

DEVELOPING MEASUREMENT WITHIN AN EVOLVING TRAINING PROGRAM

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ABSTRACT

This paper reviews the development of a measurement and feedback system using a systems approach to design in an evolving training setting. The WarFighter Feedback System is a prototype automated feedback system developed for the Battle Command Training Program. The goal of the development was to provide a means to prepare and present diagnostic feedback on unit performance to training audiences during After Action Reviews and to support the Army's requirement for systemic feedback on planning and decisionmaking for Division and Corps headquarters. The intelligence slice of division operations was selected for the evaluation and demonstration of the principles associated with training performance measurements of collective tasks. The Intelligence Battlefield Operating System is a subset of Command and Control (C2) comprised of several interdependent collective and small group tasks. The nature of these tasks and the measures of performance associated with them can be organized to support analysis and feedback in various training settings. Change management approaches and extension of this applied research to the broader context of C2 are the major reported findings.

INTRODUCTION

Command and Control performance data are primary sources of diagnostic feedback to units and systemic feedback that influences the development of doctrine, training, leadership, organizations and materiel. The Army has, until the formation of the Battle Command Training Program, been unable to capture useful command and control data for large planning headquarters because the settings in which the performance occurs are complex. Analysts often mistake battlefield outcomes for command and control performance. The aim of the project was to exploit the Battle Command Training Program (BCTP) as a "living laboratory" and to satisfy its internal and external requirements for C2 data. BCTP is a unique exercise setting where division and corps commanders and staffs can practice warfighting doctrine and receive objective, near-real time feedback on their performance. BCTP's roles are to package and deliver data for use as

diagnostic feedback to training units, and to support the flow systemic feedback to the Army. Our objective was to demonstrate how to integrate training technologies for the purpose of capturing, organizing and analyzing measurements of Division-level command and staff performance during BCTP supported command post exercises.

ADVANCED COLLECTIVE TRAINING, BCTP-STYLE

BCTP is a combat training center formed in 1987 to address the unique requirements associated with training higher order decisionmaking and team building skills at divisions and corps headquarters. The Battle Command Training Program extends the Army's National Training Center (NTC) collective training strategy from brigade- to division-level. The Program was initially modelled after the NTC experience; however, it soon became evident to BCTP that direct transfer of training technology between the two programs was

infeasible. Unlike the NTC surrogate battlefield, battles at BCTP are engaged within the confines of a simulation center, where a computer model augmented by a controller staff replicates the battlefield environment. BCTP is not heavily instrumented to collect battlefield results. The Corps Battle Simulation (formerly JESS) generates battlefield information and results which are reported by the controller staff to the training headquarters. The fog and friction of war are created through the intelligence generation system and the participation of a competitive opposing force (OPFOR). The Program is in the advanced development phase of its life-cycle as it strives to respond to summative evaluation provided by its client units.

The scope of training for command and staff teams goes beyond the application of tactics and operating procedures. Measures of C2 effectiveness at NTC and BCTP can be contrasted. At NTC, battlefield outcomes reflect the unit's ability to see the battlefield, to acquire and act upon spatial and temporal relationships and to accommodate change based on their perceptions. Engagements can be easily quantified and tabulated through the use of Multiple Integrated Laser Engagement System, MILES. At BCTP, command and control structures compete for positional advantage, to establish the tempo of battle and to seize the initiative. Learning occurs in the affective and cognitive domains because the information flows are greater and the complexity of battlefield is more completely represented. The BCTP

training strategy employs state-of-the-art, adult learning techniques such as seminars and professional reading programs, computer simulations, and a variety of measurement methodologies to influence the behavior of its training audiences. The most meaningful feedback generated during the BCTP experience is introspective, produced in near-real time, related to performance, is objective, and delivered during After Action Reviews.

We believe that Command and Control performance is observable and lends itself to evaluation with data generated during a BCTP WarFighter Exercise (WFX), a computer-assisted, force-on-force command post exercise (CPX). Our approach conforms to the systems model depicted in Figure 1. The development of a prototype system to demonstrate proof of principle proceeded with a multi-dimensional front-end analysis.

We examined 1) mechanics of the BCTP training system, 2) components of doctrine that comprised intelligence operations at Division level, and 3) mea-

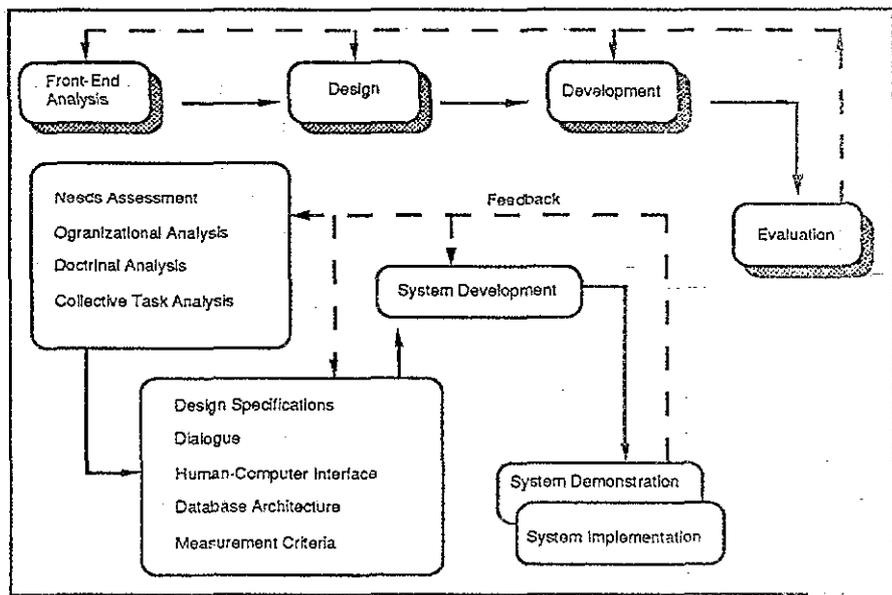


Figure 1. Systems Approach Model.

asures of performance associated with the critical Intelligence tasks. Our hypothesis is that command and control is a process outcome and not a measurement of battlefield outcome. A process measurement will consist of quantitative and qualitative measurements. The project focus was the Intelligence Battlefield Operating System (BOS). Intelligence doctrine was selected for the prototype demonstration because intelligence performance issues are high priority to BCTP, intelligence doctrine is stable and accepted by the Army intelligence community, and in practice, intelligence operations conform to the doctrine.

WARFIGHTER FEEDBACK SYSTEM: A TRAINING DEVELOPMENT TOOL

The WarFighter Feedback System (WFS) depicted in Figure 2 supports the collection, preparation and delivery of feedback to describe collective performance. It is based on the integration of quantitative and qualitative performance measurements that are grounded in the doctrine. The goals of the developers were to produce irrefutable evidence that linked staff performance to battlefield outcomes and to present the information to training audiences in a form that influenced future behavior. The principal elements of the system are 1) data extraction, 2) quality assurance, 3) data tables, 4) reports generator, and 5) presentation strategies.

(1) Data extraction processes were created to identify and collect performance data from a variety of sources available during the BCTP exercise phase.

• **Collection Strategies.** The OC Collection Guide prescribes a strategy for organizing the human observers' collection efforts. It is a job aid

developed from a survey of observation skills and collection techniques used by BCTP Observer Controllers. The Guide consists of materials that focus the observer controller on the critical events and data needed to support performance evaluation for specific training objectives. The collection plan complements the analysis plan prepared for each exercise.

• **Collection Plan.** The Data Collection Plan is prepared to support the evaluation of training issues. The plan describes the measures of performance, the data to be collected, the source of the data, and the collection instrument to be used. Collection does not rely solely on the observer. The Plan is an integrating device and control measure put in place to ensure data required to support training effectiveness analysis are available.

• **Data Extraction Tool.** The computer simulation processes combat orders and generates combat results. Status reports are produced and output to workstation controllers. Data extraction goes beyond the generation of reports. Data extraction allows the analyst to determine what data are needed to evaluate an issue and formulate conclusions. In the prototype stage, a data extractor was used to post-process data from both JESS and the Intelligence Collector Model (ICM) data files. Subsequently, this led to widespread use of formerly inaccessible data and the development of the JESS Generic Interface, a tool that extracts ground truth in near-real time and passes the data through the local area network to an on-line storage device.

• **Process Measurement.** The Army Research Institute was on-site during BCTP training rotations and applied its Command and Control Evaluation System, ACCES. The measurements were integrated into the

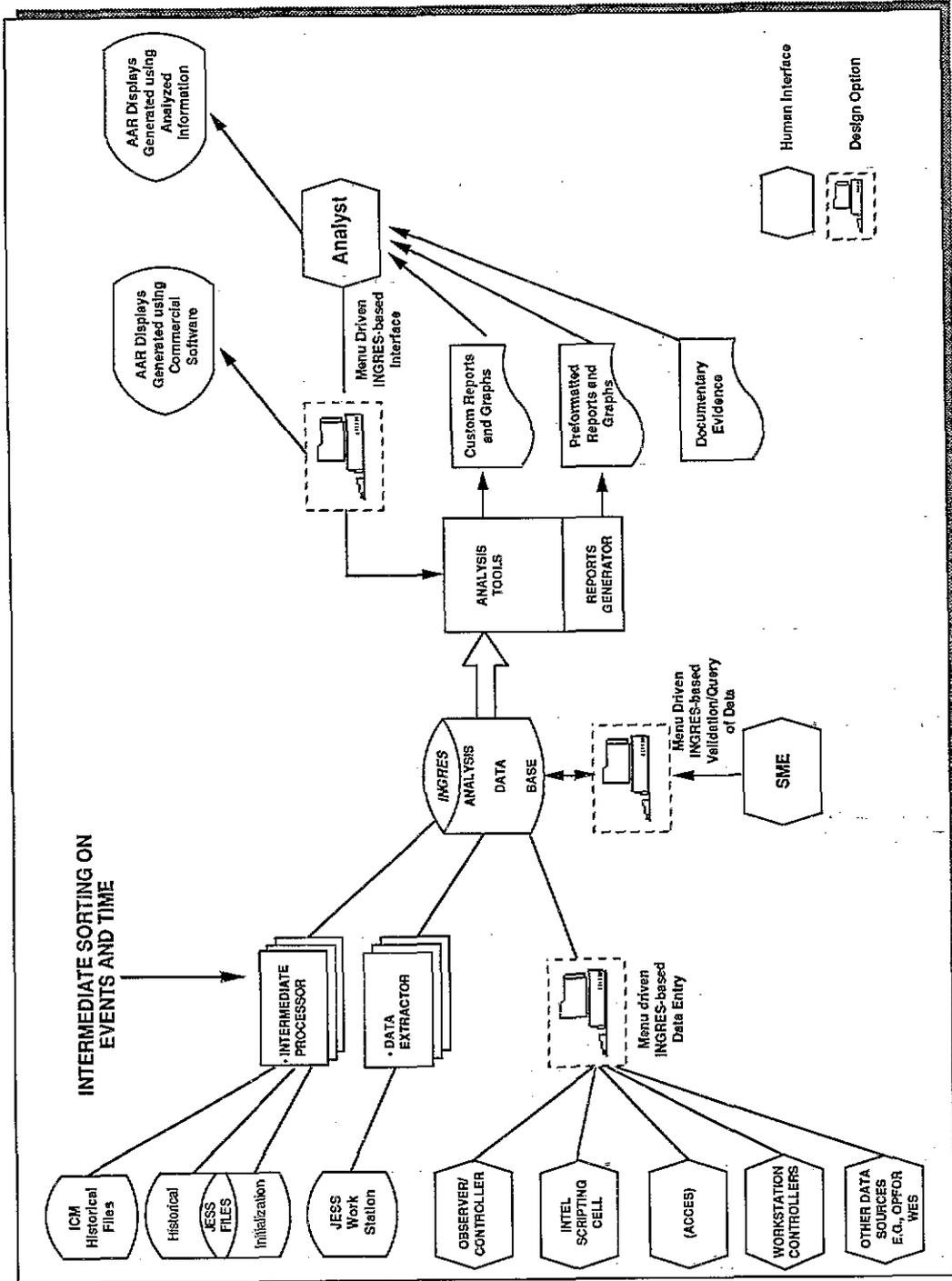


Figure 2. Architecture of the Warfighter Feedback System (WFS).

data set used to produce AAR feedback and Final Exercise Reports. ACCES relies on direct observation of command post operations using measures unlike those applied by the BCTP observer staff. Its outputs are graphical tables and indices that supplement the standard BCTP AAR products.

(2) Provisions to ensure quality assurance were developed but not implemented. In the advanced prototype, the data were subjected to screening by a subject matter expert for completeness and to ensure that computer software was not producing the effects being reported. In the objective system, software could be created to recognize gaps or anomalies and display them for review by a System Manager or Subject Matter Expert. This component is considered essential to preserving the quality of outputs to support AARs.

(3) A relational database management system, *INGRES*, was selected by BCTP to organize data collected during the training. Selection criteria were availability of the VAX hardware system, compatibility with other CTC databases, and ease of use for the complete range of BCTP users. Relational database technology enables the analyst to enter, query, update and analyze data. This capability allowed analysts to perform the information management tasks associated with preparing and presenting AARs especially defining interrelationships among the variables and data sets that make up the BCTP exercise data flow. The array of *INGRES* related tables used to support the prototype is depicted in Figure 3. Five distinct segments can be distinguished in the schematic: 1) doctrinal framework linking performance to doctrine, measures of performance, ACCES process

measures, battlefield operating systems and training issues 2) exercise specific data that describe collector, its location and time tags for each mission 3) manually collected data and an archive for documents 4) JESS generated data, and (5) Intelligence Collector Model (ICM) Intelligence History Files (IHF).

(4) An *INGRES*-based reports generator was installed to manage WFS output and reporting. Training analysts were given access to the database through the reports generator. Report formats were developed from the same analysis plan used to prepare the collection strategy. Outputs could be generated from a menu of pre-formatted report shells, (*INGRES-FORMS*), intended to support projected training issues. or, through *INGRES* Query by Forms (QBF) which allows the analyst to tailor his report format to respond to an unanticipated training performance issue.

(5) Presentation strategies are formulated prior to the training exercise and altered as required to satisfy emerging training needs. Through the WFS, BCTP was able to build an integrated feedback system that supports the entire data flow process, Figure 4. WFS is a disciplined collection and analysis approach capable of meeting emerging training concerns. It provides a means to structure the format and content of AARs. The aim is to produce integrated themes that enhance learning and retention of the battlefield lessons and experiences and link them to the applicable doctrinal tenet and operating system. The use of computer generated statistical summaries, graphs and charts was suggested to enhance the transfer of information during AARs and reduce time spent by analysts to collect and reduce the data.

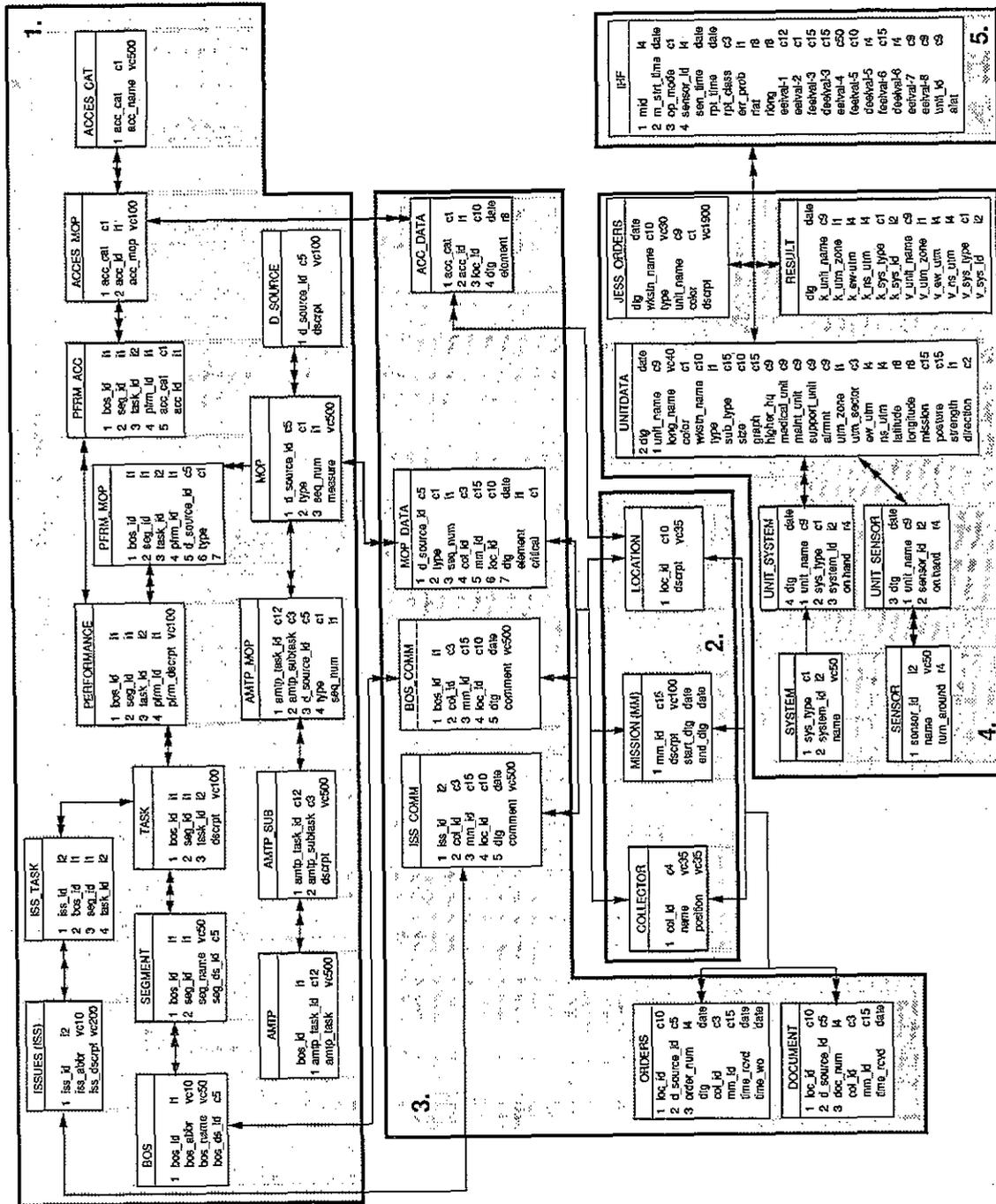


Figure 3. Relational Database Schema.

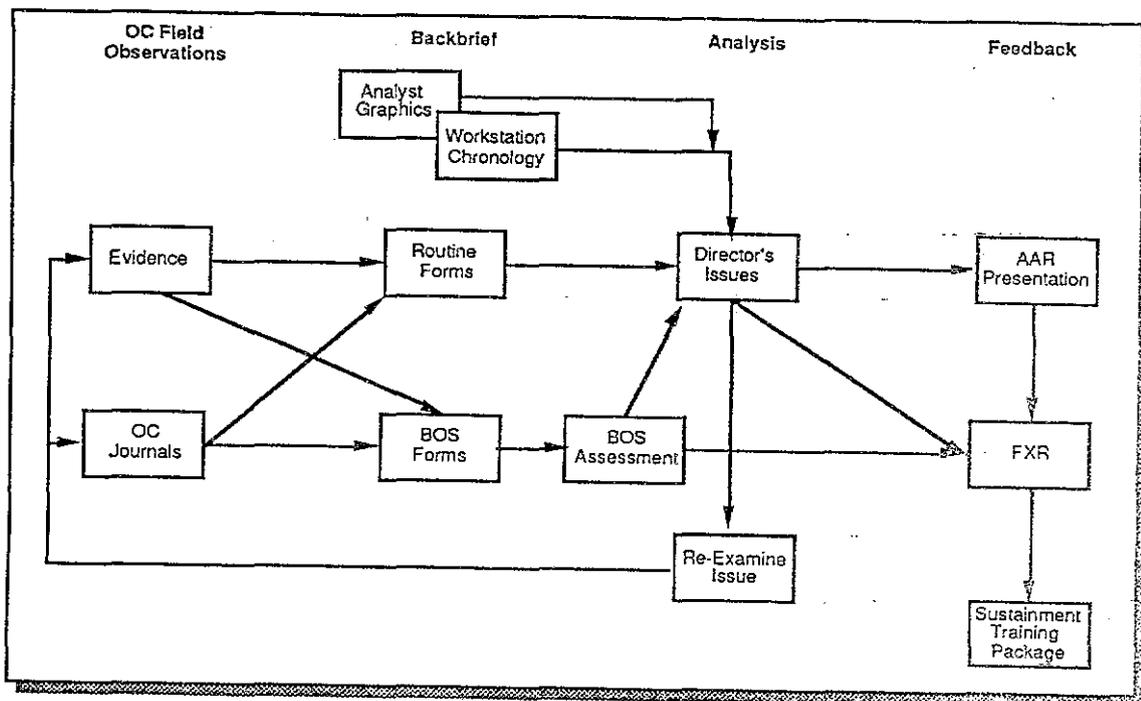


Figure 4. AAR Data Flow System.

KEY FINDINGS

WarFighter Feedback System applies a systems approach to describe command and control performance at Division headquarters. It shows the sequence and relationship among critical collective and small group tasks that make up successful intelligence operations. Hierarchic structures to describe the intelligence process were developed and validated in field interviews and subject matter expert reviews. These dendritics are the basis for defining measures of performance and organizing data for further analysis. Collection and analysis could be planned within BCTP based on these structures. It was also shown during the WFS pilot test and prototype demonstrations that proactive data collection could be used to support reactive data analysis. Evidence of command and control process was not found in computer generated battlefield outcomes. Typically, "truth" was revealed through the integration of observations and

measurements taken at various points in the planning and decision process long before the outcome could be recognized. Collection planning should be combined with an analysis of the training objective and warfighting scenario. This is a prerequisite knowledge that permits the analyst to anticipate his data requirements and to formulate an analysis plan. WFS facilitates data reduction and synthesis of outcomes that support AARs.

Organizational issues play a significant role in obtaining user acceptance. The BCTP Mobile Training Teams plan, conduct and evaluate training. Their ability to deliver credible feedback is limited by the ability to communicate observed data throughout the OC team, the ability to recognize significant battlefield events and link them to earlier direct observations, and the ability to achieve compressed timelines in support of the AAR process. Each of these factors places a burden on the observer controllers who rely on

individual background and experience. The introduction of the WFS innovation was a source of anxiety for this audience. WFS required learning new skills and reliance on different sets of skills and indicators to measure performance. Acceptance was not widespread despite the effort made to build consensus. Principal reasons were assessed to be a shift in emphasis from ad hoc and post hoc collection techniques to prescribed form and content. The shift to WFS prevented the observer from selecting areas of interest that fell within his area of expertise.

The introduction of new technology into an existing system requires an implementation strategy that involves the new user, training, post-deployment support and a regulating process to transition innovation into an existing system. For this development, relational database management systems applications were proposed. New techniques for data collection and analysis were introduced to accommodate the availability of large quantities of new information. New observation and reporting skills were suggested to standardize data collection and enhance reliability by closely relating observations to doctrinal standards.

Relational database management based on a comprehensive front-end analysis proved to be a key ingredient in describing critical command and control performances. The data table architecture was flexible enough to update, refine and modify relationships among variables. The *INGRES* application possesses one major shortcoming i.e., it does not have an integrated graphics utility which limits its use as a presentation medium. Alternative commercially available relational database software was evaluated to determine whether a stronger graphics package exists.

Measurement is a discipline that must be learned, practiced and applied with consistency. Standardized observation techniques were not evident in this setting. This finding underlines the need for rigor in collection and organization of field data. The doctrinal front-end analysis was used to highlight the relationship between performance standards and critical tasks associated with division planning and decision processes. These were arrayed as collection matrices that defined measures of performance, data sources, collection method and collection interval. Key was the recognition that observer controllers provided less than 5 percent of the available performance data, yet 95 percent of AAR content came from the observers. The vast amount of data could not be reduced and analyzed, therefore it went unused.

CONCLUSIONS AND IMPLICATIONS

The WFS prototype applied a systems approach to data collection and feedback of complex, cognitive tasks. The project demonstrated the need to integrate quantitative and qualitative data to gain insights on the strength and weaknesses of command and control processes.

The WarFighter Analysis and Reporting System (WAARS) is another *INGRES*-based analytic tool used by BCTP analysts as an interim solution to its data reduction and analysis capability shortfall. Evaluations of the WFS prototype and the interim advanced developmental system are being used by Los Alamos National Laboratory to create a Master Workstation. This new capability will include use of the JESS Generic Interface tool to extract JESS data and combine it with inputs from field observers and workstation controllers to generate AAR graphics.

The WFS prototype was a successful proof-of-principle demonstration of an integrated, scientific approach to performance measurement and feedback. WFS was capable of supporting the need for diagnostic feedback. A program is underway to develop a Command and Control Lessons Learned database that supports the Army's need for systemic feedback. The follow-on project will link *ORACLE* relational database management system and an object oriented authoring environment (*HyperCard* or *SuperCard*). The project is designed to expand the doctrinal domain from Division intelligence to Division and Corps command and control to include linkages to the remaining battlefield operating systems.

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