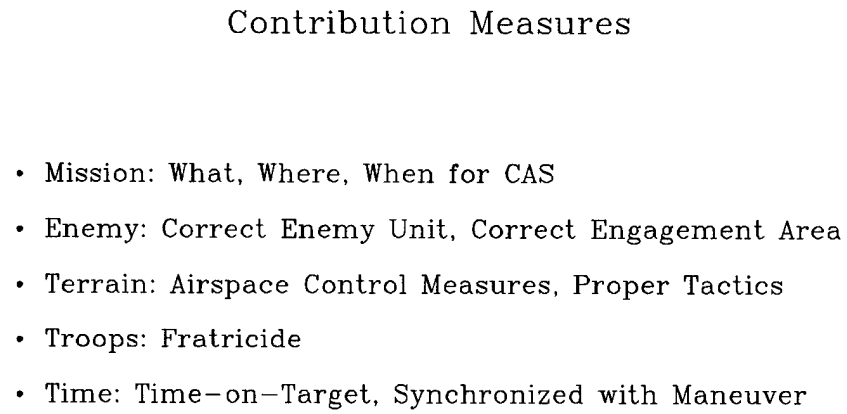


Figure 9: Contribution Measures

The mission portion of the CCM is a subjective measure gathered by an observer controller. It is simply a yes or no question: Did the close air support mission accomplish the task assigned by the ground commander? The mission portions will not answer why, that is the purview of the observer/controller.

Enemy: In the LCM we collect an objective number of enemy vehicles killed by the close air support. In the enemy portion of the CCM we are collecting a subjective measure of whether the close air support attacked the correct target. The destruction of many enemy vehicles by close air support may not have a positive influence on the mission if the correct target is not attacked. The question answered by an observer controller in determining the enemy portion of the CCM is: Was the correct (as determined by the task force or brigade commander) enemy force, or engagement area, attacked?

Troops: Fratricide is a continuing problem on the battlefield. As ranges of weapons and mobility of combat vehicles increase, the difficulties involved in correctly identifying enemy and friendly vehicles also increase. Procedural controls must be used by the close air support team to eliminate the chances of fratricide; the troops portion of the CCM is a measure of the success of the procedural controls used. The goal of all commanders is zero fratricide. The observer controller answers the question: Were friendly vehicles destroyed by friendly close air support, and/or friendly aircraft destroyed by friendly ground fires?

Indexing Outcome Measures

The LCM, SCM, and the CCM will be combined into a single index of performance. This index is an evaluation tool to be used by analysts and observer/controllers only. The weight of each component is based upon ideas about its importance to the close air support mission. Weighting of the components can be changed by commanders and/or analysts to emphasize different areas of training. However, weighting is dependent upon testing of the outcome measures over several rotations. The following weighting scheme is an example of how the outcomes can be weighted, if it is desirable to do so. One weighting scheme might be:

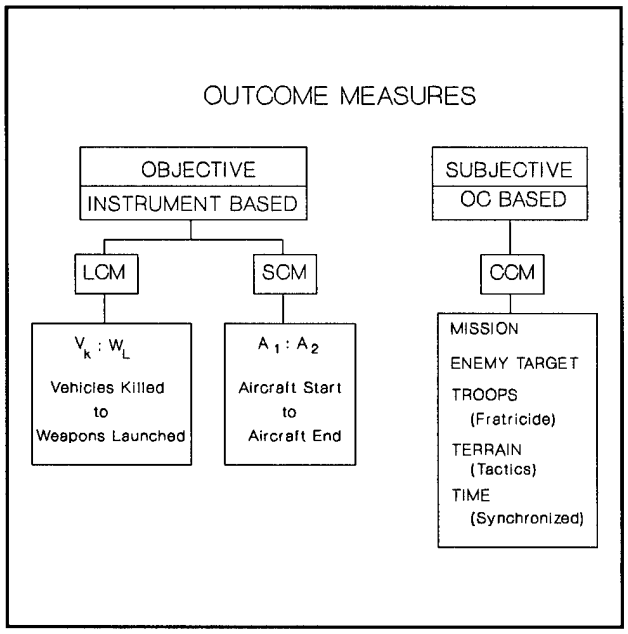


Figure 10: Indexing Outcome Measures

The LCM is a ratio of the number of vehicles killed (V_k) to the number of weapons used (W_l), V_k:W_l. The LCM will make up 25% of the outcome measure. The LCM only considers the number of vehicles killed and does not specify which vehicles were killed. It is possible that the close air support aircraft could have a very high LCM and not have attacked the target that it was assigned. The ratio measures the skill of the close air support aircraft pilots in the use of their weapons.

The SCM is a ratio of the number of close air support aircraft that survive (A_1) to the aircraft that start an attack (A_2), A_1:A_2. The SCM also makes up 25% of the outcome measure. The SCM only considers the number of aircraft that survive. At 25%, the SCM will not skew the index when a large percentage of the aircraft are destroyed in an attack that otherwise is successful, nor will it when an attack is unsuccessful and a low percentage of aircraft are killed. Since a normal close air support mission is less than four aircraft, the percentage of aircraft destroyed can easily skew the index if it were a greater percentage.

The CCM is the most heavily weighted of the three components that make up the outcomes. The collective weight of its subcomponents (Mission, Enemy, Troops, Terrain, and Time) will make up 50% of the outcome measure. It is the most important portion of the outcome measure, for this is the component that combines mission with technique. This component will most likely supply the analyst and the observer controller with the greatest amount of information for use in debriefing and determining the training strengths and weaknesses of the aircrews and ground players.

For use in the outcome measure index, each of the CCM's subcomponents are an all or

nothing proposition. If the event is accomplished, the points are added to the index, if not, no points are added. The parts of the CCM are weighted according to their importance. The subcomponents of the CCM are part of the total index, not just a subcomponent of the CCM. Using the CCM is a convenient method of grouping data. The total of the five subcomponents will equal 50% of the outcome index.

Mission: The mission is the most important part of the CCM and is weighted at 13% of the total outcome measure.

Enemy: This indicates whether or not the correct target was attacked. It is weighted at 7%.

Troops: Fratricide, the goal is that no friendly forces are attacked. This is weighted at 10%.

Terrain: Tactics and airspace use by the CAS aircraft is weighted at 10%.

Time: The timing of the attack is directly connected with the mission. To be successful on the battlefield our efforts must be synchronized. Time is weighted at 10%.

Figure 11 recaps the weights per outcome.

Outcome Measures

Measure	Weight	Index
Lethality	25	%* x 25 = ls
Survivability	25	% x 25 = ss
Contribution	50	
Mission	13	% x 13 = m
Enemy	10	% x 10 = e
Troops	10	% x 10 = t1
Terrain	7	% x 07 = t2
Time	10	% x 10 + t3
		m+e+t1+t2+t3=cs

ls + ss + cs = Weighted Index

* % is the percentage assigned by the OC

Figure 11: Weights Per Outcome

Collection of Outcome Measures

The outcome measure data is collected by observer/controllers at several locations and then centrally compiled. The data collected and the location of the collectors, is dependent upon which observer/controller can observe the outcome the best. Once the close air support has been observed, the observer/controller that has been tasked with collecting a particular portion fills out a collection sheet. This collection sheet is then sent by either distribution, facsimile, or electronic means to the central collection location. At a central location, the data is compiled and a compilation worksheet is prepare (see Figure 14). The compilation worksheet

and the observations collected are then sent to the Combat Training Center Archive, Presidio of Monterey, for storage.

The LCM and SCM are collected by an observer/controller at the DDS. The observer collects the raw data from the Full Summary screen of the DDS software or by printout. This data is then put on the LCM/SCM Outcomes collection sheet and sent to the central collection location. See Figure 12 for sample collection cards.

The CCM is collected at the DDS at the National Training Center, Air Warrior at Nellis AFB, and the task force or brigade headquarters that is responsible for selecting the target and assigning the mission.

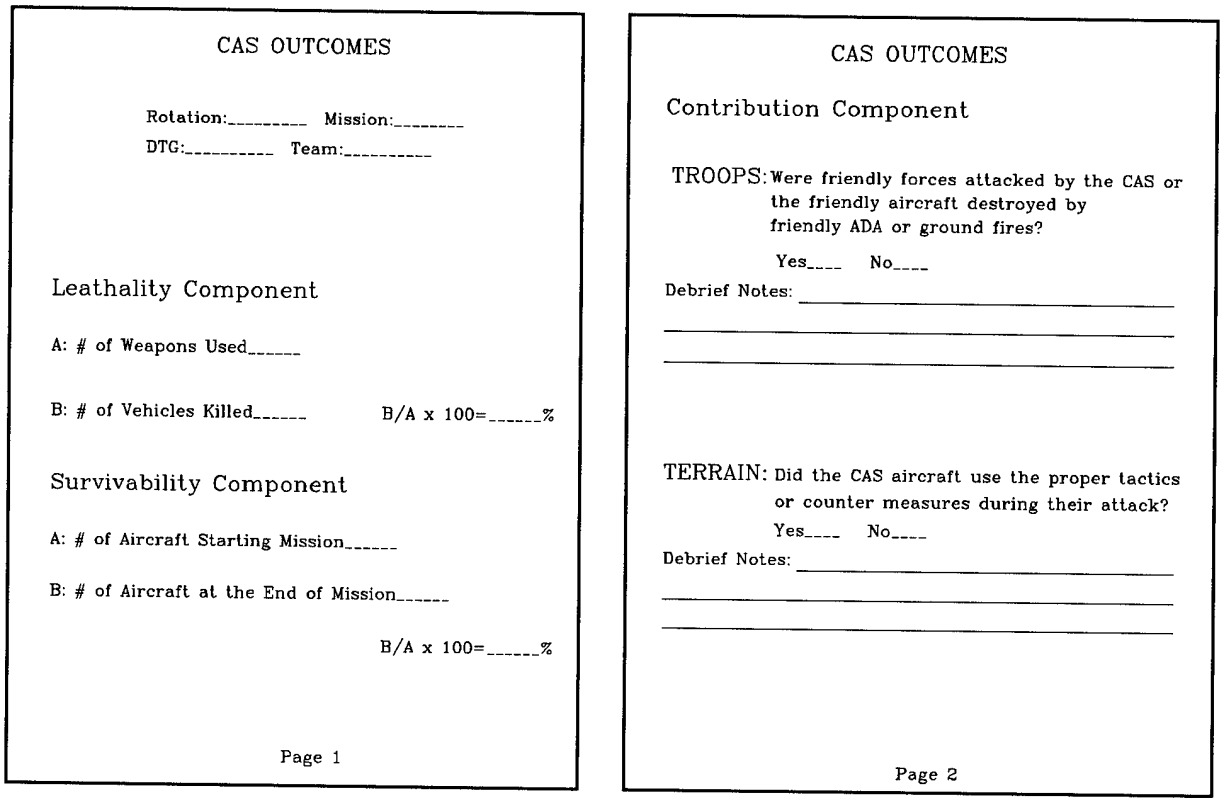
Mission: The mission portion of the CCM is collected at the controlling ground headquarters by an observer/controller. The Observer/controller is in the best position to determine what the commander's intent was and whether or not it was accomplished. See Figure 13.

Enemy: The enemy portion is collected at the same time as the mission portion at the controlling ground headquarters. See Figure 13.

Troops: The troops portion is collected at the National Training Center DDS by the observer there. The observer at the National Training Center DDS can best determine fratricide from the fires by the close air support and the air defenses. See Figure 12.

Terrain: The terrain (tactics) is collected by an observer/controller National Training Center DDS or the Air Warrior DDS. These observer/controller can best determine the tactics and flight routes used through the use of the DDS's software package that supply a plan view of the battlefield and the pilot's heads-up display. In put can also be obtained from the video shot by the aircraft's gun-camera. See Figure 12.

Time: The time portion is collected by the observer/controller at the controlling ground headquarters. This information can be obtained at the same time as the mission and enemy portions. See Figure 13.



CAS OUTCOMES

Rotation:_____ Mission:_____

DTG:_____ Team:_____

Leathality Component

A: # of Weapons Used_____

B: # of Vehicles Killed_____ B/A x 100=_____%

Survivability Component

A: # of Aircraft Starting Mission_____

B: # of Aircraft at the End of Mission_____

B/A x 100=_____%

Page 1

CAS OUTCOMES

Contribution Component

TROOPS: Were friendly forces attacked by the CAS or the friendly aircraft destroyed by friendly ADA or ground fires?

Yes____ No____

Debrief Notes: _____

TERRAIN: Did the CAS aircraft use the proper tactics or counter measures during their attack?

Yes____ No____

Debrief Notes: _____

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Figure 12: Observer Collection Cards for use at the National Training Center DDS.

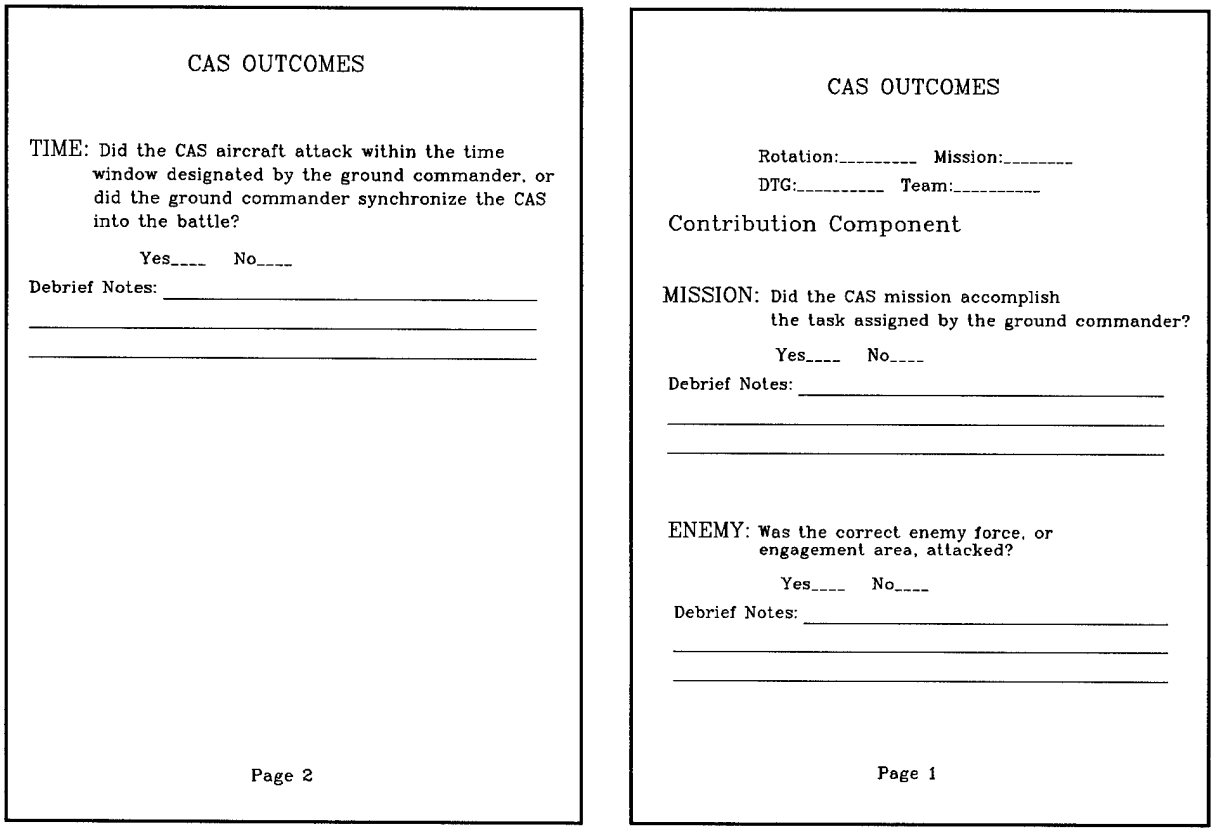
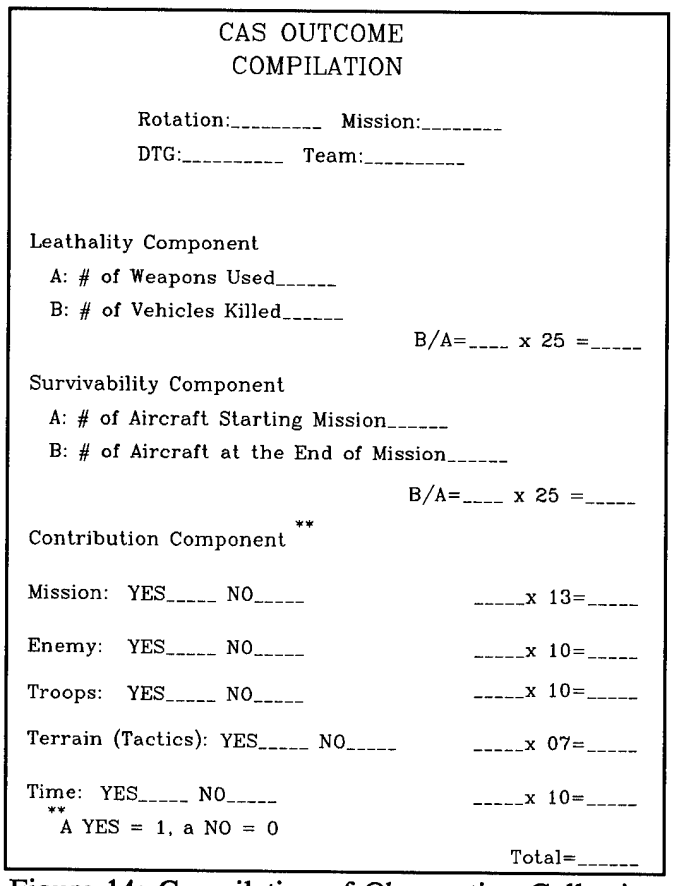


Figure 13: Observer Collection Cards for use at Ground Headquarters.



CAS OUTCOME
COMPILATION

Rotation:_____ Mission:_____

DTG:_____ Team:_____

Leathality Component

A: # of Weapons Used_____

B: # of Vehicles Killed_____

B/A=____ x 25 =_____

Survivability Component

A: # of Aircraft Starting Mission_____

B: # of Aircraft at the End of Mission_____

B/A=____ x 25 =_____

Contribution Component **

Mission: YES_____ NO_____ _____x 13=_____

Enemy: YES_____ NO_____ _____x 10=_____

Troops: YES_____ NO_____ _____x 10=_____

Terrain (Tactics): YES_____ NO_____ _____x 07=_____

Time: YES_____ NO_____ _____x 10=_____

** A YES = 1, a NO = 0

Total=_____

Figure 14: Compilation of Observation Collection Cards

CONCLUSION

The Air-Ground Training Feedback System is a promising addition to the training at the National Training Center. However, the capability of the system to produce the outcome measures discussed above is dependent upon instrumentation and availability of trained observer/controllers.

The instrumentation system is designed to collect empirical data through electronic means for the loss of both friendly air and ground, and enemy ground targets. However, the numbers of enemy vehicles destroyed still cannot be fully measured using an instrumented system. The National Training Center mounts only 70% of its Opposing Force with MILES systems. Fortunately, these are normally the combat vehicles that the close air support aircraft will attack.

We also must assume that the instrumentation package on the aircraft, its collection by sensors at the National Training Center, and transmission to the Display and Debriefing Subsystem will all function properly.

Observer/controllers are still the key player in training with this system. The raw data is nice to know information, but how and the why something happened is what training is all about. The observer/controllers will supply the how and why. It is necessary that observer/controllers observer the close air support mission from several different advantage points. First, an observer/controller must be with the task force or brigade headquarters, for here the mission will be assigned and synchronized. Second, observer/controllers must be where they can observe the actions of the close air support aircraft and the action of the enemy and friendly forces.

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