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An Initial Assessment of the Flying Carpet (FC) System

Billy L. Burnside and David W. Bessemer
U.S. Army Research Institute

August 1991

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The Defense Advanced Research Projects Agency (DARPA) developed the Flying Carpet System to help tactical commanders plan and prepare for future battles. The system integrates combined arms simulation and other technologies to display a simulated Middle Eastern battleground with static force displays. U.S. Army Research Institute personnel assisted the Armor School with an initial assessment of the system's utility in January 1991, focusing on division-level planning activities. Results indicated that the Flying Carpet has several potential applications in the tactical planning and training arenas, but numerous refinements are needed prior to fielding.

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FOREWORD

In August 1990 the Defense Advanced Research Projects Agency (DARPA) began an attempt to apply available technologies in support of Operation Desert Shield. This resulted in design and development of a prototype system, the Flying Carpet (FC), to help tactical commanders plan and prepare for future battles. Personnel from the U.S. Army Research Institute for the Behavioral and Social Sciences (ARI) Field Unit at Fort Knox, Kentucky, assisted in this initiative by developing guidance for FC use and participating in the initial assessment of the system's utility. This report documents the results of those efforts.

This research was conducted as Technical Advisory Service in response to a request from the U.S. Army Armor School's Command and Staff Department. It was performed under an ongoing ARI task entitled "Training Requirements for Combined Arms Simulators." The FC is based largely on combined arms simulation technology, and it has potential training applications. This research fits within the Fort Knox Field Unit's mission, which is to investigate innovative training applications of simulation technology.

In February 1991 the findings of this research were provided to Command and Staff Department personnel responsible for the initial FC assessment. They are incorporating these findings in their overall assessment. The findings will be useful in guiding any further development of the FC or similar systems.

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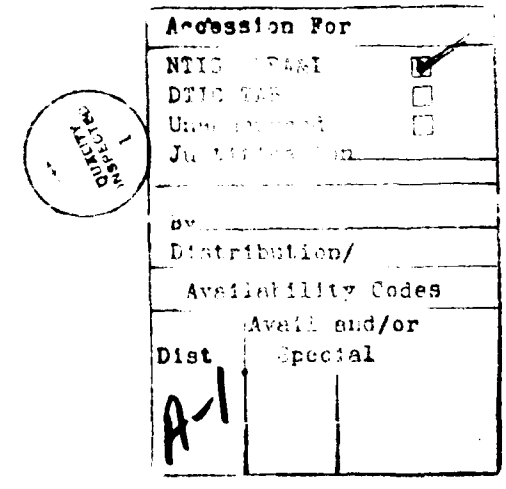

AN INITIAL ASSESSMENT OF THE FLYING CARPET (FC) SYSTEM

EXECUTIVE SUMMARY

Requirement:

Initially to support Operation Desert Shield, the Defense Advanced Research Projects Agency (DARPA) developed a prototype Flying Carpet (FC) system to help tactical commanders plan and prepare for future battles. This system integrated combined arms simulation and other technologies to display a simulated Middle Eastern battleground with static force arrays. Potential users identified a need for an assessment or "shake out" of the FC prior to deployment. This assessment was conducted at Fort Knox, Kentucky, during January 1991. Since circumstances precluded deployment of the FC to Saudi Arabia, the assessment focused on potential system applications and refinements needed. U.S. Army Research Institute for the Behavioral and Social Sciences (ARI) personnel assisted in this effort at the request of Armor School representatives.

Procedure:

The assessment was conducted over 5 days, with 3 days devoted to using the FC to support division-level planning activities. Military personnel from Fort Knox and other locations acted as a division staff and used the FC to develop and display courses of action for three different scenarios. ARI personnel observed these activities and administered a questionnaire near the end of each day. Armor School personnel conducted after-action reviews (AARs) each day and at the end of the assessment.

Findings:

Assessment participants concluded that the FC was not ready for fielding or deployment and identified numerous refinements needed. Primary concerns dealt with the system's graphics capabilities and reliability, along with the relationship of the FC to other automated command, control, and intelligence systems. Several potential uses for the system were identified, but no firm conclusions were reached on the best uses or the most appropriate echelons for fielding.

Utilization of Findings:

Armor School personnel are using the findings to formulate overall conclusions about the utility of the FC system. These findings will also be useful in guiding any further development of the FC or similar systems.

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AN INITIAL ASSESSMENT OF THE FLYING CARPET (FC) SYSTEM

Introduction

In August 1990 the Defense Advanced Research Projects Agency (DARPA) initiated Project Odin with a goal of accelerating the application of advanced technologies to meet military operational requirements. The immediate objective of this initiative was to rapidly tailor available technologies for support of Operation Desert Shield. To meet this objective, the primary focus of DARPA's effort was design and development of a system integrating several technologies having potential to support planning and preparation for tactical operations. During development, this system had several names based on its components or functions. In this report the overall system is referred to by its most common name, Flying Carpet (FC).

The majority of the technologies incorporated in the FC design were derived from the Simulation Networking (SIMNET) system. SIMNET is a network of manned and computer-controlled combat vehicle and aircraft simulators that operate on or over a simulated battleground (U. S. Army Armor School, 1989). It was developed by DARPA and has been transitioned to the Army to support collective training and combat developments. SIMNET-based technologies incorporated in the design of the FC included a Middle Eastern terrain database, a two-dimensional electronic map display, and an out-the-window three-dimensional display of simulated terrain from any position on or above it. Integrated with the map and terrain displays, a modified form of the SIMNET semi-automated forces (SAFOR) provided a capability to place and move simulated combat vehicles and aircraft on or over the terrain. Technologies included in the FC design that were not derived from SIMNET included a semi-automated link to intelligence sources and an automated wargaming capability.

The purpose of combining SIMNET-based and other technologies in the FC system was to provide Desert Shield commanders with a tool to supplement their planning and preparation for future battles. The FC was designed to allow these commanders to see a computer-generated approximation of their projected areas of operations, along with representations of orders of battle on the simulated terrain in accordance with recent intelligence. This capability would support surrogate reconnaissance of denied terrain. The FC design also called for maneuverable SAFOR and automated wargaming to be incorporated in the system. These capabilities would support wargaming of alternative courses of action and perhaps mission rehearsal (Donovan, 1990) for tactical operations. The system was housed in a mobile container, so that it could be moved readily among using units.

Development of the FC system began with a goal of deployment to Sauda Arabia by February 1991. During development, potential

users identified a need to exercise the system before deployment. The initial FC design focused on display of close-combat heavy forces, so the decision was reached to conduct an initial trial at the Home of Armor, Fort Knox, Kentucky. Since this trial was not a formal test, it was called the initial FC assessment - "shake out." As the time for the assessment neared in January 1991, it became apparent that the FC could not be deployed before Operation Desert Shield became Operation Desert Storm, nor could some expected capabilities be provided. The objective of the assessment thus changed from providing input for a deployment decision to identify potential system uses and refinements needed.

The assessment was conducted during the period 22-26 January 1991 by the Armor School Command and Staff Department. During this period a prototype FC system with many but not all of the required capabilities was available. Personnel from the Armor Center and other Army agencies used the prototype FC to plan division level operations based on generic Desert Storm missions. Two personnel (the present authors) from the Fort Knox Field Unit of the Army Research Institute (ARI) assisted in this effort by developing and administering a user questionnaire, monitoring all assessment activities, and recording users' verbal comments.

This report presents results of the ARI questionnaire, along with comments noted and observations made by ARI personnel. The report thus documents the ARI portion of assessment activities, supplementing documentation developed by Armor School or DARPA personnel. This should help ensure that the results are used to develop the potential of the technologies included in the FC system. Prior to describing the assessment and its results, a brief overview of the FC system is presented below.

FC System Overview

As part of their effort to support FC system development, the present authors prepared a draft Commander's Guide describing the system and how it could be used. This document is provided at Appendix A. Such a guide, along with an operator's manual, should be included with any FC system fielded. The draft guide describes the FC system as it was conceived in the fall of 1990, but it does not exactly represent the prototype system used in the Fort Knox assessment. During development, many features of the FC system were modified. As noted above, some of the expected FC capabilities were not available in January 1991. Also, terminology changed as the system evolved; note that the draft guide refers to the FC as the Commander's Battle Preparation System (CBPS).

The draft Commander's Guide is included with this report since it gives a fairly detailed description of the original concept for the FC system. It also describes many of the functions that the FC system should ultimately support. The guide focuses on the battalion commander and staff, but it

suggests FC uses that should have application at various echelons. It thus provides a point of departure for development of a user's guide for any FC-type system that may be fielded in the future. Since the draft Commander's Guide does not depict faithfully the FC system available in January 1991, a brief description of this version of the system is provided below, covering the system's major components and capabilities. See Appendix A for more detailed descriptions of FC components and some potential functions. Also, see the SIMNET Users' Guide (U. S. Army Armor School, 1989) for more detailed descriptions of SIMNET's subsystems mentioned below.

Terrain Database

The terrain database developed for the FC system represents a rectangular area 360 km long from east to west and 290 km wide from north to south. This area includes Kuwait, northern Saudi Arabia, and southern Iraq. See Figure 1 in the draft Commander's Guide at Appendix A for a map of the area covered. The eastern two-thirds of this area were available during the assessment.

Terrain variation, trafficability, and cultural features are represented at varying levels of detail and accuracy in different portions of the database. The coastal area is represented in greatest detail. Major buildings are shown only in Kuwait City, but major roads are represented throughout the database. Variations in terrain elevation are shown in fair detail, but not down to the level of individual sand dunes.

Using system components described below, the database supports placement and viewing of vehicle arrays on simulated terrain. As with SIMNET, the surface of this terrain cannot be modified to show prepared battle positions, ordnance effects (e.g., cratering), or residual signs of activity (e.g., tracks).

Two-Dimensional (2D) Display

The primary user's workstation in the FC system is referred to as the 2D Display. This component supports two general functions. It provides an electronic map display of the simulated battlefield from an overhead perspective, similar to SIMNET's Plan View Display (PVD). It also serves as an Order of Battle Generator (OBG), allowing unit and vehicle icons to be placed on the map display and vehicle models to be created on the simulated terrain. The OBG capability represents the next generation of SIMNET's SAFOR workstation, with added functions and improved user interface.

Electronic map. The color map is displayed on a table-top monitor and it can be manipulated using a mouse to select icons or pull down menus. Users can change the scale of the map, move it to any area in the FC battleground, and add or delete map features, such as contour lines and roads. They can also determine the distance between two points, plot a cross section

of elevation between two points, and plot intervisibility (line of sight (LOS)) between two points or throughout an area.

Users can develop electronic map overlays by creating and manipulating graphics and control measures on the 2D Display. Pull-down menus can be used to create various types of lines and points, and to add free text to the screen. Once created, overlays can be saved in user-named files for later retrieval.

OBG. The OBG function is used to place icons representing unit symbols or individual vehicles on the 2D Display. Allied icons are shown in blue and enemy icons are shown in red. Icons are selected by dragging them from an icon list on the left side of the screen or by using pull-down menus. Icons are placed on the display by clicking a point on the map or entering a grid coordinate. The placement of icons can be fine-tuned in various ways. For example, the formation and orientation of units shown as icons can be specified, units can be represented in dug-in positions, and unit designations can be entered as text on the display. Icons are available for units and unit headquarters, at echelons ranging from division to individual vehicles.

Once icons are placed on the 2D Display, the units and vehicles they represent can be created as vehicle models appearing on the simulated terrain. This is done by connecting the workstation to the simulator network. The capabilities for displaying vehicles on terrain are described in the next section.

Three-Dimensional (3D) Display

The FC 3D Display is similar to SIMNET's Stealth Display. Three color monitors show a panoramic view of the simulated terrain. The viewing "window" can be moved (driven or flown) to any point on or above the simulated terrain using an input device called the Spaceball. It can also be teleported rapidly to any selected location by using a function available at the 2D Display. An arrow appears on the 2D Display to indicate the location and orientation of the viewing "window". The view can also be attached in various ways to vehicle models on the terrain. This allows the user to follow a selected vehicle or to see a terrain view from inside the vehicle.

Vehicles are shown on the 3D Display in accordance with parameters selected (e.g., formation) using OBG functions. The available vehicle models used during the FC assessment were the M1 tank and M2 Bradley Fighting Vehicle (BFV). Models for a generic helicopter and a generic air defense vehicle were available but were not used. Units created above the battalion echelon during the assessment were shown on the 3D Display as one vehicle. This limitation was imposed by the fact that only 2,000 vehicles could be handled at one time by the prototype FC system. Units created at battalion echelon and below were shown as the appropriate number of vehicles on the simulated terrain.

Only static vehicle placements were available during the FC assessment. Future versions of the FC system are planned to provide a moving SAFOR capability. Initially, workstations will be capable of controlling only 60 moving vehicles as an upper limit. Also, the functions provided by SIMNET's Management Control Console (MCC) were not available with the prototype FC. This meant that vehicles did not interact (i.e., shoot) on the simulated battleground, and combat support and combat service support elements were not represented. Plans call for MCC functions to be integrated with the FC system in the future.

The FC system provides utilities for storing static vehicle placement files (these were available during the assessment). Vehicles placed on the system at one time can be stored in a scenario file for later retrieval. Successive vehicle placements can be stored and retrieved using a timeline function. Tracks on the map can show vehicle movements between different placements stored in the timeline. Displaying successive unit templates retreived from a timeline file represents unit movements as "snapshots". Using the capabilities described, participants developed mission scenarios and timelines as static vehicle placement files during the FC assessment.

FULCRUM

The FULCRUM system (Interactive Television Company, 1990) is intended to link the FC with intelligence sources. FULCRUM can access and display various types of map backgrounds using Defense Mapping Agency (DMA) products such as videodiscs. Users can create graphics over the map background to display information such as the locations of military units. FULCRUM can also process digital terrain data from compact disc read-only memory (CD-ROM) files to display information such as slope profiles and radial LOS. The FULCRUM environment helps a user to access and relate various types of map-based information.

The FULCRUM link provides a means for enemy unit compositions and dispositions displayed in the FC system to be based on recent intelligence. Once data are transferred from intelligence sources to FULCRUM, they can be modified as necessary and transferred electronically to the FC system's 2D and 3D Displays. The FULCRUM system was available during the Fort Knox assessment, but it was not linked to intelligence sources or fully integrated with the FC system. FULCRUM's capabilities were thus demonstrated but used little during the assessment. Generic enemy unit parameters were entered directly into the FC system at 2D Display workstations.

SABER Wargamer

The overall concept of the FC system includes a requirement for an automated wargamer having a quick turn-around time. The basic idea is to provide a means for users to analyze and compare alternative courses of action developed on the FC. This

capability may be available in future versions of the FC having moving SAFOR; users could direct SAFOR units to conduct courses of action in real-time and compare the outcomes. But the FC capability for moving SAFOR may be limited for some time, and it is not always efficient to compare alternative courses of action by running them in real-time. FC developers have thus sought an available battle simulation system that can be used with the FC to rapidly wargame and compare courses of action.

At the time of the Fort Knox assessment, a final decision had not been made on selection of a wargamer for inclusion with the FC system. A wargame system under consideration (called SABER) was available during the assessment, but it received little attention from participants. This wargame is thus not addressed specifically in the remainder of this report, although participants' comments on general wargaming needs are summarized.

FC System Configuration

The FC system is designed to be mobile so that it can readily be moved among field sites. During the Fort Knox assessment the bulk of the system was configured in a ruggedized container (approximately 20 feet in length) mounted on a truck chassis. Components mounted in this container included three 2D Display workstations, a 3D Display, and computer equipment required to support system operation. The remainder of the system was configured in a remote FC station set up in a conference room near the truck. The remote site included a 2D Display workstation, a 3D Display with three large-screen (50-inch) monitors, and a FULCRUM workstation. The majority of assessment activities occurred in the remote facility, owing to space limitations in the mobile container.

Method

The FC assessment was conducted over a period of five successive days. Approximately four hours were spent in assessment activities on each of the first and last days, and nine hours were spent on each of the intervening days. The first half day was devoted to orientation of participants to the FC system and assessment procedures. The final half day was devoted to a final after action review (AAR) during which experiences were summarized. On each of the three full exercise days, participants used the FC system to help plan and prepare for tactical operations focused on the division echelon.

The participants were drawn from the Armor Center and other Army agencies. Some personnel participated in all three exercise days, and some participated during only one day. There was thus a somewhat different mix of participants each day. Each day's participants acted as a division commander and staff, and they performed planning and decision-making activitiies within the context of a generic Desert Storm scenario. A different division scenario was used each day. Near the end of each exercise day,

participants completed an ARI-developed questionnaire (see Appendix B) and took part in a daily AAR. Further details on the assessment approach are provided below.

Questionnaire

The purpose of the Project Odin Flying Carpet User Questionnaire shown in Appendix B was to capture participants' views on the utility of the FC system. The questionnaire was divided into four parts, with Part I addressing the backgrounds of participants, Part II addressing the utility of the FC system for supporting military planning and decision-making activities, Part III addressing the general utility of the system, and Part IV addressing a comparison of the FC system with a Desert Shield demonstration sandtable located in Stacy Hall at Fort Knox.

Participants

A total of 22 personnel (including one active and one retired military observer who did not take active roles) participated in the FC assessment. Thirteen of these personnel came from Fort Knox agencies and the remainder came from Army agencies at other locations. Ten personnel participated for more than one exercise day.

Roles of participants. The division roles in which participants served during the assessment are listed in Table 1. This table also shows the numbers of personnel (by rank) who served in each role over the three exercise days.

Table 1

Number and Ranks of Personnel Playing Each Role in Division Staff Exercises Using the Flying Carpet (FC) System

Role	Number of Personnel by Rank[a]
Division Commander	1 COL, 2 LTCs
Chief of Staff (CS)	1 COL(Ret)
Intelligence Officer (G-2)	1 MAJ, 1 CPT
Operations Officer (G-3)	1 LTC, 1 MAJ, 2 CPTs
Fire Support Officer (FSO)	1 LTC, 1 MAJ, 1 CPT
Air Defence Artillery Officer (ADA)	2 CPTs
Air Liason Officer (ALO)	1 MAJ, 1 CPT
Engineer Officer	1 MAJ, 1 CPT
Nuclear, Biological, and Chemical Warfare Officer (NBC)	1 SFC
Participant-Observers	1 COL(Ret), 1 MAJ

[a]COL = Colonel, LTC = Lieutenant Colonel, MAJ = Major, CPT = Captain, SFC = Sergeant First Class, Ret = Retired.

Backgrounds of participants. The background information summarized in this section was derived from responses to Part I of the ARI questionnaire (see Appendix B). Each participant provided the requested background information when he or she first completed the questionnaire. The group of participants included one female officer.

The duty positions of participants at the time of the assessment are summarized in Table 2. The range of time in present duty position was 2-36 months, with an average of 13 months. The levels of participants' previous command and staff experience are summarized by echelon in Table 3. Their command experience was limited, and they had relatively little staff experience at echelons above brigade level.

Table 2

Summary of Current Duty Positions for Participants in Division Staff Exercises Using the FC System

Type of Position	Number
Service school trainers or training manager	10
Test officers or testing agency managers	5
Retired military consultants	2
Squadron commander	1
Miscellaneous	4

In terms of other experience, only two participants had experience on a joint staff or in a unified or specified command. One of these had extensive experience at this level. Twelve of the participants had been to the National Training Center (NTC), 2 during assignments and 10 during unit rotations (range of 1 to 3 rotations). None of the participants reported having been to Saudi Arabia, and 7 described other experience in desert terrain (locations included Yakima, Washington; Fort Bliss, Texas; and Twenty-Nine Palms, California). Eleven of the participants reported SIMNET experience, and 6 of them described this experience as extensive.

Procedures

At the beginning of each exercise day participants were provided a briefing on the current tactical situation, including the corps commander's intent, the friendly forces available, and the disposition of enemy forces over the past several days. Disposition of enemy armor and mechanized infantry forces was created on the FC system prior to the assessment, and briefing view-graphs and hand-outs were produced using the FC printer. Participants then proceeded to perform division-level planning and decision-making activities using the FC system.

Table 3

Summary of Participant's Command and Staff Experience at Specific Echelons and Highest Echelon of Experience

Echelon	Number with Experience		
	Command[a]	Staff[a]	Highest
Battalion	4	16	6
Brigade	1	8	6
Division	0	6	5
Corps	0	4	4
Above Corps	0	1	1

[a]Participants can be counted at several levels.

Activities started with the provision of guidance by the individual acting as division commander. Participants were encouraged to use the FC system as much as possible, but little specific guidance was provided on how to use it. Contractor personnel provided a brief overview of FC operation. On the second and third exercise days, one participant acted as division chief of staff to provide further structure to activities. This resulted in more integrated staff efforts and increased use of the FC system by more participants.

Each day's staff activities initially concentrated on identifying specified and implied tasks and developing alternative courses of action. The FC system was not used for much more than surrogate reconnaissance during this phase. Once alternative courses of action were developed, staff members attempted to represent them on the FC system using scenario or timeline creation functions. Operational failures generally limited participants to creation of one course of action on the FC system each day. System problems also limited attempts to wargame each course of action using the timeline function.

Participants operated the FC workstations, assisted by contractor personnel and three military operators. The military operators provided limited assistance, since they were not available until the start of the assessment, and did not receive extensive training on the system. Participants had ample opportunity to work with the FC system, including FULCRUM.

Each day's activities were halted at approximately 1600 to allow administration of the ARI questionnaire. About 30 minutes were allowed to complete questionnaire responses. Most exercise participants present on a given day completed the questionnaire. Since some personnel participated in more than one of the division exercises, they completed the questionnaire more than

once. After the first day, they were instructed not to repeat Part I background information, the Part IV sandtable comparison, or voluntary comments provided previously in other sections.

Questionnaire completion was followed by a daily AAR. During this activity participants discussed the advantages and disadvantages of the FC system for supporting steps in the accomplishment of the military decision-making process. This discussion was focused on completion of intelligence preparation of the battlefield (IPB) and development of courses of action. Results of the daily AARs were used to guide the final AAR on the fifth day of the assessment. In addition to available exercise participants, some senior Armor School Command and Staff Department personnel joined in the final AAR.

Results

Planning and Decision-Making Processes

Support by the FC system. The participants were largely neutral to slightly positive on the degree to which the current FC system would help or hinder accomplishment of steps in the various military planning and decision-making activities. Mean ratings on the five-point scale appear in Table 4, with higher means indicating higher judged benefit. The means show small differences between echelons, and few steps in the processes have ratings that are consistently higher or lower over echelons.

For troop-leading procedures, the means tended to be higher for the steps of receiving/analyzing the mission, making a tentative plan, conducting reconnaissance, and supervising and revising the plan. No consistent differences appeared in means for the commander's estimate of the situation. For intelligence preparation of the battlefield, lower ratings were given to weather analysis, corresponding to the fact that weather could not be represented in the FC system. For the military decision-making process, the highest averages were found for providing information to the commander and staff.

The number of participants rating the steps in each process varied for each echelon. Most participants provided complete ratings for the division, but only one-half to one-quarter rated processes at other echelons. In order to utilize all available data, separate distribution-free tests based on rank orders (Lehman, 1971) were performed for each echelon and process.

Most participants present in the staff exercises for two or three days did not repeat filling out the same portions of Part II. No meaningful averages could be computed by day, and no statistical tests could be performed to examine trends across days. In the few cases that ratings were given on more than one day, values averaged over days were used in subsequent analyses. The number of participants contributing to the mean ratings for each process and echelon are presented in Appendix C, Table C-1.

Table 4

Mean Ratings of FC System Support of Planning and Decision-Making

Step	Echelon				
	BN	BDE	DIV	CPS	EAC
Troop-Leading Procedures					
Receive/analyze mission	3.19	3.22	3.19	3.45	3.17
Issue warning order	2.61	2.80	3.20	3.37	2.95
Make a tentative plan	2.97	3.13	3.52	3.93	3.24
Initiate movement	2.75	2.73	3.20	3.40	2.81
Conduct reconnaissance	3.60	3.52	3.98	3.95	3.45
Complete the plan/order	2.71	2.85	3.23	3.47	3.10
Issue order	2.78	2.73	3.17	3.47	2.95
Supervise/revise plan	3.22	3.28	3.66	3.79	3.21
Commander's Estimate of the Situation					
Analyze mission in detail	3.28	3.09	3.54	3.44	2.83
Analyze situation (METT-T)	3.43	3.37	3.70	4.00	3.17
Develop courses of action	3.33	3.30	3.58	3.77	3.00
Analyze courses of action	2.90	2.81	3.44	3.42	3.00
Compare courses of action	3.07	3.02	3.43	3.71	3.33
Develop decision/concept of operation	3.07	3.04	3.48	3.44	3.25
Intelligence Preparation of the Battlefield					
Battlefield area evaluation	3.60	3.39	3.59	3.94	3.00
Terrain analysis	3.67	3.57	3.74	4.10	3.20
Weather analysis	3.03	2.94	3.04	3.06	2.71
Threat evaluation	3.53	3.30	3.61	3.90	3.20
Threat integration	3.23	3.18	3.47	3.83	3.20
Military Decision-Making Process					
Receive mission	2.62	2.83	3.18	3.38	2.80
Provide information	3.04	3.15	3.74	3.98	3.20
Analyze/restate mission	2.71	2.96	3.30	3.57	3.20
Complete staff estimates	3.00	3.11	3.39	3.71	3.20
Prepare plans/orders	2.79	3.04	3.31	3.57	3.00
Approve plans/orders	2.67	2.78	3.14	3.14	2.80
Issue plans orders	2.62	2.89	3.34	3.57	2.80

Note. BN = Battalion, BDE = Brigade, DIV =Division, CPS = Corps, and EAC = Echelons Above Corps.

Usually, ratings were provided for all steps in a process or no steps. Seven participants gave 14 scattered ratings that were dropped from the data analyses. Fifteen participants omitted a single step from their ratings at one or more echelons. Their ratings were retained in the analyses by using a least squares estimate for the missing value computed by Yate's method (Cochran & Cox, 1957). The number of rating values estimated for each process and echelon are given in Table C-1.

Differences among procedural steps. Friedman rank tests indicated differences among ratings mainly at the division level, where larger numbers of participants provided more statistical power. The tests shown in Appendix C, Table C-1 were significant for troop-leading procedures and the military decision-making process at division level. Tests for steps in intelligence preparation of the battlefield were significant at both division and corps levels. Tests were not significant for the commander's estimate of the situation at any echelon.

Mean ranks derived from the Friedman tests are presented in Appendix C, Table C-2. Pairwise comparisons at division level between steps in troop-leading procedures are summarized in Table 5, based on Wilcoxon test statistics in Appendix C, Table C-3. These comparisons show that the FC system was judged more helpful in conducting reconnaissance than other troop-leading steps, except possibly for making a tentative plan and supervising or revising the plan. While the latter two steps also tended to be judged higher than the remaining four steps, these smaller differences were not statistically significant. However, an *a posteriori* contrast between ratings for conducting reconnaissance and the mean of ratings for all other steps combined was found significant, $z = 3.46$, $n = 20$, $p = .0005$. The Wilcoxon statistic for this contrast was tested at $p < .0006$, using a familywise error rate of $\alpha = .10$ for the set of 162 possible partitions of eight means into two categories. These results indicate that the participants considered reconnaissance to be the one outstanding benefit of the FC system for troop-leading procedures.

Table 5

Summary of Pairwise Comparisons Between Steps in Troop-Leading Procedures at Division Level

RECN > (MISS, WARN, COMP, ORDR)	RECN = TENT = SUPR
TENT = SUPR = MISS = WARN = COMP = ORDR	

Note. MISS = Receive/analyze mission, WARN = Issue warning order, TENT = Make a tentative plan, INIT = Initiate movement, RECN = Conduct reconnaissance, COMP = Complete the plan/order, ORDR = Issue order, SUPR = Supervise/revise plan.

Comparisons between steps in intelligence preparation of the battlefield are summarized in Table 6, based on statistics shown

in Appendix C, Table C-4. At division level, weather analysis was judged significantly lower than three of the other steps, and was nearly significant for the fourth. An a posteriori contrast between rating for weather analysis and average ratings for the other steps combined was significant, $z = 3.29$, $n = 20$, $p = .0010$. Clearly, at division level the participants judged the current FC system to have least utility for weather analysis. At corps level with a smaller n, the same comparisons failed to reach the level required for significance. The a posteriori contrast also was not significant, $z = 2.20$, $n = 8$, $p = .0277$. Wilcoxon statistics for the contrasts were tested at $p < .0067$, using a familywise error rate of $\alpha = .10$ for the set of 15 two-catgory partitions among five means.

Table 6

Summary of Pairwise Comparisons Between Steps in Intelligence Preparation of the Battlefield

Division:	WTHR < (BATT, TERR, EVAL) BATT = TERR = EVAL = INTG	WTHR = INTG
Corps:	WTHR = BATT = TERR = EVAL = INTG	

Note. BATT = Battlefield area evaluation, TERR = Terrain analysis, WTHR = Weather analysis, EVAL = Threat evaluation, INTG = Threat integration.

In the military decision-making process, the step rated highest was that of providing information. At division level, only the comparison of this step with the step of approving plans and orders produced a significant difference. Table 7 presents the pairwise comparisons, based on the Wilcoxon tests shown in Table C-5. However, an a posteriori contrast between the ratings for providing information and average ratings for the other steps combined was not significant, $z = 2.79$, $n = 19$, $p = .0052$. The Wilcoxon statistic for this contrast was tested at $p < .0016$, using a familywise error rate of $\alpha = .01$ for the 62 possible partitions of seven means into two categories. Thus, the participants did not reliably judge the FC system to have exceptional value for any particular step in decision-making.

Differences among procedures. With differences absent at all echelons except division, the ratings for steps in each procedure could be assumed to be homogeneous permitting them to be averaged over steps. No significant differences were found between procedures in tests based on these averages. Friedman rank tests based on the participants who rated all procedures at an echelon are presented in Appendix C, Table C-6. Pairwise comparisions between procedures using all available participants for the two procedures are given in Appendix C, Table C-7. These results indicate that the current FC system was not considered substantially more helpful in performing any one procedure.

Table 7

Summary of Pairwise Comparisons Between Steps in the Military Decision-Making Process

INFO = MISS = ANAL = COMP = PREP	INFO > APPR
INFO = MISS = ANAL = COMP = PREP = APPR	

Note. MISS = Receive mission, INFO = Provide information, ANAL = Analyze/restate mission, COMP = Complete staff estimates, PREP = Prepare plans/orders, APPR = Approve plans/orders, ISSU = Issue plans/orders.

Differences among echelons. Friedman rank tests were used to compare ratings among battalion, brigade, and division echelons for each procedural step. Tests shown in Appendix C, Table C-8 did not reveal any significant differences. With fewer participants available at the higher echelons, pairwise comparisons were made between division, corps, and above corps levels for each procedural step. The Wilcoxon tests presented in Appendix C, Table C-9 did not show any significant differences. Similar tests based on procedural averages also did not indicate significant differences between echelons for any procedure, as shown in Appendix C, Tables C-10 and C-11. Therefore, the Part II ratings provided no evidence that participants judged the FC system to be more helpful at any echelon, either for performing overall procedures or for performing individual procedural steps.

Assessment of the FC System

Usefulness of the FC system. Participants did not agree about the utility of the FC system (Item 1 in Part III of the questionnaire). More participants indicated a negative opinion of its usefulness than the number who considered it highly useful. Few responses were extreme; no participants chose the highest ("Extremely useful") category, and only one participant chose the lowest ("Of no use") category. The distributions of responses shown in Table 8 suggest that participants did not become more positive about system usefulness over exercise days. Instead, they may have become slightly more negative.

Combined over days, 45.4% chose the negative categories, and just 18.2% were above the middle category. A 95% confidence interval for the population value for negative ratings ranges from 24.4% to 67.8%. This interval indicates that the percentage of negative responses is not reliably smaller than 50%.

Other statistical analyses showed no evidence for significant differences in responses between days, or between groups having different amounts of experience using the FC system. Based on eight participants that were present and that responded to the item on all three days, a Friedman rank test for change was not significant, $\chi^2(2) = 0.750$, $p = .687$. Five

Table 8

Overall Assessment of Usefulness of the FC System

Response	Percentage of Responses		
	Day 1[a]	Day 2[b]	Day 3[c]
"Of considerable use"	14.3	20.0	12.5
"Of use"	53.6	35.0	37.5
"Not very useful" or "Of no use"	32.1	45.0	50.0

Note. Responses made to questionnaire Part III, Item 1.
[a]n = 14. [b]n = 10. [c]n = 16.

participants present on two or more days did not change their response, and this constant response was used as a combined response, with numerical values from 1 to 5 assigned from the lowest to highest categories. For five individuals who changed responses, the changes were small and showed no apparent pattern. The average value on the five-point scale for each individual was used as a combined response value. The combined values for the group (n = 10) present on more than one day were then compared with the single response values for the group (n = 12) present on only one day. The average values in the former group (M = 2.83) and the latter group (M = 2.54) were similar. After ranking the response values for both groups, a Mann-Whitney rank sum test showed that the value distributions did not differ significantly between groups, z = 0.979, p =.328. Taken together, the results of the Friedman and Mann-Whitney tests indicate that it is reasonable to combine the data both for days and groups.

Within the overall group, military rank of the participants tended to be related to their opinions on the usefulness of the FC system, with higher ranks associated with more negative responses. However, a Spearman rank-order correlation was not significant, r = -.357, $t(20)$ = -1.713, p = .102. Other experience variables were also unrelated to usefulness judgments.

Echelons for fielding. Participants did not show a clear consensus on the appropriate echelons to use the FC system. Table 9 shows the echelons selected as first, second, and third priority choices combined over the three days of staff exercises. A majority of participants selected either the division or echelons above corps as their first choice. A strong plurality selected the corps as a second choice, and a lesser plurality selected the division third. Few participants selected the company or platoon, indicating agreement that the FC sytem is

Table 9

Choice of Echelons for Fielding the FC System

Echelon	Percentage of Responses		
	First Choice	Second Choice	Third Choice
Above Corps	24.1	2.8	9.8
Corps	17.7	38.4	2.1
Division	31.3	15.4	26.8
Brigade	10.2	14.7	14.9
Battalion	9.1	9.6	8.9
Company	0.0	0.0	0.9
Platoon	0.0	0.0	0.9
No Echelon	7.6	23.5	35.6

Note. Choices combined over days from responses to questionnaire Part III, Item 2. N = 22 for each column of choices.

inappropiate at these levels. The percentage of nonresponses also increased as the priority decreased. Appendix D, Table D-1 shows the separate response distributions for each exercise day.

The choice distributions in Table 9 cannot easily be compared statistically, since they are partially nonindependent. Some individuals provided repeated choices on two or three days, while others were present on only one day. A priority measure was used to provide a simple summary of the data allowing statistical comparisons. The priority measure was created by assigning numbers corresponding to the participant's order of choosing echelons (1st choice = 1, 2nd choice = 2, etc.). Equal choices were given the average number for the group of tied priorities. For example, if three echelons were chosen in fourth place (after three others), they were given the value 5, the average number for the 4th, 5th, and 6th choices. Echelons not chosen were given the value 8, below the lowest priority value (i. e., the value 7) used when all seven echelons were chosen. Using the value 8 for unchosen echelons was based on an assumption that the participant's failure to choose represents a judgment that the echelon was unsuitable for fielding.

Table 10 shows the average priority measures for echelons. Each day and combined over days, division and corps were given the highest priorities, while company and platoon were given the lowest priorities. Other echelons were between these extremes. At every echelon, Friedman rank tests for change did not reveal any significant differences in the distributions of priority measures between days. Test statistics are shown in Appendix E, Table E-1. Half or more of the eight participants present on all three days did not change the priority given on successive days to a particular echelon. For ten participants present on two or more days, an average priority value was used as the combined response. Comparing combined responses for this group with single responses for the group of participants present on one day, Mann-Whitney rank sum tests did not show significant differences between groups at any echelon. The group means and results of the tests are given in Appendix E, Table E-2. The Friedman and Mann-Whitney tests again indicate that it is reasonable to combine the data both for days and groups.

Disregarding days and groups, an overall Friedman rank test for differences in priority distributions among echelons was significant, $\chi^2(6) = 44.094$, $p = .000$. In part, this result reflects the substantial differences observed among the combined means in Table 10. Table 11 shows the results of pairwise

Table 10

Priority of Echelons for Fielding the FC System

	Mean Priority			
Echelon	Day 1[a]	Day 2[b]	Day 3[c]	Comb.[d]
Above Corps	4.75	6.10	5.03	5.17
Corps	3.04	4.30	4.34	4.13
Division	2.64	3.50	3.34	3.62
Brigade	4.57	5.70	4.66	4.85
Battalion	5.71	6.60	5.50	5.52
Company	6.93	7.00	7.25	7.19
Platoon	7.29	7.40	7.56	7.48

Note. Priority from responses to questionnaire Part III, Item 2. Lower numbers indicate higher priority. Echelons not chosen were assigned an arbitrary priority value of 8.
[a]$n = 14$. [b]$n = 10$. [c]$n = 16$. [d]$n = 22$.

Table 11

Summary of Pairwise Comparisons Between Echelons

{EAC, CPS, DIV, BDE, BN} > {CO, PLT}	
EAC = CPS = DIV = BDE = BN	CO = PLT

Note. EAC = Echelons Above Corps, CPS = Corps, DIV = Division, BDE = Brigade, BN = Battalion.

Wilcoxon signed-rank tests (see Appendix E, Table E-3). These tests show that the company and platoon priorities were lower than the priorities for all higher echelons. There were no significant differences among echelons from battalion to EAC.

Recommendation for fielding. The majority of participants each day felt that the system should be fielded only after modification, and many indicated that this modification would be extensive. Several participants each day (including all three commanders) indicated that the system should not be fielded. Based on their verbal comments, the interpretation is that the commanders felt that the system had potential but should not be fielded in its present configuration. Table 12 shows the distribution of responses on each day. The observed percentages do not show any systematic trend from day to day. Combined across days, 70.1% of participants chose the "Yes, but only after modification" alternative. A 95% confidence interval for the population value of this percentage ranges from 47.0% to 87.5%. This interval indicates that the majority response percentage is not reliably greater than 50%.

Table 12

Recommendations for Fielding the FC System

	Percentage of Responses		
Response	Day 1[a]	Day 2[b]	Day 3[c]
"Yes, in its current configuration"	0.0	0.0	0.0
"No"	28.6	45.0	33.3
"Yes, but only after modification"	71.4	55.0	66.7

Note. Responses made to questionnaire Part III, Item 3. [a]n = 14. [b]n = 10. One ambiguous response was divided equally between categories. [c]n = 15. One participant failed to respond.

Analyses showed no evidence for significant differences in responses between days, or between groups having different amounts of experience using the FC. Based on seven participants that were present and that responded to the item on all three days, the Cochran's test for change was $Q(2) = 2.00$, $p = .368$. Eight participants present on two or more days did not change their response, and this constant response was used as a combined response. Only two individuals changed responses, and their combined responses were counted in proportion to the number of responses made in each category. Based on combined responses, the percentage of responses (64.2%) in the majority category for the group ($n = 10$) present on more than one day did not differ significantly from the percentage (75.0%) in the group ($n = 12$) that was present on only one day, $\chi^2(1) = 0.285$, $p = .593$. These statistical results indicate that the overall combined percentage reasonably represents the division of opinion for both groups.

The combined responses were found to relate directly with the participants' opinions on usefulness of the FC system, indicating a degree of consistancy between the questionaire items. The Spearman rank-order correlation coefficient was significant, $r = .525$, $t = 2.761$, $p = .012$.

The participant's military rank was related to their fielding recommendation. Below the rank of major, the participants were virtually unanimous in agreeing that the FC system could be fielded with modifications; at or above that rank, the opinions were equally divided. The value of the Spearman rank-order correlation between rank and fielding recommendation was $r = -.496$. This coefficient was statistically significant, $t(20) = -2.557$, $p = .019$. This relationship may reflect less acceptance of computer technology by higher ranking (and older) participants. Although some comments indicated that judgements of the higher ranking participants were influenced by greater familiarity with staff processes at higher echelons, the level of a participant's highest echelon of staff experience was not significantly correlated with their fielding recommendation, $r = -.284$, $t = -1.326$, $p = .200$. Rank predicted better despite the positive and significant relationship found between rank and staff experience level, $r = .472$, $t = 2.395$, $p = .027$.

Uses for the FC system. Participants suggested various possible uses for the FC system (Item 4 in Part III). These suggestions are summarized in several categories in Table 13. The larger number of uses were categorized as planning or training. Suggested planning applications dealt largely with long-range planning for possible future contingencies, and the suggested training applications were largely institutional in nature. Suggestions were also offered for use of the FC system as a reconnaissance tool and as a means for high-level staff personnel to visualize the battlefield. Some participants indicated that the FC system, with enhancements, could be used to integrate the staff planning process and to support the creation of staff products such as overlays.

Table 13

Summary of Suggested Potential Uses for the FC system

Planning (8)
Long-range planning at division and/or corps echelons.
Planning tool for possible future conflict areas.
Training/Rehearsal (7)
Combat arms training at basic or advanced course level.
Training in relating map analysis to terrain.
Training in staff estimate/IPB processes.
Reconnaissance (5)
Reconnaissance asset for denied terrain.
Means to check intervisibility.
"Seeing" the Battlefield (5)
Help commanders and staff (primarily at high echelons) to visualize the battlefield.
Staff Communications/Integration (5)
Produce graphics and text for briefings/dissemination.
Integrate staff products with scheme of maneuver.

Note. Responses to questionnaire Part III, Item 4. Numbers in parentheses show the number of comments in each category.

Enhancements of FC system. Participants identified numerous enhancements needed in the FC system (Item 5 in Part III). Their suggestions are categorized in Table 14. The foremost concern expressed with greatest frequency in the questionnaires (and in daily verbal comments) dealt with needed improvements in graphics capabilities. Most problems with graphics were identified when participants attempted to create or manipulate graphics on their own; operator support often was minimal during staff exercises. Participants found the FC graphics and icons to be cumbersome to create and manipulate, and they suggested many improvements.

A major concern expressed in questionnaires and verbal comments involved the relationship of the FC system to other automated command and control or intelligence systems. For example, many participants raised the issue of how the FC system should interface with or may largely duplicate the Maneuver Control System (MCS). Some participants indicated that the 3D Display is the only part of the FC system that is unique from the MCS, leading them to the conclusion that the FC system should be used to expand or improve the MCS. Several participants also

Table 14

Summary of Suggested Enhancements to the FC system

Graphics Capabilities (20)
Make creation of graphics less cumbersome (free draw). Display 2D graphics on 3D display. Provide graphics tools tailored for staff sections. Provide more unit symbols and vehicle models.
Links to C^3I Systems (11)
Connect FC to MCS, ATCCS, and intelligence systems.
Wargame/Analyze Courses of Action (7)
Provide a fast automated wargaming capability.
Automated Computations (4)
Integrate automated tools for computing march tables, MCOO, terrain analysis, relative combat power, etc.
System Responsiveness/Reliability (4)
Make system run more reliably and quickly.
2D Display (4)
Provide large 2D display for group planning/briefings.

Note. Responses to questionnaire Part III, Item 5.

raised concerns about how the FULCRUM component of the FC system can link with intelligence systems to provide near real-time intelligence on the 2D and 3D Displays. This capability was not demonstrated during the staff exercises.

Several participants indicated that an automated wargaming capability should be included with the FC system. The majority of these seemed to favor an automated system to quickly analyze alternative courses of action, rather than a system with SAFOR allowing staff members to play out courses of action in real-time. Related to this suggested wargaming capability, several participants indicated that the system should automatically do many of the computations (e.g., march tables, terrain analysis) that must be completed during the staff planning process. In group discussions, participants concluded that the FC system should provide computational and graphic tools tailored to the needs of each staff section. Such a system would help to develop and integrate staff products such as operational overlays. There was general agreement that the configuration of the FC system

should implement the "Sigma Star" concept for linking automated command, control, and intelligence systems (Kind, 1990).

Another major concern that was expressed more in verbal comments than in questionnaire responses related to the responsiveness and reliability of the FC system. Several participants noted that the system often was slow in responding to user requests, and that it frequently failed to operate. ARI recorded observations indicated that the entire system "crashed" three or four times each day, and parts of it (such as the 3D Display and individual OBG workstations) "crashed" more often.

Other comments and observations. Participants provided few comments on the draft Commanders' Guide (Item 6 in Part III). Three comments noted that the current FC system omits several capabilities described in the guide. A few other comments (Item 7 in Part III) related to system uses and enhancements, and were included in the comment summaries for Items 4 and 5 above.

Few specific comments on the FULCRUM component of the system were made in the questionnaire, although FULCRUM capabilities were demonstrated for several participants. Comments during the demonstrations and in AARs indicated that some FULCRUM features were of value. In particular, the ALO and ADA participants indicated that radar coverage overlays were useful in mission planning for air operations and defense. Few participants examined the SABER wargame, and no comments mentioned SABER.

Additional observations and comments during use suggested that the participants found the ability to make hardcopies useful at a variety of points in planning and decision-making processes. On the first day, the G-3 personnel used FC hardcopy maps and overlays exclusively to perform their tasks, as a replacement for paper maps. There was a consistent desire to see map information in greater detail over a wider area than was possible with the 2D Display. This could be accomplished by taping together several pages of printer output. A number of comments also indicated that the ability to make hardcopies would increase the utility of information available in FULCRUM. Printer output from FULCRUM was not available during the staff exercises.

Comparison with Sandtable

In Part IV of the questionnaire, six items related to a sandtable display (small model vehicles placed on a sand surface representing terrain, and supported by a large table) that was used at Fort Knox to present briefings on tactics for breaching Iraqi defensive positions. Responses to the first item showed that ten participants had seen the sandtable briefing; this is 45% of the 22 participants. Only these ten participants were asked to respond to the remaining five items in Part IV.

When the ten participants who had seen the sandtable were asked to assess its usefulness, seven (70%) considered it

"Extremely useful" and three considered it "Of considerable use". Participants did not select the lesser response categories "Of use," "Not very useful," or "Of no use." A Wilcoxon signed-rank test of symmetry showed statistically significant asymmetry for the distribution of responses around the middle category, z = 2.92, p = .004. This result indicates that there was a positive consensus on the usefulness of the sandtable.

When these participants compared the usefulness of the FC system with the sandtable, six (60%) chose responses indicating that the sandtable was more useful ("much better" or "somewhat better") than the FC system. Two participants indicated that they were equally useful or that the answer depended on the purpose for use, and two considered the FC system to be more useful than the sandtable. For this response distribution, a Wilcoxon signed-rank symmetry test was not significant, z = 1.35, p = .177. Although a majority of participants favored the sandtable over the FC system, the extent of agreement in this small sample did not demonstrate a reliable consensus. Responses to open-ended questions identified several advantages for each that are summarized in Table 15. No suggestions indicated how to use the FC system combined with sandtables or terrain boards.

Table 15

Summary of Comparative Advantages of Sandtable and FC system

Advantages of Sandtable
Flexible, reliable, cheap, easily operated.
Large groups of people can view it.
Does not require train-up.
Better visualization of obstacles.
Advantages of FC System
Can display terrain from ground level.
Can determine intervisibility (LOS).
Hard-copy capability.
Can speedily change enemy/friendly situations.
More terrain is represented on FC.

Note. Responses made to questionnaire Part IV, Items 4 and 5.

Discussion

Backgrounds of Participants

Based on responses to Part I of the questionnaire, few participants had command experience at battalion or higher echelons and most staff experience was below division level. Their views of the FC system were thus based more on general familiarity with command and staff procedures than on specific

experience at the echelon focused on during the assessment. Any further evaluation of the FC system should involve personnel with extensive experience at the target echelon.

Not surprisingly given the small sample size, few relationships were found between participants' backgrounds and their questionnaire responses. There was an indication that higher ranking participants had a more negative view of the utility of the FC system. Also, higher ranking personnel were significantly more negative toward fielding of the system. The results do not allow final determination of whether this reflects less acceptance of computer technology by older personnel or some other factor (e.g., greater familiarity of higher ranking personnel with other automated command and control systems that the FC may to some extent duplicate).

Utility of FC

Participants indicated that the prototype FC system does not have high utility overall, for specific echelons, for particular planning and decision-making processes, or for many specific steps in those processes. They saw some utility in areas that involve gathering and sharing information (e.g., conduct reconnaissance, provide information). The participants were unanimous that the FC system should not be fielded in its current form. Most participants felt that the FC system should be fielded only after modification. They did not reach a clear consensus on appropriate echelons for fielding, but assigned the highest priorities to division and corps. The group who had seen a Desert Shield sandtable briefing were more favorable toward the sandtable than the FC system. However, some advantages that the FC offers over the sandtable were identified.

Despite a generally unenthusiastic view toward the prototype FC, participants saw considerable potential for this type of system. They identified various possible uses in both tactical planning and training arenas. Several participants indicated that a system of this kind could help commanders visualize the battlefield and help staff integrate their products (e.g., map overlays). They thus saw the FC as offering promise for meeting the need for automated support of command and control processes.

Participants identified many enhancements needed to allow the FC system to achieve its potential. By far the largest number of these were needed improvements in graphics functions. Many comments pointed out changes to make the FC system easier to use for creating graphics and unit symbols. Other improvements suggested by several participants related to provision of automated wargaming and computational capabilities to support rapid analysis of alternative courses of action. Another primary concern was the need to increase system responsiveness and reliability. All these needs should be readily addressable during refinement of the FC system.

Relationship of FC to Other Systems

A final topic that deserves further discussion is the relationship of the FC system to other automated command and control or intelligence systems. Several participants expressed concern that the FC system may largely duplicate the functions of other systems that are currently being developed or fielded. The primary concern with overlap related to the Maneuver Control System (MCS).

The MCS is being fielded as an integral part of the Army Tactical Command and Control System (ATCCS, also referred to as "Sigma Star"). It is an automated system designed to carry graphical and statistical information currently used in manual systems in tactical operations centers (Kind, 1990). The MCS network of computers connects command posts at various echelons to provide the current status of friendly forces and their resources, current intelligence relating to enemy forces, and information about the operational environment (U. S. Army Combined Arms Combat Developments Activity, 1989).

The FC and MCS have many common functions. It also appears that features unique to the FC (e.g., the 3D Display) are currently being incorporated into the MCS. According to Kind (1990), an electronic map background display and a 3D terrain view are being developed for the MCS, along with automated computations and a link to intelligence sources through the All Source Analysis System (ASAS). The MCS thus should soon provide the capabilities of the prototype FC system, along with other needed capabilities identified in the assessment.

New automated command and control systems are to be designed and tested within the ATCCS environment (Knudson, 1990). Thus, any further development of the FC system should be pursued within the MCS context. Developers should integrate the best features of both systems to help commanders see and fight future battles.

Conclusions

Data collected by ARI personnel during the FC assessment lead to the general conclusions listed below. This list is not intended to represent conclusions reached by DARPA or Armor School personnel.

1. Participants saw the FC system as having great potential but not being ready for deployment or fielding in its present form.

2. Several potential uses of the system were suggested, but no definitive conclusions were reached on the best uses for the system or the most appropriate echelon(s) for fielding.

3. Many needed system enhancements were identified. The highest priorities among these seem to be improvements in graphics capabilities and system reliability.

4. There appears to be a good deal of overlap between the FC system and the MCS. Any further development of the FC should be accomplished within the ATCCS/MCS environment.

5. If refined versions of the FC system configured for different echelons are developed, additional evaluations are needed with experienced participants at each echelon.

References

Cochran, W. G., and Cox, G. M. (1957). Experimental designs. New York: Wiley.

Donovan, K. B. (1990, November). Real-time mission rehearsal. National Defense, pp. 21-24.

Interactive Television Company. (1990). FULCRUM user's manual. Arlington, VA: Author.

Kind, P. A. (1990, July). Army tactical command and control system. Military Review, pp. 35-41.

Knudson, W. (1990, July). The future of command and control. Military Review, pp. 18-24.

Lehmann, E. L. (1975). Nonparametrics: Statistical methods based on ranks. San Francisco, CA: Holden-Day.

U. S. Army Armor School. (1989). SIMNET users' guide. Fort Knox, KY: Author.

U. S. Army Combined Arms Combat Developments Activity. (1989, March). Maneuver Control System functional guide. Fort Leavenworth, KS: Author.

Appendix A
COMMANDER'S GUIDE

Commander's Battle Preparation System (CBPS)

1. Introduction

1..1 Overview. The Commander's Battle Preparation System (CBPS) provides a computer-generated battlefield environment that represents the deployment and operations of both allied and enemy orders of battle. Visual displays allow you to see the simulated battlefield directly from any desired viewpoint, air or ground, and to examine the overall situation on a simulated map. Initially you will be able to observe the disposition of forces in static positions on the terrain corresponding to current intelligence data and operational plans. Subsequently, at least portions of your force will be able to move on the terrain according to your intelligence estimates and plans, report their own and enemy actions, and respond to your orders. With enemy forces acting under interactive command within the constraints of current intelligence estimates, you will be able to fight realistic battles, wargaming courses of action for a variety of offensive or defensive missions. The system can also be set up to support rehearsals in various ways, enabling you and your staff to rehearse command and control tasks for specific missions.

1..2 System Utilization. The purpose of this guide is to assist you in using the CBPS to plan and prepare for future battlefield operations. It describes the system capabilities available now or in the near future, the necessary coordination between operators and you and your staff, and the major ways that you can use the system.

a. Preparation for Use.

(1) Information. Operators need detailed information to support your use of the CBPS facility. To represent static deployments, they need information on the composition and disposition of friendly and enemy forces, based on intelligence templates and operational plans. This information should be provided in as much detail as possible, down to the locations of platoons and individual vehicles. To represent unit movements, operators need information on planned or expected routes and techniques. Again, all available details (such as avenues of approach and control measures) should be provided.

(2) Coordination. Prior to your use of the CBPS facility, operators will obtain intelligence estimates and operational plans from your higher HQ. This information is likely to require fine-tuning and elaboration to support your CBPS operations. To accomplish this, members of your staff (S2

and S3) should go to the facility and coordinate with system operators at least one day prior to your entry into the facility. During this coordination, staff members can also obtain information on special characteristics of the system (e.g., elements that cannot be represented realistically on the simulated battleground).

(3) Planning. Effective use of the CBPS requires advance planning similar to that for a field training exercise. An informal CBPS Activities Plan should be prepared, outlining your objectives and the sequence of activities you expect to conduct to accomplish these objectives.
Map overlays, plans, or other supporting reference material you will need during CBPS use should be attached to the Activities Plan. Your staff should provide a copy of the plan at their initial coordination meeting with the system operators. The operators can assist your staff to estimate how much can be done in the time available on the CBPS. They will provide a copy of the CBPS map and assist your staff in any necessary conversion of your overlays. The operators will also provide guidance on which staff members or subordinate commanders should accompany you to the CBPS facility to assist in conducting the planned activities.

b. Operation of Facilities.

(1) Sites. CBPS facilities are housed in air-conditioned transportable containers sited in the logistic support areas for major HQ, or other accessible locations. Access to a facility in your area is scheduled by the CBPS Point of Contact (POC) established by your higher HQ. Each facility consists of a van containing CBPS equipment and displays, along with remote displays located nearby.

(2) Operators. Experienced operators man each CBPS facility. These operators provide all required input to the simulation equipment to make it perform at your command. To provide appropriate input, the operators may need to be assisted by some of your staff or subordinate commanders. Once you are familiar with the simulation capabilities that are available, the living man-machine interface provided by the operators will allow you to use the capabilities in any desired manner without special training.

c. Modes of Utilization. Three principal ways of using the CBPS are described below:

(1) Surrogate Reconnaissance. Initially you can use the CBPS to supplement available methods of reconnaissance. The system provides you with an alternative approach to map reconnaissance, allowing you to view the simulated battleground from various perspectives on or above it. You can also examine the disposition of forces represented as icons on the

battleground and on a simulated map. This disposition will be up-to-date based on recent input from various intelligence sources. Used in conjunction with traditional reconnaissance methods, this capability should enhance your planning and preparation for battle.

(2) Simulated Wargaming. Based initially on sequential snapshots or templates and later on the capability to interactively move simulated vehicles and units, you can use the CBPS to wargame alternative courses of action. You and your staff will be able to direct the activities of friendly and enemy forces in accordance with operational plans and intelligence estimates. This capability can supplement your analysis of contingencies and alternative courses of action, giving you an opportunity to refine your concept of operation.

(3) Command & Staff Rehearsal. You can use the CBPS to support rehearsals of selected courses of action with key staff and subordinate commanders. The system's displays provide perspectives of the battlefield that you can use to supplement rehearsals conducted on sandtables or actual terrain. With radio nets set up to link the CBPS facility to your main command post (CP), you may also be able to use a simulated battle exercise to run a CPX. This will support rehearsal of command and control for a planned mission with radio communications over the command net and battlefield events unfolding on a realistic time line. These rehearsals and CPXs should suggest refinements to operational plans and help your staff to improve the synchronization of combat power.

1..3 System Description. An overview of the four major components of the CBPS is provided in the following sections.

a. Terrain Database.

(1) Region. The CBPS terrain database represents a rectangular area covering about 27,000 km² as shown in Figure . This area is 360 km long from east to west, and 290 km wide from north to south. Topography, trafficability, and cultural features are represented at varying levels of detail and accuracy in different portions of the database. The levels of detail and accuracy will change over time as the database is improved. You or members of your staff will need to coordinate with system operators to determine the current status of terrain representation for your area of operations. You will not be able to modify the terrain representation to show features such as prepared battle positions (BPs). However, you should identify needed modifications to the operators, as input to possible database enhancements in the future.

(2) Function. The database supports creation of simulated terrain that you can see and move on or over, using

Figure 1. Area included in terrain database.

displays and tools described below. This provides you the capability to supplement map, ground, and aerial reconnaissance, as well as an "automated sandtable" to support conduct of wargaming and rehearsals.

b. Semi-Automated Forces (SAFOR).

(1) System. The SAFOR capability supports creation of vehicles and units, both allied and enemy, on the simulated battleground. This is accomplished through an Order of Battle Generator (OBG) System that runs on two kinds of computers: a MIPS workstation and a simulation host. The initial OBG System will allow placement of a large number of static vehicles on the battleground. The expanded follow-on OBG System will allow movement and interaction of at least 60 vehicles at a time.

(2) Workstations. Each MIPS workstation includes a keyboard, a mouse, and a color monitor for displaying maps, graphics, vehicles, and units. The operator interacts with the system by using menus that provide various actions and options. The CBPS facility you use should include two workstations (one for friendly and one for enemy forces) and a trained operator for each. Your S2 and S3 will need to work closely with these operators before and during your CBPS activities.

(3) Host. The simulation host projects data packets onto the computer network so that the vehicles they represent appear on the simulated battleground. The vehicles represented include tanks, infantry fighting vehicles, fixed- and rotary-wing aircraft, ADA systems, howitzers, and combat service support vehicles. The ground vehicles can be represented in dug-in positions. The system may not be able to visually represent all the types of vehicles that you may encounter in future operations. However, the operating characteristics associated with the available vehicles can be altered to approximate almost any similar kind of vehicle. Coordination between your staff and system operators will be necessary to determine the specific vehicles represented and their operating characteristics.

(4) Function. The OBG System and its operators provide friendly and enemy SAFOR that can be placed on the simulated battlefield and later moved as you and your staff direct. Coordination between your staff and system operators will allow files of planned SAFOR placements and movement commands to be established prior to your use of the facility. This can be arranged so that you can modify SAFOR dispositions or movements during wargaming simulations or other activities, without having to wait for new groups of vehicles to be created.

c. Plan View Display (PVD).

(1) System. The PVD provides a graphic overhead view of the simulated battleground, similar to looking down at a situation map. The display includes a color map, vehicle icons, and a set of menus. The operator uses a keyboard and a mouse to select actions from the menus and the map. You will work with this operator to see the simulated battleground.

(2) Icons. The operator can provide you a key describing the vehicle icons used on the PVD. Blue icons represent friendly vehicles and red icons represent enemy vehicles. Vehicle turrets are white. Whenever a vehicle has been destroyed, its turret and hull colors reverse. The size of vehicle icons can be adjusted as users desire.

(3) Menus. The PVD menus make available numerous tools that the operator can use to support you. These include map manipulation capabilities such as changing map scales, zooming in on selected areas, and adding or deleting map features. The system can also determine the distance between two points, plot a cross section of elevation between two points, and plot intervisibility between two points or throughout an area. Overlays can be added to the map display; these include unit symbols, control points, and free draw objects (such as phase lines). In general, only major control graphics should be included in the PVD overlays.

(4) Function. The PVD provides you a powerful overview of the CBPS battleground. It will allow you to observe the disposition of units and assess the overall situation during wargaming and rehearsals. By using the PVD in conjunction with the Mobile Observer's Window, you will be able to integrate various perspectives on the simulated battleground.

d. Mobile Observer's Window (MOW).

(1) System. The MOW (a.k.a. Flying Carpet and Stealth Vehicle) furnishes you the capability to view the simulated terrain directly, from any position on or above it. The position and orientation of your viewing window are indicated by an arrow on the PVD, but the MOW does not appear on or in any way affect the battleground. This system is collocated with the PVD and includes a panoramic terrain view displayed on three color monitors, a movement controller (Spaceball), and a touch panel mounted on a small box.

(2) Movement. The PVD/MOW operator will use the controller and touch panel to move the MOW as you direct. Available options include moving at ground level, free flying over the terrain, and rapidly transporting from one location to another. The MOW can also be attached to vehicles on the battleground in various ways, so that you can follow a vehicle or see the terrain view from inside a vehicle.

(3) Function. The MOW provides you an "out-the-window" view of the simulated battleground from many perspectives. You can use it to view static vehicle emplacements or to follow moving vehicles during wargaming and rehearsals. You can quickly move around the battlefield by using the PVD to determine where you want the MOW to go. In combination these displays enable you to see an overall situation map while directly viewing selected portions of the battlefield.

1.4 System Limitations. While the CBPS has many capabilities to support your planning and preparation for battle, it also has several limitations. Some key limitations that you should be aware of are summarized below. Further details on the effects of these and techniques for working around them can be obtained from system operators. Since the CBPS is based on rapidly evolving technology, operators can also provide up-to-date information on enhancements that may have been added to reduce system limitations.

a. Dismounted Elements. Dismounted infantry is not represented on the CBPST battleground, so only mounted operations can be simulated.

b. Terrain Representation. The simulated terrain does not represent actual terrain in complete detail. The level of detail varies in different areas, but details such as shifting sand dunes are not represented. Trafficability may not be represented accurately in all areas.

c. Vehicle and Unit Types. The simulation does not include all the types of vehicles and units you may employ or encounter in future operations. The available vehicle icons are limited. For example, all tank icons may look like M1s or T72s. However, operators may be able to modify operating characteristics to represent a greater variety of vehicles.

d. Mobility, Countermobility, and Survivability. Engineer assets are not represented on the simulated battleground. The simulated terrain cannot be modified to improve fighting positions or emplace obstacles. Minefields are also not represented. Check with operators on approaches to representing obstacles and minefields notionally.

e. Intelligence Assets. Ground surveillance radars (GSRs) and remotely employed sensors are not included in the simulation, although operators may be able to approximate these capabilities with available vehicles. Representation of intelligence gathering assets is limited largely to the scout platoon and mounted infantry patrols.

f. Limited Visibility Operations. The simulation generally does not represent night or limited visibility

conditions. Operators may be able to provide limited smoke capabilities.

2. Working with CBPS Operators

2..1 Activity Plan. The utility of the PVD and MOW depends upon effective communications between you and the operator. The PVD/MOW operator will familiarize himself with your Activities Plan, including maps and overlays, before you arrive. You should have your map and overlays handy for reference during your use of the PVD and MOW. Before starting each activity, briefly review your plan with the operator to make sure he fully understands what you want to do, enabling him to help you use the CBPS capabilities to best advantage in accomplishing your objectives.

2..2 Using PVD Capabilities. To help the operator prepare for your PVD usage, specific map-related information should be included in the CBPS Activities Plan in the form of overlays on the CBPS map. One map overlay should show boxes indicating the areas you will want shown on the PVD. Set the boundaries of the largest box to indicate the entire region you will use during one activity. This region will be set up by the operator in the top level display. Use smaller boxes within the region to indicate areas you want to explore in detail as you travel around. These boxes should be numbered in the order you want to visit them, allowing you and the operator to refer to them by number. The overlay also should show the major control graphics you want displayed on the PVD, and any special display requirements (map scales, contour intervals, grid intervals). If the overlay is not too crowded, indicate map reference points where you expect to use intervisibility displays. The operator can then tailor the display to meet your needs and prepare PVD overlay files in advance. This will minimize time spent redrawing displays and creating graphics while you are using the CBPS. The capabilities that you can ask the operator to provide during PVD usage are described below. Requirements to be coordinated ahead of time are suggested.

a. Map Manipulation.

(1) Zoom In. The operator can enlarge a portion of the map display to fill the PVD map screen. Point out or designate by a prearranged number the area you want enlarged on the screen, and the operator will select it by making a rectangular box appear around it. Tell him to zoom when the appropriate area is selected.

(2) Pan. The operator can move any point on the map display to the center of the screen. Designate the point you want centered and tell him to pan.

(3) Save/Display Zoom. You can ask the operator to save a display and bring it back later. Only the screen that was most recently saved can be recalled. You can use this function to look at different displays and return quickly to the one saved previously.

(4) Previous/Next View. By asking the operator to show the previous view, you can quickly see the display that appeared on the screen prior to the current one. When you ask him to show the next view, the display that appeared when "Previous View" was selected will reappear. You can use this function to move back and forth rapidly between two displays.

(5) Zoom Out. This will increase the area displayed by a factor of four.

(6) Top Level. This will return the display to the entire terrain map that appeared when you began using the PVD. You should designate the top level view you want before beginning your CBPS operations.

(7) Zoom 1:25,000/1:50,000/1:125,000. The operator can display the map at any of these scales that you designate. You should designate the initial scale you want prior to your use of the CBPS.

b. Map Features.

(1) Set Contour On/Off. You can direct the operator to draw or remove contour lines from the map. You may at times want them removed to reduce screen clutter.

(2) Set Grid On/Off. You can direct the operator to draw or remove grid lines.

(3) Set Shading On/Off. You can direct the operator to draw or remove shaded regions from the map.

c. Select Grid Intervals. You can select from four distances (10000 meters, 1000 meters, 500 meters, and 250 meters) for the operator to set the interval between grid lines. If you do not designate otherwise, the interval will be set to 10000 meters when the PVD begins operating.

d. Select Contour Intervals. You can select from four distances (60 meters, 20 meters, 10 meters, and 5 meters) for the operator to set the interval between contour lines. If you do not designate otherwise, the interval will be set at 60 meters. This will reduce screen clutter and drawing time.

e. Map Information. If you desire, the operator can turn on options to show color keys at the leftmost bottom section

of the map display. These include keys for terrain colors, icon colors, and intervisibility ray colors.

f. Map Tools.

(1) Cross Section On/Off. You can ask the operator to show or remove a graph of the elevation between two points. To see an elevation plot, designate on the screen the two points you want and direct the operator to turn on the cross section option.

(2) Ruler. You can ask the operator to obtain the distance between two points. Select two points on the map display and tell him to turn on the ruler option.

(3) Select Vehicle. If you want to find a specific vehicle on the display, tell the operator the vehicle ID or bumper number. A box will appear around the icon for the vehicle you designated.

(4) Clear All. This option can be used to clear all markings (intervisibility rays, overlay objects, etc.) that you and the operator may have created on the display.

g. Intervisibility. The PVD system can perform several types of intervisibility or line of sight (LOS) calculations between points or throughout an area. The results are shown as color-coded rays on the map display. Purple denotes full visibility, light blue denotes partial visibility, and white denotes invisibility (no LOS). Unless you designate otherwise, the range of the viewer is 3500 meters, the height of the viewer is 2.6 meters, and the target height is 2.4 meters.

(1) Area. If you tell the operator to select this option, a fan of intervisibility rays will be shown emanating from a point you designate.

(2) Point to Vehicle. This option can be used to determine and display whether vehicles are visible from a selected point. Intervisibility rays will be drawn from the point you designate to all vehicles or only opposing vehicles, whichever you choose.

(3) Vehicle to Vehicle. This option works like the previous one, except you designate a viewing vehicle rather than a viewing point. The display will update as the viewing vehicle moves. This option causes a slow response time and should be used sparingly if there are many vehicles in the display.

(4) Point to Point. You can request this option to see a display of intervisibility between two points you designate.

h. PVD Overlays. The operator can use this option to create overlays on the PVD map screen. You should provide him with the control graphics you want displayed prior to your use of the CBPS facility. To reduce screen clutter and drawing time, you should only ask for major control graphics, such as boundaries, phase lines, and control points.

(1) Unit Symbols. The operator can display unit symbols at the locations you designate. Friendly unit symbols will appear in blue and enemy in red.

(2) Free Draw. The operator can use this option to create lines and boundaries. Free draw objects appear on the map display in blue for friendly and red for enemy graphics.

(3) Control Points. The operator can create six types of control points (check, contact, release/start, coordinating, linkup, and passage points) at locations you designate.

(4) Other Options. The operator has the capability to delete, move, resize, or add text to overlays, as you direct.

2..3 Using MOW Capabilities. To help the operator prepare for your MOW usage, provide an overlay in your Activities Plan showing the specific terrain routes you will want to follow. Use a solid line to indicate routes you want to drive over on the ground, and a dashed line for routes you want to fly over. Provide map reference points at positions you want to jump to, without driving or flying. Identify vehicles that you want to attach to and look from, or to follow when moving. Place numbered checkpoints to show the order you want to use when traveling over the routes and stopping at positions or vehicles. Place arrows or fans to show special directions you want to see while moving along a route, or while stationary at a position or from a vehicle. If you just want to see straight ahead or the initial view at a position, no viewing directions are needed. If you intend to follow a moving vehicle during a planned operation (once moving vehicles are available), show its initial position and expected route or axis of movement on the overlay. The overlay will reduce the directions you need to give the operator as you travel around using the MOW. You retain complete freedom to depart from the route plan on your overlay whenever you wish. The modes of travel and attachment to vehicles that you can ask the operator to use with the MOW are described below.

a. Moving to a Location (Teleportation). You can move the MOW directly to any point on the terrain. The operator only has to know where you want to go. You can give the operator map coordinates, identify a point on your map overlay in terms of some control measure, or simply point out a location on the PVD. You also should tell the operator the direction of the initial line of sight (LOS) you want when the MOW arrives at the point. The direction may be a point of the compass (e.g., NNW) or a heading in terms of an azimuth angle in degrees (with N at 0·). When the operator completes the move, the MOW will face in the desired direction, with a view along the requested LOS parallel to level ground.

b. Aerial Movement (Free Fly). You can move the MOW over the terrain as though you are riding in a helicopter or fixed-wing aircraft, with complete freedom to travel in three dimensions. This type of MOW movement is called the "Free Fly" mode. This mode allows you to see the terrain and tactical situations from any desired perspective.

(1) Viewpoint. Initially, the MOW shows a view of the terrain with LOS in the direction of forward movement. The LOS is set at the current height above the ground, and at an angle parallel to level ground, not the actual slope of the terrain. This helps you see that the ground is rising or falling to your front. The LOS will change as the altitude and direction of movement changes. Also, you can change the viewing angle (pitch) relative to the ground by asking the operator to look up (or down). Unlike the view from an aircraft, you cannot tilt your view by rolling the MOW to one side.

(2) Control of Movement. You control your flight path over the terrain by directing the operator like a pilot. The operator directly controls the speed and direction of movement, but without simulating a particular kind of aircraft. You can ask the operator to speed up, slow down, move at a speed specified in knots or kph, keep the present speed, or stop (or hover). The maximum speed is about 575 knots or 1060 kph. For most purposes, speeds well below the maximum provide the best viewing conditions. You can ask the operator to ascend (or descend) to a particular altitude, or to increase (or decrease) the height of the MOW above the ground by a specific amount in meters. You can ask the operator to move out (or forward), back up, and turn right (or left). You can follow a route or other control measure on your overlay, orient on a visible terrain feature or object, or move on a fixed heading. One additional kind of movement possible with the MOW is to move laterally without changing your heading. For example, you might want to look in one direction from several positions along the length of a wadi. To move laterally, tell the operator to move sideways to the right (or left) and keep the present heading. Lateral

movement also is possible while forward movement continues in the same direction.

c. Ground Movement (Constant AGL). You can move the MOW over the ground surface as though you were riding in a vehicle, but unaffected by surface trafficability. This is also called the "Terrain Hug" mode of movement. This mode allows you to see the terrain and tactical situations from the perspective of a ground vehicle.

(1) Viewpoint. The MOW shows a view of the terrain with LOS in the direction of forward movement, and parallel to the ground surface. The LOS will change with the direction of movement. The view will raise and lower (change in pitch) as the slope of the ground surface changes, just as it would from a moving vehicle. However, the view does not tilt when the slope runs from one side to the other, since the motion of the SD does not include vehicle cant. The MOW viewpoint is fixed at a constant height (2.6 m) above ground, at the same level as the commander's hatch on the M1 tank. You can change the viewing angle (pitch) relative to the slope of the ground by asking the operator to look up (or down).

(2) Control of Movement. You control movement of the MOW over the ground by directing the operator like a vehicle driver. The speed and direction of movement is controlled by the operator without simulating a specific kind of vehicle. Ground movement directions to the operator can be similar those for aerial movement, with the single exception that you cannot request a change in altitude. However, the maximum speed of the MOW on the ground is about 86 knots or 160 kph. Lateral movement of the MOW is possible on the ground, even though normal vehicles cannot perform this maneuver.

d. View from Vehicle (Mimic). To see the terrain from the viewpoint of a particular vehicle, identify and describe the location of the vehicle on the monitor or PVD, and tell the operator you want to see out of or look from that vehicle. The operator will then attach the MOW to the vehicle in what is called "Mimic" mode. This mode of attachment is useful with both static and mobile SAFOR vehicles.

(1) Commander's View. The initial view will be forward in the direction of the vehicle heading, and with a LOS pitched up or down at the same angle as the base of the vehicle. This corresponds to the frontal head-out view from an armored vehicle. If the vehicle moves, the MOW view moves with it.

(2) View from Position. After the initial Commander's View appears, views from the same position can be obtained at other headings and angles by asking the operator to look right (or left), or to look up (or down).

(3) Gunner's View. If the vehicle has a turret and gun, you can ask the operator to switch to Gunner's View. A magnified view at ten power pointing in the direction of the gunner's sight will appear on the central monitor of the MOW. The actual magnification in the gunner's sight at that time may be at other settings. If the turret is rotated or the sight is elevated or depressed, your view will change accordingly. No other changes in the view can be made in this mode, but you can switch back to the Commander's View.

e. Following a Vehicle. Three other modes of MOW attachment are designed to be used with moving vehicles, and they are less useful when only static SAFOR vehicles are placed on the terrain. However, you can attach to static vehicles in these modes if you desire. To set up these modes, the operator must be told what vehicle to follow. You can describe or point out a vehicle on the MOW or PVD, or give the vehicle's bumper number in your unit. In all three modes, the operator uses the movement controller to change the position and viewpoint of the MOW.

(1) Tether. This mode attaches the MOW to the vehicle at a fixed point. Initially, the point is behind and a little above the selected vehicle, with LOS on the vehicle heading and parallel to flat ground. However, if you change to this mode from another attached mode, the direction of the LOS will be unchanged from the previous mode. Without further input from the operator, the MOW will follow the vehicle, exactly matching its speed and heading to maintain the position of the MOW relative to the vehicle. The operator can adjust the tethered position in any manner desired, since all the kinds of motion possible in aerial movement are available. Operator inputs cause Free Fly movement to be added to the vehicle motion, changing the relative position of the MOW according to your directions. The viewpoint can be changed by asking the operator to look right (or left), and to look up (or down) until you see the view you want. You can also specify a desired point of the compass for the viewpoint, or a desired heading in terms of an azimuth angle. Once moved, both the position and the viewpoint will keep the same distance and LOS angle relative to the vehicle as it moves. For example, suppose you are looking 45· to the right of a vehicle, from 100m to its rear. If the vehicle turns left your view will also turn to the left, and your position will move to the right, staying to its rear. When the vehicle completes its turn, you will still be looking 45· to its right, from 100m to the rear. Tether mode is most useful for observing the actions of a vehicle in response to terrain, other vehicles, and targets lying in one direction relative to its direction of movement, e.g., to its front, side, or rear. When following a unit in this mode, it is usually best to attach to a following vehicle at one end of the formation if you want to see the actions of all the vehicles. You can then adjust your distance

and LOS to keep the entire unit constantly in view despite changes in the axis of movement.

(2) Compass. This mode is similar to the Tether Mode, keeping the MOW attached at a fixed position in relation to a selected vehicle, unless operator input changes the position. The initial position is the same, and you can change the position in the same way as Tether Mode. The initial viewpoint is also the same, unless you switch from another attached mode. As in Tether Mode, the viewpoint can be moved to the right or left, and up or down from the initial direction. However, in Compass Mode, the LOS direction is not altered by vehicle movement, but keeps one constant direction until the viewpoint is changed by operator input. The LOS will remain fixed on the same azimuth and viewing angle relative to level ground, unaffected by how the vehicle turns, or how the vehicle pitches up and down with changes in slope of the ground. Compass Mode is most useful for observing terrain and activities at specific locations lying in one particular direction. For example, while following a unit moving to contact, you may want to keep your view fixed along the compass direction of the planned axis of movement, unchanged by the temporary turns of the vehicle that you are following. Or, you may want to continously watch an enemy defensive position and intervening terrain during an assault, regardless of the turns made, or the dips and ridges crossed by the followed vehicle.

(3) Orbit. Like the other modes, Orbit keeps the MOW attached at a fixed position relative to a selected vehicle, unless the position is changed by operator input. The operator can move the MOW closer to or further from the followed vehicle. However, in Orbit Mode, once the distance is set the movement of the MOW is confined to a spherical surface, with lateral and vertical motions corresponding to lines of latitude and longitude, respectively. Lateral motion is not possible along a straight line, but only on a circle centered on the vehicle. Straight vertical motion is also impossible, but is forced to follow a circular path up to a maximum position directly above the top of the vehicle. Initially, the LOS always points directly at the followed vehicle. You can change the viewpoint to the right or left and up or down as in other modes. The direction of the LOS then will be maintained relative to the vehicle as in Tether Mode. However, usually only the up and down adjustment is useful in Orbit mode. When the LOS is on the vehicle you are following, Orbit Mode allows you to rapidly circle around the vehicle to see terrain, other vehicles, and targets that lie in different directions, while keeping continuous watch on the actions of the vehicle. This mode also allows you to move up quickly to a bird's-eye view looking down on the vehicle together with nearby vehicles and terrain. Orbit mode occasionally may be useful with a static vehicle or unit, if you first move away to a considerable distance, and then circle around rapidly to look at the position from all different

directions. Orbit Mode is best used, at either long or short distances, to circle a moving leader or unit to see surrounding terrain, vehicles, and ongoing activities on all sides.

(4) Switching Modes. You can change directly from any one of the four attached modes (Mimic, Tether, Compass, or Orbit) to a different one. Just tell the operator which mode you want. The MOW will keep the same position and viewpoint relative to the followed vehicle, except when you enter Mimic or Orbit Mode. In these cases, the LOS will change as required by the new mode. For example, if you are in Compass Mode, the MOW will turn to point in the direction of the vehicle when you enter Orbit Mode. The operator can tell you the current heading if you are uncertain about the direction you are looking. You can also change to an unattached mode. When you switch to Free Fly Mode, the MOW will stop moving to remain at your current position, and the viewpoint will reset to become parallel to level ground. When you switch to Terrain Hug Mode, the MOW descends to the ground to stop at your current location, and the viewpoint resets to become parallel to the ground surface. After detaching from a vehicle, if you later attach to the same or a different vehicle, the MOW will return automatically to the previous attached mode unless you request a different one.

f. View Reset. After changing the MOW viewing conditions in any mode of movement, such as raising or lowering the LOS, you can return to the initial conditions by asking the operator to reset the view. With aerial movement, the viewpoint is reset parallel to level ground, and with ground movement, it is reset parallel to the ground surface. In the attached modes, the viewpoint is moved back to the normal initial position for the current mode in relation to the current location of the vehicle being followed.

g. Vehicle Search (Pick from Monitor). The operator can select a vehicle for attachment from the PVD by using the mouse or a vehicle identification number. He can also select a vehicle from the view shown on the MOW by using the "pick" button on the movement control. MOW attachment using the "pick" button can be used as a search function to find vehicles that lie in a given direction, but are hidden or too distant to be seen. Ask the operator to look right (or left) until you see a view you want to search, or give the operator the heading you want, and then ask him to pick up a vehicle lying in that direction. When the "pick" button is pressed, the MOW will attach to the vehicle closest to the center of the middle monitor. If no vehicle is near enough to the centerline to be selected, rotating the view to the right or left will find the vehicle nearest the center on that side. Before searching, it is convenient have the operator switch to Free Fly Mode, and then preset the Tether Mode before attaching. When this is done, the MOW will move directly to the initial Tether position putting the vehicle in view.

2..4 Static SAFOR Capabilities. The static OBG System allows operators to place and create SAFOR objects (vehicles and units) on simulated terrain. The operators will use one or two (one for allied forces and one for enemy forces) MIPS workstations. Initially, they will place objects on the terrain map display at each workstation. Then they will connect to the simulation host to create objects on the simulation network. As a result, created vehicles and units will appear on the PVD and MOW. Your staff (S2 and S3) must work closely with workstation operators to get the required vehicles and units placed where you want them. Your CBPS Activities Plan should specify in as much detail as possible the types of vehicles and units needed, along with the task organization of units. The formation, lead vehicle location (as an 8-digit grid coordinate), and orientation or heading (in mils) should be provided for any unit you and your staff plan to command independently during later mobile SAFOR activities. The location and heading should be provided for any individual vehicle(s) that you and your staff will later want to move independently. You should also specify whether or not you want ground vehicles to appear dug-in on the simulated terrain. These specifications must be provided for every situation or event template you want to observe.

a. Workstation Screen. Each MIPS workstation has a color screen divided into rectangular panes.

(1) Map Pane. The Map Pane takes up most of the screen. It displays a terrain map similar to the PVD map screen, including features such as grids, contour lines, and roads. As vehicles and units are placed, they are represented as appropriate military symbols appearing on this pane in locations specified by the operator. Symbols for allied vehicles and units are drawn in blue, and enemy symbols are red.

(2) Commands Pane. To interact with the OBG System, operators use a Commands Pane located at the top of the screen. They access specific commands and options by temporarily activating pop-up displays (menus and forms) on the screen.

(3) Icon Pane. When they are placing objects on the map display, operators may call up an Icon Pane located to the left of the Map Pane. Two Icon Panes will appear if both allied and enemy forces are being placed.

(4) Legend Pane. A Legend Pane is located below the Map Pane. Operators can use this to adjust the map display.

b. Map Manipulation. Using options available in the Map Pane and Legend Pane described above, operators can control and tailor the MIPS workstation map display as you and your staff direct. This capability may become more important later when your staff can command the movement and interaction of SAFOR

units through workstations. The major map manipulation tools available are briefly described below.

(1) Zoom In. This option allows the operator to center the map display on any location selected from the Map Pane, and to magnify the terrain view by decreasing the map scale one level.

(2) Zoom Out. This option centers the map around a location selected from the Map Pane and increases the map scale one level.

(3) Zoom In on an Area. The operator can draw a rectangular box on the map display to select an area to fill the screen.

(4) Scroll. The operator can rapidly scroll the map display, horizontally or vertically.

(5) Describe a Symbol. Using the mouse, operators can select a vehicle or unit symbol inside the Map Pane and obtain a description of it. Symbols are named with the company, platoon, and vehicle, followed by the battalion in parentheses. For example, 321(5) denotes vehicle 1 of platoon 2 of company 3 of battalion 5.

(6) Scale. The map display can be drawn to any of a large number of scales, ranging from 1:1,600,000 to 1:45.

(7) Terrain Features. The terrain features displayed in the Map Pane (such as grid lines, water, roads, trees, buildings, and contour lines) can be selectively deleted as users desire.

(8) Set Map Center. When operators enter a valid grid coordinate using the keyboard, the map will shift to place the location of the entered coordinate at the center of the Map Pane.

c. Object Placement.

(1) Setting Parameters. Operators place vehicles and units on the workstation map display using either icons from the Icons Pane or menus. In doing this they must set various parameter values by selecting one value from a list of available values, or by entering a value using the keyboard or mouse. The parameters and example values (where values are selected from a list) are listed below. Coordination between your staff and workstation operators will be necessary to determine all available values for some parameters.

(a) Alignment: friendly or enemy.

(b) Echelon: for example, battalion, company, team, or vehicle.

(c) Unit Type: as appropriate for selected alignment and echelon; for example, valid platoon types may be tank or motorized rifle.

(d) Unit Designation: for example, platoon 2, company 3, battalion 5.

(e) Formation: for example road, wedge, vee, echelon-left, or echelon-right.

(f) Position: 8-digit coordinate selected from map display using mouse or entered from keyboard.

(g) Direction: heading in mils, selected using mouse and on-screen direction scale.

(h) Dug-In: toggle on or off to control whether ground vehicles appear dug-in on the MOW.

(2) Refining Placements. As shown by the parameter list above, operators can organize and place units on the terrain display in detail, down to platoon formations and the locations and headings of individual vehicles. Based on intelligence templates and operational plans obtained from your higher HQ, along with your CBPS Activities Plan, operators should initially place your battalion, adjacent units, and enemy units on the display. Prior to your CBPS operations, your S2 and S3 should review these placements and request necessary adjustments to parameter values. Your S2 can update placement of enemy units, based on latest intelligence. Your S3 can direct operators to decompose your battalion into lower echelons (companies, platoons, or vehicles) and task organize units or place units and individual vehicles as needed. During this interaction with operators your S2 and S3 can also become familiar with any limitations (such as types of units and vehicles available) in the OBG System. They can then brief you on the static SAFOR capabilities prior to your initial use of the CBPS facility.

(3) Saving Placements. Once the operators have completed placement of vehicles and units to the satisfaction of you and your staff, they can save the parameter values in a file. They can readily retrieve this file to create vehicles and units on the network to support your CBPS operations. They have the capability to develop and save multiple retrievable files. Your staff could work with the operators to develop multiple placement files based upon anticipated enemy and friendly courses of action. That is, they can develop a series of situation or event templates. Time and resource constraints may place practical

limits on the number of templates that can be developed on the CBPS, but the static SAFOR capability does not limit you to only one view or template of the battlefield.

2..5 Mobile SAFOR Capabilities. (This section will be completed once a mobile SAFOR manual is available.)

2..6 Preparing a Take-Home Package. Due to limitations on the amount of time that the CBPS facility will be available to your unit, you and your staff will need to develop a take-home package to support review of CBPS activities and communication of lessons learned to unit personnel. In addition to your notes on observations and adjustments needed in plans, a videotaping capability will be available. The primary application of this capability will be to record the center MOW screen. Operators may also be able to record the PVD map screen; coordinate with them if you need this. Some suggestions on videotaping MOW views are provided below.

a. Static SAFOR Video. Taping MOW views should probably be the last activity you conduct using static SAFOR. In this way, you can direct the PVD/MOW operator to focus the center screen on and record key views you have noted for presentation to unit personnel. These views may include force dispositions from various perspectives, key terrain features or control measures, NAI/TAI, and movement along ground or air avenues of approach.

b. Mobile SAFOR Video. Wargaming exercises with mobile SAFOR can be recorded by the CBPS data logger and replayed on the PVD and MOW. Operators can mark or flag key events during an exercise, as you direct. They can then replay the exercise at varying speeds and move rapidly to these events. Videotaping should probably be accomplished during such replay. This will allow you to focus the tape on key events in the simulated battle, as well as taping unit movements from various perspectives. You can use the replay and taping capability to support rehearsals reinforcing the scheme of maneuver and the fire plan.

3. Surrogate Reconnaissance

3..1 Static SAFOR

a. Aerial Survey of Bde and Bn/TF Areas. For the first activities in CBPS, make an aerial reconnaissance of the terrain and disposition of forces in your Bde and BN/TF areas of operation and interest. Initially, your attention should be focused on defensive sectors occupied by friendly units, including your own. This activity allows you to see how the PVD and MOW work. Second, you can check how the PVD maps match up with your own situation maps. More importantly, you can compare scenes shown by the MOW with your knowledge of how these scenes

look on familiar ground, especially areas in your own sector where you have previously flown, driven, or walked over the actual ground. This experience will help you develop expectations about the kinds of terrain features and details that are well represented by CBPS, and expectations about those things that may be poorly represented, or entirely missing. Such expectations play an important role in guiding how you will use CBPS to look at enemy areas where you have no other opportunity to fly, drive, or walk. You will want to have a good idea of what you can learn with confidence by using the CPBS, and what you should regard with skepticism. After gaining substantial experience with CBPS in familiar areas, you should then be prepared to avoid drawing any misleading conclusions from reconnaissance of enemy terrain and forces.

(1) Defensive Sectors. Overfly the entire Bde area at a relatively high level to gain perspective on the general topography, to recognize major features important for navigation, and to identify Bn/TF sectors and important rear areas. Then descend to lower levels to look more closely at specific features in each sector. Finally, travel near the ground to make a detailed inspection within your own sector. While conducting your reconnaissance, make note of important discrepancies and missing features for later review and discussion with the SIMNET operators.

(a) Terrain Analysis. Use the terrain analysis developed by Bde and your staff as a basis for comparison with the terrain represented in the CPBS. Conduct this initial reconnaissance without vehicles deployed on the ground to focus solely on terrain characteristics. Examine closely each of the military aspects of terrain (OCOKA). Using your trafficability overlay, follow the margins of areas classified as SLOW-GO and NO-GO terrain to see if they are recognizable based on similar visual characteristics to those you would use looking at the actual ground. Look for significant natural obstacles to verify that they are represented in the terrain, and appear normal. Examine key terrain to confirm that characteristics that cause it to be classified as key are adequately represented in the CPBS. Travel over the avenues of approach (AAs) into and through your sector, identifying the defensive positions you plan to use to block or control each mobility corridor. Check the topography elsewhere to see if additional covered and concealed routes can be found that may have been overlooked in your plans. You may also want to look at the terrain around resupply points, combat support positions, assembly areas, command centers and logistic support areas in the rear, and fly over withdrawal and resupply routes from forward to rear positions.

(b) Control Measures. Travel along the Bde and Bn/TF sector boundaries, phase lines, and other control lines

(e.g., FLOT, or BP and EA boundaries) to determine if the terrain features are present that normally would be used to locate these lines. Also visit control points to observe features locating these points. As you travel around, examine the PVD overlay to verify the correct placement of control lines and points. Note any control measures on the PVD that you would like to have changed, added, or deleted.

(c) Disposition of Forces. At the same time you are examining the Bde and Bn/TF control measures, you may want to look at displays of vehicles in their current positions, or at an initial battle template, with units in their initial BPs. Fly over initial BPs in your sector to see if the positions of units and vehicles accurately represent how you want the defense organized. If you notice some deviation from your concept of the defense, this may simply result from the SAFOR operators improperly interpreting information provided by your staff. In this case, the operators simply need to adjust unit or vehicle positions. On the other hand, such deviations may indicate that your staff did not fully comprehend some specific implications of your operational concept, suggesting that some refinements to the OPORD are needed. Repeat this reconnaissance several times using a number of battle templates, including both friendly and enemy forces, that show the various contingencies that may arise as the battle develops, and your plans to meet these contingencies. Video recording of these templates will be particularly useful for later review and discussion with your staff and subordinate commanders. As you examine each template, check for other possible contingencies that may have been overlooked by your staff.

(d) Obstacle Overlay. While man-made obstacles are not represented in the terrain display, you can fly over or around the locations where they are placed. This allows you to see how the obstacle positions relate to the avenues of approach, and how they relate to the BPs that cover each obstacle with direct fire. It may be revealing to set up static displays of enemy vehicles deployed to approach or breach obstacles when you look at the obstacle locations. Your examination of the terrain and enemy force may suggest possible locations for additional obstacles, or some modifications of the obstacle system that could help to strengthen your defense.

(2) Threat evaluation. After looking at familiar terrain, you are then prepared to reconnoiter the enemy-occupied region in your area of operations. The main focus of your earliest forays into enemy territory should be to assess the offensive capabilities of the enemy order of battle arrayed against your prepared defense, since enemy defensive works will not be represented initially in the CBPS. As you did in your own sector, start flying at a high level to get a general overview of the region, and then descend to inspect specific areas or

positions from intermediate or low levels. Note any apparent discrepancies from your planning data on the enemy, as well as noticeable intelligence gaps that are candidates for information requirements (IRs).

(a) Terrain Analysis. The terrain shown in the CBPS should be compared to the available map-based terrain analysis prior to deploying enemy organizations. Using the MOW, examine trafficability, mobility corridors, enemy AAs, and key terrain to determine important features of the terrain database that need to be represented more accurately or in greater detail.

(b) Enemy Disposition. The CBPS will be able to display the positioning of enemy units and vehicles in according to locations provided by your current intelligence. While looking at these arrays with the MOW and PVD, you should check your overlays with your staff to keep in mind which aspects of the layout are based on assumptions, and which parts represent hard intelligence. Examining the current disposition of the enemy order of battle may provide some indications of enemy intentions in the near term. You may also want to compare the current situation with those that existed at one or two previous points in time to see if there are signs of a recent change in intentions. This reconnaissance may suggest PIR that should be added to those that have already been identified.

(c) Situational Templates. Examining a series of snapshots of enemy deployments will allow you to see the progressive preparation and development of enemy offensive action that has been projected in the situational templates prepared by your staff. Viewing these templates in three dimensions may reveal vulnerabilities, contingencies, or possible NAIs that may have been overlooked in previous planning.

(d) Obstacle Overlays. While man-made enemy obstacles are not represented, it may be useful to look at situational templates near obstacle locations shown in your overlays. This will help you to see how the obstacles will channel offensive deployment and movement of enemy forces.

(e) Event Templates. One of the most useful applications of the CBPS for threat evaluation is to use it to check your reconnaissance and security plan, and decision support template in the enemy region. As you use the MOW and PVD to inspect the templated snapshots of enemy movement to contact, close examination of event templates at the NAI, TAI, and DPs may suggest possible refinements or revisions that will improve your control and synchronization of combat power. Views from the observer's positions may show ambiguities in the expected indicators of enemy activity that will delay reports and decisions. To reduce these ambiguities, you can use the MOW to

try out alternate positions for your reconnaissance assets, or adjust your decision criteria.

b. Ground Reconnaissance of Bn/TF BPs. The main purpose of ground reconnaissance in CBPS is to examine intervisibility. However, small-scale terrain features may not always be accurately represented, so it should be kept in mind that subtle variations in intervisibility will often be unreliable. During ground reconnaissance, the focus should be on the implications of large-scale topographic forms that shape the major intervisibility cells. Since the speed that the MOW can travel is limited on the ground, the amount of ground reconnaissance that is desirable is determined by the time available. If time permits, you can conduct a detailed ground reconnaissance to examine intervisibility from the perspective of the defender's BPs, and from the attacker's movement routes. If time is short, you may want to combine ground and aerial reconnaissance, descending to visit selected important points as you come to them during your flight. Teleporting from one location to another without traveling on the intervening ground will also help to save time.

(1) Perspective from BPs. Observations using the MOW from the BPs at ground level allows you to see how battle situations develop as they will be seen by your subordinate commanders. This should yield some insights about the problems that they may encounter as they fight the battle according to your intent.

(a) Sectors of Observation. Travel over the ground on each BP, examining the ground within assigned sectors of observation, and identifying distinctive terrain features that mark the sector boundaries. The location of phase lines, engagement areas, and other control measures should be visible and identifiable. The intervisibility area (fan) display on the PVD can be used to show areas within the sector that are "dead ground" when viewed from individual battle positions. Compare such areas to those marked on unit fire plans, noting apparent discrepancies between the plan and the PVD. Below some size depending on the accuracy of the terrain representation in your region, small areas will not reliably appear on the PVD. Based on his experience, the PVD/MOW operator should be able to help you determine what size should be disregarded. Larger areas that appear on the PVD but not on the fire plan, or vice versa, may indicate an error in the terrain database that should be corrected. On the other hand, it may indicate an area that should be reexamined on the ground to reconfirm or correct the fire plan.

(b) Detection Ranges. Limits on the resolution of images in television displays will prevent distant targets from being detected at normal ranges. Therefore, the

appearance of targets in the MOW display should not be used to judge the distance from a BP at which enemy forces will first appear. This distance can only be established on the actual ground. However, the PVD functions can be used to determine LOS out to 3,500 m from locations on a BP. Together with the PVD, the MOW can be used to identify or confirm larger terrain features that break the LOS and mark the limits of detection.

(c) Co/Tm Fire Plans. LOS to EA and within primary fields of fire can be checked visually from vehicles in their battle positions by attaching the MOW to each vehicle in mimic mode. Seen from these positions, enemy templates may suggest additional target reference points (TRPs) or other control measures to aid fire control. Alternate and supplementary positions also can be checked by traveling or transporting the MOW to each position. To use mimic mode from these positions, additional vehicle deployments for the entire unit have to be prepared and stored by the SAFOR operators. Each deployment configuration must be retrieved and activated independently for the unit, permitting additional but separate rounds of visits to the BPs.

(d) Control Lines. Check boundaries, phase lines, trigger lines, restrictive fire lines, and break lines to confirm that the locations of these lines are visible and identifiable from platoon leader and platoon sergeant positions. Also look at enemy templates from these positions to see that engagement and withdrawal criteria are clearly stated. Recording MOW views of these templates can help to demonstrate the criteria in later reviews with subordinate commanders.

(e) Fire Support Plans. Check LOS to TRPs to see that their locations are visible and identifiable from the ground positions of observers or leaders that may be required to call indirect fires using each point. Use situational templates to examine how the fire support plan synchronizes with the maneuver and obstacle plans. When viewed from the BPs, the situations illustrated by the templates may suggest advantageous changes in the location of TRPs, additional TRPs, possible conflicts between calls-for-fire, and needs for additional fire support at particular times.

(f) Movement Routes. Travel the ground on withdrawal routes or counterattack routes to examine situational templates existing at the time these routes are used. This may suggest points where cover is inadequate, orientation is difficult and the unit may go off-track, or where some special measures must be taken to reduce the possibility of fratricide.

(g) Disposition of Support. Travel on routes to and from unit trains and other supporting elements. Distances and features of the terrain may suggest that positions

should be moved closer or further from the battle, or that more secure positions can be found than the ones specified in current plans.

(2) Enemy Perspective. One of the unique features of the CBPS is the capability it gives you to put yourself "in the seat" of the enemy commander or his subordinates. By looking at battle situations from their standpoint at ground level you may be able to improve your understanding of what information will flow to the commander, what factors will influence critical decisions, and how they will react to specific events at various points in time.

(a) Enemy Intelligence. Given the known limitations on the enemy's intelligence gathering capabilities, the enemy commander will probably have only partial knowledge of your force, disposition, and defensive preparations. Using the PVD to show situational templates based on intelligence that is likely to be available to the enemy should help you to gain some idea of one or more possible estimates of the situation from the enemy point of view. This enables you to project the kind of offensive missions that might be assigned to the enemy forces, and what they might choose as initial, intermediate, or deep objectives for attacks in your sector.

(b) Reconnaissance Targets. The enemy places a premium on the acquisition of intelligence to provide a basis for planning and achieving surprise in the offense. By examining possible gaps in enemy intelligence, likely priorities for reconnaissance can be identified. Given the possible reconnaissance targets, travel the ground to seek out concealed routes that may be used by patrols and infiltrators. Look for positions in your sector where the enemy might attempt to establish OPs. Check your counterreconnaissance plans against the possible enemy recon effort that is suggested by routes and positions identified in the CBPS. Using the MOW to observe your force, estimate what will be added to the enemy's intelligence if some of his reconnaissance efforts are successful. This should help to set priorities and allocate assets for the counterreconnaissance battle.

(c) Scheme of Maneuver. Moving the MOW over AAs on the ground and attaching to commander vehicles allows to see how the battle develops from the enemy point of view. As you follow the path of his approach, deployment, and assault on your positions, examine what is progressively revealed to the enemy as additional terrain comes into view, and your forces execute planned actions. Consider how the flow of information to the enemy commander will influence his decisions and reactions. This may reveal opportunities for deception, suggest weaknesses in your defense that might be exploited by the enemy commander, or indicate other vulnerabilities to unexpected enemy actions.

(d) Combat Support and Reserves. As you move with the enemy commanders through a sequence of template snapshots of the battle, examine how the attack can be supported and strengthened, given the enemy assets available. Look for likely targets for his initial artillery preparation, and how artillery will be used as the battle develops. Consider how the enemy force will encounter your obstacles and attempt to breach or bypass them. Consider also where reserves will be positioned, how the will move as the battle develops, and where and when they may be used to add weight to the attack. This examination may indicate some NAIs, TAIs, and DPs that are candidates for incorporation in your decision support template. Requirements for support of the deep battle needed to interdict or disrupt enemy offensive action may also be identified.

c. Update on Enemy Defensive Preparations. The use of CBPS for reconnaissance related to offensive operations is likely to be more beneficial if it is deferred until the terrain database has been modified to improve the representation of enemy defensive preparations, and the most recent and detailed intelligence has been used to update the defensive positioning of enemy forces. After using the CBPS with defensive plans, you can consider using it for offensive planning when the necessary enhancements become available. For the offense, new CBPS templates representing your possible courses of action, enemy reactions, and your counterreactions will have to be prepared in advance. Surrogate offensive reconnaissance, by air or ground, is essentially the reverse of the processes outlined for the defense in the previous sections. However, you would begin by looking at defensive preparations in the enemy area to be attacked, and then look at your plans for the attack starting with your assembly area.

Limitations on the CBPS capability to represent earthworks and other defensive obstacles, and the lack of dismounted infantry may reduce its utility in relation to offensive missions that involve the initial assault to penetrate a well-prepared defense. If the CBPS representation of terrain and enemy defenses is not sufficiently detailed to help plan a deliberate attack, you may prefer to use the CBPS to examine the situations and missions that follow a successful breakthrough. Enemy withdrawal, hasty defense, reinforcement, and counterattack templates can be examined together with your plans for continuing the attack to deep objectives. The CBPS should be most useful for examining fluid battlefield situations that occur in pursuit and exploitation missions.

Other additions to the CBPS may be completed in time for use in offensive planning, making capabilities for mobile SAFOR available. Thus, besides looking at snapshots of initial dispositions of enemy forces in a series of situational templates, you can wargame the potential reactions and radius of

action for enemy forces in or near a planned area of operations. Once mobile forces can be represented, a smaller portion of your available time in the CBPS should be allocated to reconnaissance of static displays, with the majority of time used for wargaming your offensive plans.

d. After-Action Reviews (AARs). After one or more reconnaissance activities in CBPS, review the results with the CBPS staff, and with your own staff and commanders.

(1) CBPS Review. Immediately after finishing your activity session, meet with the PVD/MOW and SAFOR operators responsible for the terrain and order of battle in your area. Go over any important discrepancies you have encountered in the terrain or force representations. Explore with the operators what database corrections are feasible in what time frames. Follow up this meeting with a formal request for modifications through your CBPS POC, establishing priorities among the types of enhancements needed in your sector.

(2) Unit Review. After returning to your unit, review the products of your reconnaissance. Besides the personnel that may have been present during the CBPS activities, include other commanders or staff that may benefit from this review. Replay your videotapes, commenting on what you have seen, and the main implications you have drawn from the experience. The main purpose of the review should be to identify areas of uncertainty, if any, about your unit's IPB and operational plans that were suggested by the reconnaissance, and to assign responsibility for follow-up work to reconfirm or refine the situational estimate and courses of action. You should emphasize the point that firm conclusions cannot be drawn from CBPS reconnaissance alone, but that it is simply a tool giving a different perspective to expose possible problems overlooked in earlier planning.

3..2 Mobile SAFOR (This section will be completed once a mobile SAFOR manual is available.)

4. Simulated Wargaming

4..1 Overview. Prior to using the CBPS, you and your staff will have developed alternative courses of action and wargamed them by visualizing each step of the battle considering actions, reactions, and counterreactions. Through your surrogate reconnaissance activities, you and your staff will become familiar with the simulation's capabilities to represent terrain, forces, and battlefield operations. This should provide you a good basis for using the simulation to supplement your wargaming activities. The CBPS can help you visualize the battlefield and analyze selected critical events within courses of action against enemy capabilities. A key requirement for you and your staff is

to determine enemy and friendly capabilities and critical events that can reasonably be wargamed with the simulation. Use CBPS to wargame critical task clusters that it represents well (e.g., command and control or maneuver), always giving consideration to CS and CSS integration. Apply techniques for working around CBPS's limitations. For example, if sufficient mobile SAFOR is not available to support your wargaming activities, use a series of static "snapshots" of projected key points in the battle. Use your tactical judgment and experience to integrate simulated wargaming with other wargaming techniques to develop an overall visualization of future battles.

4..2 Identify Enemy Capabilities. Through intelligence from various sources, you should have a good picture of enemy capabilities. You and your S2 need to determine the most important capabilities that can be wargamed on the CBPS, given the time available and the system's capabilities. During your surrogate reconnaissance activities, work closely with system operators to identify enemy capabilities that can be represented satisfactorily. The system can represent various enemy capabilities, including maneuver (of at least 60 vehicles), fire support, and resupply. It may not represent prepared defensive positions or all enemy weapon systems that you may encounter in future operations.

4.3 Identify Friendly Capabilities. As with enemy capabilities, you need to work closely with operators to identify the friendly capabilities that can be represented satisfactorily in the simulation. Determine the friendly forces, assets, and combat multipliers that are available. Examine approaches for working around any limitations in the capabilities represented.

4.4 Identify Critical Events. Once you have identified the enemy and friendly capabilities that are available, you should be able to select critical events for simulated wargaming. Based on your mission analysis, identify tasks essential for mission accomplishment that can be performed in the simulation. Limitations on time and mobile SAFOR available may lead you to wargame portions of planned operations, such as initial contact between security and reconnaissance forces. The lack of prepared defensive positions on the simulated terrain may lead you to concentrate on exploitation and pursuit rather than penetration tasks during simulated wargaming. You may choose to represent critical events through a series of static displays or templates of expected battlefield conditions. Give consideration to representing enexpected contingencies in these displays.

4.5 Identify Assumptions. In simulated wargaming you need to identify not only the assumptions you have made about future battlefield conditions, but also assumptions made in the simulation. Coordinate with operators to identify assumptions made about factors such as trafficability of terrain, movement

rates and other operating characteristics of vehicles, availability of fire support, and resupply requirements. Specify any assumptions that need to be modified. List any assumptions that may affect the end results of your wargaming activities.

4.6 Select Criteria for Analysis. In addition to criteria you may have developed based on the principles of war, METT-T, and your intent, look for unique criteria that simulated wargaming can provide you. For example, wargaming portions of operations with mobile SAFOR can provide you projections of battle losses, times required for repositioning forces, and consumption rates for fuel and ammo. Use simulated wargaming to refine resupply plans and the integration of fire support with maneuver. Identify to the operators the data that you need as output from simulated wargaming. They may in the future be able to provide such data as automated printouts to support your analysis of courses of action.

4.7 Wargame and Assess Results. Based on the wargaming method (avenue-in-depth, belt, or box technique) that you select, identify to the operators the perspective(s) from which you wish to view the battlefield. Time and mobile SAFOR constraints may lead you to emphasize the box technique to microanalyze critical areas, such as engagement areas. Designate staff members to view the simulation displays, along with the observations they should make (based on events and criteria selected) and the method for recording and displaying results (operators can suggest wargaming worksheet formats). You and your staff should direct and observe the simulated wargame in terms of actions, reactions, and counterreactions, including CS, CSS, and time requirements in recordings of results. As time allows, repeat the wargame to analyze the effects of different contingencies and changes to the course of action. Direct the operators to videotape your wargaming activities to support further analysis of results, AARs, and rehearsals. Examine the results and the impact of any assumptions made to determine the advantages and disadvantages of the course(s) of action wargamed.

5. Command & Staff Rehearsal

5.1 Mission Rehearsal. The CBPS provides a tool for augmenting, supplementing, or reinforcing rehearsals conducted through other means (sandtables, terrain models, or actual terrain). You can use this tool to translate tactical plans into visual representations of the battleground and the sequence of key actions within planned operations. A primary objective for you and other rehearsal leaders is to ensure that the representations are valid ones that help each member of the unit understand his role in and your intent for future operations. Other objectives include verification of your ability to control future operations, identification of problem areas and

contingency actions, determination of movement and reaction times, enhancement of coordination, and refinement of plans.

a. Rehearsal Capabilities. Static SAFOR displays can be used to support rehearsals, through creation of templates or snapshots of force dispositions at projected key points in future battles. You and your staff can use these displays to guide discussions of planned actions with unit personnel. Full utilization of the CBPS to support rehearsals will depend on availability of mobile SAFOR. Once this capability is available, the CBPS can support rehearsals through replay of simulated exercises on displays in or remotely fed from the van or through presentation of videotaped exercises in unit facilities.

(1) Exercise Replay. Your wargaming activities in the CBPS facility should result in a simulation of future mounted battlefield operations that is as complete and realistic as possible within system limitations. The operators can record this simulation using the data logger and replay it on the PVD and MOW in the SIMNET van or remotely on large screens in a nearby facility. Small numbers of personnel (e.g., you and your primary staff) can view and discuss this replay in the van to rehearse future operations. Other unit personnel (e.g., subordinate commanders and specialty platoon leaders) can participate in rehearsals by viewing the remote displays. You can direct the operators to stop the replay at any time and to focus the displays on key actions or events from various viewing perspectives. Initially you may want to use the replay capability to rehearse as much of an entire operation as possible, within the constraints of time and mobile SAFOR capability available. Later you may direct operators to replay specific parts of an operation so you or your S3 can concentrate on key actions or critical tasks with selected individuals.

(2) Exercise Videotaping. Through videotaping of the simulation replay, the CBPS can support rehearsals for large numbers of unit personnel. Rehearsal leaders can use the MOW videotape to present views of parts of an operation and key events that you have had recorded. They can stop the videotape and allow individuals to talk through their planned actions. Videotaping provides the advantage of supporting rehearsals when the CBPS facility is not available to your unit. The primary disadvantage is that only views that were taped can be shown, whereas replay directly on the PVD and MOW provides nearly unlimited perspectives.

b. Planning. You should include your initial rehearsal plans in your CBPS Activities Plan. Indicate whether you intend to rehearse major portions of an operation through replay in the CBPS facility and/or videotape. If possible, identify specific parts of the operation or key events that you want to focus on during replay or videotaping. Specify the

personnel that you want to attend exercise replays, and coordinate with operators on availability of the CBPS van and remote displays. Designate the individual(s) responsible for rehearsal preparation.

c. Preparation. In preparing for CBPS rehearsals, unit personnel will not have to produce a reasonable facsimile of your area of operations. But you and your primary staff will need to work with the operators to ensure that the CBPS facsimile is as realistic as possible. During your CBPS activities, identify differences between CBPS and projected real-world operations that will need to be brought to the attention of rehearsal participants. Apply creativity to work around CBPS's limitations; e.g., move vehicles as if barriers are emplaced, even though they do not appear on the simulated battleground. You can then represent barriers through overlays on screens during rehearsals. Refine and complete your rehearsal plans as you become familiar with CBPS's capabilities. Identify the perspectives from which you want actions displayed during rehearsals. This is especially critical for videotaping displays. Specify to operators key actions or portions of an operation you want recorded on the data logger or videotape. They can then flag these events for later retrieval. For example, within a movement to contact operation you may want to focus on disengagement of the security force to support later rehearsal with the advanced guard and security force commanders. Specify alternative or unexpected actions you want to simulate and record as support for rehearsal of contingency plans. As you complete your simulated wargaming activities, ensure that rehearsal leaders and system operators have a common understanding of the displays to be presented during rehearsals, the means for presenting these displays (replay versus videotape), and the schedule and planned attendance for exercise replays.

d. Conduct. Leaders should initiate CBPS rehearsals by orienting participants to the simulated battleground. They should point out any limitations in CBPS's representation of terrain and forces, along with any parts of operations that cannot be represented in the simulation and must be rehearsed through other means. To provide rehearsal participants with a thorough understanding of a planned operation, leaders can show the recorded action in real time followed by a replay with frequent pauses for discussion of key events. After anticipated actions are rehearsed, leaders can present and discuss unexpected contingencies that might arise. Key points that should be emphasized during rehearsals include integration of fire support, events which trigger different contingency actions, and actions on contact. Each rehearsal should conclude with a replay of the planned operation and an AAR. Leaders should use the AAR to review lessons learned and modifications needed in current plans.

5.2 CPX Driver. With the integration of radio nets, a CBPS exercise can be used to drive a CPX. You and your command group can observe and move on the battlefield, performing command functions as though in a command vehicle. Subordinate commanders and staff observing remote CBPS displays can generate reports and other communications to you and the CP, approximating the operational traffic to be expected on the command net. They can also work with the system operators to execute the OPORD and subsequent FRAGOs. This application of the CBPS will allow integrated rehearsal of command and control activities for a planned mission in a realistic time frame. Presently, this type of rehearsal is limited by the fact that all exercise participants will see the same view of the battlefield; i.e., the view from the command group's position. In the future, additional simulators may be available to provide each subordinate commander and specialty platoon leader with the view from his position on the simulated battlefield. You and your staff will need to coordinate closely with the operators to determine the capabilities available for setting up a CBPS CPX.

Appendix B
PROJECT ODIN FLYING CARPET (FC)
USER QUESTIONNAIRE

PT 5863R

DATA REQUIRED BY THE PRIVACY ACT OF 1974

AUTHORITY: Title 10, USC, Sec 4503.
PRINCIPAL PURPOSE: The data collected with this form are to be used for research purposes only.
ROUTINE PURPOSE: This is an experimental personnel data collection form developed by the U.S. Army Research Institute for the Behavioral and Social Sciences pursuant to its research mission as prescribed in AR 70-1. When identifiers (name or Social Security Number) are requested they are to be used for administrative and statistical control purposes only. Full confidentiality of the responses will be maintained in the processing of these data.
DISCLOSURE: Your participation in this research is strictly voluntary. Individuals are encouraged to provide complete and accurate information in the interests of the research, but there will be no effect on individuals for not providing all or any part of the information.

Instructions

After participating in a Flying Carpet (FC) exercise as a unit commander or staff member, please complete this questionnaire to provide input on how the system should be used. Provide background information in the detail requested in Part I. Provide ratings of the system's capabilities to support planning and decision-making, as requested in Part II. In Part III provide brief written comments on your overall assessment of the system's utility. You will have an opportunity to expand on these comments verbally during a group interview session after you complete this questionnaire. Complete Part IV if you have received a Desert Shield briefing on the sandtable in Stacy Hall at Ft. Knox.

Please provide the information requested below, so that you can be contacted to expand on your responses, if necessary. This page will be removed from the remainder of the questionnaire before responses are examined so that your input will be identified by questionnaire number only.

Name: _____ Duty Phone #: _____

Organization: _____ Ques. #: _____

Questionnaire Number: _____

Part I - Background Information

1. In what role (echelon and position; e.g., BN S3) did you participate in the FC exercise?

_____

2. What is your rank? _____

3. a. What is your current duty position? _____

_____

b. How long (in months) have you been in this position?

_____

4. Briefly describe your previous corps/div/bde/bn command and staff experience, in terms of position, unit, and approximate timeframe (e.g., S3, 1-68 AR, Nov 88 - Oct 89).

_____

_____

_____

_____

_____

5. a. Have you worked on a joint staff or in a unified or specified command? Yes____ No____

b. If yes, briefly describe your experience (command(s) and position(s)). _____

_____

_____

_____

6. a. Have you been in a unit rotation to NTC or been assigned to NTC? Yes____ No____

b. If yes, briefly describe your experience below.

	Unit	Position	App. Date
(1) Unit rotation(s)	_____	_____	_____
	_____	_____	_____
	_____	_____	_____

	Unit	Position	App. Date
(2) Assignment(s)	_____	_____	_____
	_____	_____	_____
	_____	_____	_____

7. a. Have you been to Saudi Arabia? Yes____ No____

b. If yes, briefly describe circumstances (assignment and approximate dates). _____

_____

_____

_____

_____

8. a. Other than NTC and Saudi Arabia, have you had any military experience in desert terrain? Yes____ No____

b. If yes, identify location and briefly describe experience. _____

_____

_____

_____

9. a. Have you had previous experience with SIMNET?

Yes____ No____

b. If yes, briefly describe experience (duty position(s) and time on SIMNET for each position).

_____

_____

_____

_____

_____

Part II - FC Support for Planning/Decision-Making

Instructions. The major steps in planning and decision-making for a military operation are listed in various groupings on the next two pages. Please rate the degree to which you think use of the FC system will affect (help or hurt) accomplishment of each of these steps for tactical operations. Base your ratings on comparison of the FC capabilities you have seen (not those projected for the future) with current non-FC approaches for each step, from the perspective of the position you occupied during the FC exercise. Provide your rating for each step by entering a number from the scale below in the appropriate blank. Provide ratings for the echelon at which you participated in the FC exercise, and for any other echelons that you can.

1 - FC will hinder or degrade accomplishment of the step greatly; FC is much worse than current approach.

2 - FC will hinder or degrade accomplishment of the step somewhat; FC is moderately worse than current approach.

3 - FC will not affect accomplishment of the step; FC is no better or worse than current approach.

4 - FC will help or enhance accomplishment of the step somewhat; FC is moderately better than current approach.

5 - FC will help or enhance accomplishment of the step greatly; FC is much better than current approach.

NOTE: The next two pages include reminders of the rating scale.

1	2	3	4	5
FC will hinder greatly	FC will hinder somewhat	no effect	FC will help somewhat	FC will help greatly

Troop-Leading Procedures

	Bn	Bde	Div	Corps	EAC
Receive/analyze mission	____	____	____	____	____
Issue warning order	____	____	____	____	____
Make a tentative plan	____	____	____	____	____
Initiate movement	____	____	____	____	____
Conduct reconnaissance	____	____	____	____	____
Complete the plan/order	____	____	____	____	____
Issue order	____	____	____	____	____
Supervise/refine plan (including rehearsals)	____	____	____	____	____

Commander's Estimate of the Situation

	Bn	Bde	Div	Corps	EAC
Analyze mission (in detail)	____	____	____	____	____
Analyze situation (METT-T)	____	____	____	____	____
Develop own courses of action	____	____	____	____	____
Analyze courses of action (wargaming)	____	____	____	____	____
Compare courses of action	____	____	____	____	____
Develop decision/concept of operation	____	____	____	____	____

1	2	3	4	5
FC will hinder greatly	FC will hinder somewhat	no effect	FC will help somewhat	FC will help greatly

Intelligence Preparation of the Battlefield (IPB)

	Bn	Bde	Div	Corps	EAC
Battlefield area evaluation	____	____	____	____	____
Terrain analysis	____	____	____	____	____
Weather analysis	____	____	____	____	____
Threat evaluation	____	____	____	____	____
Threat integration	____	____	____	____	____

Military Decision-Making Process

	Bn	Bde	Div	Corps	EAC
Receive mission	____	____	____	____	____
Provide info to cdr & staff	____	____	____	____	____
Analyze/restate mission (cdr's planning guidance)	____	____	____	____	____
Complete staff estimates	____	____	____	____	____
Prepare plans/orders	____	____	____	____	____
Approve plans/orders	____	____	____	____	____
Issue plans/orders	____	____	____	____	____

Part III - Overall FC System Assessment

1. What is your overall assessment of the usefulness of the current FC system for supporting tactical commanders and their staffs in preparing for future battles?

____ Extremely useful

____ Of considerable use

____ Of use

____ Not very useful

____ Of no use

2. If the FC system is fielded in its present form, which echelon(s) should use it? Answer by providing a number indicating priority for each echelon that should use it (1 for highest priority, etc).

____ Echelons above Corps

____ Corps

____ Division

____ Brigade

____ Battalion Task Force

____ Company Team

____ Platoon

3. Should the FC system be fielded to support tactical operations?

____ Yes, in its current configuration

____ Yes, but only after modification

____ No

4. Briefly describe the potential uses you see for the FC system. List who should use it for what purpose(s) (e.g., planning, command and control, training).

a. _____

_____

b. _____

_____

c. _____

_____

d. _____

_____

e. _____

_____

5. List (by corresponding letter) modifications or enhancements needed in the FC system for each use you described above. Put an * by any that should be completed before fielding.

a. _____

_____

b. _____

_____

c. _____

_____

d. _____

_____

e. _____

_____

6. a. Have you reviewed the draft Commander's Guide for the FC system (titled Commander's Guide for the Commander's Battle Preparation System (CBPS))?

Yes____ No____

b. Provide any suggestions you have on information that should be in a Commander's Guide for the FC system. If you reviewed the draft Guide, provide any comments you have on it.

_____

_____

_____

_____

_____

_____

_____

_____

7. Provide any other comments that should be considered in development/fielding of the FC system (e.g., interface with other systems, tips/techniques for use).

_____

_____

_____

_____

_____

_____

_____

_____

Part IV - Comparison with Sandtable

1. Have you received a Desert Shield briefing on the sandtable in Stacy Hall at Fort Knox? Yes____ No____

NOTE: If no, do not complete the remainder of this section.

2. What is your overall assessment of the usefulness of a sandtable like the one in Stacy Hall for supporting Desert Storm commanders and their staffs in preparing for tactical operations?

____ Extremely useful

____ Of considerable use

____ Of use

____ Not very useful

____ Of no use

3. Compare the usefulness of a sandtable like the one in Stacy Hall and the FC system for preparing for Desert Storm operations by selecting a response below.

____ Sandtable is much better

____ Sandtable is somewhat better

____ Sandtable and FC have equal utility

____ FC is somewhat better

____ FC is much better

4. List the advantages, if any, that the sandtable offers over the FC system.

5. List the advantages, if any, that the FC system offers over the sandtable.

6. Provide any suggestions you have for combined use of the FC system and sandtables/terrain boards.

Appendix C

Statistics for Part II Ratings

Table C-1

Friedman Rank Tests of Differences Among Procedural Steps in Part II Sections of the FC Questionaire for Each Echelon

	Echelon				
Statistics[a]	BN	BDE	DIV	CPS	EAC
			Troop-Leading Procedures		
$\chi^2(7)$	13.819	12.525	25.488[b]	10.658	4.524
p	.0545	.0846	.0006	.1542	.7178
n	12	10	20	10	7
m	1	1	1	1	1
			Commander's Estimate of the Situation		
$\chi^2(5)$	2.686	4.190	2.083	3.286	1.095
p	.7483	.5223	.8376	.6560	.9545
n	10	9	19	8	6
m	0	0	0	0	0
			Intelligence Preparation of the Battlefield		
$\chi^2(4)$	4.740	6.300	13.700[b]	10.125[b]	1.840
p	.3150	.1778	.0083	.0384	.7652
n	10	10	20	8	5
m	2	2	2	1	1
			Military Decision-Making Process		
$\chi^2(6)$	4.500	4.571	13.624[b]	8.939	3.150
p	.6093	.5998	.0341	.1771	.7898
n	9	9	19	7	5
m	0	1	1	0	0

Note. BN = Battalion, BDE = Brigade, DIV = Division, CPS = Corps, EAC = Echelons Above Corps.
[a]m = number of least-squares estimates for missing responses.
[b]Significant with $p < .05$.

Table C-2

Mean Ranks of FC System Support for Planning and Decision-Making

Step	Echelon				
	BN	BDE	DIV	CPS	EAC
Troop-Leading Procedures					
Receive/analyze mission	5.25	5.65	3.80	3.55	4.57
Issue warning order	3.38	3.95	3.67	3.85	4.07
Make a tentative plan	4.54	4.95	4.93	5.45	4.79
Initiate movement	3.67	3.25	3.75	3.55	3.43
Conduct reconnaissance	6.29	5.85	6.45	6.00	6.00
Complete the plan/order	3.92	3.80	3.90	4.05	4.43
Issue order	3.83	3.35	3.90	4.20	4.07
Supervise/revise plan	5.13	5.20	5.60	5.35	4.64
Commander's Estimate of the Situation					
Analyze mission in detail	3.70	3.44	3.50	3.25	3.00
Analyze situation (METT-T)	4.00	4.11	3.97	4.38	3.58
Develop courses of action	3.90	4.22	3.66	3.75	3.42
Analyze courses of action	2.90	2.78	3.32	2.88	3.25
Compare courses of action	3.30	3.39	3.26	3.63	4.00
Develop decision/concept of operation	3.20	3.06	3.29	3.13	3.75
Intelligence Preparation of the Battlefield					
Battlefield area evaluation	3.15	3.10	3.22	3.44	2.90
Terrain analysis	3.65	3.85	3.63	3.81	3.30
Weather analysis	2.30	2.10	1.92	1.50	2.20
Threat evaluation	3.30	3.10	3.33	3.25	3.30
Threat integration	2.60	2.85	2.90	3.00	3.30
Military Decision-Making Process					
Receive mission	3.31	3.22	3.13	3.07	3.30
Provide information	4.88	4.67	5.34	5.79	4.70
Analyze/restate mission	3.94	4.22	3.84	4.00	4.70
Complete staff estimates	4.88	4.67	4.37	4.50	4.70
Prepare plans/orders	4.06	4.33	4.03	4.00	4.00
Approve plans/orders	3.63	3.22	3.21	2.71	3.30
Issue plans orders	3.31	3.67	4.08	3.93	3.30

Note. Ranks are in inverse order. BN = Battalion, BDE = Brigade, DIV = Division, CPS = Corps, EAC = Echelons Above Corps.

Table C-3

Pairwise Wilcoxon Signed-Rank Tests of Rating Differences Between Steps in Troop-Leading Procedures at Division Level

		Step						
Step		MISS	WARN	TENT	INIT	RECN	COMP	ORDR
WARN								
	z	0.09						
	p	.9292						
TENT								
	z	1.54	1.61					
	p	.1235	.1080					
INIT								
	z	0.10	0.15	1.89				
	p	.9188	.8785	.0587				
RECN								
	z	3.18[a]	3.30[a]	2.24	3.06[a]			
	p	.0015	.0010	.0249	.0022			
COMP								
	z	0.73	0.31	1.53	0.21	3.30[a]		
	p	.4631	.7598	.1263	.8336	.0010		
ORDR								
	z	0.00	0.12	1.82	0.42	3.18[a]	0.21	
	p	1.000	.9063	.0684	.6744	.0015	.8339	
SUPR								
	z	2.29	1.76	0.62	2.16	1.38	2.13	2.17
	p	.0219	.0783	.5337	.0310	.1688	.0328	.0303

Note. MISS = Receive/analyze mission, WARN = Issue warning order, TENT = Make a tentative plan, INIT = Initiate movement, RECN = Conduct reconnaissance, COMP = Complete the plan/order, ORDR = Issue order, SUPR = Supervise/revise plan. N = 20 for each comparison.

[a]Significant with two-tailed $p < .00357$ for an error rate $\alpha = .10$ per family of comparisons.

Table C-4

Pairwise Wilcoxon Signed-Rank Tests of Rating Differences Between Steps in Intelligence Preparation of the Battlefield at Division and Corps Levels[a]

		Step				
Step		BATT	TERR	WTHR	EVAL	INTG
BATT						
	z		1.34	2.20	0.27	0.55
	p		.1797	.0277	.7893	.5839
TERR						
	z	1.69		2.20	1.34	1.60
	p	.0910		.0277	.1797	.1088
WTHR						
	z	2.73[b]	3.23[b]		2.20	2.20
	p	.0063	.0012		.0277	.0277
EVAL						
	z	0.13	0.65	2.66[b]		1.00
	p	.8939	.5147	.0079		.3173
INTG						
	z	0.70	1.51	2.29	1.57	
	p	.4846	.1307	.0218	.1159	

Note. BATT = Battlefield area evaluation, TERR = Terrain analysis, WTHR = Weather analysis, EVAL = Threat evaluation, INTG = Threat integration.
[a]Tests at corps level are above the diagonal, and tests at division level are below the diagonal. Corps n = 8 and division n = 10.
[b]Significant with two-tailed $p < .01$ for an error rate $\alpha = .10$ per family of comparisons.

Table C-5

Pairwise Wilcoxon Signed-Rank Tests of Rating Differences Between Steps in the Military Decision-Making Process at Division Level

		Step					
Step		MISS	INFO	ANAL	COMP	PREP	APPR
INFO							
	z	2.70					
	p	.0069					
ANAL							
	z	1.26	2.27				
	p	.2084	.0234				
COMP							
	z	1.29	1.95	0.70			
	p	.1973	.0506	.4838			
PREP							
	z	1.27	2.55	0.10	0.51		
	p	.2049	.0108	.9165	.6121		
APPR							
	z	0.10	2.93[a]	1.26	1.84	2.02	
	p	.9165	.0033	.2076	.0663	.0431	
ISSU							
	z	1.35	2.20	0.34	0.28	0.45	1.94
	p	.1763	.0281	.7353	.7794	.6547	.0519

Note. MISS = Receive mission, INFO = Provide information, ANAL = Analyze/restate mission, COMP = Complete staff estimates, PREP = Prepare plans/orders, APPR = Approve plans/orders, ISSU = Issue plans/orders. *N* =19 for each comparison.

[a]Significant with two-tailed $p < .00476$ for an error rate $\alpha = .10$ per family of comparisons.

Table C-6

Friedman Rank Tests of Rating Differences Among Staff Procedures

	Mean Rank[a]				Test	
Echelon	TLP	CES	IPB	DMP	$\chi^2(3)$	p
Above Corps[b]	2.38	3.13	2.50	2.00	1.575	.6651
Corps[c]	3.14	2.29	2.64	1.93	3.386	.3359
Brigade[d]	2.44	2.61	2.67	2.28	0.500	.9198
Battalion[e]	1.94	2.63	3.31	2.13	5.438	.1424

Note. TLP = Troop-Leading Procedures, CES = Commander's Estimate of the Situation, IPB = Intelligence Preparation of the Battlefield, DMP = Military Decision-Making Process.
[a]Ranks are in inverse order. [b]n = 4. [c]n = 7. [d]n = 9. [e]n = 8.

Table C-7

Pairwise Wilcoxon Signed-Rank Tests of Rating Differences Between Staff Procedures at Echelons Above and Below Division

		Procedures					
Echelon		TLP CES	TLP IPB	TLP DMP	CES IPB	CES DMP	IPB DMP
Above Corps	z	0.13	0.00	1.10	1.34	1.07	1.00
	p	.8927	1.000	.2733	.1797	.2850	.3173
	n	6	5	5	4	5	4
Corps	z	1.40	0.28	1.86	0.17	0.85	1.26
	p	.1614	.7794	.0630	.8658	.3980	.2084
	n	8	8	7	7	7	7
Brigade	z	0.77	1.36	0.59	0.56	1.01	1.40
	p	.4413	.1731	.5536	.5754	.3105	.1614
	n	9	9	9	9	9	9
Battal'n	z	1.24	2.38	0.00	1.54	1.36	2.03
	p	.2135	.0173	1.000	.1235	.1730	.0425
	n	10	9	8	9	8	8

Note. TLP = Troop-Leading Procedures, CES = Commander's Estimate of the Situation, IPB = Intelligence Preparation of the Battlefield, DMP = Military Decision-Making Process. An error rate per family of $\alpha = .10$ requires $p < .01667$ for significance.

Table C-8

Friedman Rank Tests of Differences Among Echelons for Steps in Staff Procedures

Step	Mean Rank[a]			Test	
	BN	BDE	DIV	$\chi^2(2)$	p
Troop-Leading Procedures[b]					
Receive/analyze mission	1.85	2.00	2.15	0.450	.7985
Issue warning order	1.60	1.95	2.45	3.650	.1612
Make a tentative plan	1.65	1.95	2.40	2.850	.2405
Initiate movement	1.75	1.90	2.35	1.950	.3772
Conduct reconnaissance	2.00	1.90	2.10	0.200	.9048
Complete the plan/order	1.75	1.90	2.35	1.950	.3772
Issue order	1.85	1.85	2.30	1.350	.5092
Supervise/revise plan	1.70	2.30	2.00	1.800	.4066
Commander's Estimate of the Situation[c]					
Analyze mission in detail	2.00	1.88	2.13	0.250	.8825
Analyze situation (METT-T)	2.00	1.88	2.13	0.250	.8825
Develop courses of action	1.94	2.00	2.06	0.062	.9692
Analyze courses of action	1.75	1.94	2.31	1.312	.5188
Compare courses of action	1.88	2.06	2.06	0.188	.9105
Develop decision/concept of operation	1.81	2.00	2.19	0.250	.8825
Intelligence Preparation of the Battlefield[d]					
Battlefield area evaluation	2.06	1.83	2.11	0.389	.8233
Terrain analysis	2.00	1.89	2.11	0.222	.8948
Weather analysis	2.00	2.11	1.89	0.222	.8948
Threat evaluation	2.17	1.89	1.94	0.389	.8233
Threat integration	1.94	2.00	2.06	0.056	.9726
Military Decision-Making Process[e]					
Receive mission	1.93	1.93	2.14	0.214	.8984
Provide information	1.86	1.86	2.29	0.857	.6514
Analyze/restate mission	1.86	1.86	2.29	0.857	.6514
Complete staff estimates	1.79	1.79	2.43	1.929	.3813
Prepare plans/orders	1.86	1.86	2.29	0.857	.6514
Approve plans/orders	1.86	1.86	2.29	0.857	.6514
Issue plans/orders	1.86	1.86	2.29	0.857	.6514

Note. BN = Battalion, BDE = Brigade, DIV = Division.
[a]Ranks are in inverse order. [b]n = 10. [c]n = 8. [d]n = 9. [e]n = 7.

Table C-9

Pairwise Wilcoxon Signed-Rank Tests for Differences Between Echelons for Steps in Staff Procedures

Step		Echelon Difference DIV-CPS	DIV-EAC	CPS-EAC
Troop-Leading Procedures				
Receive/analyze mission				
	z	0.45	0.94	0.80
	p	.6547	.3452	.4227
	n	9	7	7
Issue warning order				
	z	1.00	1.34	1.34
	p	.3173	.1797	.1797
	n	9	7	7
Make a tentative plan				
	z	0.00	1.40	1.60
	p	1.000	.1441	.1088
	n	9	7	7
Initiate movement				
	z	1.00	1.60	1.34
	p	.3173	.1088	.1797
	n	9	7	7
Conduct reconnaissance				
	z	0.00	1.21	1.34
	p	1.000	.2249	.1797
	n	9	7	7
Complete the plan/order				
	z	0.53	0.91	1.34
	p	.5930	.3613	.1797
	n	9	7	7
Issue order				
	z	0.45	0.91	1.60
	p	.6547	.3613	.1088
	n	9	7	7
Supervise/revise plan				
	z	0.13	1.78	1.75
	p	.8927	.0747	.0796
	n	9	7	7
Commander's Estimate of the Situation				
Analyze mission in detail				
	z	0.37	1.48	1.60
	p	.7150	.1380	.1088
	n	7	6	6

(table continues)

Step		DIV-CPS	DIV-EAC	CPS-EAC
Analyze situation (METT-T)				
	z	0.00	1.21	1.60
	p	1.000	.2249	.1088
	n	7	6	6
Develop courses of action				
	z	0.53	1.46	1.60
	p	.5930	.1441	.1088
	n	7	6	6
Analyze courses of action				
	z	0.45	1.46	1.34
	p	.6547	.1441	.1797
	n	7	6	6
Compare courses of action				
	z	1.00	1.07	1.34
	p	.3713	.2850	.1797
	n	7	6	6
Develop decision/concept of operation	z	1.00	0.00	1.00
	p	.3173	1.000	.3173
	n	7	6	6
Intelligence Preparation of the Battlefield				
Battlefield area evaluation				
	z	0.00	1.60	1.60
	p	1.000	.1088	.1088
	n	7	5	5
Terrain analysis				
	z	0.27	1.46	1.60
	p	.7893	.1441	.1088
	n	7	5	5
Weather analysis				
	z	0.45	1.34	0.45
	p	.6547	.1797	.6547
	n	7	5	5
Threat evaluation				
	z	1.07	1.28	1.60
	p	.2850	.2012	.1088
	n	7	5	5
Threat integration				
	z	0.80	1.10	1.34
	p	.4227	.2733	.1797
	n	7	5	5
Military Decision-Making Process				
Receive mission				
	z	0.00	1.00	1.00
	p	1.000	.3173	.3173
	n	6	5	5

(table continues)

Step		DIV-CPS	DIV-EAC	CPS-EAC
Provide information				
	z	0.45	1.07	1.34
	p	.6547	.2850	.1797
	n	6	5	5
Analyze/restate mission				
	z	1.00	1.07	1.34
	p	.3173	.2850	.1797
	n	6	5	5
Complete staff estimates				
	z	1.00	1.34	1.34
	p	.3173	.1797	.1797
	n	6	5	5
Prepare plans/orders				
	z	0.45	1.07	1.34
	p	.6547	.2850	.1797
	n	6	5	5
Approve plans/orders				
	z	1.00	1.34	1.00
	p	.3173	.1797	.3173
	n	6	5	5
Issue plans/orders				
	z	1.34	1.60	1.34
	p	.1797	.1088	.1797
	n	6	5	5

Note. DIV = Division, CPS = Corps, EAC = Echelons Above Corps.

Table C-10

Friedman Rank Tests of Rating Differences Among Echelons

	Mean Rank[a]			Test	
Procedure	BN	BDE	DIV	$\chi^2(2)$	*p*
TLP[b]	1.65	2.20	2.15	1.850	.3965
CES[c]	1.94	2.00	2.06	0.062	.9692
IPB[d]	2.00	2.00	2.00	0.000	1.0000
DMP[e]	1.86	1.86	2.29	0.857	.6514

Note. TLP = Troop-Leading Procedures, CES = Commander's Estimate of the Situation, IPB = Intelligence Preparation of the Battlefield, DMP = Military Decision-Making Process. BN = Battalion, BDE = Brigade, DIV = Division.
[a]Ranks are in inverse order. [b]*n* = 10. [c]*n* = 8. [d]*n* = 9. [e]*n* = 7.

Table C-11

Pairwise Wilcoxon Signed-Rank Tests of Differences Between Echelons Above Brigade for Staff Procedures

Echelons		Procedure			
		TLP	CES	IPB	DMP
Division-Corps					
	z	0.13	0.00	0.53	0.53
	p	.8927	1.0000	.5930	.5930
	n	9	7	7	6
Division-Above Corps					
	z	1.15	1.48	1.46	1.10
	p	.2489	.1380	.1441	.2733
	n	7	6	5	5
Corps-Above Corps					
	z	1.48	1.60	1.60	1.34
	p	.1380	.1088	.1088	.1797
	n	7	6	5	5

Note. TLP = Troop-Leading Procedures, CES = Commander's Estimate of the Situation, IPB = Intelligence Preparation of the Battlefield, DMP = Military Decision-Making Process. An error rate per family of $\alpha = .10$ requires $p < .01667$ for significance.

Appendix D

Distributions of Echelon Choices by Day

Table D-1

Choice of Echelon for Fielding the FC System

Echelon	Percentage of Responses								
	Day 1 Choice[a]			Day 2 Choice[b]			Day 3 Choice[c]		
	1st	2nd	3rd	1st	2nd	3rd	1st	2nd	3rd
Above Corps	25.0	3.8	20.0	25.0	0.0	20.0	35.0	2.1	2.3
Corps	32.1	42.3	9.1	12.5	83.3	0.0	8.3	52.1	2.3
Division	38.1	33.3	21.2	62.5	0.0	40.0	28.3	10.4	65.9
Brigade	2.4	17.9	32.1	0.0	16.7	20.0	15.0	18.8	20.5
Battalion	2.4	2.5	13.9	0.0	0.0	20.0	13.3	16.7	9.1
Company	0.0	0.0	1.8	0.0	0.0	0.0	0.0	0.0	0.0
Platoon	0.0	0.0	1.8	0.0	0.0	0.0	0.0	0.0	0.0

Note. Responses made to questionnaire Part III, Item 2. Echelons given equal priority were credited with equal response fractions. [a]$n_1 = 14$, $n_2 = 13$, $n_3 = 11$. [b]$n_1 = 8$, $n_2 = 6$, $n_3 = 5$. [c]$n_1 = 15$, $n_2 = 12$, $n_3 = 11$.

Appendix E

Statistical Tests for Priority Measures

Table E-1

Friedman Rank Tests of Differences Among Staff Exercise Days

	Mean Rank[a]			Test	
Echelon	Day 1	Day 2	Day 3	$\chi^2(2)$	p
Above Corps	1.88	2.38	1.75	1.750	.4169
Corps	1.81	2.06	2.13	0.438	.8035
Division	1.94	2.06	2.00	0.062	.9692
Brigade	1.75	2.13	2.13	0.750	.6873
Battalion	1.88	2.06	2.06	0.188	.9105
Company	2.00	2.00	2.00	0.000	1.0000
Platoon	2.00	2.00	2.00	0.000	1.0000

Note. N = 8 at each echelon.
[a]Ranks are in inverse order.

Table E-2

Mann-Whitney Rank-Sum Tests of Differences Between Groups

	Mean Priority		Mean Rank[a]		Test	
Echelons	Group 1	Group 2	Group 1	Group 2	U	p[b]
Above Corps	5.12	5.22	11.75	11.20	57.0	.8718
Corps	4.62	3.54	12.04	10.85	53.5	.6613
Division	4.58	2.46	13.00	9.07	42.0	.2543
Brigade	4.83	4.88	11.42	11.60	59.0	.9742
Battalion	4.92	6.25	10.38	12.85	46.5	.3810
Company	7.42	6.92	12.92	9.80	43.0	.2829
Platoon	7.58	7.35	12.92	9.80	43.0	.2829

Note. Group 1 participants (n = 12) were present on one day; Group 2 participants (n =10) were present on two or three days.
[a]Ranks are in inverse order. [b]Two-tailed.

Table E-3

Pairwise Wilcoxon Signed-Rank Tests of Priority Differences

Echelon [Mean Rank]		Echelon EAC	CPS	DIV	BDE	BN	CO
Above Corps [3.73]							
Corps [2.84]	z	2.09					
	p	.0362					
Division [2.50]	z	1.77	0.57				
	p	.0766	.5713				
Brigade [3.52]	z	0.34	0.99	2.29			
	p	.7323	.3242	.0222			
Battalion [4.14]	z	0.35	1.51	2.21	2.18		
	p	.7275	.1305	.0269	.0288		
Company [5.43]	z	2.82[a]	3.46[a]	3.62[a]	3.41[a]	3.18[a]	
	p	.0047	.0005	.0003	.0007	.0015	
Platoon [5.84]	z	3.11[a]	3.52[a]	3.62[a]	3.41[a]	3.18[a]	2.52
	p	.0019	.0004	.0003	.0007	.0015	.0117

Note. EAC = Echelons Above Corps, CPS = Corps, DIV = Division, BDE = Brigade, BN = Battalion, CO = Company, PLT = Platoon. N = 22 for each comparison.
[a]Significant with two-tailed $p < .00476$ for an $\alpha = .10$ error rate per family of comparisons.