AD-A082 442   IBM FEDERAL SYSTEMS DIV ARLINGTON VA   F/G 15/4
INTELLIGENCE PREPARATION OF THE BATTLEFIELD (AUTOMATED) IPB(A).(U)
FEB 80   DAAK21-79-C-0040
UNCLASSIFIED   NL

1 of 2
AD
A082442

INTELLIGENCE PREPARATION OF THE BATTLEFIELD (Automated)

IPB(A)

PHASE II

FINAL REP[redacted]T

Submitted to:

Headquarters USADARCOM
Directorate for Battlefield Systems Integration
5001 Eisenhower Avenue
Alexandria, Virginia 22333

Contract No. DAAK21-79-C-0040

14 Feb[redacted]980

169

INTERNATIONAL BUSINESS MACHINES CORPORATION
Federal Systems Division
1701 North Fort Myer Drive
Arlington, VA 22209

UNCLASSIFIED

SECURITY CLASSIFICATION OF THIS PAGE (*When Data Entered*)

REPORT DOCUMENTATION PAGE

READ INSTRUCTIONS BEFORE COMPLETING FORM

1. REPORT NUMBER	2. GOVT ACCESSION NO.
3. RECIPIENT'S CATALOG NUMBER	
4. TITLE (*and Subtitle*) Intelligence Preparation of the Battlefield - IPB (A)	5. TYPE OF REPORT & PERIOD COVERED Phase II Final Report 14 Feb 80
	6. PERFORMING ORG. REPORT NUMBER
7. AUTHOR(s) International Business Machines Corp. Federal Systems Division 1701 N. Ft. Myer Drive, Arlington, VA 22209	8. CONTRACT OR GRANT NUMBER(s) DAAK21-79-C-0040
9. PERFORMING ORGANIZATION NAME AND ADDRESS International Business Machines Corp. Federal Systems Division 1701 N. Ft. Myer Drive, Arlington, VA 22209	10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS 6.57.13A
11. CONTROLLING OFFICE NAME AND ADDRESS HQ DARCOM, Battlefield Systems Integration Dir. ATTN: DRCBSI 5001 Eisenhower Ave., Alexandria, VA 22333	12. REPORT DATE 14 Feb 80
	13. NUMBER OF PAGES 169
14. MONITORING AGENCY NAME & ADDRESS(*if different from Controlling Office*)	15. SECURITY CLASS. (*of this report*) UNCLASSIFIED
	15a. DECLASSIFICATION/DOWNGRADING SCHEDULE N/A

16. DISTRIBUTION STATEMENT (*of this Report*)

Approved for public release; distribution unlimited.

17. DISTRIBUTION STATEMENT (*of the abstract entered in Block 20, if different from Report*)

18. SUPPLEMENTARY NOTES

Prepared in compliance with sub-paragraph F.5.7, Part II - Section F (Description/Specifications) of contract identified in Block 8 above.

ORIG... ...ATES: ALL DDC REPRODUCT... ...BLACK AND WHITE

19. KEY WORDS (*Continue on reverse side if necessary and identify by block number*)

TIAX; Automated IPB; Terrain factor overlay; Named Areas of Interest; mobility corridors; Fire Support; Tactical Battlefield Targeting; ASAS; Target Analysis Matrix; 4-step templates; situation snapshots; fusion; intervisibility; Event matrix; Build Process; combined obstacles.

20. ABSTRACT (*Continue on reverse side if necessary and identify by block number*)

[illegible] describes an operational concept for [illegible] IPB, [illegible] to representing terrain data on a [illegible] mobility. It includes a similar approach [illegible] of incor[illegible] [illegible] plat[illegible] they could be combined [illegible] cles, [illegible] during hostilities [illegible] intelligence functions, operations functions, and the commander's decision process.

DD FORM 1 JAN 73 1473 EDITION OF 1 NOV 65 IS OBSOLETE

UNCLASSIFIED

SECURITY CLASSIFICATION OF THIS PAGE (*When Data Entered*)

ABSTRACT

This report describes work done under contract for the Battlefield Systems Integration Directorate of DARCOM to develop automated support for the Intelligence Preparation of the Battlefield (IPB) processes described in TC30-27. It describes an operational concept for automated IPB operations, and summarizes an approach to representing terrain data on a CRT in terms of its impact on ground force mobility.

It includes a similar approach to ground intervisibility, and a means of incorporating current weather information to provide effects on both mobility and intervisibility. A major emphasis is on describing automated IPB products and explaining how they could be (1) constructed in the field during normal planning cycles, and (2) used during hostilities to support intelligence functions, operation functions, and the commander's decision process. The effort required to develop the laboratory or workshop capability is described as well as results of over 30 workshop demonstrations for DoD personnel, including reactions of the participants.

TABLE OF CONTENTS

Section		Page

LIST OF ILLUSTRATIONS

Figure		Page

SECTION 1. EXECUTIVE SUMMARY

1.1 BACKGROUND

The Tactical Intelligence Application Experimentation (TIAX) Program (now called Automated IPB) was initiated by the Battlefield Systems Integration staff of DARCOM in the summer of 1978. Its main purpose was to develop and demonstrate the use of Intelligence Preparation of the Battlefield (IPB) techniques as they would be applied in an automated environment. This was felt to be necessary in light of (1) the wide-spread acceptance of IPB within the Army as a valuable and needed improvement to tactical intelligence operations; (2) the difficulties in implementing IPB techniques in a manual mode, particularly the problems of organizing and physically handling numerous paper maps and acetate overlays during a battle situation; and (3) the high implementation costs the Army had encountered of providing the terrain data bases to the detail called for in manual IPB applications.

The TIAX/Automated IPB effort was defined in three phases:

Phase I (previously called Phase A) - Development of IPB automation concept and implementation of terrain graphics and ground force mobility approach.

Phase II - Development of IPB 4-step templating processes and implementation of intelligence estimate support functions, maneuver and fires support functions, and automation support to the template development process.

Phase III - Field test of laboratory demonstrated functions in a potential tactical battlefield situation.

Phase I was completed in October 1978. A report entitled IPB - An Automated Approach to Terrain and Mobility Corridor Analysis dated October 1978 was distributed summarizing the results of Phase I.

Phase II is now complete. This report summarizes the work done to develop Workshops 1 and 2, and includes the results of a series of workshops held during the period August 1979 through January 1980.

The ultimate objective of the TIAX/Automated IPB Program is to validate the utility of IPB processes in support of intelligence analysts, maneuver analysts, targeting analysts and the commander in a division and corps battle situation. Although the IPB emphasis is on preparation activities prior to hostilities, the automated applications must also continue the use of IPB processes after the battle begins, since that is where the results of the considerable pre-hostilities planning effort will be of most value.

It should be noted that TIAX/Automated IPB is not planned to be implemented as a standalone automation system. Rather, the functions it demonstrates would be a part of the All Source Analysis System (ASAS) as currently defined by USAICS. The software required to perform the functions demonstrated are described in detail in the IPB(A) Software Functional Description dated 4 January 1980. Assuming validation of Automated IPB requirements, the ADP system(s) that will be procured as part of ASAS would include capabilities to support Automated IPB functions along with others.

1.2 TIAX/AUTOMATED IPB OPERATIONAL CONCEPT

IPB focuses on integration and analysis of enemy doctrine, terrain and weather information relative to the commander's mission and specific battlefield conditions. The purpose of this analysis is to determine and evaluate enemy capabilities, vulnerabilities, and potential courses of action as the basis for friendly operations planning. The commander's intelligence system must handle timely combat information and intelligence which enables him to identify and attack those enemy organizational, geographical, or functional elements which will seriously impede his progress. These are "critical target nodes." In a combat situation this detailed analysis is the basis for determining enemy intentions.

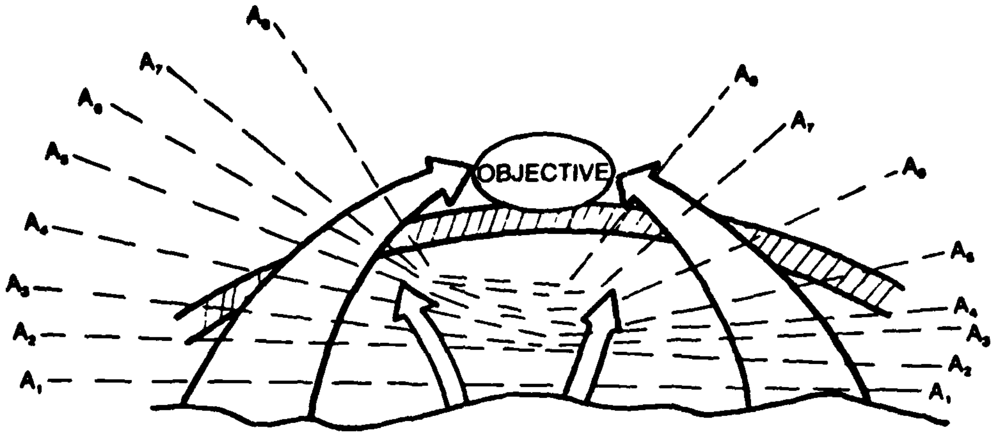
Currently, the intelligence analyst is involved in assembling bits of information much like putting together pieces in a puzzle. Where pieces are missing, he estimates. The overall intelligence estimate is based on assembling as many facts as possible, judgmentally filling the "holes," and interpreting the completed picture in terms of enemy intent.

The advent of IPB and the TIAX/Automated IPB approach to its operational use offers the analyst the opportunity to develop intelligence estimates more rapidly, and with higher degrees of certainty. It also demands more preparation and planning on his part. The premise is that the analyst can more readily recognize enemy situations and intent if (1) he has carefully planned out in advance all the options available to the enemy for pursuing his objectives, and (2) these enemy options have been documented in the form of graphics to compare with realtime graphics (situation displays) as hostilities proceed. Obviously, it is easier to compare stored pictures of the preplanned enemy situation with the realtime situation map to select one that matches than to continuously interpret the meaning of the constantly changing situation.

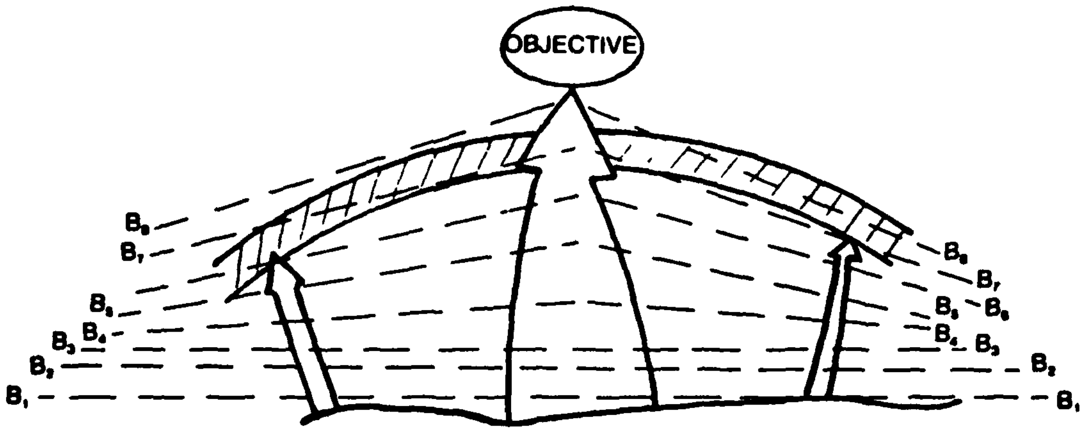
So, the TIAX/Automated IPB concept employs IPB products in realtime situation analysis to determine with a high degree of confidence which option the enemy is pursuing, and at what point he is in that option. In addition, the TIAX/Automated IPB operational concept affords more rapid compilation of the intelligence estimate--the prediction of enemy intent in terms of where he is expected to be at what time with what force.

Figure 1.2-1 illustrates the beginning of the analytical process employed during the planning phase in which the analyst carefully thinks through the options available to the enemy for achieving his objectives. In the illustration the enemy's objective is to destroy two divisions that are arrayed against him, and he has two options for achieving it: (A) a double envelopment operation with diversionary attacks in the center; and (B) a classic breakthrough attack. For each of these options the analyst, using results of previous IPB analyses, fits the enemy force to the terrain at a sequence of logical points along the option. The graphic depiction in situation display format of all of the enemy forces at one of these points is called a snapshot. The dashed lines A1, A2, etc., through A8 represent the series of snapshots developed for Option A. Snapshots would be developed for each option, and stored in an automated file for recall by the analyst when needed. Another of their main purposes is to enable development of situation templates, the primary IPB product used in realtime.

Figure 1.2-2 illustrates the next step in the planning phase. Upon completing snapshots for each option, the analyst next develops the situation template. These are selected portions of snapshots in which the enemy force is configured differently than in any other option. The differences may be a result of the unit deployments due to terrain factors, or different types of units in a particular geographic area, or different sized units in a specific area.



OPTION A



OPTION B

Figure 1.2-1. Situation Snapshot Points Within Options

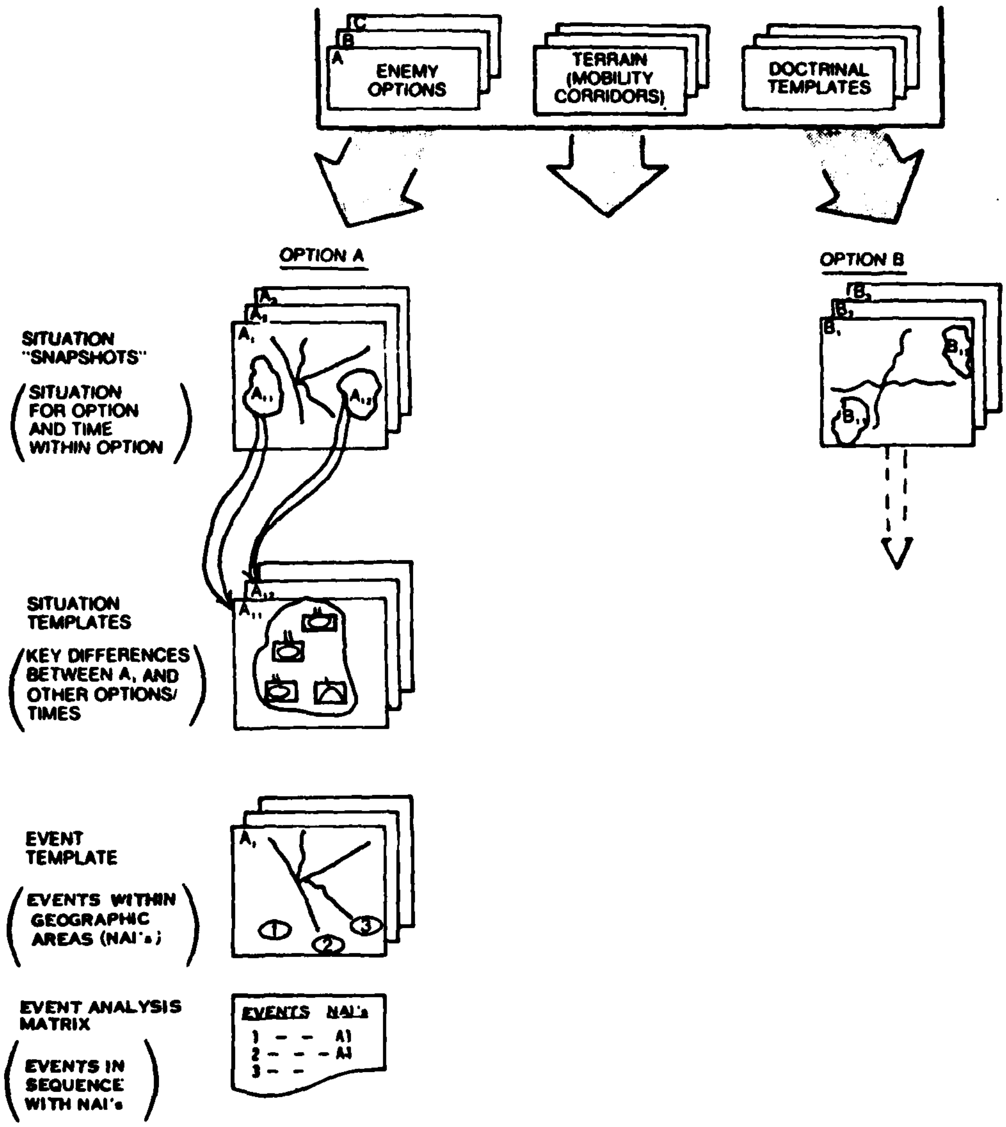


Figure 1.2-2. IPB Products to Determine Enemy Options and Points Within Option

In any event, the situation template is a configuration of units on a map background which if detected in that arrangement at that location would be an option differentiator, and therefore key to identifying the enemy in that option and at that point in the option.

Another important step in the planning phase is the preparation of event templates and event matrixes. Once the enemy options are planned out and snapshots and situation templates are defined within each option, anticipated enemy actions subsequent to each snapshot point in the sequence are compiled into event matrixes and event templates. There is an event matrix/template for each snapshot. The event matrix is an alphanumeric listing of significant enemy events that should occur immediately after a given snapshot point. The event template is a graphic that shows the named areas of interest (NAIs) in which the anticipated events are expected to occur. As Figure 1.2-2 illustrates, sets of situation templates are developed for each option by analyzing snapshots. These, along with event templates and event matrixes, would be digitally stored for analyst recall.

Figure 1.2-3 illustrates how the preplanned IPB products are utilized during hostilities to support the G-2's development of the realtime intelligence estimate and to focus collection resources on higher yield areas of interest.

The upper right portion of Figure 1.2-3 shows the process of receiving intelligence inputs and developing the current situation display through correlation and fusion processes. This is assumed to be a continuous process of receiving inputs, assessing their significance to the current military situation, and updating the military situation display if warranted.

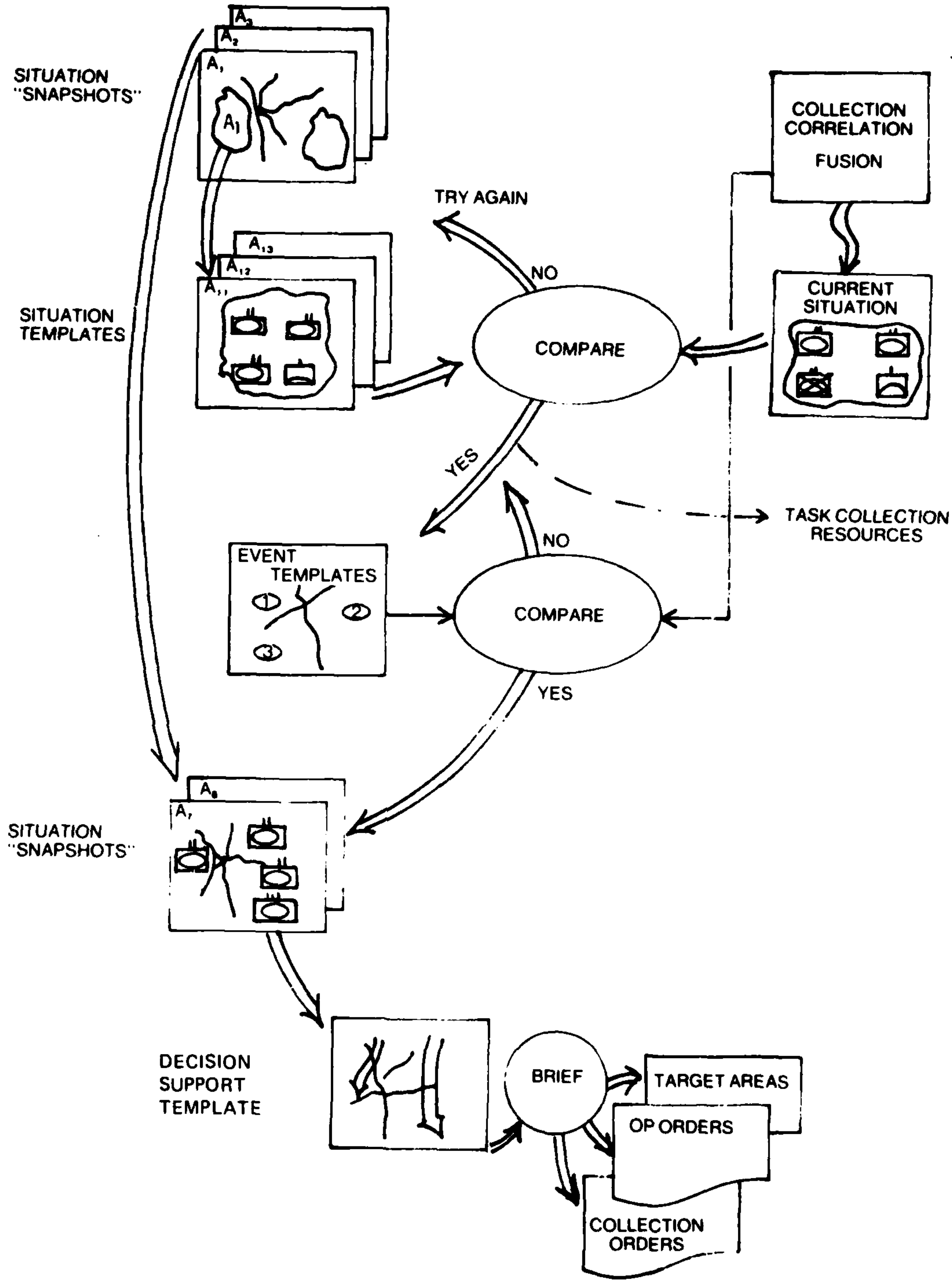


Figure 1.2-3. Operational Concept

The IPB products are shown on the left side of the illustration. In the realtime process the IPB analyst is constantly searching his situation templates file trying to match one with the current realtime situation display. This is a visual comparison process. He does not expect to find an exact match, and will frequently draw on his other IPB files (doctrinal templates, terrain overlays, etc.) to try to rationalize observed differences in the situation displays. When he thinks he may have a match, his first actions are to try to confirm his hypothesis. He does this by accessing his event templates and event matrixes to determine what enemy activities should be observable in the next few hours if the enemy is indeed at the point in his option that the analyst suspects. He next requests that collection resources place a priority on collecting data about the events selected from his event matrix in the sequence and at the locations (NAIs) indicated. He cues the input processing system to alert him immediately upon receipt of any returns to these specific collection requests. He further places a time limit on how long he is willing to wait to receive verifying information. If the system notifies him that no confirming data has been received by the specified time, he would probably drop that hypothesis. Several of these hypotheses may be working in parallel with one another. Thus, system support in eliminating those that are not verified would be helpful.

When confirming data is received that anticipated events have indeed been observed, the probability is significantly increased that the enemy has been detected in a certain option and at a specific point in that option. The analyst can therefore proceed more positively to exploit that knowledge. Toward developing an intelligence estimate, the analyst references his snapshot file, selects one several hours hence, and updates it based on current situation knowledge. This forms the basis of the estimate of where the enemy will be if he continues in the option he is presently pursuing with terrain already taken into account.

It would be used to brief the commander so that appropriate countermoves can be initiated. In addition, event templates can be exploited to not only focus collection resources again but also notify the Fire Support Element (FSE) of what targets can be expected at which locations over the next several hours. Preplanned operations orders can be finalized for deployment of friendly forces to meet the enemy. The terrain analyses completed in advance by the G-2 staff would be useful to the FSE and maneuver sections in planning fires allocation and friendly force movements to interdict.

Although certain IPB techniques can be usefully applied at any echelon, the concept presented here is felt to be most practical at echelons no lower than division, where larger enemy force elements must be monitored, and where a reasonable automated data processing capability will be resident in the center. Also, the continuation of this basic process throughout a battle situation demands local ability to modify the IPB products stored in the system, and to develop new ones as enemy courses of action vary.

1.3 WORKSHOP 1 SYNOPSIS

The primary focus of Workshop 1 is to demonstrate how the IPB analyst and the G-2 staff use preplanned IPB products in determining early in the action which option the enemy is exercising and at what point he is in that option. The demonstration setting has second echelon units beginning to move after a lull in the battle situation. The IPB planning phase is completed, and the IPB analyst is utilizing the products of that planning phase in identifying enemy intent as he receives updates to the current situation display. The demonstration concludes at the point where the IPB analyst and G-2 staff have "caught" the enemy at a certain point in an option, and are initiating the development of a decision support template.

1.3.1 Workshop 1 Development Approach

To effectively illustrate the use of Automated IPB products by the G-2, it was necessary to:

- Develop a Realistic Scenario Environment

  A scenario situation developed previously under DARCOM auspices was used as a point of departure. A time period was selected (D+3) after the initial attack had run its course as being more demanding of the IPB process. An enemy objective was assumed of destroying the defending corps and seizing ground west of the river. Two options, double envelopment and classic breakthrough (penetration), were developed for achieving that objective. General routes and corridors of advance were identified for movement of division sized forces from rear assembly areas to the objective. The enemy forces were moved over planned routes in accordance with doctrine, and enemy unit locations over time were recorded. This provided realistic data from which IPB products could be designed.

- Design Automated IPB Products

  Snapshot points were selected along the planned routes of each option. A sampling of snapshots was developed for each option; several situation templates were developed for each snapshot. A variety of situations was selected to illustrate templates near the FEBA (attack formations) plus those to the rear (road columns). Doctrinal templates were utilized to position units in corridors or on roads in building situation templates. Event matrixes for each option were composed based on operations plans for units within each option and key indicators. Event templates were formulated from the event matrixes. Throughout this process conventions were established regarding use of symbology suitable for automated colorgraphic displays. The result is a set of automated IPB products designed in an operational (scenario) context and with consideration toward displaying them in color in an automated environment.

- Develop a Scenario-based Demonstration Sequence to be Displayed in the TSF Utilizing IPB Products

As a basis for conducting Workshop 1, a demonstration sequence was developed that represents the actions an IPB analyst would take at a terminal in a TOC in utilizing preplanned IPB products to recognize the enemy's intentions early in the action. The data necessary to support the sequence was entered into the Tactical System Facility (TSF) at IBM Gaithersburg and changes in system software and hardware were accomplished to permit its operation. It was necessary to develop a series of current situation displays that presented the detected elements of enemy activity in several updates over the demonstration period. The TSF equipment and software configuration were modified to provide for the current situation display.

1.3.2 The In-Process Review (IPR)

The statement of work required that an In-Process Review (IPR) be conducted 75 days after contract award to determine whether or not to continue the Phase II work effort after completion of Workshop 1. The Review was held in IBM's Gaithersburg facility with representatives from the following organizations in attendance:

CACDA
DARCOM/BSI
DCSOPS, DA
FORSCOM
INSCOM
OACSI, DA
TRADOC HQS
USAICS

A summary of the overall TIAX program was presented, followed by a detailed briefing on the planned approach to Workshop 1 and Workshop 2 under the current contract. Considerable discussion ensued across a full range of IPB issues. The minutes distributed by DARCOM/BSI subsequent to the review included the following summation:

"There was general agreement that:

1. The results of Phase 1 have shown that IPB has excellent potential for the Army

2. The BSI/IBM concept for the development of Phase II is properly focused

3. The IPB experiment should continue."

1.4 WORKSHOP 2 SYNOPSIS

The Workshop 2 effort has been directed towards two primary objectives:

1. To analyze, specify and demonstrate automated techniques for preparation and build of IPB templates/products with emphasis on special application algorithms to enhance this process.

2. To analyze, specify and demonstrate how the IPB analyst and the G2/G3 staff use the automated IPB processes/products during hostile periods to support G3 maneuver and fires operations planning and to support the commander's decision making process.

The demonstration is designed to show these two aspects of the automated IPB process. In a continuation of the scenario representing a double envelopment attack by two enemy reserve divisions, the Workshop 2 demonstration action shows how the IPB analyst, the G3 maneuvers planner and the G3 fires planner in the TOC utilize the IPB processes/products in determining feasibility of maneuvers and artillery fires actions in response to predicted enemy movement. The demonstration action shows how weather effects, basic terrain data and doctrinal templates are combined as inputs to the IPB process. Another demonstration segment shows how the IPB analyst and G3 staff planners readily invoke various automation aids to construct and subsequently update situation dependent IPB products. The demonstration concludes with the determination of the achievable force concentrations and expected combat power ratios at alternative defense lines to aid the commander's decision process in deciding where best to mount his main defense.

1.4.1 Workshop 2 Development Approach

The efforts leading to the Workshop 2 experimentation and demonstrations included the following:

- **Analysis and Development of IPB Support to Additional TOC Functions**

  The functions of maneuver planning, fires planning and commander's decision support were analyzed. Sets of IPB related products were defined to directly support these functions. These included graphic and tabular displays, computational algorithms and the related data base applications.

- **Design of Automated IPB Products**

  This effort was directed at the definition and design of displays, symbology and related data base applications needed to graphically depict the new functions of maneuvers and fires operations planning and commander's decision support. Other IPB products whose design was not finalized during the Workshop 1 activity were designed for use in the Workshop 2 demonstrations. Display items in these categories included:

  Doctrinal Option Templates
  Doctrinal Event Menus
  Doctrinal Target Menus
  Planned Routes
  Snapshot Lines
  Decision Alternative Templates
  Decision Support Templates
  Weather Overlay

Route Timing Results
Mobility Corridor Rating Results
Intervisibility Corridor Rating Results
Fires Planning Displays
Maneuvers Planning Displays

Definitions of new terms are provided in Appendix A.

- Analysis and Development of Scenarios and Current Situation Displays

  The scenario environment was extended from that of Workshop 1. A weather overlay was defined and represented in a graphic overlay. A revised transit time profile was calculated for movement of the northern division along its planned routes under conditions of saturating rainfall. The overall disposition of blue force maneuver and artillery units and their areas of responsibility were established. These steps provided realistic data against which the demonstration sequences could be implemented. Current situation displays were developed to support the workshop demonstrations.

- Analysis and Development of Algorithms/Special Processes

  A number of automation aids had been described and analyzed in the earlier phases of this contract. In the Workshop 2 phase, a more detailed analysis was made of all IPB build and use functions defined up to this point. Suggestions and comments collected in the Workshop 1 demonstration sessions were evaluated. From these sources, a set of automation aids was defined to reduce analyst console time as he prepares and subsequently applies his IPB techniques and products. These are described in Section 3.4.

1.4.2 Army Evaluation Team Review

A 13-member IPB Evaluation Team convened in Gaithersburg on November 13-16. The following organizations were represented:

TRADOC HQS (Chairman)	CACDA
INSCOM	HQ FORSCOM
BETA Program Office	ETL
XVIII Airborne Corps	DMA
III Corps	OACSI
USAICS	

Their purpose was to (1) evaluate the IPB(A) capability against IPB requirements as defined in TC30-27 to determine the degree to which the IPB processes are supported by automation in the lab system; (2) investigate whether or not a field test is required; and (3) if so, what type of test, where, and when should it be conducted.

The evaluation team report enumerated the following:

- The IPB(A) experiment successfully demonstrated the concept of automated template production, manipulation, modification and use

- The ability to construct and use such templates in automated mode will be an essential function within the All Source Analysis System (ASAS)

- Although the lab system fully satisfies the program objectives set for it, there are a number of important questions remaining that can only be answered in a field test.

1.5 WORKSHOP OPERATIONS

For both Workshops 1 and 2, a total of 31 sessions have been held in the time period from July 27, 1979 through January 31, 1980. About 214 Army officers and government civilians have participated. Reactions have been positive toward the design of the IPB products and the processes within which they are used. The consensus has been that they would be a definite help to the tactical intelligence analyst in determining enemy intent and to the operations planning functions of the G2/G3 staff in planning friendly force maneuver options. Several suggested improvements to the workshops and to the automated processes as they would be implemented for field use have been incorporated in the demonstration. Results of workshops are further discussed in Section 6 of this report.

SECTION 2. PHASE II PROGRAM APPROACH

This section describes the overall approach used to perform this phase of TIAX/Automated IPB. The objectives for both workshops, the methodology for preparing and conducting the workshops, and the schedule for accomplishment are explained.

2.1 WORKSHOP OBJECTIVES

The TIAX statement of work defines eight tasks to be performed during the current contract period. The first three tasks address definition of IPB 4 Step Templates, and require experimentation and demonstration of the resulting template designs early in the contract period. Tasks 4 through 8 are aimed at demonstrating how these automated IPB products could support tactical intelligence functions, the fire support and maneuver elements within the G-3, and the tactical commander's decision process. Accordingly, two separate workshops were planned and implemented to accomplish the experimentation and demonstration aspects of the SOW requirement.

Workshop 1 - The objective of Workshop 1 was to develop a computer based demonstration to display the following IPB products:

- Snapshots
- Situation templates
- Event templates/matrixes
- Doctrinal templates

These IPB products were designed and demonstrated in the context of a realistic scenario battle situation. The demonstration illustrates how the G-2 staff would be supported by these products during battle conditions.

Another goal of Workshop 1 (and of all workshops) was to have the demonstration reviewed by experienced Army personnel in order to get reactions and feedback for enhancing the capability. If feasible, recommended improvements are added to the demo system immediately. All comments are documented and are included in the workshop report.

Workshop 2 - Workshop 2 emphasized the following areas:

- IPB products in support of G-3 staff functions (Fires, Maneuver)
- Development of the decision support template
- Definition of automation aids to near realtime IPB product development, i.e., what machine assists can be provided to the G-2 staff to enable rapid building of IPB product files during stabilization periods within the battle.

The two workshops conducted this year (plus one last year) have demonstrated all key aspects of an automated IPB capability as currently visualized. A number of qualified reviewers have participated in the workshops; their comments have been incorporated into subsequent demos and/or included in the final report. The next logical step is to conduct a field test of automated IPB capabilities, currently described as Phase III of Automated IPB.

2.2 METHODOLOGY

2.2.1 Workshop 1

Figure 2.2-1 illustrates the study approach taken toward development of Workshop 1. The initial tasks involved developing a suitable scenario backdrop for realistically illustrating the use of automated IPB products by the G-2 staff. The DIVRAS scenario (DARCOM/BSI Contract DAAG39-77-C-0055, January 1977 to March 1978) was selected as a baseline on which to build, since it was familiar to Army personnel (SCORES IIa) and already available in IBM's Tactical Systems Facility, a demonstration facility located at Gaithersburg, Maryland. Operations plans were generated for each of two options--double envelopment and penetration--that the enemy might logically employ in committing reserve forces to the attack on D+3. Details on scenario development are contained in Section 5.1.

With a general plan of attack in each option, doctrinal templates and other doctrinal data were used to plan out each option. A sampling of IPB products was identified for development. Snapshot points were selected throughout each option, and snapshots designed. Situation template candidates were selected, sketched up, and checked for uniqueness. Event matrixes were developed and event templates designed for each matrix. An example decision support template was developed manually to illustrate that process.

While these design activities were underway, it was necessary in conjunction with DARCOM to plan and conduct an In-Process Review (IPR) 75 days into the program. This is described briefly in Section 1.3.2.

METHODOLOGY - TIAX PHASE B WORKSHOP 1

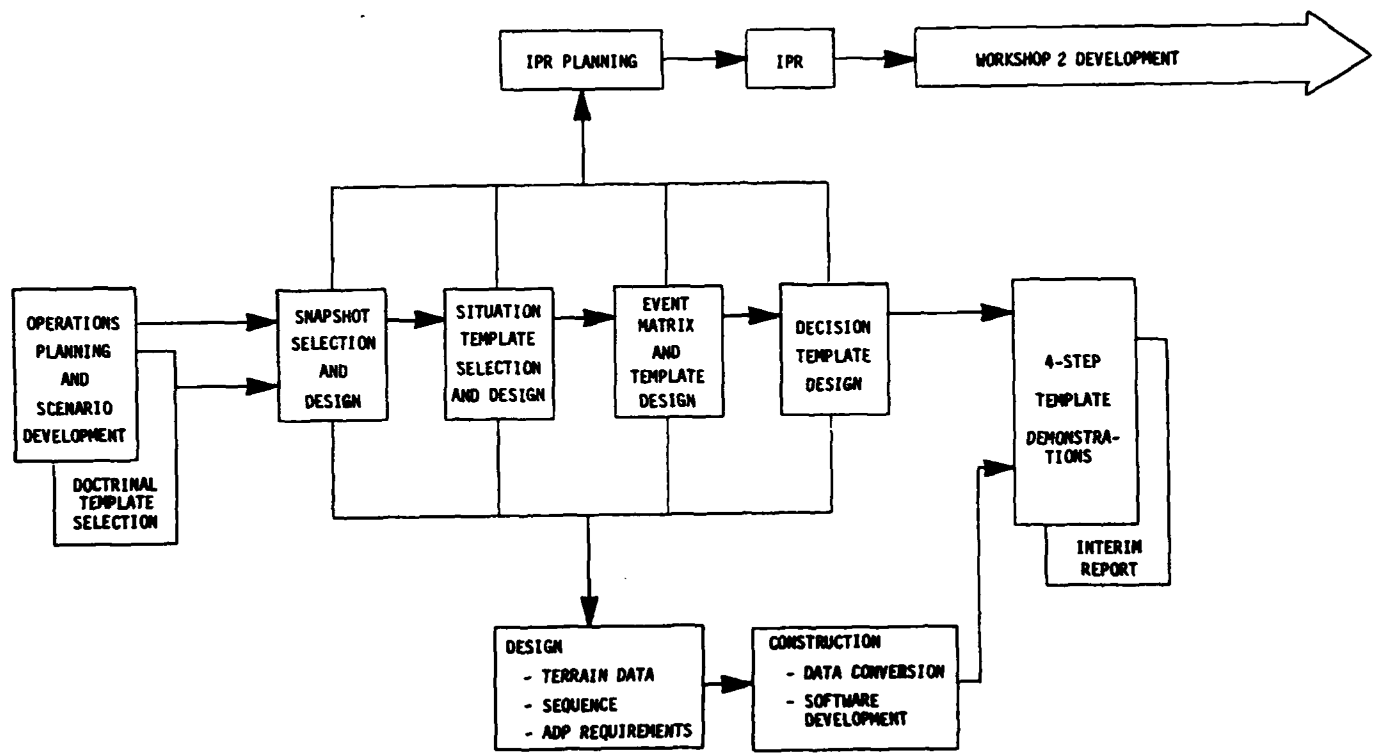


Figure 2.2-1. Workshop 1 Methodology

With the completion of the scenario work and selection of specific IPB products to be designed, a demonstration sequence for Workshop 1 could be developed. This defined necessary modifications to existing demonstration software as well as requirements for inputting map/terrain data and military situation data into the system. Upon completion of data entry and editing operations, the demonstration sequence was tested and modified. Conduct of Workshop 1 for Army personnel began July 27, 1979 and continued through contract completion.

2.2.2 Workshop 2

Figure 2.2-2 illustrates the study approach taken towards development of Workshop 2. First the functions to support the G3 maneuvers, fire support and commander's decision process were analyzed in detail. Additional template products, menus, displays, data base elements and analyst control functions were defined and specific designs for demonstration purposes were begun.

Detailed definitions of the input/output and operational use requirements of the automation aids including algorithmic processes within IPB were established and the programming of these for laboratory demonstration was initiated.

Since most of the scenario development work for Workshop 1 was applicable for Workshop 2, there was a minimum of additional work of this type required. Weather forecasts were defined and represented in graphic overlay form. The blue force disposition and brigade areas of responsibility were established. Some additional terrain subfactor data and crosscountry and road classification data were prepared from the ETL source data.

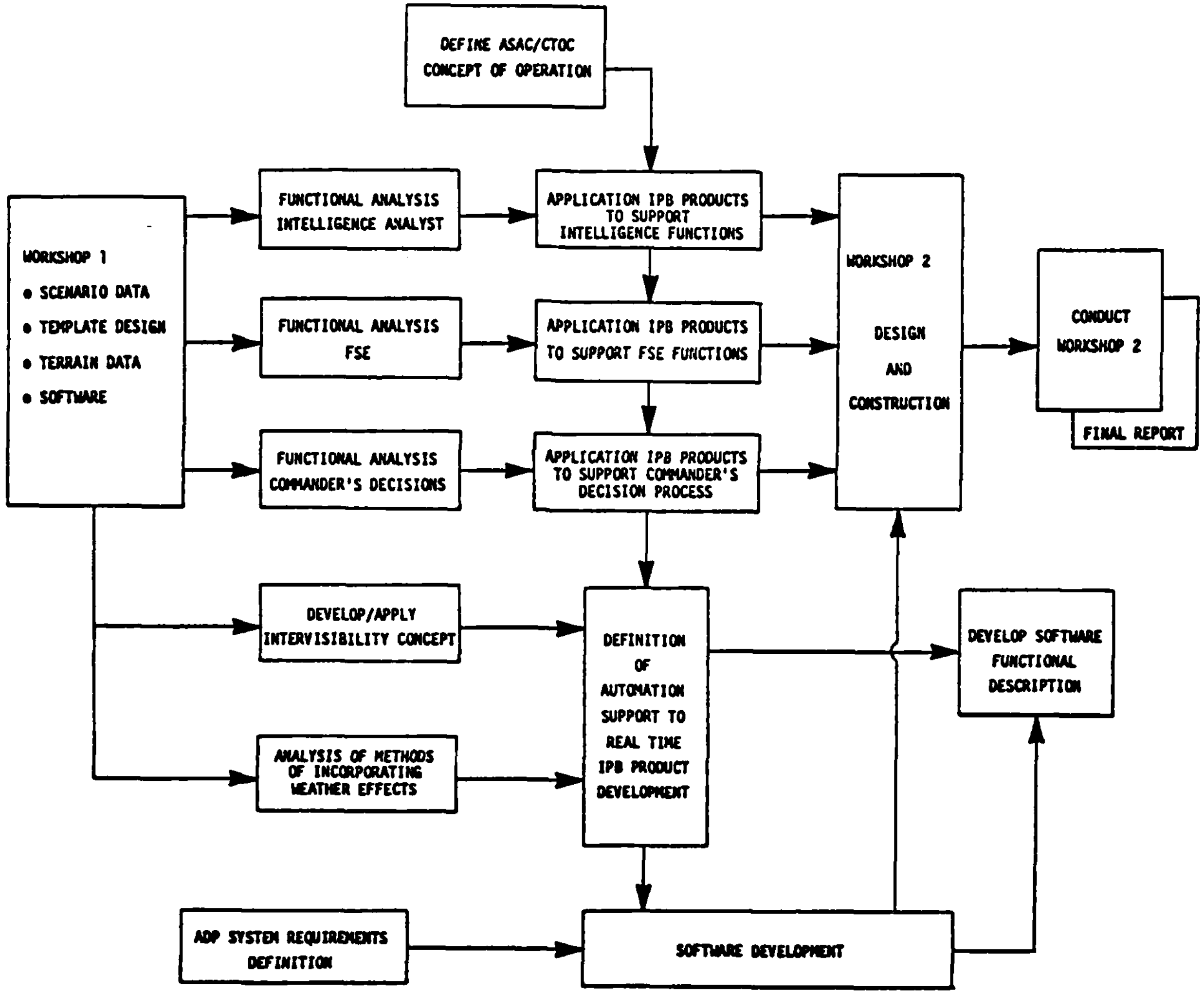


Figure 2.2-2. Workshop 2 Methodology

With the completion of these efforts, the demonstration sequences for Workshop 2 were developed. This defined certain further modifications to existing demonstration software as well as requirements for inputting additional map/terrain data and military situation data into the system. Upon completion of data entry and editing operations, the demonstration sequence was tested and modified. Conduct of Workshop 2 for Army personnel began November 13, 1979 and continued through January 31, 1980.

2.3 DEVELOPMENT SCHEDULE

Figure 2.3-1 depicts the IPB(A) development schedule. Workshop 1 continued to be held throughout the balance of the contract period, the two workshops being run jointly after November 13.

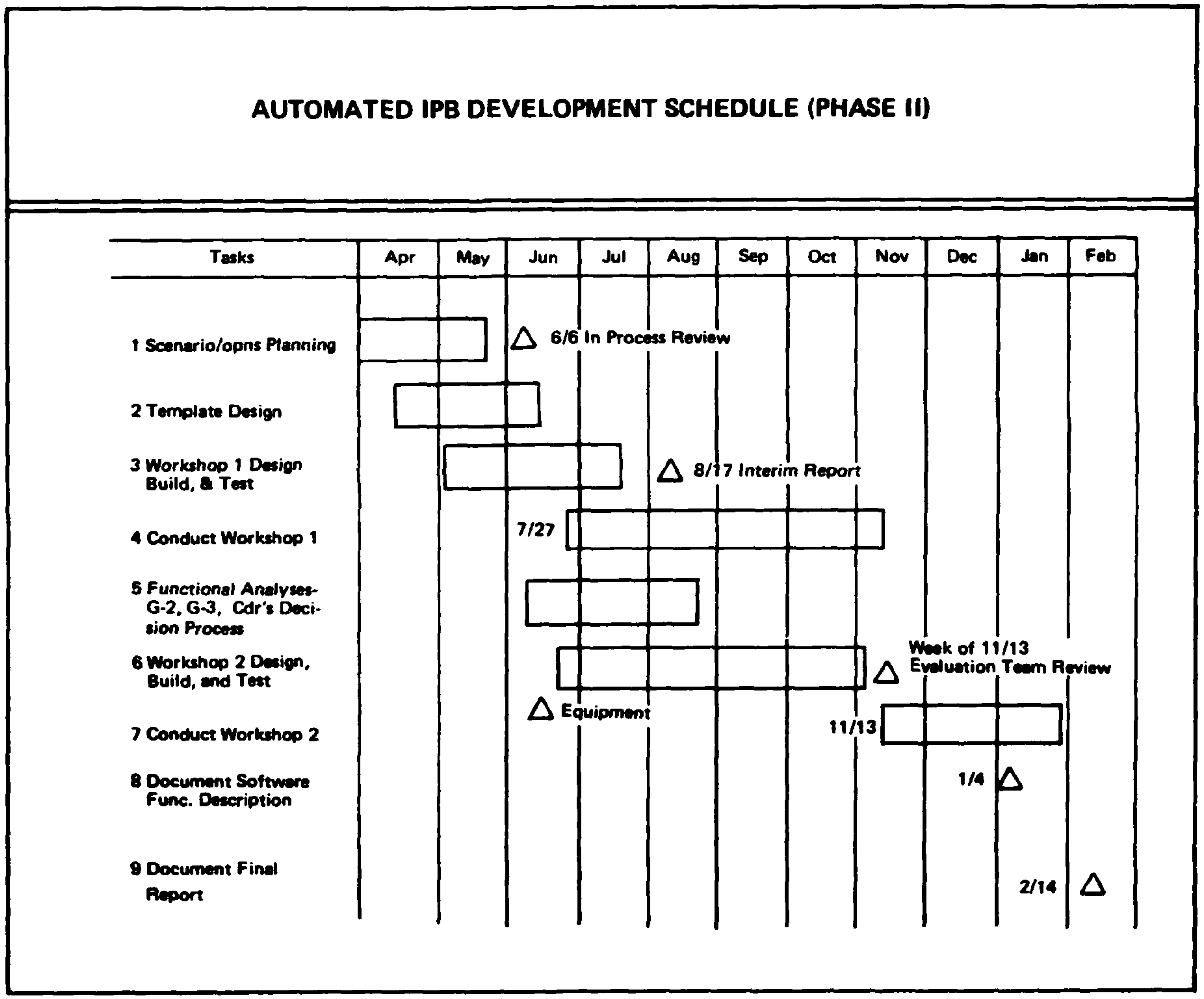


Figure 2.3-1. Phase II Schedule

SECTION 3. MOBILITY AND INTERVISIBILITY DETERMINATION

Two of the major concerns of a military commander are mobility and intervisibility. Inseparably linked to these factors are terrain and weather. Figure 3-1 shows specific terrain and weather factors that have effects on mobility and intervisibility. Slope and vegetation terrain factors can impact both mobility and intervisibility; elevation is a major determinant of intervisibility. This section will touch on Automated IPB approaches to ground force mobility, intervisibility, and the integration of weather data into IPB processes.

3.1 MOBILITY APPROACH

The approach to determining and displaying the impact of terrain features on ground force mobility was developed during the Phase 1 (formerly Phase A) portion of TIAX/Automated IPB concluded October, 1978. A Final Report was published and distributed that described the approach in detail. A brief summary will be included here as preliminary to discussing the approaches to mobility corridor and intervisibility corridor determination and use of weather.

Figure 3.1-1 illustrates the set of terrain products required to support the concept of automated IPB application. A general flow of how these products combine together to produce mobility corridors is also shown. All terrain data other than lines of communication (LOCs) is contained in four types of overlays: slope, vegetation, soils, and wetlands. These, plus LOCs, form the combined obstacles matrix; mobility corridors are derived from examining the combined obstacles matrix in conjunction with postulated enemy options. The mobility corridors incorporate the results of all terrain analysis and are basic to developing all situation-dependent IPB products.

FACTOR	EFFECT ON MOBILITY	EFFECT ON INTERVISIBILITY (LOS)
TERRAIN		
• Slope, Cuts, Ravines, etc.	X	X
• Vegetation - (Tree spacing, Stem diameter, canopy closure, vegetation density	X	X
• Soils: Type, Condition, Drainage	X	
• Elevation		X
• River Crossing Points	X	
• Built-up Areas	X	X
WEATHER/CLIMATE		
• Fog (Density, Burn-off)		X
• Precipitation (Rain, Snow, etc.)	X	X
• Dust/Smoke		X
• Cloud Cover		X
• Condition of Ground	X	

Figure 3-1. Key Mobility and Intervisibility (Line-of-Sight) Factors

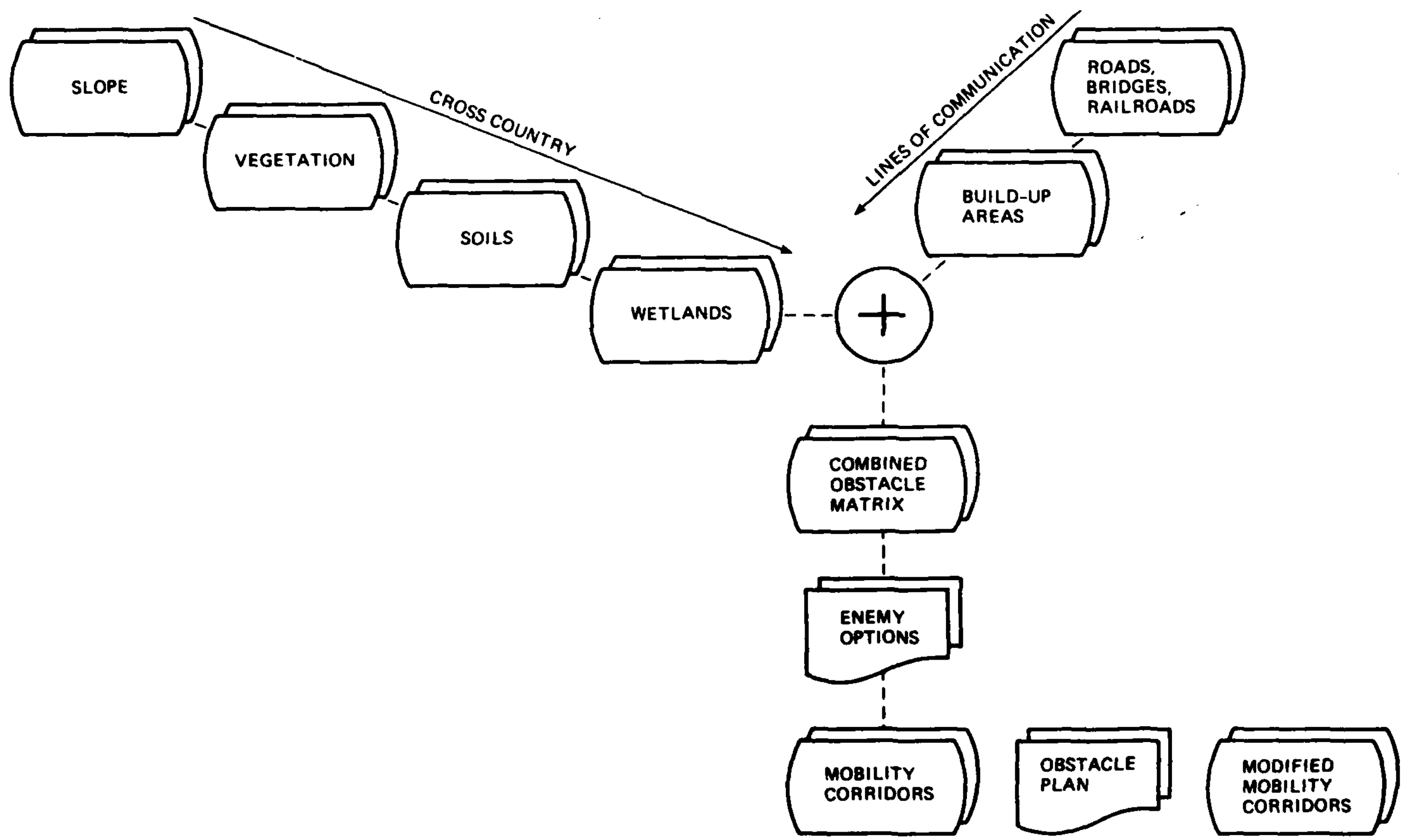


Figure 3.1-1. Combined Obstacles Matrix and Mobility Corridors Construction

The mobility concept developed to express the net effect of terrain on military ground force movements is to determine the number of battalions per hour that can traverse the terrain. Use of this simple quantifier permits the analyst to rapidly assess the time of passage of any force of battalion size and larger across selected terrain. In using this approach there are two types of mobility which must be considered. The first is cross-country, and the second is along roads or other lines of communication. The mobility in cross-country terrain is defined as the number of equivalent battalions per hour which can pass a linear kilometer of front. Where there are no terrain impediments this number is determined by assuming a red force advance in a stylized front moving at the doctrinal rate of 12 kilometers per hour for mechanized forces. In the stylized attack a mechanized battalion advances across 1.5 kilometers of front and the battalion depth is 3 kilometers. At 12 kilometers per hour, 4 battalions per hour would pass in succession across a 1.5 kilometer front. For each kilometer of front the equivalent of 2.7 battalions per hour will pass. The basic measure of mobility for cross-country movement for terrain which offers no impediments is 2.7 battalions per hour per kilometer of front.

For lines of communication a similar measure has been developed for linear traffic along roadways or other lines of communication. This measure is based on a battalion moving in column with specified vehicle separation between vehicles and between battalions while traveling at the doctrinal rate of 25 kilometers per hour. For this rate of advance the equivalent mobility is 5.5 battalions per hour. Since road traffic must also accommodate wheeled vehicle traffic in excess of the combat battalions, a second measure of mobility is provided for lines of communication which defines the time to pass a full division. Using doctrinal rates of advance and vehicle spacing this time is 4.2 hours for primary roads.

To simplify the presentation of large volumes of terrain data, and to take advantage of automation capabilities, a new approach to the way terrain data is represented on overlays was developed during Phase 1. It involves determining the "throughput" of a selected piece of terrain for a ground force of a specified size. To interpret the effects of multiple elements of terrain on force mobility, and take advantage of automation to support the process, a single, common mobility scale has been developed for all terrain factor overlays and composites thereof. This scale and its relationship to mobility in terms of information of military significance is as shown in Figure 3.1-2.

The combined obstacle matrix overlay presents the characterization of cross-country terrain and lines of communication in terms of these five categories of mobility. The result is a multicolored overlay as shown in Figure 3.1-3, with each color conveying relative mobility of military ground forces across the terrain. The goal of an IPB terrain analysis is to identify potential favorable corridors of movement for enemy forces from this basic terrain presentation. The mobility corridor overlay is therefore a simplification of the combined obstacles overlay which highlights the best routes of enemy mobility across the terrain in question. Once established, the corridor can then be rated for a given echelon.

3.1.1 Mobility Corridor Determination

With the mobility picture as represented by the COM graphic, plus knowledge of the enemy's present location and an assumption about his probable objectives, the analyst can proceed to identify favorable corridors of movement for enemy forces.

MOBILITY CATEGORY DEFINITIONS

Category	Definition	Color Code
• Stopped	(No Passage)	Red
• Very Slow	(Movement Only with Unusual Engineer Support)	Magenta
• Slow	(Movement Slower than Dismounted Infantry	Yellow
• Inhibited	(Considerably Less than Doctrinal Advance Rate)	Cyan
• Go	(Doctrinal Advance Rate or Greater)	Green

Figure 3.1-2. Mobility Categories

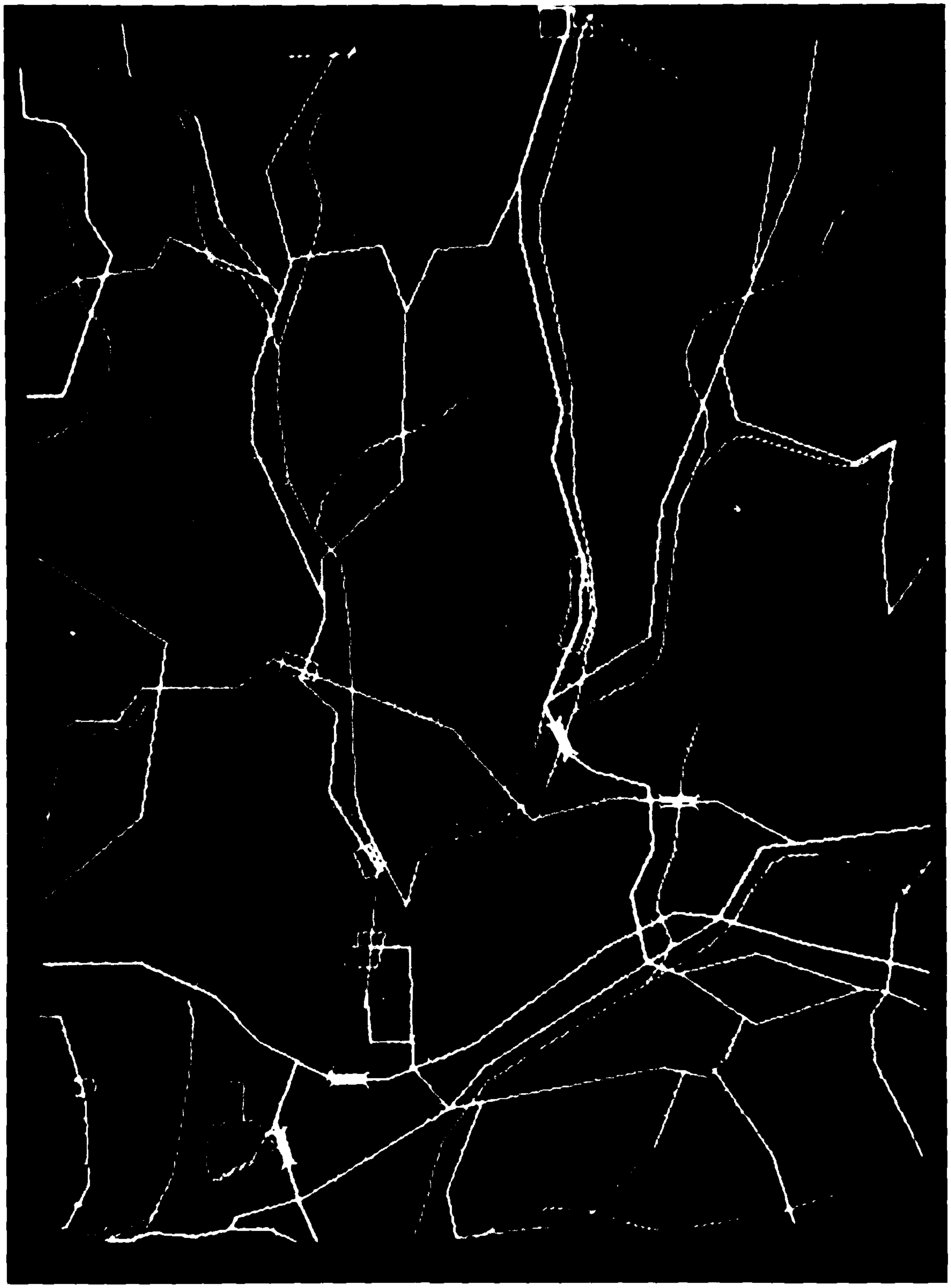


Figure 3.1-3 Combined Obstacles Matrix Overlay

The mobility corridor overlay is built from the data contained on the COM; when completed it highlights the best routes for enemy movement across the terrain in question. Mobility corridors are established for a particular sized force echelon.

The corridor build and rate process is both iterative and interactive and requires analyst awareness of the tactical environment. The process consists, in summary, of the following basic steps:

- Build a crosscountry corridor on the CCM
- Determine the effect of river and stream crossings on the cross-country corridor
- Build road corridors
- Cause the system to rate the overall corridor using a single color corresponding to the lowest rated (choke point) segment contained in the corridor.

The analyst is not constrained to performing the above four steps in specific sequence. He may, at any time, intermix the building of road or cross-country corridors, or look for alternate paths around the observed choke point(s) to make the corridor more acceptable.

Implicit to this process is the ability of the analyst to subdivide a force into lower echelons (e.g., army into division, divisions into regiments, etc.). This provides the capability of using multiple smaller corridors to comprise enough throughput for higher echelons to attain their military objectives.

The mobility corridors are modifiable at any time to reflect implementation of friendly obstacle plans. These include preplanned minefields, obstacles, blocking positions, etc., that can change the mobility corridor picture. This modified mobility corridor normally reflects a reduction in the number of corridors available or the mobility rating within a corridor.

Initialization

The analyst initializes the system through the graphics function keyboard by selecting the echelon expected to traverse the corridor and the COM of interest. Map scale is included, automatically, as header information and weather effects are included through the previously discussed weather menu input COM build process.

Cross-country Corridor

1. The analyst through the graphics function keyboard selects the cross-country corridor build function. Using the graphics cursor he draws a line on the CRT tracing the desired course on the COM.

2. When the desired course has been completed by the analyst, a polygon is created whose sides are parallel to the vector trace and ends are normal to the vector trace (see Figure 3.1-4) The width of the polygon is a function of echelon the length is (approximately) equal to the vector trace. This polygon is used for computational purposes along with a sliding window.

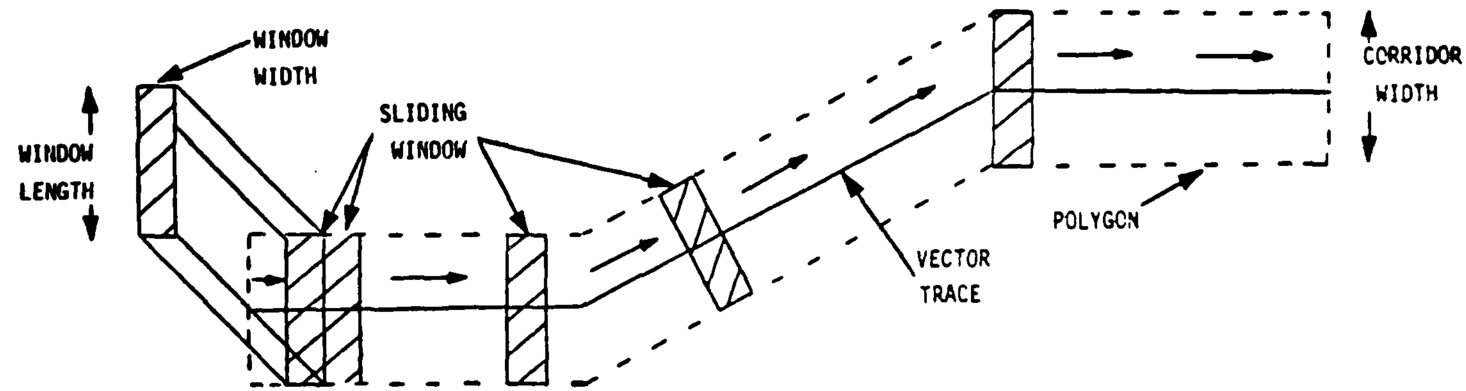


Figure 3.1-4. Cross-country Corridor Polygon

3. A sliding window constructed and controlled by the system is then used to build the corridor. The length of the window is equal to the width of the corridor and its orientation is normal to the vector drawn by the analyst (Figure 3.1-4). The window width is equal to the 500 meter COM blocks. This dimension is changeable through the graphic function keyboard.

   The numbers of COM blocks falling inside the sliding window and their mobility values are determined and computed in terms of a given echelon. When the window has traversed the length of the vector trace, a polychrome corridor is displayed to the analyst on the graphic screen (Figure 3.1-5). The color of the segments of the corridor corresponds to the IPB(A) five-part mobility rating: green = go, cyan = inhibited, yellow = slow, magenta = very slow, red = no go. An outline of the outside edge of the corridor (polygon) also appears along with the corridor.

   The pattern of the corridor (vertical, diagonal, horizontal, etc., cross-hatching) designates the echelon for which the evaluation was done. In the case of Figure 3.1-5, the pattern is for a regiment.

4. If, upon examining the polychrome corridor, the analyst finds unacceptable choke points, the corridor may be upgraded by finding an alternate path(s). To do this, the analyst utilizes a modify corridor function, which permits him to delete the unacceptable segment(s) of corridor, trace new paths around the choke point and have the new segments automatically rated. When the analyst is satisfied he merges the modified corridor with the originally defined corridor.

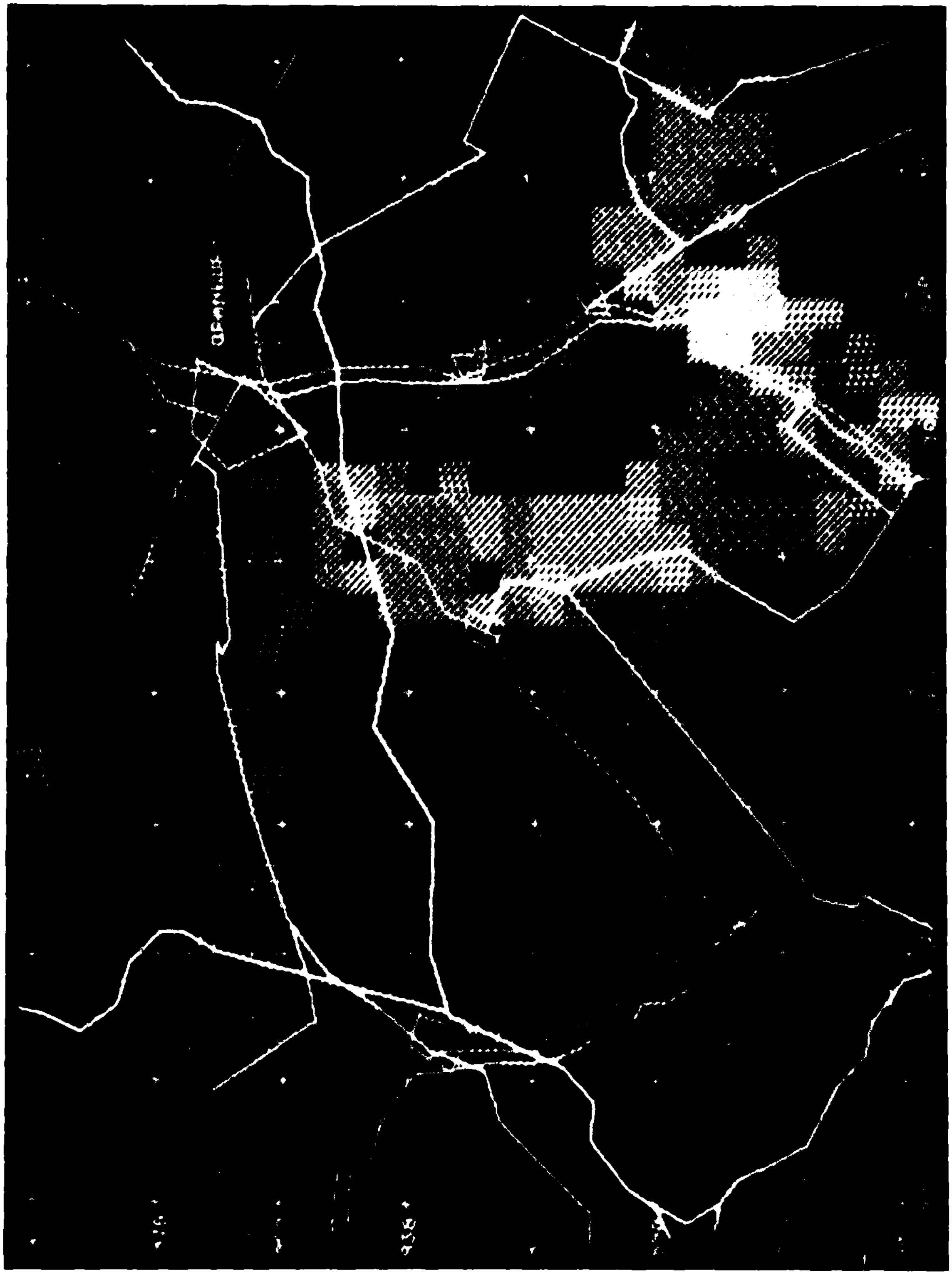


Figure 3.1-5 Polychrome Crosscountry Corridor on COM

River and Stream Crossing

The analyst selects the River Crossing function and uses the width of the previously determined crosscountry corridor to determine the width of the river crossing to be considered as well as the location of the crossing. The rivers and streams are available in the data base coded as to their effect on mobility (either blue, cyan or magenta as defined in IPB/TIAX Phase A Final Report). The analyst, using the graphic cursor, draws a line on or nearly on that portion of the river to be crossed. A program search is done to locate the river/stream, measure the width of the crossing and determine the stored mobility classification. The computer then calculates the mobility rating for that segment of corridor, compares this value with the determined values of the corridor for that terrain segment and stores the lower of the two mobility ratings. That segment of corridor is then color coded according to this stored mobility rating.

Road Corridor Build

The analyst, using the graphic function keys, selects the LOC Corridor Build function and draws a line on or near the road to be used. The search algorithm locates the road segment and identifies its stored mobility classification. Then by applying the basic mobility measure for lines of communication, the road corridor rating is automatically determined and graphically displayed for the specified force size.

The analyst inputs weather effects and the force size expected to traverse this road segment and initiates the computation process. The system selects values from stored tables and computes equivalent battalions per kilometer of road. This value would typically be smaller for the larger echelons which are moving combat service support trains as well as combat vehicles. The system again from stored tables selects values and causes the nominal rate of speed for the road class to be adjusted for weather and day-night conditions.

The system, using the equivalent battalions per kilometer and the weather-adjusted rate of travel just determined, computes a throughput in battalions per hour. This result is compared against the mobility category boundaries contained in another stored table to determine into which of the 5 mobility categories the road segment falls when traversed by this force size. The category determined in this manner is subsequently used in the route timing computation.

Figure 3.1-6 presents the road corridor category boundaries. This and the other stored tables used for the computation of road corridors can be changed by the analyst at his local station to reflect doctrinal differences associated with the rates of movement and equipment capabilities and the organization of specific enemy forces.

Figure 3.1-7 shows an example of the result of a road corridor analysis merged with the previously determined cross-country corridor. Again, the color of the corridor represents the IPB(A) five-part mobility scale and the pattern represents the echelon.

As an example of this process, a division-sized force having 22 equivalent battalions over a total single column road distance of 145 kilometers on a nominally GO category road is calculated to pass 3.8 battalions per hour. This throughput by comparison with the category boundary data in Figure 3.1-6 is found to fall into an inhibited range. The road segment is therefore rated inhibited for division travel.

ROAD CORRIDOR RATING		ROAD CORRIDOR CATEGORY BOUNDARIES
GO	(Green)	$A_E \geq 4.2$
INHIBITED	(Cyan)	$\geq 2.1\ A_E > 4.2$
SLOW	(Yellow)	$\geq 0.9\ A_E > 2.1$
VERY SLOW	(Magenta)	$\geq 0.25\ A_E > 0.9$
STOP	(Red)	$A_E > 0.25$

Figure 3.1-6. Road Corridor Category Boundaries

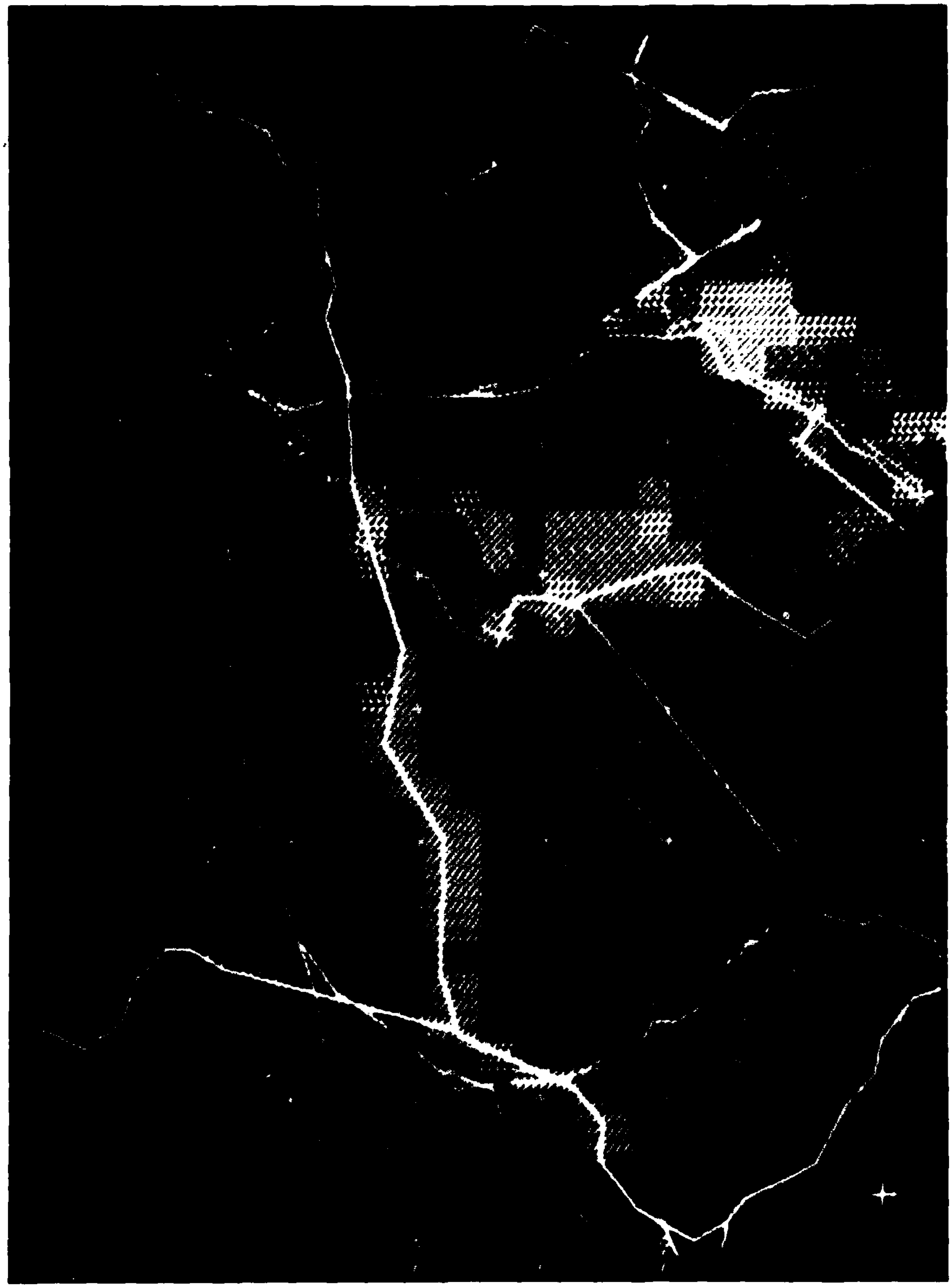


Figure 3.1-7 Polychrome Crosscountry and Road Corridor on COM

Corridor Rating

Upon satisfactory completion of the corridor build process using roads, crosscountry and river and stream effects, the analyst, through graphic cursor and function key input paints the total corridor the color of the lowest rated segment (choke point) within the corridor (see Figure 3.1-8). The analyst shall be able to delete the CCM portion of the COM and keep the corridor(s) and roads merged as shown in Figure 3.1-9.

3.2 INTERVISIBILITY APPROACH

Intervisibility, as applied to IPB(A), is for use at the Corps/Division echelons and is focused on large force movements, viz., divisions and regiments. The approach is similar to that used for mobility determination. Five categories of intervisibility have been defined and used in quantizing map and terrain overlay data into 500 meter squares. This initial quantization process is independent of either the military situation or line-of-sight (LOS) interests. When the IPB analyst wants to determine an intervisibility corridor, he selects the area of interest, LOS direction, and his assumed vantage point. Each 500 meter square contains quantized data which describes an intervisibility category. The computer automatically computes the corridor using the appropriate data plus the analyst's inputs. The following subparagraphs will define the process in detail.

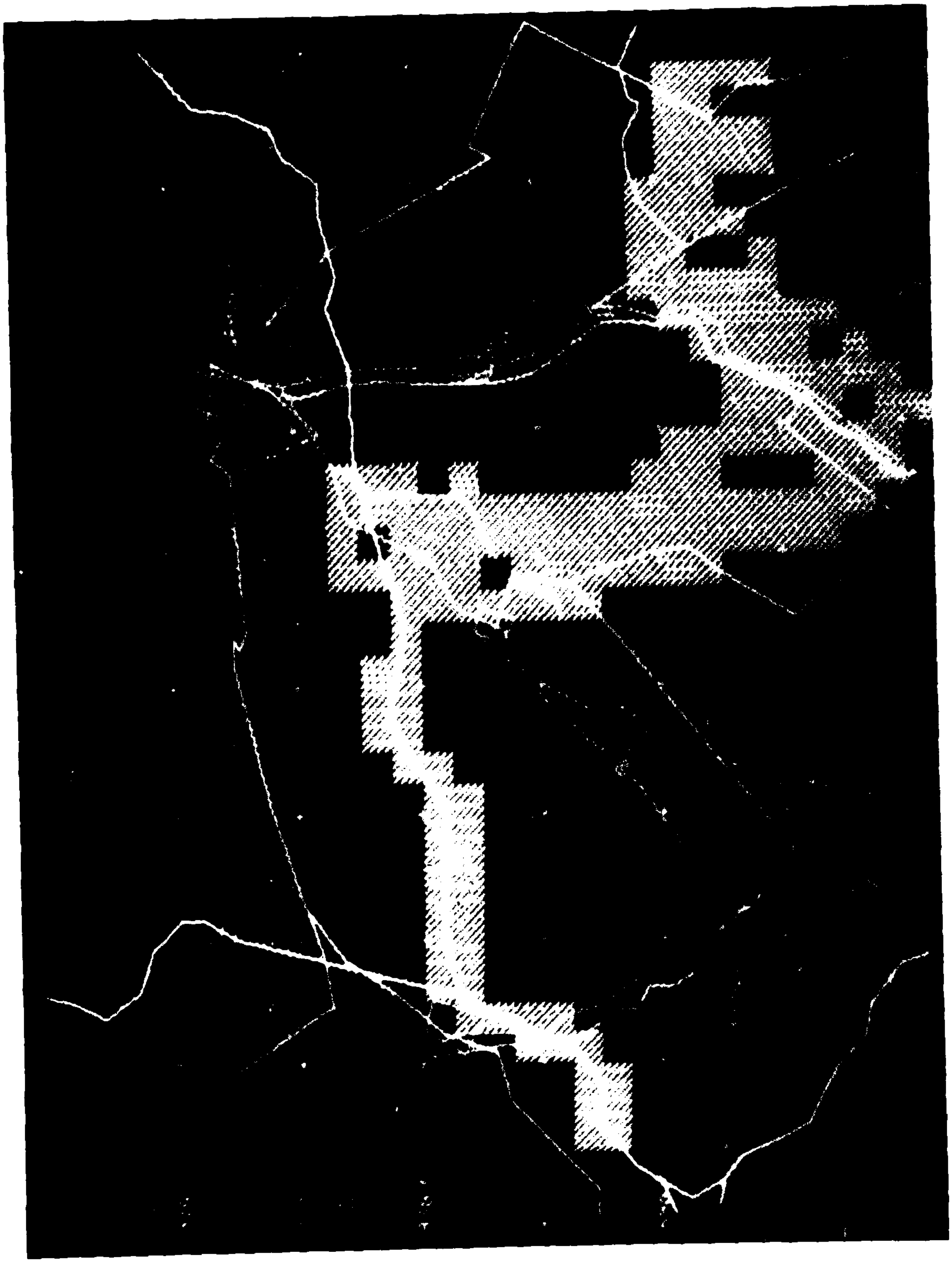


Figure 3.1-8 Rated Regimental Corridor on COM

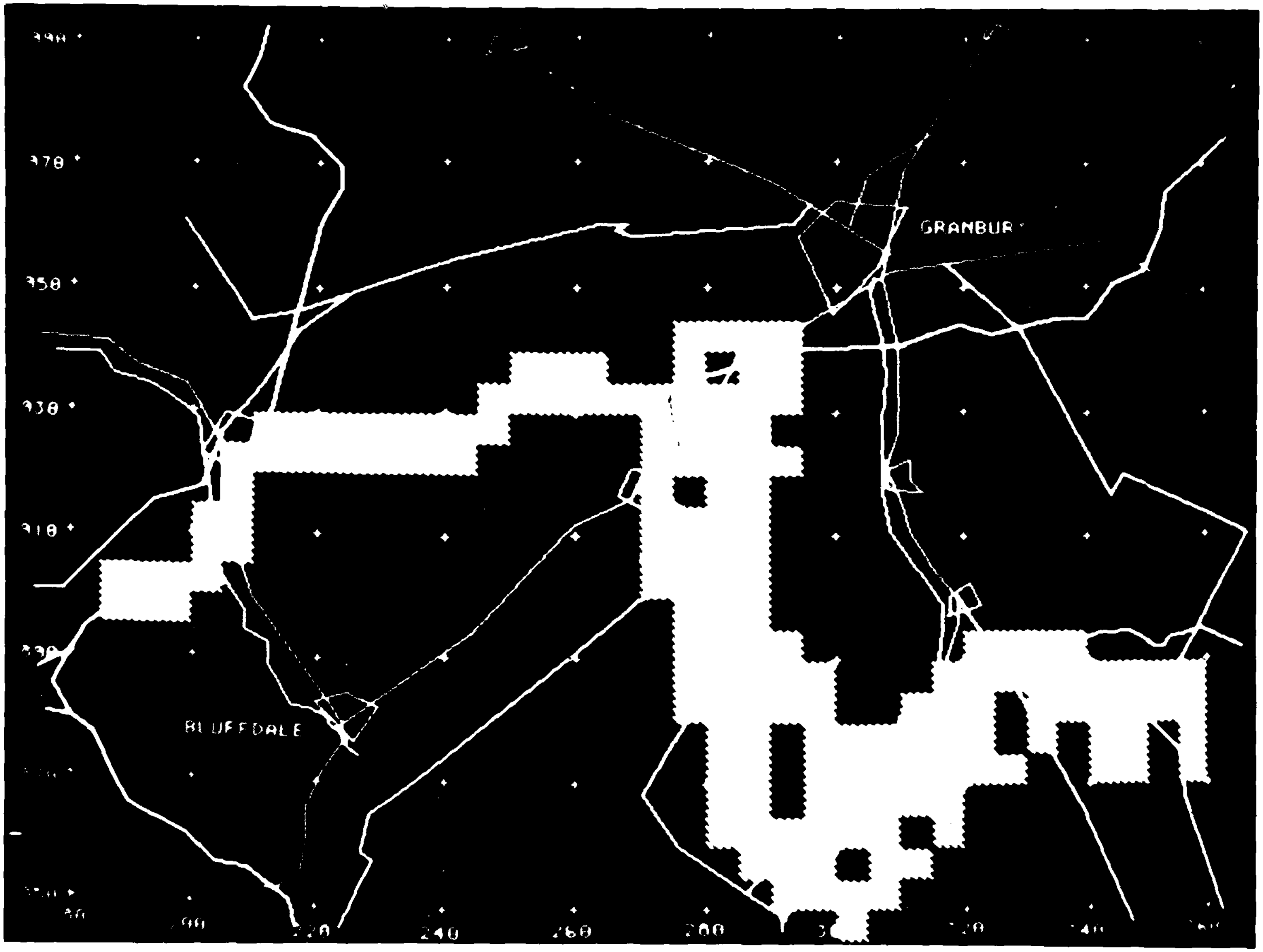


Figure 3.1-9 Rated Corridor on Map

3.2.1 Intervisibility Categories and Intervisibility Overlay Build

Figure 3.2-1 lists the five categories of intervisibility defined for use in the IPB(A) program. The category definitions aim at describing an area in terms of the military operations it can support from an intervisibility standpoint. Thus category V5, with average line of sight of 100 meters, would only be suited for cover and concealment of either enemy or friendly units. Category V4, with average line of sight of 400 meters, would enable close combat engagements. In areas coded V3 direct fire weapons could be employed. Areas coded V1 or V2 are potentially more open, and depending on the line of sight of interest, could provide visibility of up to 10 kilometers.

A geographic area can be represented in terms of categories V3, V4 and V5 independent of any situation data or directional parameters. The intervisibility overlay is built by logically combining (see Figure 3.2-2) classes of vegetation with surface configuration and built-up areas. The same terrain source data is used to build the intervisibility overlay as was used for the CCM build process. At the top of the illustration are charts that cross-reference the terrain data types with the three intervisibility codes. Code definitions are listed at lower left, and the logic used to form the overlay is indicated in the center. Figure 3.2-3 is a photograph of a CRT version of an intervisibility mosaic. In the photo the most dense green dot pattern portrays the V5, Cover and Concealment category; the least dense green dot pattern portrays the V4, Close Combat Engagement category; the empty (black) squares portray V3, Direct Fire Weapons category.

The steps necessary to build an intervisibility overlay are as follows:

INTERVISIBILITY CATEGORY DEFINITION

Category	Definition	Average LOS
V1 Long Range Surveillance	Two points, at least 10km apart, unobstructed by topographic or cultural features	10km
V2 Short Range Surveillance	Visibility between two points limited to 3km by topographic or cultural features	3km
V3 Direct Fire Weapons	Area visibility limited to 1km by topographic & cultural features	1km
V4 Close Combat Engagements	Moderate area topographic & cultural features limit visual range *to 400 meters*	400m
V5 Cover or Concealment	Severe area topographic & cultural features limit visual range to 100 meters	100m

Figure 3.2-1. Intervisibility Category Definition

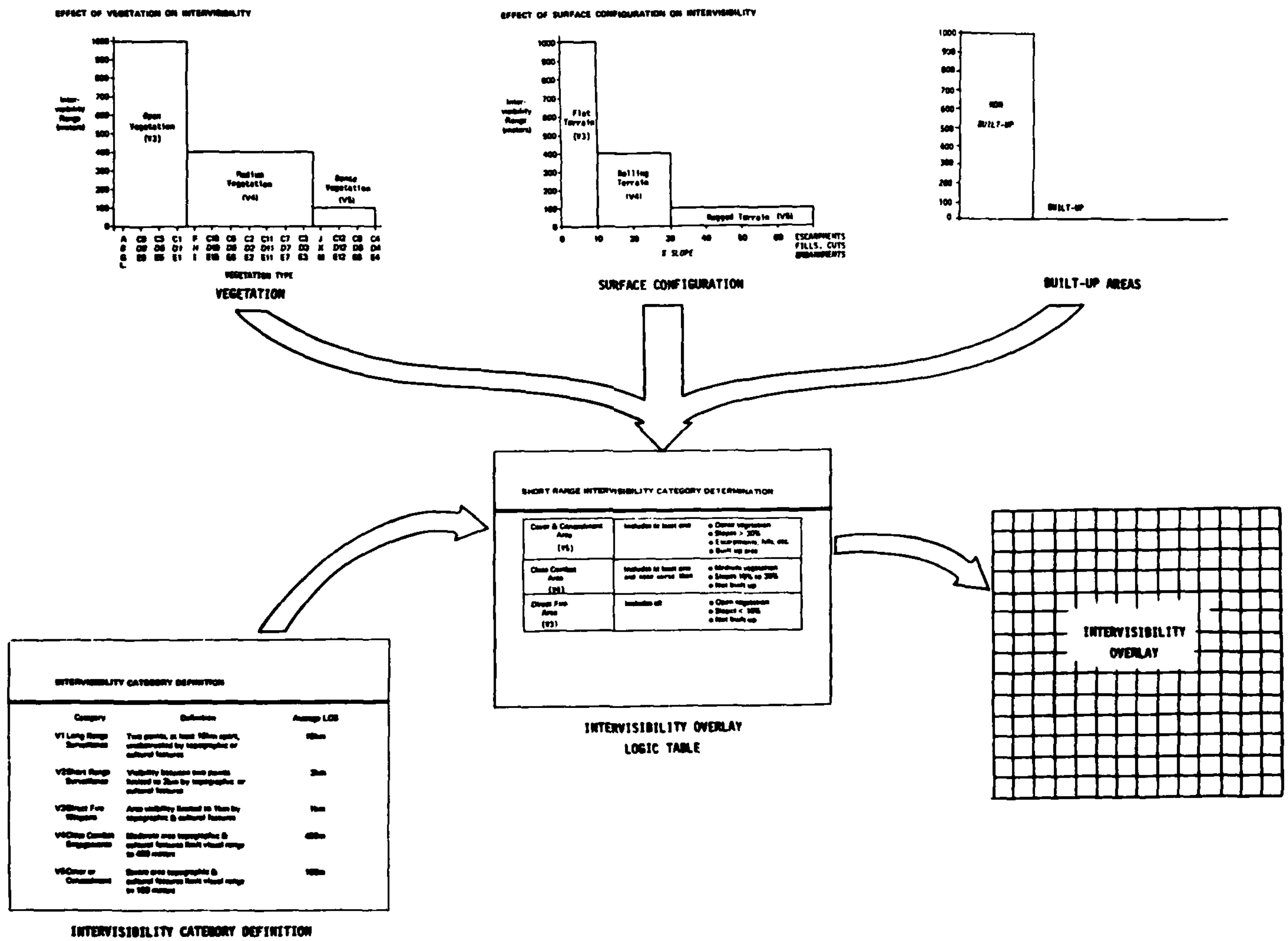


Figure 3.2-2. Intervisibility Overlay Build

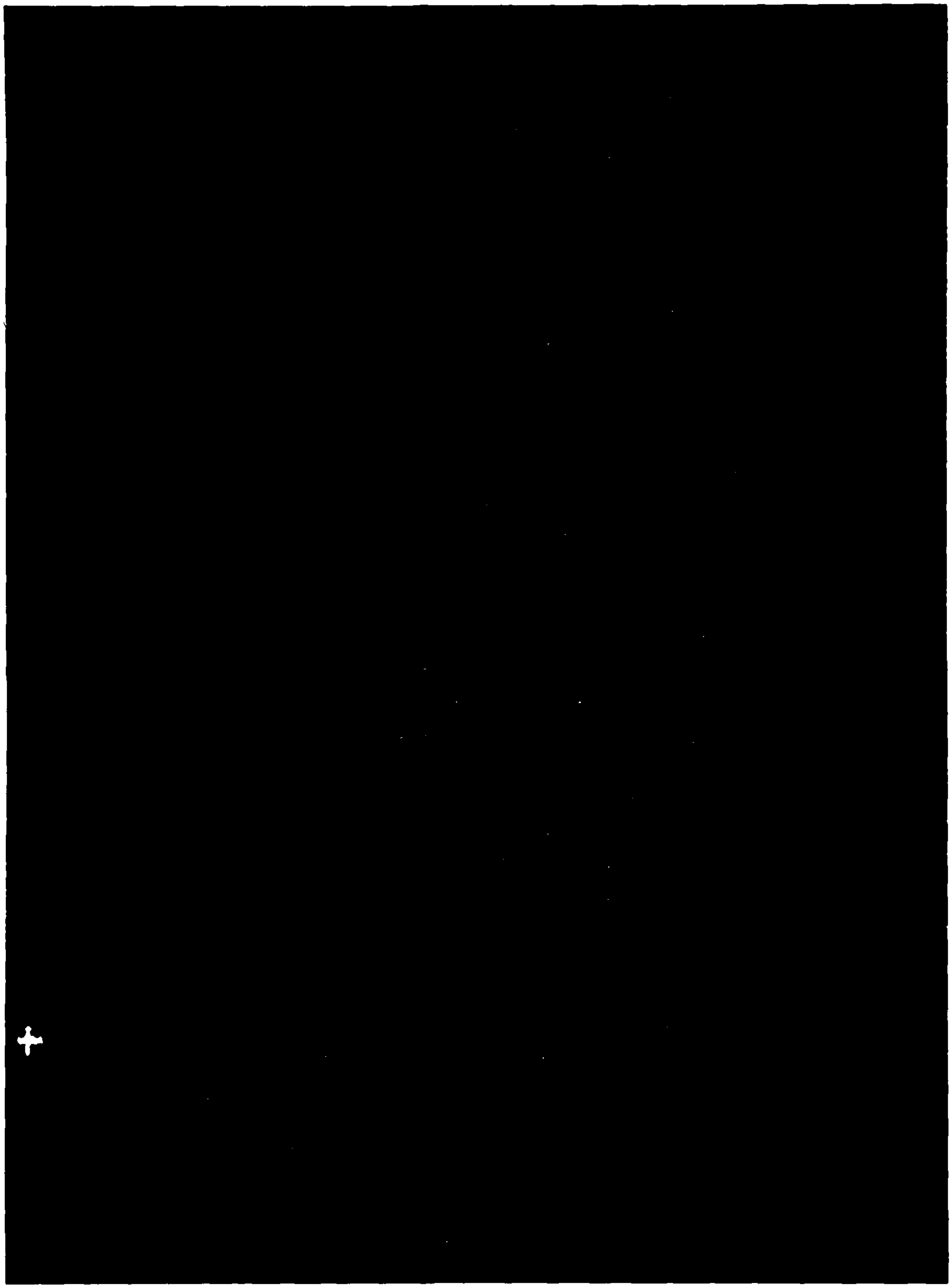


Figure 3.2-3 Example – Intervisibility Overlay

- Input weather/season effects as discussed in Section 3.3. (Note that it is not necessary to perform this operation each time an intervisibility overlay is to be built.)

- The analyst through the graphic terminal selects the area of interest and the function to be performed, e.g., display intervisibility overlay for selected area.

- The computer modifies the stored terrain data codes into appropriate IPB(A) intervisibility codes using the weather factor tables as defined by operator inputs.

- The computer logically combines the surface configuration intervisibility factor with the vegetation intervisibility factor with the built-up area intervisibility factor. With this done, the intervisibility factor for that 500 meter square is determined.

- Depending on the value determined, the 500 meter square is rated as Cover and Concealment, Close Combat or Direct Fire.

- This process is repeated by the computer for the total area selected by the analyst. The result is stored in a working file and graphically displayed when desired. On a 19-inch diagonal CRT, at a scale of 1:50,000, an area of 15 km x 20 km can be displayed utilizing 1,200 intervisibility blocks.

The logic for converting existing data into the desired intervisibility categories is shown in Figure 3.2-4. The categories are mutually exclusive, starting from the V5 Cover and Concealment category and progressing through V4 Close Combat Area to V3 Direct Fire area, i.e., if there are any terrain features that would classify a block as Cover and Concealment it cannot be classified as either Close Combat or Direct Fire.

SHORT RANGE INTERVISIBILITY CATEGORY DETERMINATION

Cover & Concealment Area (V5)	Includes at least one:	• Dense vegetation • Slopes > 30% • Escarpments, fills, etc. • Built-up area
Close Combat Area (V4)	Includes at least one and none worse than:	• Medium vegetation • Slopes 10% to 30% • Not built-up
Direct Fire Area (V3)	Includes all:	• Open vegetation • Slopes < 10% • Not built-up

Figure 3.2-4. Short Range Intervisibility Category Determination

If any terrain feature would classify the block as a Close Combat area, it cannot be classified as a Direct Fire area. Therefore, to be classified as a Direct Fire area, the block must contain open vegetation, slopes less than 10 percent and not be built-up.

If a block is classified as V5 or V4 it is implied that a line-of-sight cannot, on the average, be attained either into or out of the block. If the block is not classified as a V4 or V5 it is implied that intervisibility can at least be attained between contiguous blocks. All 500 meter squares can be so classified and the data stored as the intervisibility overlay for the area (see Figure 3.2-3).

3.2.2 Intervisibility Corridor Determination

The construction of the intervisibility corridors shall be dependent on both the military situation and line-of-site (LOS) interest. Again, terrain source data used for the mobility and intervisibility build processes shall be used.

The determination of intervisibility corridors requires the inclusion of two factors in addition to others previously mentioned to each 500 meter block code: average tree height and average elevation. Average tree height is determined from vegetation data and classified into four categories: 25 meters, 12 meters, 3 meters and 0 meter. Average block elevation can be determined from the topographic map.

The process to be followed by the analyst in building an intervisibility corridor includes the following steps:

- The initialization step took care of selecting appropriate terrain data as affected by weather/seasonal effects. Weather data inputs would also limit LOS as a function of atmospheric attenuation.

- The analyst, through graphic cursor and function keys, selects the area of interest, map, intervisibility overlay, indicates the desired LOS direction, and locates the vantage point.

- The system automatically computes the intervisibility corridors and presents a graphic display like that shown in Figure 3.2-5. In the figure, the very dense green dot pattern represents the areas which are masked from observation from the selected vantage point by intervening terrain. Those unmasked pattern blocks, then, are visible to the observer and constitute the intervisibility corridors.

In making the calculation, the observer's field of view is considered unlimited unless/until obstructed due to intervening terrain elevation. The observer is assumed to be at the center of the vantage point block, 3 meters above the average terrain elevation of the block. When an area is blocked due to elevation, the original intervisibility overlay pattern is replaced by the most dense pattern. If no elevation blockage occurs, the original intervisibility overlay pattern remains.

Figure 3.2-6 illustrates the elements of the problem. For positive elevation angles to the observed area, an intervening block can mask the observed block if the elevation angle to the intervening area is equal to or greater than the elevation angle to the observed area. For negative elevation angles to the observed area, an intervening block can mask the observed block if: (1) the elevation angle to the intervening area is negative in value and has a smaller absolute value than the absolute value of the elevation angle to the observed area, or (2) has a positive elevation angle. The convention used for elevation angles is: positive if above the horizontal and negative if below the horizontal. The angle is calculated as follows:

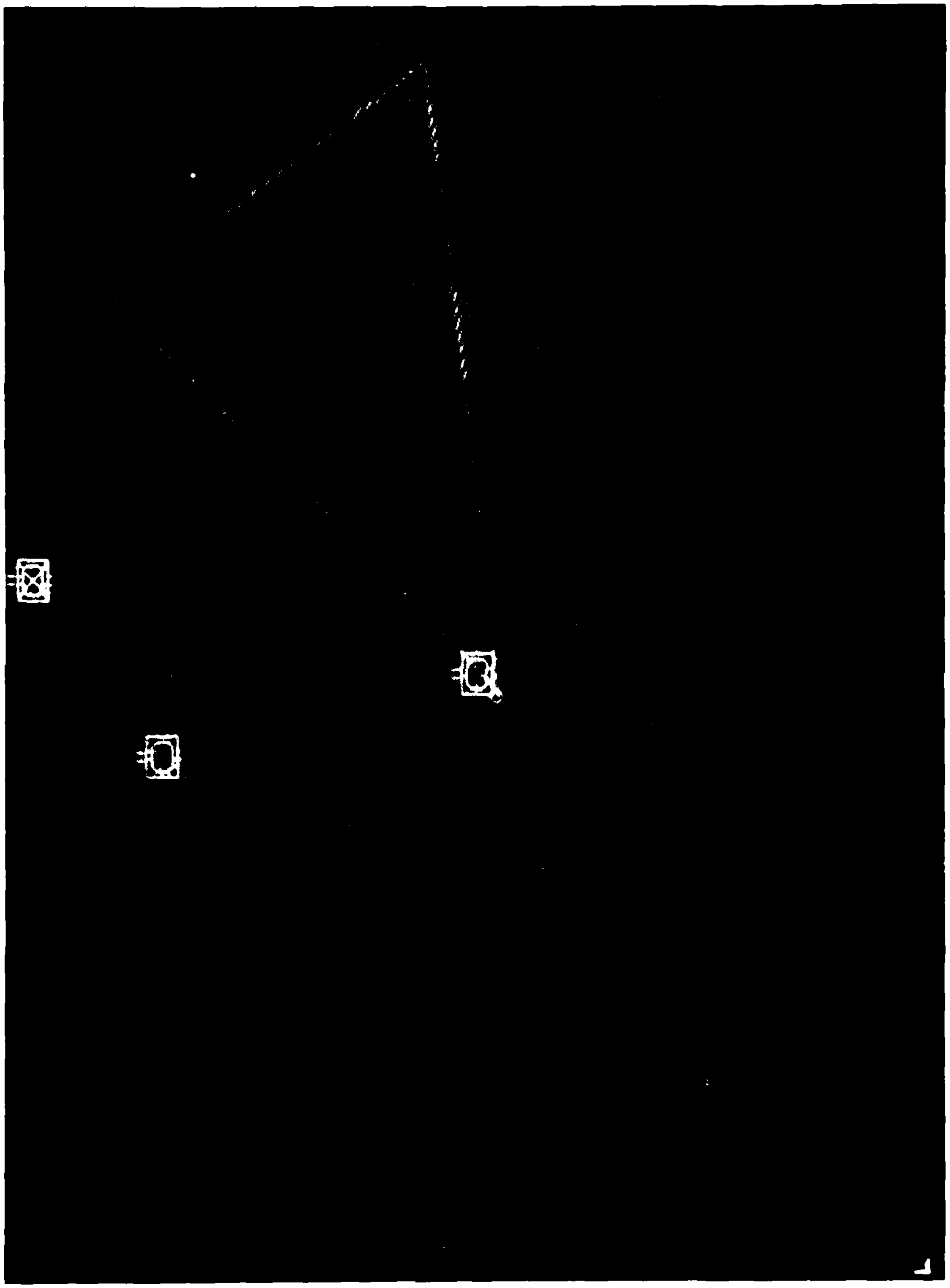


Figure 3.2-5 Example – Intervisibility Overlay and Corridor

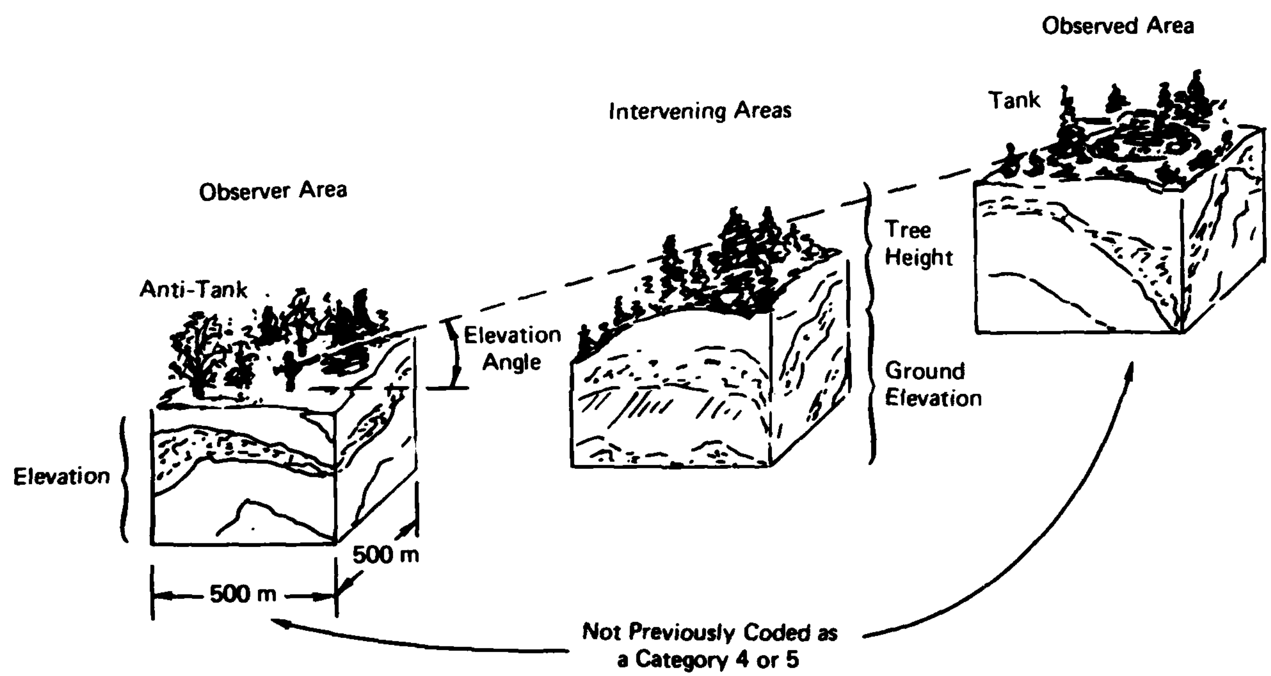


Figure 3.2-6. Intervisibility Corridor Determination

$$\text{elevation angle} - \text{arc tan}\ \frac{A + B - C}{D}$$

where, A = average tree height of intervening areas

B = average ground elevation of intervening or observed area

C = average ground elevation of observer area plus 3 meters

D = distance from center point to center point of the two blocks under consideration

Development of an intervisibility corridors overlay involves the calculation of elevation angles between the observer and all intervening blocks in the defined area and then comparing these elevation angles to determine where masking by intervening blocks takes place.

3.3 WEATHER EFFECTS

3.3.1 Approach to Integrating Weather Effects

Weather conditions frequently have a significant effect on the outcome of military operations. The ability to accurately forecast weather is a necessary but not sufficient capability--the planner must interpret the effect of the forecasted conditions on military operations. The IPB process, with its emphasis on thoroughly pre-planning enemy options, bases its planning on the best weather forecasts available. The process must also, however, have the ability to adjust those plans in realtime to accommodate changes in weather conditions.

The Automated IPB approach to integration of weather data with terrain is illustrated in Figure 3.3-1. Provision of multiple versions of soils and wetlands subfactor overlays for different weather conditions (right half of the chart) combined with a system capability to compute

USE OF WEATHER DATA

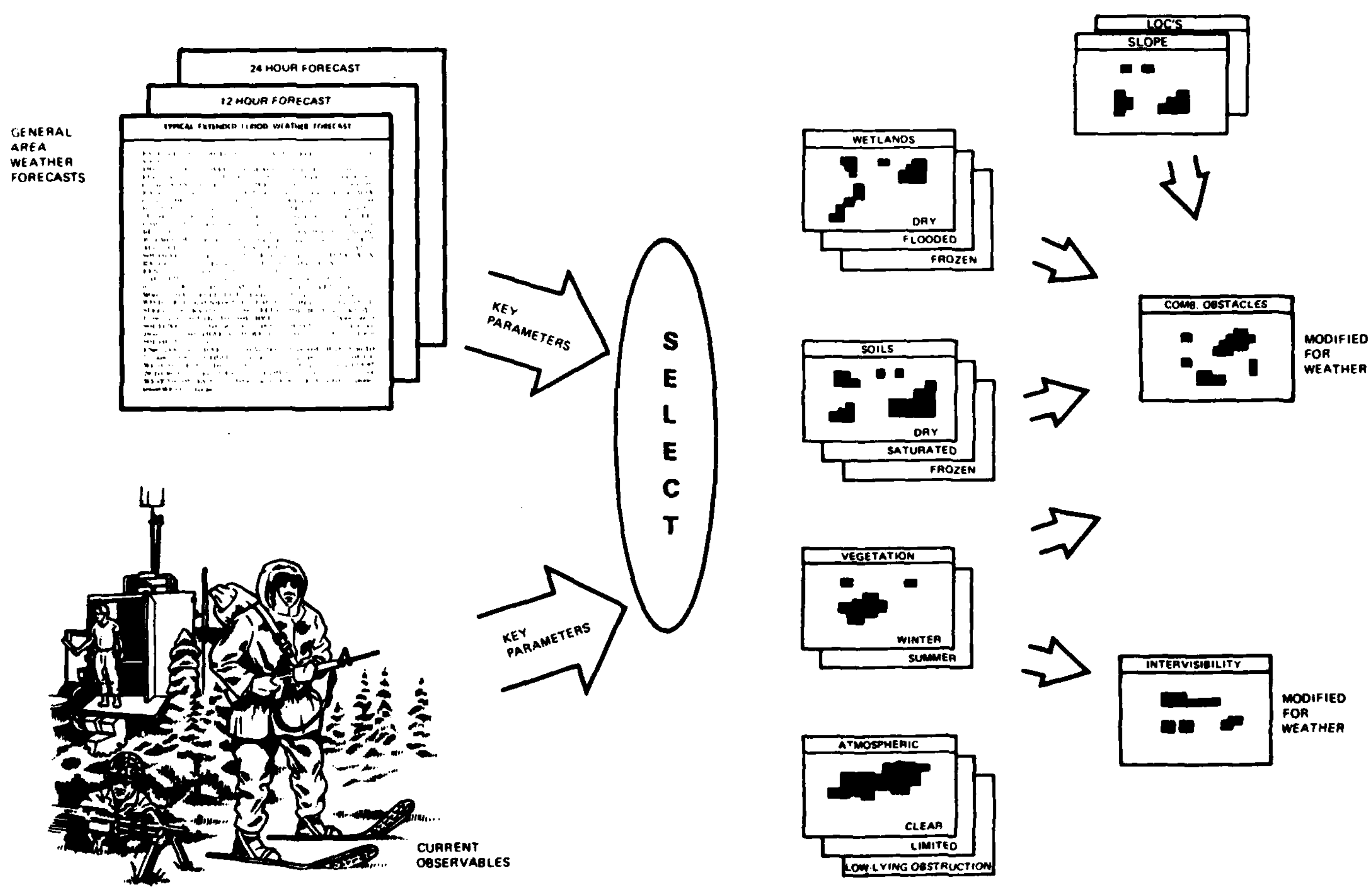


Figure 3.3-1. Use of Weather Data

the combined obstacles matrix in realtime allows the IPB analyst to modify his preplanned IPB products to account for weather changes. The process would operate as follows for assessing the impact on mobility:

- During the planning cycle, the IPB analyst uses the forcasted/observed weather and seasonal data for the plan period he is addressing to select the appropriate vegetation, wetlands and soils subfactor overlays for system use in building the combined obstacles matrix. He then computes his mobility corridors as required and builds the balance of his IPB products for system storage.

- During his use of the preplanned IPB products in the course of battle, he monitors weather forcasts and observables along with other intelligence data. If the weather conditions used in preparation of the IPB products at plan time are no longer applicable at time of use, the system has capability to recompute the combined obstacles matrix based on analyst input of current weather information. When the system develops a new combined obstacles matrix based on the new weather inputs, the analyst must then retrace the mobility corridors on the modified COM to rerate for a given echelon. With the corridors now revised to reflect current weather conditions, the analyst can make adjustments to his IPB products as required.

In similar fashion a set of atmospheric subfactor overlays is provided depicting primarily climatic data within given geographic areas that could have effects on intervisibility. These are shown at the bottom of Figure 3.3-1. The current forecasts are used to input appropriate weather data for system computation of intervisibility corridors. The weather factor of, for instance, low lying fog along river banks could have the effect of diminishing intervisibility along a given line-of-sight. A general hazy condition limiting visibility over a wide area would have an overall effect on intervisibility.

Through the provision of (1) terrain and atmospheric subfactor overlays depicting boundary effects of weather on mobility and intervisibility, and (2) the system capability to compute terrain and weather composites in realtime, the IPB analyst has the ability to incorporate current weather conditions into IPB processes.

3.3.2 Use of Weather Data

Forecasted weather information is converted to graphic display form; it includes a crude map, location and type of weather activity, direction of movement, cloud cover, temperature and precipitation. It would be supplied through conventional weather facsimile devices and manually input into the IPB system through the graphic tablet and A/N terminal. Figure 3.3-2 is an example of the resulting weather overlay as stored in the IPB analyst files. A primary use of this weather overlay is as an aid for correlating the weather situation with the analyst area of interest.

Prestored climatic data reflecting climatological effects--ground fog, cloud cover, prevailing wind conditions--as a function of location and expected time of occurrence is also supplied to the system.

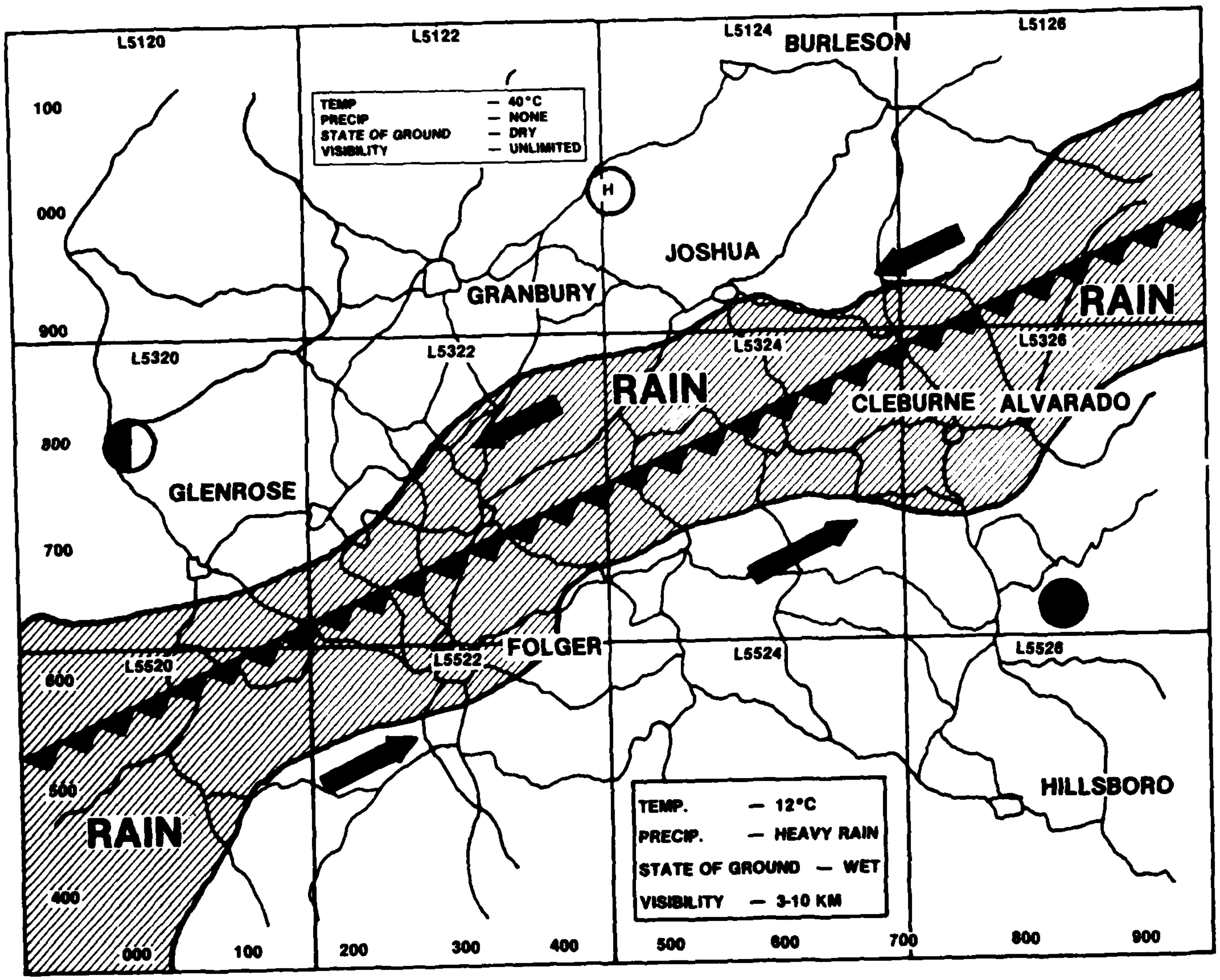


Figure 3.3-2. Weather Map Display Graphic

Figure 3.3-3 is an example of a fog layer which can normally be expected to exist along the high river banks of the Granbury region during certain seasons. In addition to fog and haze data the IPB system shall have the capability to receive/store other types of climatic information represented graphically for use with background maps.

The IPB analyst inputs weather forecast data by means of light pen selection of weather conditions from menus displayed on his tabular screen.

Five menus are available to the analyst for inputting weather data (see Figure 3.3-4):

- Weather Update Menu List
- Intervisibility Overlay Initialization Menu
- Cross-country Mobility (CCM) Overlay Initialization Menu
- Line of Communication (LOC) Overlay Initialization Menu
- Combined Obstacles Matrix Current Weather Update Menu

The Weather Update Menu List is called up on the tabular display. The analyst also calls the current weather map (Figure 3.3-2) on the graphic display. Through the graphic cursor, the operator inputs the coordinates for the area of interest and the coordinates appear on the A/N display. The analyst then identifies by light pen the box associated with the overlay to be updated; the selected menu appears and he enters his selections.

The effect of the menu inputs is to select appropriate tables for modification of the terrain data codes. Using these table values, the system generates subfactor overlays or composite subfactor overlays (soils, CCMs, COMs, intervisibility, etc.) reflecting the integration of current weather information with terrain data for the areas of interest.

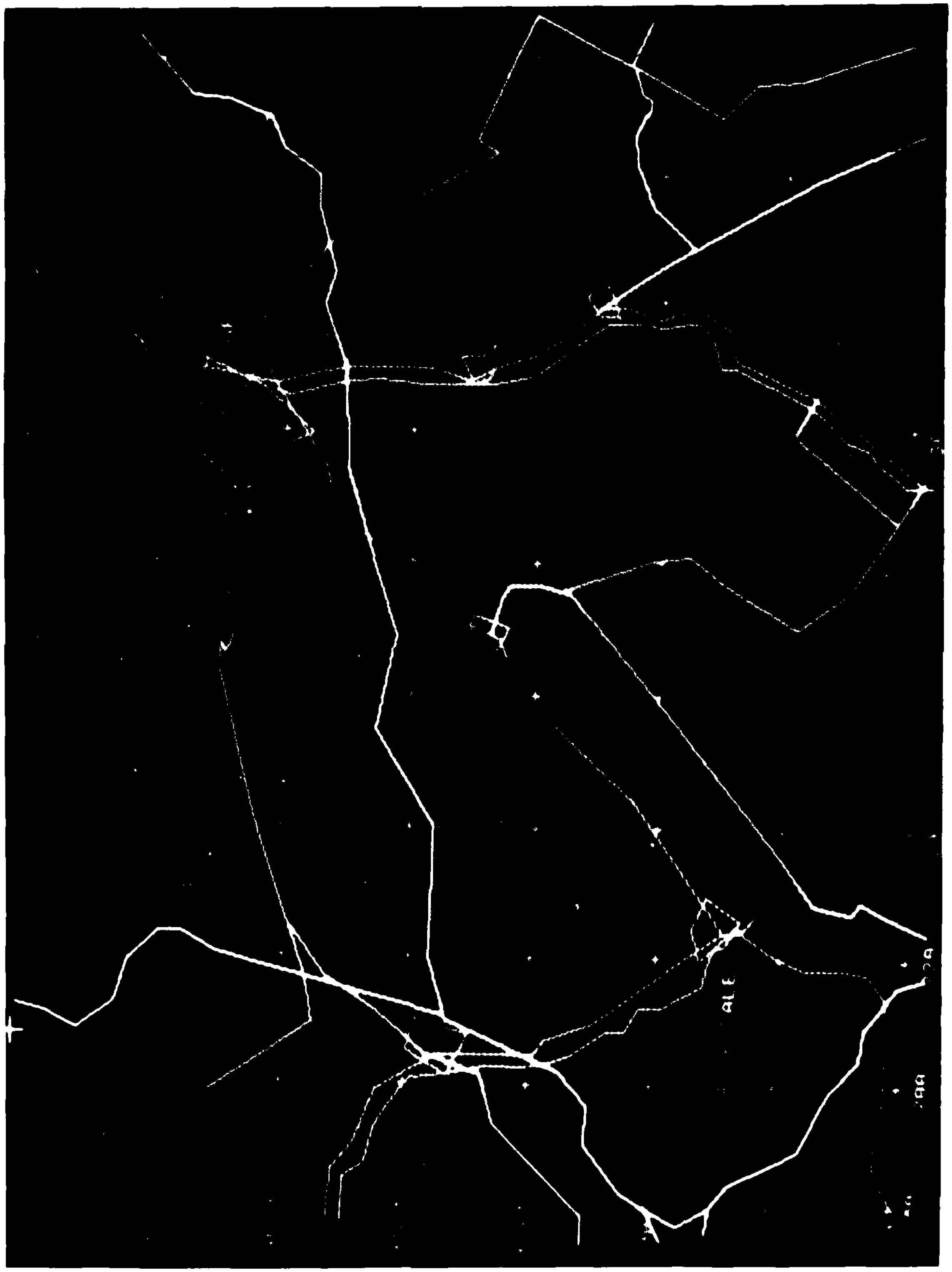


Figure 3.3-3 Fog Overlay on Map

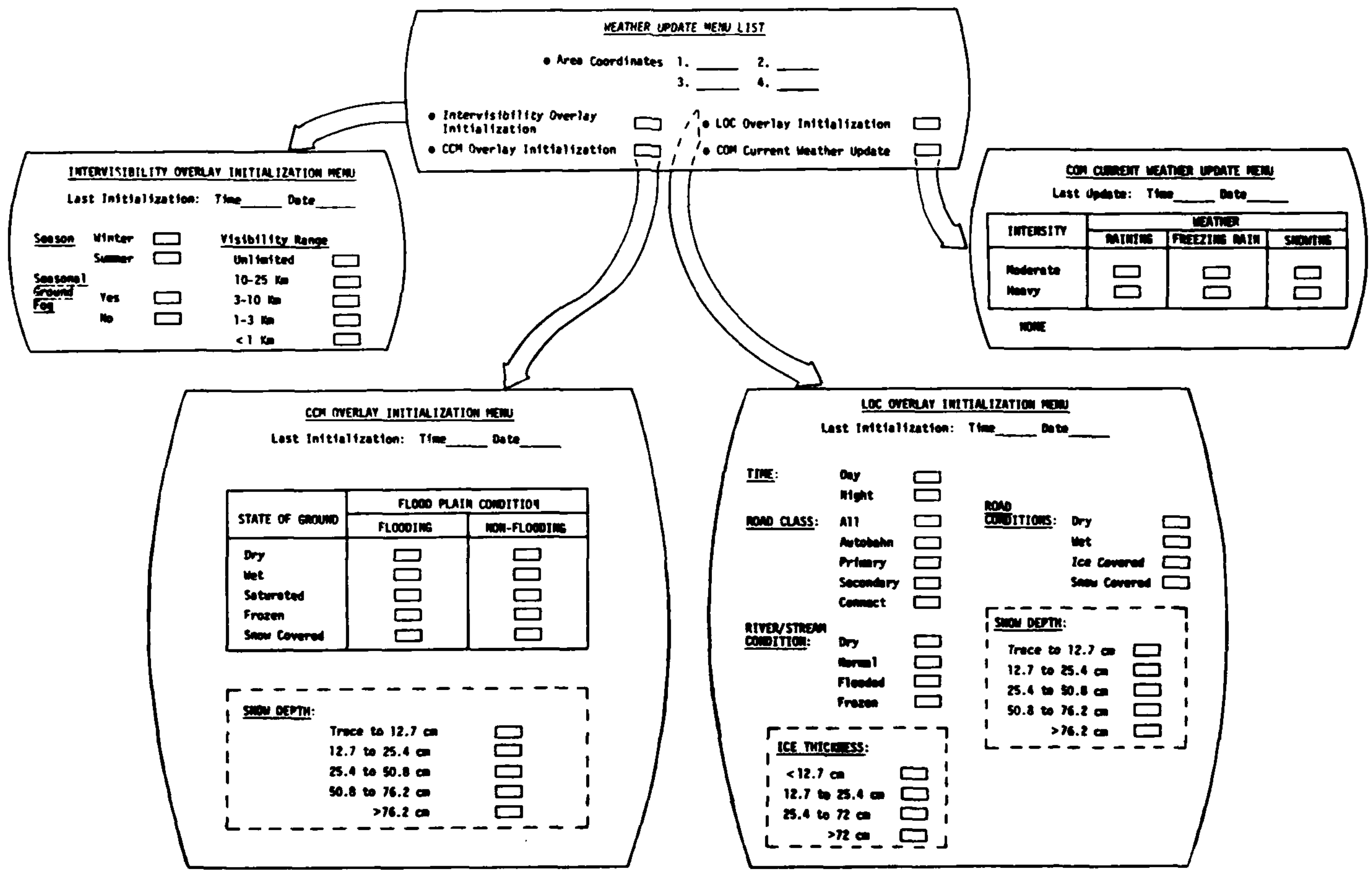


Figure 3.3-4. Weather Update Menus

3.4 AUTOMATION AIDS

This section provides a brief description of automation aids that have been identified as useful to the IPB analyst in the course of developing and demonstrating the laboratory capability. A complete description of each can be found in the report titled IPB(A) Software Functional Description dated January 4, 1980.

Weather Effects Input Process

The analyst is assisted in selecting and inputting weather effects data by this process. He is prompted by use of the following 5 menus:

- Weather Update Menu List
- Intervisibility Overlay Initialization Menu
- Cross-country Mobility (CCM) Overlay Initialization Menu
- Lines of Communication (LOC) Overlay Initialization Menu
- Combined Obstacles Matrix Current Weather Update Menu

Inputs to the process are (1) coordinates identifying the 1:50,000 map squares to be modified, and (2) the weather effects data which are input via light pen on the tabular menus.

Cross-country Mobility (CCM) Overlay Build

This is a process for composing the CCM overlay using weather effects and the individual terrain subfactor data codes for 500 meter squares. The analyst inputs the geographic area of interest. He uses weather effects menus to input seasonal and weather forecast data.

The process automatically selects from its tables the appropriate derating factors and causes the mobility rating of each subfactor in each square to be computed. The process then automatically combines the ratings to obtain a composite mobility rating of each square. The result is the CCM overlay with weather effects for the geographic area of interest.

Lines of Communication (LOC) Overlay Build

This is a process for composing the LOC overlay using weather effects and the mobility ratings of roads, rivers and streams. The analyst inputs the geographic area of interest. He uses weather effects menus to input day-night and weather forecast data. The process automatically selects from its tables the appropriate derating factors and causes the mobility rating of each road, river and stream segment to be computed. The result is the LOC overlay with weather effects for the geographic area of interest.

COM Build

This is a process for composing the Combined Obstacles Matrix (COM) overlay to reflect the combined CCM and LOC mobility ratings with weather effects taken into account. Also reflected on the COM can be changes to mobility ratings of terrain, roads, bridges, etc., which are the result of military actions.

The analyst controls the COM build process through his graphic and alphameric keyboards. If the weather forecast has not changed and if no need exists to modify for weapons damage or other military actions, the analyst calls and graphically merges the CCM and LOC overlays of the area thus yielding the COM.

If the forecasted weather has changed since the last COM for the area was prepared, the analyst initializes the system for weather and in accordance with the build techniques just described he modifies the CCM and LOC overlays. He examines and modifies the area LOCs further to reflect the effects of known military actions and when satisfied he creates the COM through the merge process.

Cross-country Corridor Build

With this process the analyst determines the mobility ratings of cross-country corridors. Inputs by the analyst are (1) a vector trace of the desired corridor made on top of the CCM overlay, and (2) the echelon of the force in question. The result is a corridor constructed as a function of the doctrinal frontage for the echelon and the mobility values of the 500 meter squares traversed. The corridor is color coded in transverse segments to highlight the location of choke points.

Road Corridor Build

With this process the analyst determines the mobility ratings of road corridors. Inputs are (1) the cursor identification of the road on the graphic screen, and (2) the unit echelon. The process automatically identifies the road's mobility class. The result is a road corridor constructed as a function of echelon and road mobility class. For a road corridor composed of several mobility classes the output graphic is presented in color coded segments to highlight choke points.

River and Stream Crossing Corridor Build

This is a process similar to the Road Corridor Build process above. Inputs are the cursor identification of the river crossing sector and the unit echelon. The result is a computed mobility rating for the river or stream as a part of a cross-country corridor portrayed in a color coded output graphic.

Mobility Corridor Build

With this process the analyst causes the system to combine the three corridor types--cross-country, river and stream, and road--and output a single color corridor over the entire path at the lowest mobility rating computed. The technique and interactive controls are designed to allow the analyst to perform the build steps in any sequence. He may at any time intermix the building of road or cross-country corridors, or delete portions of a computed corridor and look for alternate paths around the observed choke points to make the corridor more acceptable.

Route Timing

This is a process by which transit time of a force element along a cross-country or road corridor is computed. Inputs are (1) corridor type (cross-country or road), (2) mobility class, and (3) mode to indicate one of four output forms. Also input are a series of cursor locations to identify to the system the route to be timed. Special symbols are displayed by the system along the selected corridor at the cursor locations to mark the selected route. The output is displayed as one of the following output forms:

Incremental Pass Time
Incremental Arrival Time
Cumulative Pass Time
Cumulative Arrival Time

Pass time is defined as the time between when the first element of the unit being measured passes a given point and when the last element passes the same point. Arrival time is defined as the time the head of the column of the unit being measured takes to reach a designated point.

The incremental mode displays time between cursor identified points. The cumulative mode displays accumulated time along the route in terms of equal, operator specified time intervals.

Intervisibility (I/V) Overlay Build

This is a process for composing the intervisibility overlay using weather effects and the individual terrain subfactor data codes for 500 meter squares. The analyst inputs the geographic area of interest. He uses the weather effect menus pertinent to intervisibility to input seasonal and weather forecast data. The process automatically selects from its tables the appropriate derating factors and causes the intervisibility rating of each subfactor in each square to be computed. The process then automatically combines the ratings to obtain a composite intervisibility rating of each square. The result is the intervisibility overlay with weather effects for the geographic area of interest.

Intervisibility Corridor Build

Using this process the visibility from a selected vantage point into 500 meter COM squares along a line of sight path is computed. A vantage point is selected and a line of sight area of interest drawn by the analyst on top of the intervisibility overlay graphic as inputs to the system. The system automatically determines visibility from the vantage point to each square contained in the triangular shaped area selected by the analyst. Those squares which are not visible within the triangular area of interest due to intervening topographic or cultural features are indicated on the display as heavily shaded areas.

SECTION 4. IPB PRODUCTS - DESIGN AND USE

This section describes the various IPB products automated for IPB analyst use. Products are described in terms of their use in the four-step templating process.

4.1 IBP PRODUCTS - GENERAL

Figure 4.1-1 is an overview of IPB automated products for use by the G-2 analyst.

The items under Inputs would be developed by support agencies and "provisioned" in appropriate sets to units in the field. They have the common attribute of being situation independent; their preparation require application by specialists of considerable technical information. They could be modified in the field, but the basic set would be provided by support agencies.

Inputs

The analyst has available doctrinal descriptions of major options employed by enemy forces to achieve their objectives in various military situations.

The inputs include digitized terrain information which defines individual and combined terrain factors (slope, vegetation, dry and wet soils, and cross-country mobility) effects on armored vehicle mobility. Further information is included on road and river classifications and their effect on armored vehicle and wheeled vehicle mobility.

Map backgrounds for graphic screen display at varying scales and levels of detail are available in the IPB data base.

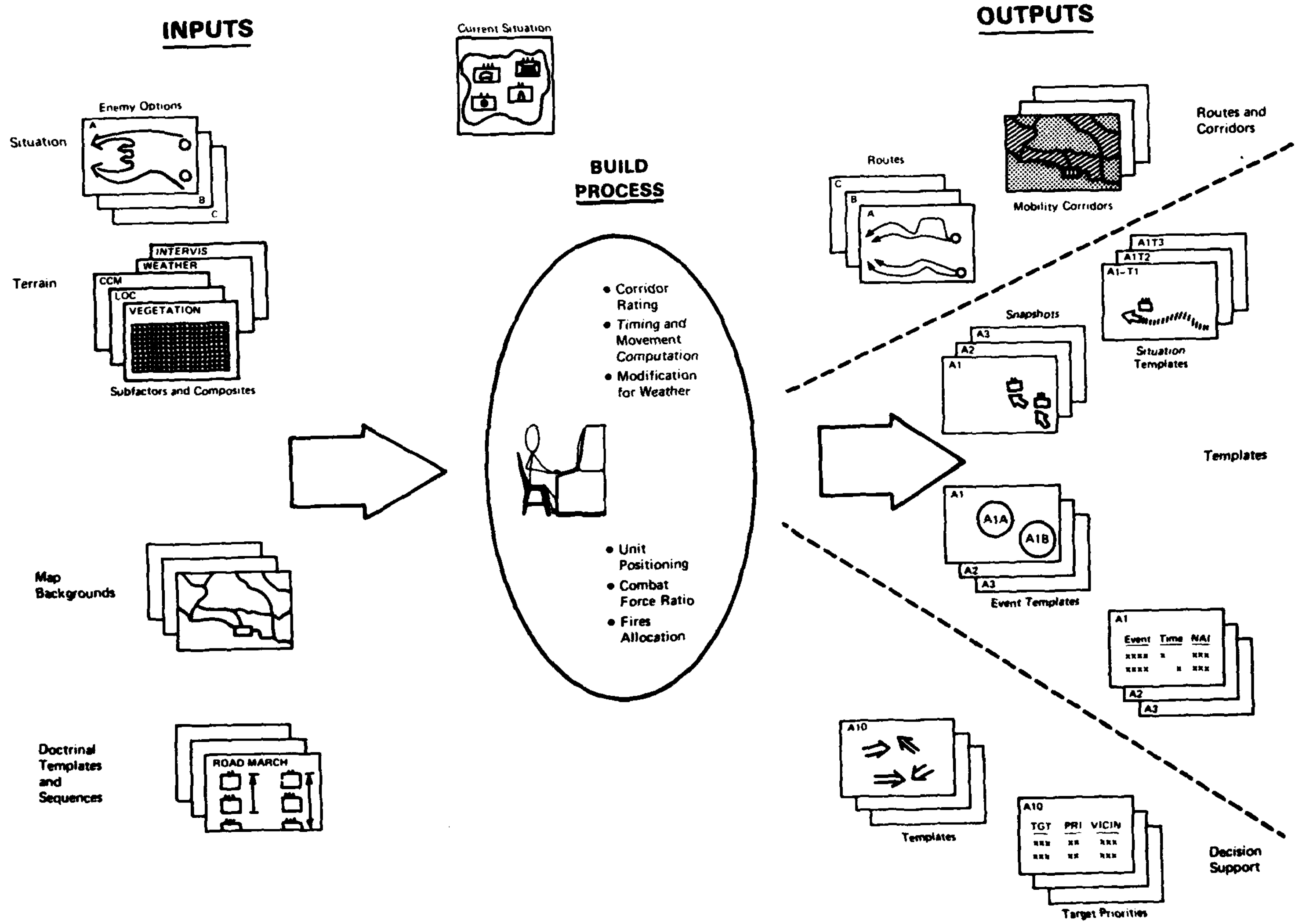


Figure 4.1-1. Build Process

Doctrinal templates of enemy forces at the echelons of battalion and higher are available. They provide the analyst with graphic representations of high interest force elements in road march, pre-combat and combat formation.

In support of these graphic data sets, the IPB data bases include detailed technical data in tabular form. Examples are detailed technical data on lines of communications; detailed terrain subfactor characteristics, and detailed weather effects characteristics.

Processing Algorithms

Processing functions are available to the analyst in the IPB software programs. These allow him to input real time computation parameters at his station and cause the system to immediately compute information on corridor mobility ratings, force movements and timings; changes to composite mobility ratings caused by weather; combat power ratios, and intervisibility corridor ratings.

Outputs

Outputs or products which are prepared ahead of a battle and stored for real time use by the analyst are shown on the right hand side of Figure 4.1-1. With a basic set of maps, terrain data, and doctrinal templates, operating units can begin development of the products illustrated under Outputs as soon as they have a specific military situation to deal with. It can be the "current situation" as understood prior to an initial attack (or during the battle), or it could be a contingency situation for which operating plans must be developed. In order to develop the basic IPB products illustrated, there must be an enemy force at a known or estimated location, friendly forces having a mission to deal with the enemy, and hypothesized enemy objectives and options for achieving these objectives. With these ingredients, the IPB process can begin to function.

Route plans for each option are prepared. These are further detailed into routes which follow lines-of-communication and routes which follow mobility corridors over cross-country terrain.

From applying doctrinal templates to lines of communication and terrain, the snapshots are prepared depicting major force elements as they progress through the steps of an option.

Again, using doctrinal templates on terrain and singling out from snapshots the areas and force elements that make one option unique from any other, the situation templates are prepared.

Also prepared in advance are event templates and event analysis matrixes. These reflect a series of key, critical events at a highly granular level that can be anticipated to occur shortly after a snapshot point. Their occurrence or non-occurrence provides a significant step in confirming that the enemy is in a certain option and at a specific point within that option.

Snapshots reflecting enemy force positions and sequences at the time chosen to counter the enemy threat fall in the category of decision support templates. These are prepared in advance and are available to the analyst for realtime update prior to their use for briefing the G-3 staff and commander.

Target templates and target analysis matrixes go with each snapshot and afford the analyst preplanned tools for supporting the Fire Support Element in the TOC.

4.2 PRODUCTS DESCRIPTIONS

4.2.1 Planned Routes and Snapshot Points

The planned routes template of Figure 4.2-1 presents the predicted avenues of approach for large enemy forces to reach an attack line and ultimate objective. Shown in the figure is a double envelopment operation (Option A), one of the two options developed for Workshop 1. It shows the most likely routes that would be used by two second echelon divisions as they proceed in two columns from rear assembly areas to their objective. The scale is 1:250,000 which provides a field of view on the CRT of 75 km by 100 km.

Figure 4.2-2 is a Snapshot Lines Template. It shows a series of contoured lines intersecting the avenues of approach with elapsed times between these lines. These lines laid across the routes were selected by the IPB analyst as points in the double envelopment operation at which snapshots should be developed. Eight snapshot lines were identified at key stages of the double envelopment action as follows:

Snapshot Line 1 - 2nd Echelon Moving (H-5 hours)

At this point the advanced guard battalion of each column of each division have cleared the assembly areas and are out on the roads. This represents the earliest detectable indication of possible commitment of these reserve forces. Note that although the snapshot line indicates the location of the lead elements of the main body (well to the rear), there would also be activity near the front at that time in the form of artillery movements and patrols.

Figure 4.2-1 Planned Routes Example

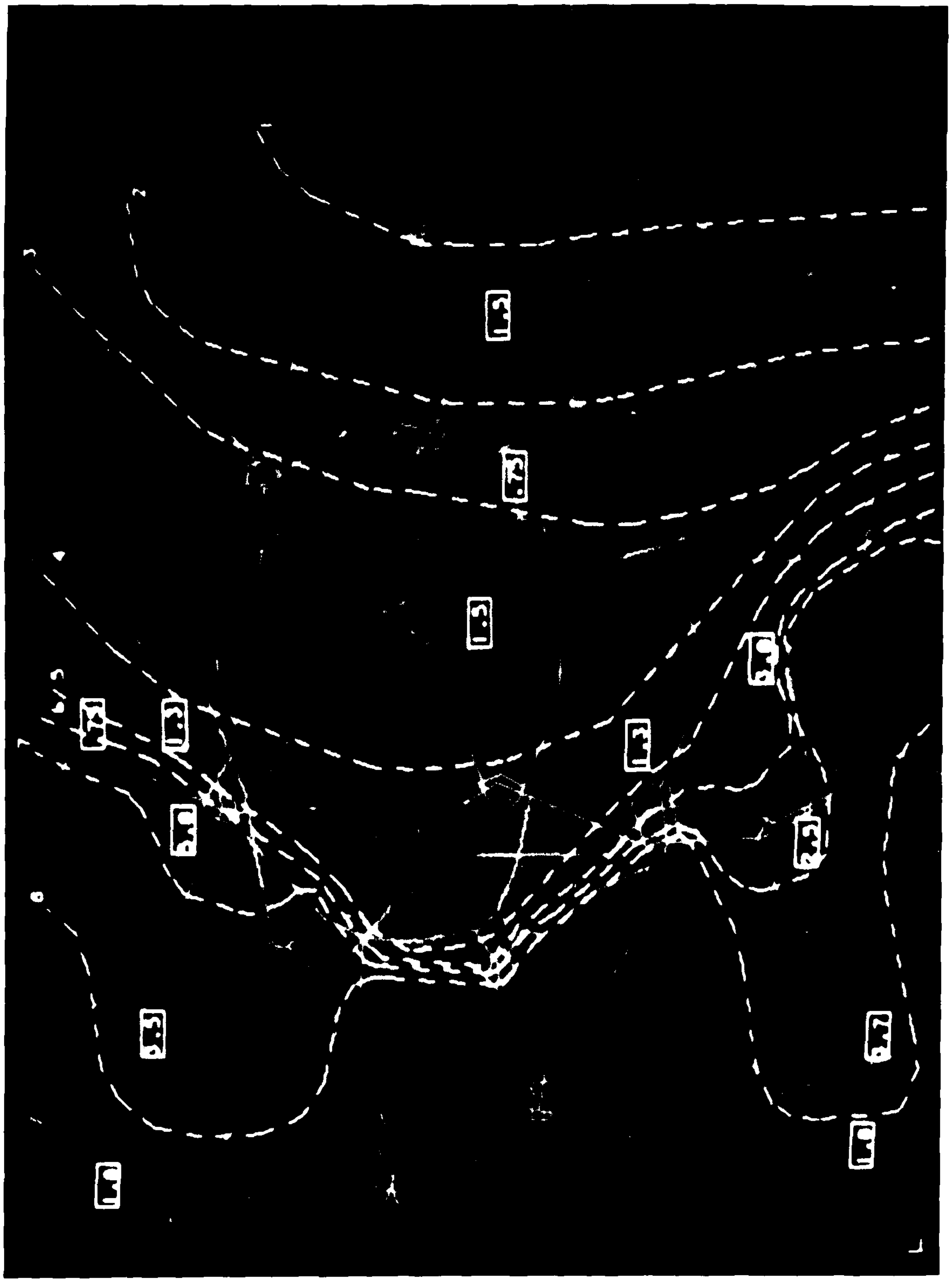


Figure 4.2-2 Snapshot Lines Example

Snapshot Line 2 - Division Sized Forces (H-3.5 hours)

At this point the lead regiments of one or both divisions have cleared the assembly area and are moving in four road columns of sufficient vehicle numbers and column lengths that they are distinguishable as at least one regiment per column. This tells the friendly G-2 that a force probably of division strength has been committed.

Snapshot 3 - Key Direction Indicators (H-2.7 hours)

At this point the lead regiments of both divisions have progressed far enough that their principal routes are distinguishable. This represents the earliest indication of the area to be attacked.

Snapshot 4 - Deployment (H-1.3 hours)

At this point the heads of lead regiments of both divisions have reached their respective deployment lines approximately 8 kilometers behind the line of contact.

Snapshot 5 - Line of Contact (H hour)

At this point the lead regiments of both divisions are deployed in combat formation, cross the attack line and initiate the main attack.

Snapshot 6 - River Crossings (H+2 and H+4 hours)

In this particular geographic area and attack option a significant enemy force deployment occurs when the forces must cross a large river in the MBA. Each division crosses at different times. Each attack force accomplishes its river crossings relying on scissors and ponton bridging operations, a particularly vulnerable operation.

Snapshot 7 - 1st Echelon Containment (H+6 and H+5.5 hours)

At this point the attack force of each division has fought its way to the area of the friendly first echelon brigade CP, a distance of 8 to 10 kilometers beyond the line of contact. This point is critical in main battle defensive operations; if the front units are overrun, the aggressor forces can resume a more rapid advance rate and the defensive tactics may have to change.

Snapshot 8 - Flanks Vulnerable (H+9.5 hours)

At this point the attack force of each division has reached a point as far west as it will go resulting in the maximum extension of combat support services and the maximum exposure of its flanks.

Objective (H+11 hours)

The enemy plans its attack timetable so that the two enveloping divisions simultaneously reach the objective - the pincer action in the White Bluff area.

Of significance to note here is the rationale for the IPB analyst's selection of snapshot points within an option. The number of snapshot points taken is very much a matter of judgment and will be influenced by such factors as:

- the overall length of enemy advance
- blue force knowledge of the terrain and road network
- time available for option planning
- collection resources available

Those points selected on the enemy side of the line of contact (LOC) will be geared to identification of enemy force configurations to determine which option is being exercised. The snapshot points on the friendly side of the LOC will be geared toward identifying the most logical and effective lines of defense for each option situation.

4.2.2 Snapshots

Figure 4.2-3 is a picture of the second snapshot point in Option A (double envelopment). It occurs at H-3.5 hours and was developed using the scenario cited in Section 5.1. At this point the two lead regiments of the 206th Division are clear of the assembly area.

Snapshots are prepared at a scale of 1:250,000. A snapshot shows the maneuver forces at the level of regiment and higher. It may show forces of special interest such as forward detachments, advanced guards and engineers at the level of battalion and lower. A snapshot shows both first and second echelon enemy units. A two-color code is used for enemy units: (1) magenta to identify second echelon units unique to this option; and (2) red to identify second echelon units common to more than one option and all first echelon units. Uniqueness is determined in the course of the analyst's build process by use of a symbol matching algorithm. The algorithm provides automation assistance as the analyst causes the snapshot he is composing to be compared with the snapshots of all other options directed at the same military objective. Second echelon unit symbols not matched with a like unit within a predefined search radius are considered unique and color coded magenta. Other second echelon units that produce a match are color coded red.

Subsequent to the snapshot build step and when all unique units by option have been identified, the analyst selects the map areas containing unique units as those he will highlight in the larger scale situation templates.

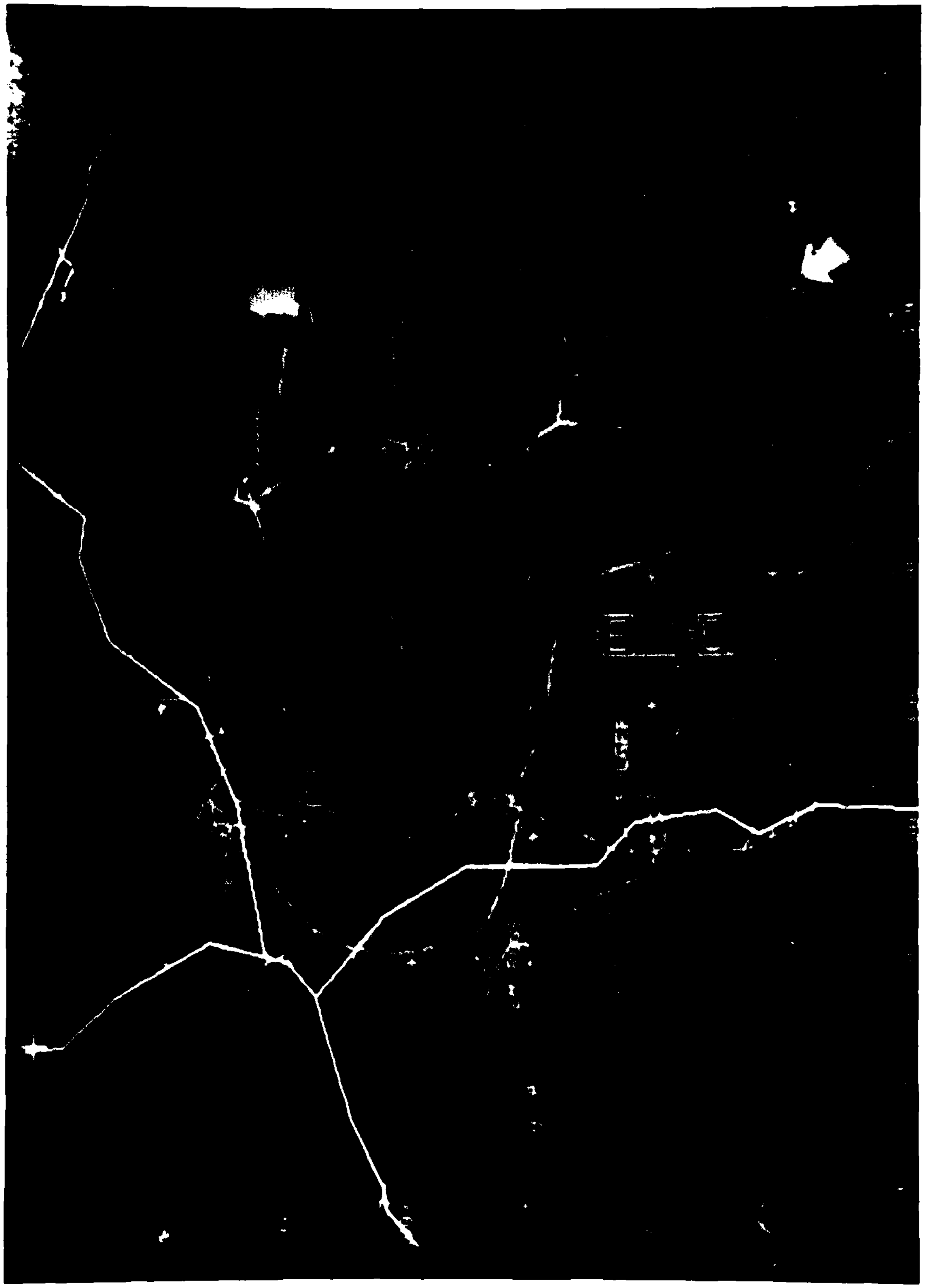


Figure 4.2-3 Snapshot A2

A force en route to a new position in march formation is shown with an arrow symbol for location and direction and a flag symbol to denote unit type and echelon. The point of the arrow is the location of the head of the formation at snapshot time. A solid arrow denotes the head of the main body of each column. A force that has reached a stationary position which it is expected to occupy for several hours is shown only by a flag symbol indicating location, type unit and echelon. The lower left corner of the symbol is the current location.

In snapshot A2, the stationary engineer force has reached a position close to the line of contact; it is reconnoitering and executing preparatory river crossing operations. The two moving artillery regiments at the left are non-divisional units en route by road to their final firing positions. The column heads are approaching the points at which they will move off the road and deploy into their firing positions.

The moving tank battalions are the advanced guard battalions which are approaching their deployment lines 8 kilometers from the line of contact. Close behind the advanced guard columns are the Division Artillery Groups (DAG) still on the road.

The solid arrows with tank regiment symbols are the lead regiments of the division main forces which have progressed sufficiently far that their column rear guards have cleared the rear assembly areas.

4.2.3 Event Matrixes

Figure 4.2-4 shows the event matrix associated with Snapshot A2. An event matrix consists of a series of key events and indicators which can doctrinally be predicted to follow closely the snapshot point and occur prior to the next snapshot. It is displayed on the alphanumeric CRT.

EVENT MATRIX A2

SEQ #	EVENT NAME	DESCRIPTION	HOURS (0 1 2 3)	NAI	COORD
A2-1	VEHICLE COLUMN	25 VEHICLES PASSING JUNCTION US22 AND US35 (102 TD/DAG)	XX	A2E1	PL475935
A2-2	PATROL ACTIVITY	INTENSIFIED PATROL/RECCE VICINITY FEBA	XX	A2E1 A2E3	PL325960 PL360580
A2-3	BRIDGE EQT	PONTON BRIDGE EQT ENTERS REGT SUPPLY WEST OF I20/US22	XX	A2E1	PL365940
A2-4	VEHICLE COLUMN	MOVING SOUTHWEST ON I20 - TURNING SOUTH ON SECONDARY ROAD EAST OF GRANBURY	XX	A2E1	PL405990
A2-5	TRACK LOSS	10 VEHICLE GRP MOVING NORTH-WEST ON IS222 (130 MM REGT DEPLOYMENT)	XX	A2E1	PL335865
A2-6	WEAPONS MOVED	A/D WEAPONS INSTALLATION 102 TD REAR ASSEMBLY AREA REMOVED	XXX	A2E4 A2E5	PL880800 PL860730

Figure 4.2-4. Event Matrix A2

Individual events are defined in terms suitable for rapid tasking of collection systems available to the division or corps TOC. Individual events would normally be expressed at the level of indicators--mover columns at key turns and at key phase lines; key radars; key command posts--rather than at the level of complete units or force elements as are expected to be seen on the current military situation screen.

A key indicator in event matrix A2 is labelled A2-3. This event deals with the expected arrival of bridging equipment in the supply area of one of the 102nd TD regiments, west of the junction of highways I20 and U.S. 22. The event matrix data includes an anticipated time window at which the event should follow Snapshot A2. It includes the named area of interest (NAI) identification and includes a coordinate location in the vicinity where it is anticipated the supply area will be located. Each event is defined similarly.

4.2.4 Event Templates

Figure 4.2-5 is the event template for snapshot A2. This graphic at a 1:250,000 scale shows the numbered NAI circles to scale. Each circle clusters a group of event matrix items that are expected to occur there. The analyst can query the system to find out which events are expected in which NAI. Each event in the event matrix references a NAI. Thus, the event template represents a geographic version of its event matrix.

4.2.5 Situation Templates

Figure 4.2-6 is a situation template associated with snapshot A5 in the double envelopment option. It is a template of the area of the main attack by the northern division forces at attack time. Four tank battalions (two from each lead regiment) are in combat formation at the

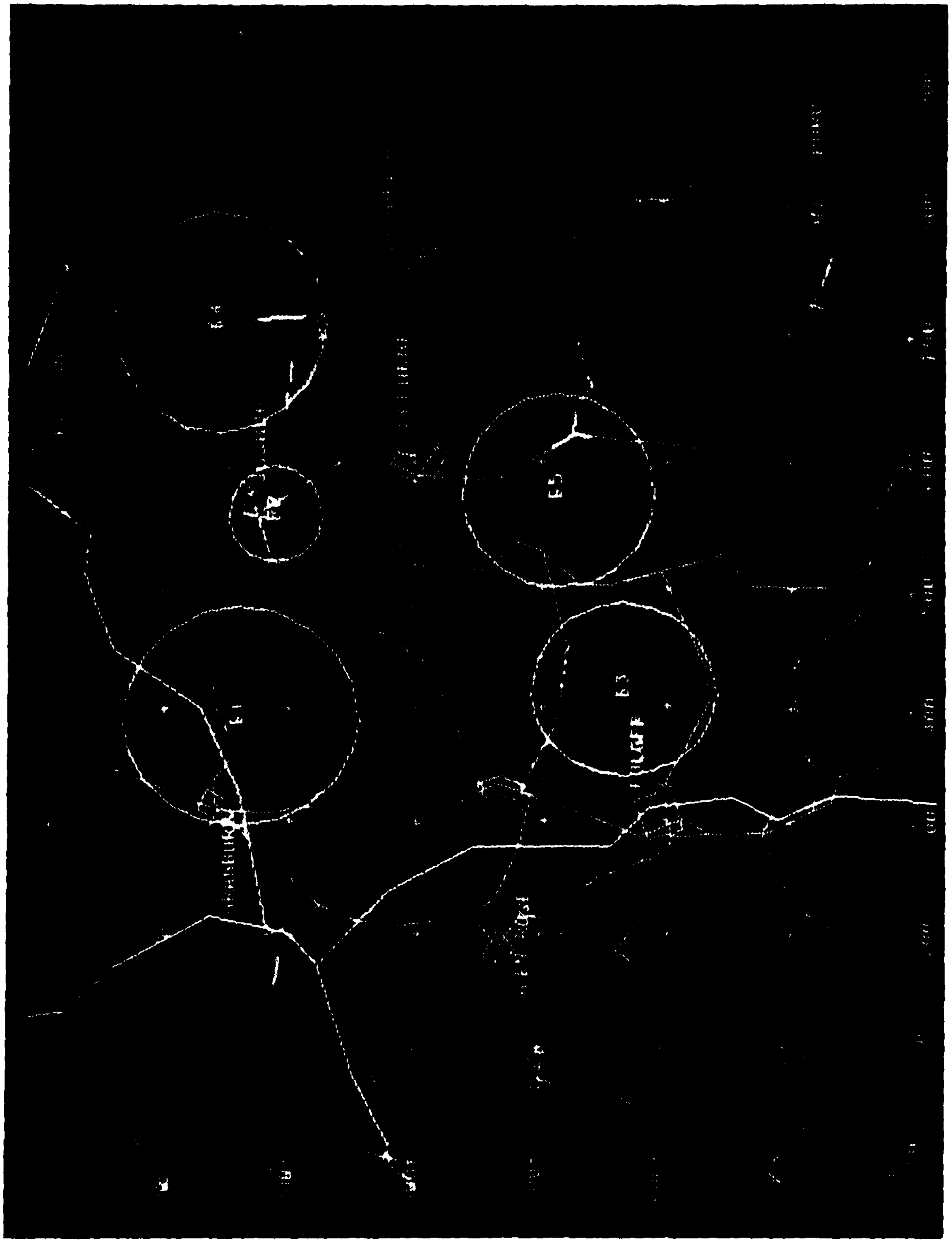


Figure 4.2-5 Event Template A2

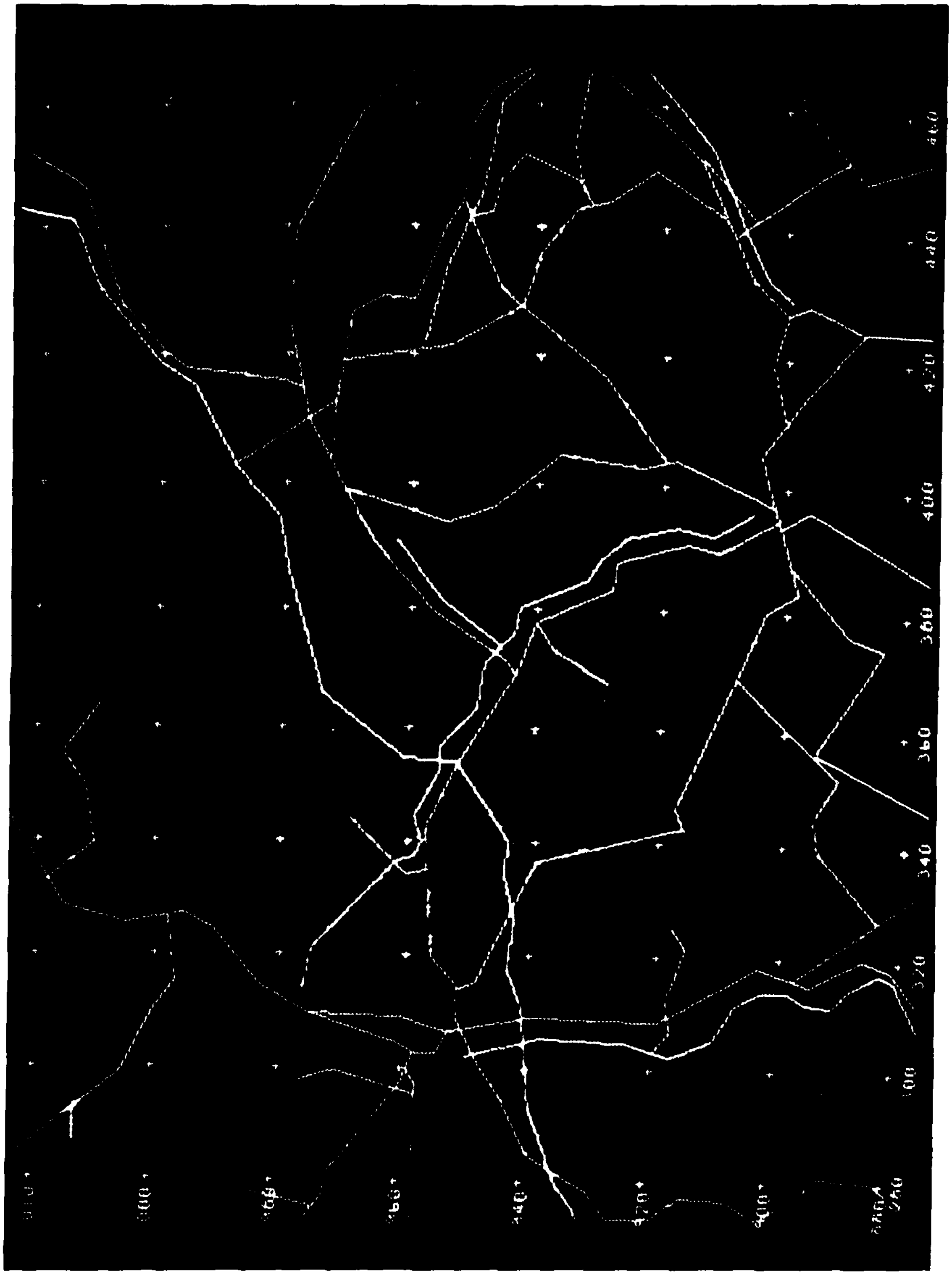


Figure 4.2-6 Situation Template A5T3

attack line. Each battalion is symbolized as a pointed rectangle which is drawn to scale and encloses a ground area 1.5 kilometers wide and 3 kilometers deep. Immediately following are two more battalions which completes the inverted wedge formation of the two tank regiments. Behind these are the division's two second echelon regiments, the moving tank regiment in the upper right corner and the moving MRR in the lower right. These regiments have reached the deployment line and are commencing their deployment into pre-combat formation just as the lead regiments initiate the main attack.

Situation templates are prepared at a scale of 1:50,000. MGR coordinates are shown as in snapshots. There will usually be several situation templates associated with a single snapshot. A situation template may deal with anticipated movements or events occurring anywhere in the enemy battle area.

In the IPB planning phase situation templates are selected to highlight the force configurations that uniquely differentiate one option from any other option. Unique items are differentiated by color on the display screen. Situation templates show forces that belong to the existing first echelon as well as forces of the 2nd echelon that are common to more than one option in red; the elements of the scene that are option differentiators are in magenta.

Maneuver forces beyond the deployment line are shown at the battalion level. They are displayed as arrows drawn at near actual scale size. Maneuver forces which have not reached the deployment line are shown at the regimental or higher echelon using the same arrow symbol for location and direction and an attached flag symbol for type and echelon as used in snapshots.

Artillery and missile forces on situation templates are shown at battalion level if deployed in their firing positions or if beyond the maneuver force deployment line. Otherwise, they are shown as standard arrows and flag symbols at regiment level. Special areas are depicted by an irregular shaped amoeba with the appropriate symbol for maintenance, POL or supply.

Figure 4.2-7 is a situation template associated with snapshot A2. This template shows two regimental columns moving along highways north of Alvarado. These are the leading tank regiments of the 102nd Division when they have travelled sufficently far from the assembly area to indicate the commitment of that division. The string of ovals (the symbol representing "movers") is scaled to represent column length of a regiment. The head of the arrow is placed at the estimated location of the head of the column at snapshot time.

4.2.6 Doctrinal Templates

Doctrinal templates for the various types and echelons of forces are available to the analyst, some drawn to a 1:250,000 scale, some to a 1:50,000. These are prepared for forces in various stages of combat including marching, pre-combat, river crossings and offensive and defensive combat operations.

Figure 4.2-8 is a doctrinal template of a motorized rifle regiment in a breakthrough attack. It shows two lead motorized rifle battalions abreast, each configured with supporting artillery, air defense and anti-tank elements. Each battalion on line occupies a ground area 4 kilometers wide by 3 kilometers deep. As the attack is mounted the frontage jointly occupied by the two battalions narrows to 2 to 4 kilometers. Following the lead battalions are a third motorized rifle battalion and the regiment's tank battalion minus one tank company which is attached to the on-line battalions.

AD-A082 442 IBM FEDERAL SYSTEMS DIV ARLINGTON VA F/G 15/4
INTELLIGENCE PREPARATION OF THE BATTLEFIELD (AUTOMATED) IPB(A).(U)
FEB 80 DAAK21-79-C-0040

UNCLASSIFIED NL

2 of 2
AD
A082442

END
DATE
FILMED
5 80
DTIC

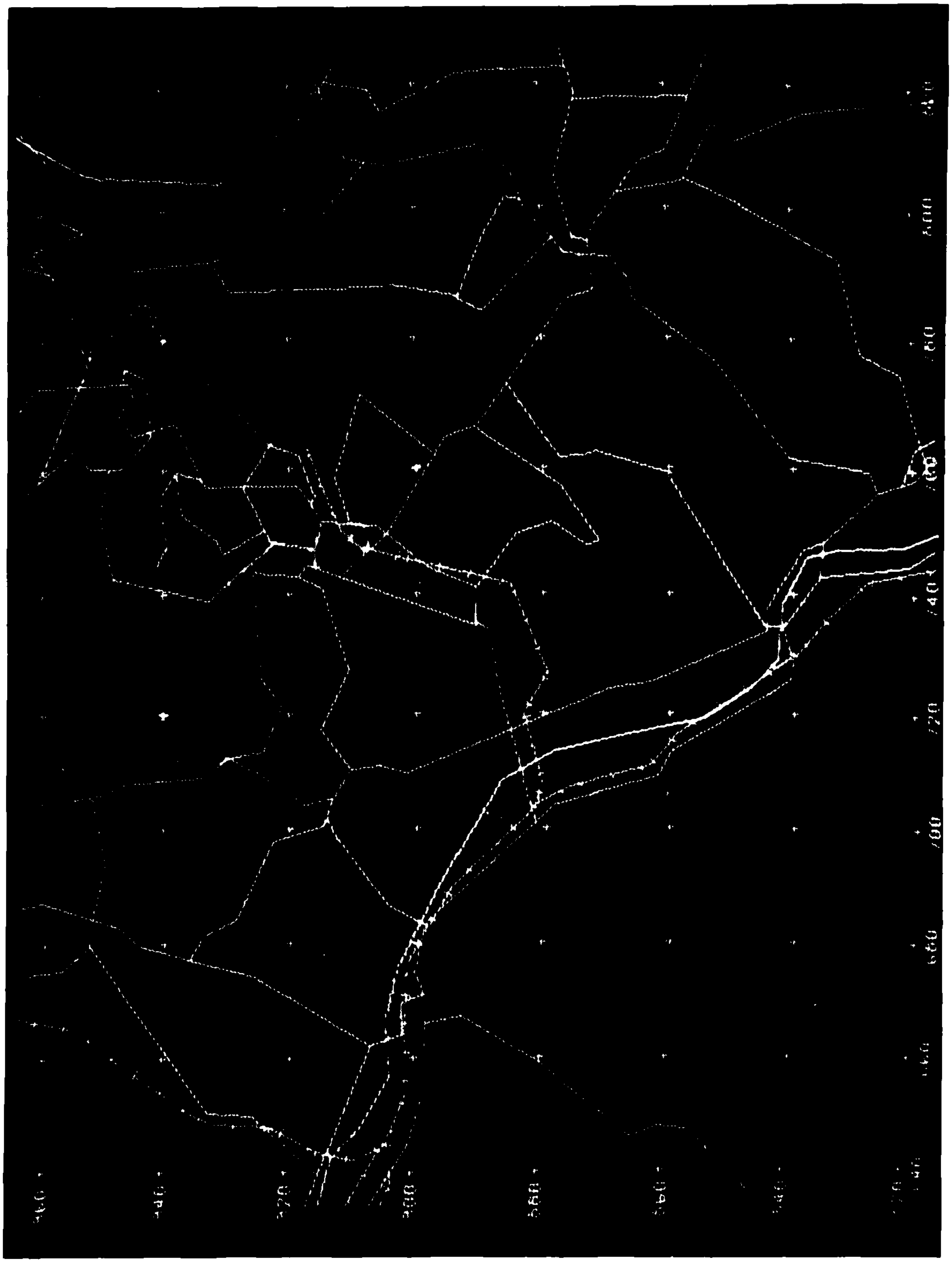


Figure 4.2-7 Situation Template A2T5

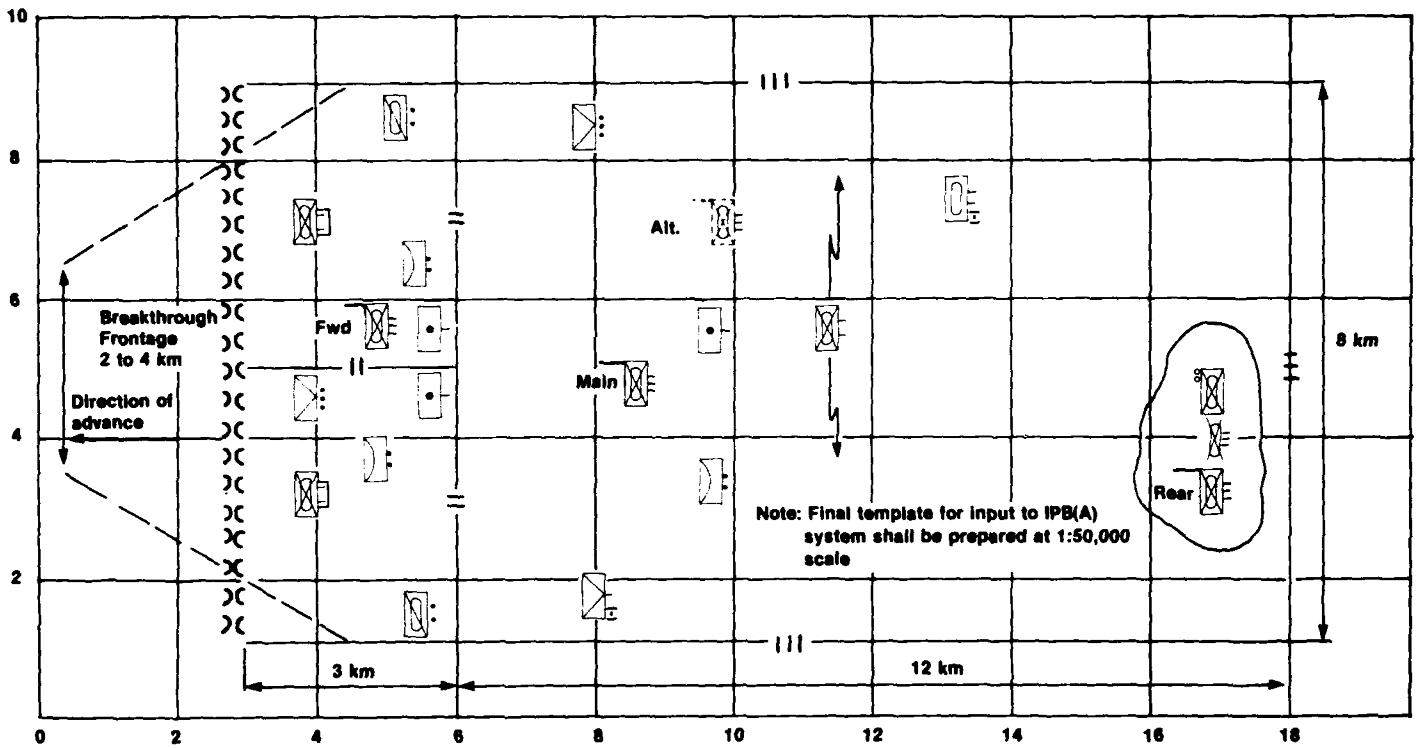


Figure 4.2-8. Doctrinal Template - Motorized Rifle Regiment in a Breakthrough Attack

This template is layed out on a grid at a 1:50,000 scale. Approximate spacings of units and major boundary dimensions are indicated. The IPB analyst by positioning this template on analyzed mobility corridors, can interactively select and relocate individual units to produce the situation template.

Figure 4.2-9 is a doctrinal template of a motorized rifle regiment in a movement to contact. It shows the regiment in three elements--an advanced detachment, advanced guard and main body--with approximate distances between them and overall road distances indicated. The template is layed out on a grid at a 1:250,000 scale. This type template would be used by the analyst in constructing snapshots early in an option which involve large second echelon force movements along roads in the rear area.

4.2.7 Target Matrixes/Templates

Figure 4.2-10 shows a typical target matrix associated with Snapshot A5. A target matrix consists of a series of potential high priority targets and target areas which can doctrinally be predicted to follow closely a snapshot point and occur prior to the next snapshot. It is closely related to the corresponding event matrix/event template but with emphasis towards conveying planning information to the Fire Support Element in the TOC.

Individual target areas are defined in terms suitable for communication to the Fire Support Element. Individual target areas selected are those which if successfully interdicted have the greatest effect in disrupting and blunting the enemy's main attack by denying his forces the most vulnerable corridors and key strong points.

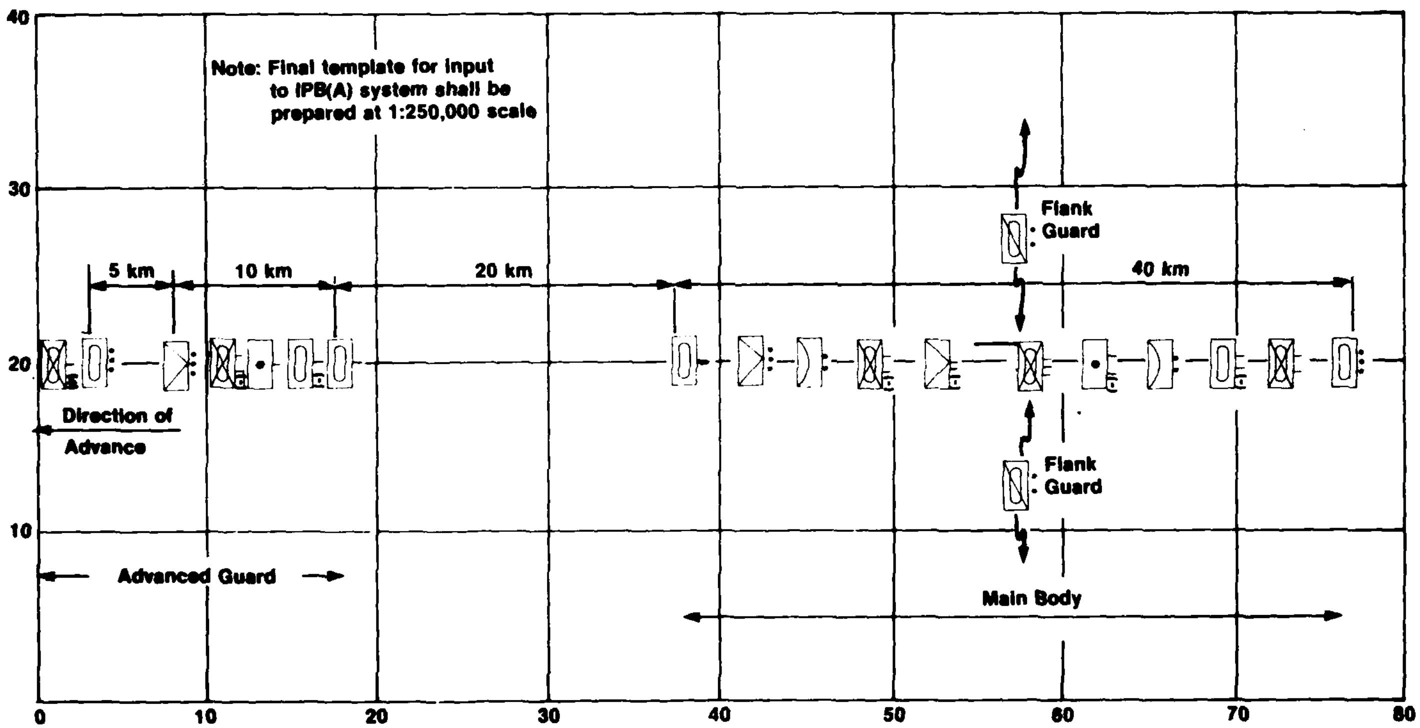


Figure 4.2-9. Doctrinal Template - Motorized Rifle Regiment in Movement to Contact

TARGET ANALYSIS MATRIX - A5

PG 1 OF 2PGS

TGT SEQ #	TARGET TYPE	TARGET DESCRIPTION	PERM	HOURS 1	2	3	VICIN	TAI	WRTH	WPNSYS ASSIGN
A5A1	EMIT	ARTY BTRYS	STA	X			PL350940	A5A	20	FA
A5A2	SHOOT	ARTY BTRYS	STA	X			PL350930	A5A	20	FA
A5A3	MOVE	TRP/VEH CON CENTRATION	CONT MOVE		X		PL365910	A5A	30	
A5A4	MOVE	TRP CONCEN- TRATION	EXP STOP		X		PL340980	A5A	10	AIR
A5A5	EMIT	MET RADAR/ ROCKET MSL POSITION	STA	X			PL380835	A5A	30	JAM
A5B1	EMIT	ARTY BTRYS	STA	X			PL310690	A5B	10	JAM
A5B2	MOVE	TANK CONCEN TRATION	EXP STOP		X		PL390580	A5B	10	FA
A5B3	EMIT	RGT CP	EXP MOVE	X			PL380920	A5B	10	INTCPT

Figure 4.2-10. Target Analysis Matrix Example

One of the high priority targets in target matrix A5 is labelled A5A3. This target event deals with the expected movement of a combined arms force through the choke point of a key mobility corridor. The target matrix data includes an anticipated time window at which the target event should follow Snapshot A5. It identifies the target area of interest (TAI) and includes coordinates defining the choke point's location. It shows as well certain critical target parameters including target type, permanence and worth. Also indicated is a preliminary weapon assignment made in accordance with the commander's rules of engagement.

Figure 4.2-11 is the target template for Snapshot A5. This graphic at a 1:250,000 scale shows the TAI circles to scale. Each circle encompasses a group of target matrix items that are expected to occur there. The analyst can query the system to find out which target events are expected in which TAI. Each target event in the target matrix references a TAI.

In the IPB planning phase target matrixes/templates are prepared in skeleton form; detailed terrain mobility/intervisibility analysis to determine likely locations would be limited. Detailed analysis to locate target events and fix time windows thus completing the matrixes/templates is performed after enemy intentions have been perceived and the intelligence estimate is made.

4.2.8 Decision Alternative Templates

For each predicted enemy course of action, one or more friendly maneuver/fires counterplans are prepared for the commander's consideration. These plans when summarized in graphic display form are designated as decision alternative templates.

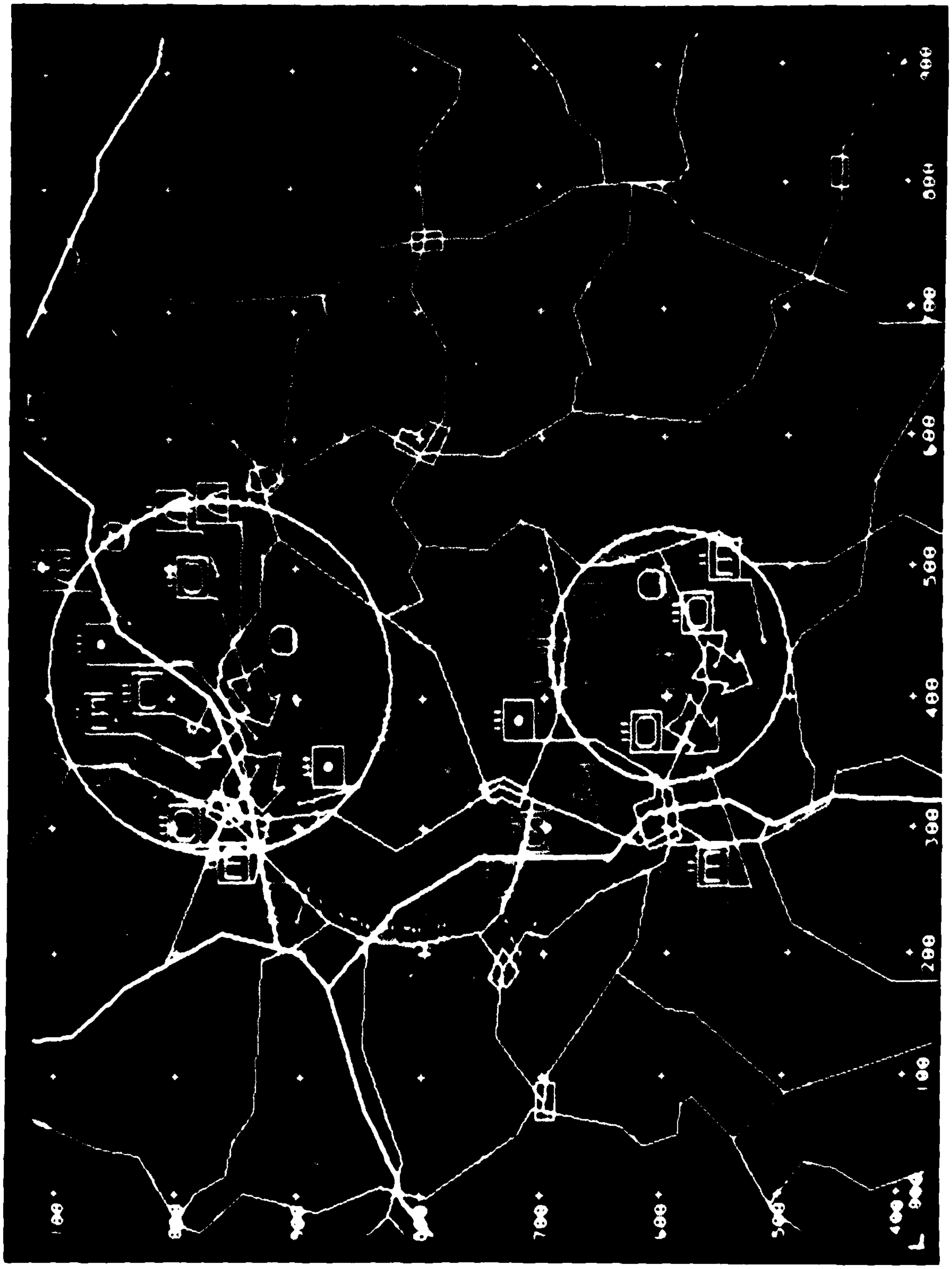


Figure 4.2-11 Target Template Example

A sample decision alternative template at 1:250,000 scale is shown in Figure 4.2-12. On the enemy side are shown predicted force locations taken from the pre-built snapshot which is updated as necessary to reflect real time changes of force size and attack corridors as inferred from current situation developments. On the friendly side are shown friendly unit boundaries and the forces within these boundaries in two color categories to signify their disposition status at template time. These categories are:

Color	Disposition Status
Blue	Units currently in position and planned positions which by mobility analysis are achievable in the available time
Cyan	Shortfalls. Planned positions which by mobility analysis cannot be achieved in the available time.

The time available between time of detection and projected time the enemy will reach the attack line represented on the template is annotated on the graphic screen. The graphic may also indicate, in addition to the attack line, various phase lines and other military boundaries/features of key interest.

The analyst uses this template to compute combat power ratio based on projected blue force maneuver achievability. By preparing decision alternative templates and combat power ratios at several phase lines, the G-3 staff planners can brief the commander in terms of comparative terrain attributes, combat power ratios and risks thus preparing him to make his assessment and decision.

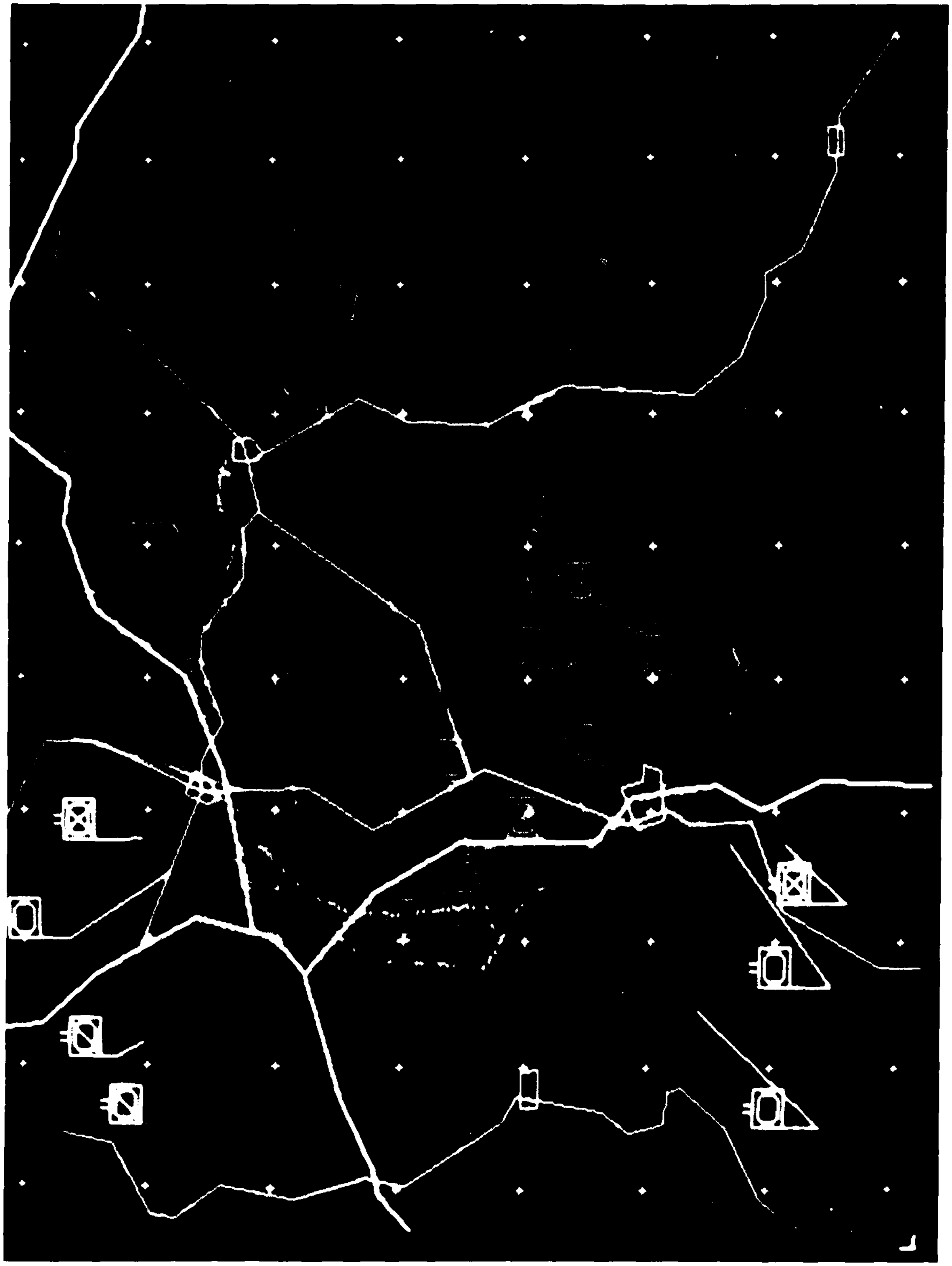


Figure 4.2-12 Maneuver Decision Alternative Template Example

In the IPB planning phase decision alternative templates for maneuver and fires are prepared in skelatal form and emphasize gross allocation of friendly forces to satisfy the commander's guidance as to desired combat power ratios by sector. The detailed terrain analysis for placement of units and mobility analysis to determine achievable maneuvers and more precisely construct the templates and validate maneuver achievability is performed in the course of hostilities at a time when the enemy's intentions have been perceived and the intelligence estimate is made.

4.3 IPB PRODUCT UTILIZATION BY G-2

4.3.1 G-2 Utilization Process

Figure 4.3-1 is a diagram showing the way the IPB analyst uses pre-built IPB products in performing his realtime intelligence estimating function. In the upper right corner of the diagram are a group of 3 blocks indicating that the IPB analyst receives frequent updates to the current military situation picture. This picture shows enemy locations and movements at the unit level and is displayed at the IPB station on a separate monitor. The IPB analyst can cause a situation update to appear on his current situation monitor, and can cause it to be scaled to match his IPB products.

When he receives a current situation update, he will normally position the cursor (on the IPB graphic monitor) close to a newly reported activity of interest and ask the system to display on the alphanumeric screen, a list of all prestored situation templates which contain the identified point. Figure 4.3-2 depicts an alphanumeric response. He compares prestored situation templates with similarly scaled areas on the current situation screen. He looks for

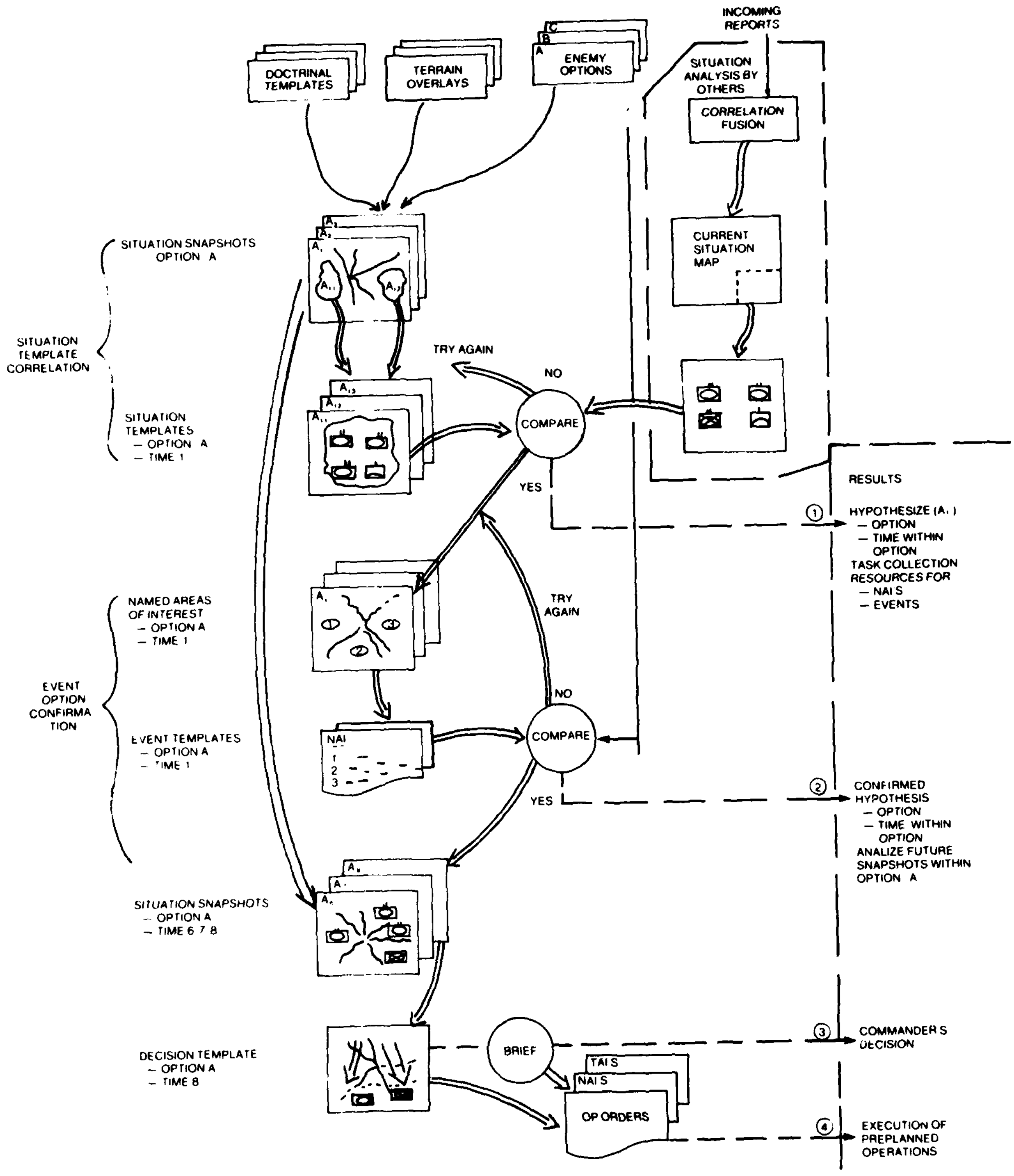


Figure 4.3-1. IPB Realtime Intelligence Estimate

SITUATION TEMPLATES IN FILE:

TEMPLATE #	LOCATION (LL)	COLUMN LENGTHS (KM)	
A1S5	PL450975	7.5	8
A2S5	PL425850	15	
A2S6	PL630815	25	25
B2S6	PL600750	10	25
B3S6	PL720680	40	25

Figure 4.3-2. Situation Template List(s)

approximate matches, relying on his experience and familiarity with templates and parent snapshots previously built. He repeats this process as further updates are received. He is continuously attempting to isolate the enemy option and snapshot point. When he believes he has identified an option and snapshot he attempts to confirm his hypothesis. He does this by requesting intelligence collections against the pre-planned event matrix and event template following the selected snapshot point. He also invokes automatic filters at the front end of his system to immediately route messages to his alphanumeric screen when sensor returns for specific collection requests are received.

The automatic filters also signal the analyst after a prescribed time if none of the event matrix events are detected. This allows him to terminate collection and front end filtering if he chooses.

At a point when, in his judgment, a sufficient number of events have been identified as fitting the event matrix, the analyst may choose to declare the option and snapshot point confirmed. He then analyzes additional snapshots that occur far enough in the future in the option so that friendly actions can be taken to adequately defend the attack. He may need to update the snapshots to reflect current situation, e.g., slightly different unit locations or force composition. Once satisfied that the snapshot reflects the best portrayal of enemy intentions, the analyst uses it as his "intelligence estimate." He prepares data on two or more future snapshots as a briefing tool for the G-3 staff and commander. He prepares tradeoff data dealing with factors such as characteristics of terrain for defense versus combat power ratio obtainable in the time before the attack. He prepares data detailing required friendly force movements and timings. Alternates are briefed to the commander for his final decision.

approximate matches, relying on his experience and familiarity with templates and parent snapshots previously built. He repeats this process as further updates are received. He is continuously attempting to isolate the enemy option and snapshot point. When he believes he has identified an option and snapshot he attempts to confirm his hypothesis. He does this by requesting intelligence collections against the pre-planned event matrix and event template following the selected snapshot point. He also invokes automatic filters at the front end of his system to immediately route messages to his alphanumeric screen when sensor returns for specific collection requests are received.

The automatic filters also signal the analyst after a prescribed time if none of the event matrix events are detected. This allows him to terminate collection and front end filtering if he chooses.

At a point when, in his judgment, a sufficient number of events have been identified as fitting the event matrix, the analyst may choose to declare the option and snapshot point confirmed. He then analyzes additional snapshots that occur far enough in the future in the option so that friendly actions can be taken to adequately defend the attack. He may need to update the snapshots to reflect current situation, e.g., slightly different unit locations or force composition. Once satisfied that the snapshot reflects the best portrayal of enemy intentions, the analyst uses it as his "intelligence estimate." He prepares data on two or more future snapshots as a briefing tool for the G-3 staff and commander. He prepares tradeoff data dealing with factors such as characteristics of terrain for defense versus combat power ratio obtainable in the time before the attack. He prepares data detailing required friendly force movements and timings. Alternates are briefed to the commander for his final decision.

These future snapshots, modified to include current knowledge of enemy intent and friendly defensive options, form the basis for the decision support template.

4.3.2 Current Situation Graphic

The approach initially taken for viewing the current military situation graphic has been to display it on a separate monitor at the IPB analyst's station. The analyst compares the current situation picture and the situation template on side by side screens.

An alternative is to provide system controls and graphic screen capacities that would enable the display of both pictures superimposed on the same screen. Color coding and/or blinking would be used to differentiate them. This alternative should be helpful to the analyst in making accurate comparisons. A disadvantage is the potentially higher cost of providing the more complex system controls and larger screen capacities.

A further alternative is to provide system controls that would enable display of both the military situation graphic and the templates on the same screen but not superimposed simultaneously. The analyst by operating a selector switch would alternately call and delete the two pictures to make a comparison between them.

Further experimentation is planned with these alternatives, as part of the field test.

4.4 OVERVIEW OF IPB PRODUCT BUILD PROCESS

Real time utilization of IPB products by the G-2 analyst requires preparation of these products prior to the commencement of an enemy operation. Product building may be accomplished in peacetime for the initial battle, but may also be accomplished in near real time 24 to 48 hours before additional enemy initiatives. The IPB build process supplements the normal staff planning process at corps and division levels.

Figure 4.4-1 depicts schematically the building of Snapshots, event matrixes, event templates and situation templates. It is an interactive process with the G-2 analyst using a keyboard, a graphic display and an alphanumeric display plus some functional software. Doctrinal templates are one of the first tools used to construct other templates and will have been prepared well in advance. Basic enemy attack options including standardized snapshot lines would have been templated to the scale of map/terrain background displays.

Step one of the build process is to overlay the option doctrinal template on a 1:250,000 scale map background display. General areas/ routes are evident and they lead to specific route selection. The most feasible routes for the enemy to use are developed using the mobility corridor rating technique described in Section 3. Terrain mobility ratings for the routes selected and enemy movement doctrine enter into route timing computation algorithms which produce the timelines for each movement column for each option. The analyst selects from the timeline the relative time for each snapshot and constructs a Snapshot Lines Template (see Figure 4.2-2 of Section 4.2.1).

ENEMY TEMPLATING

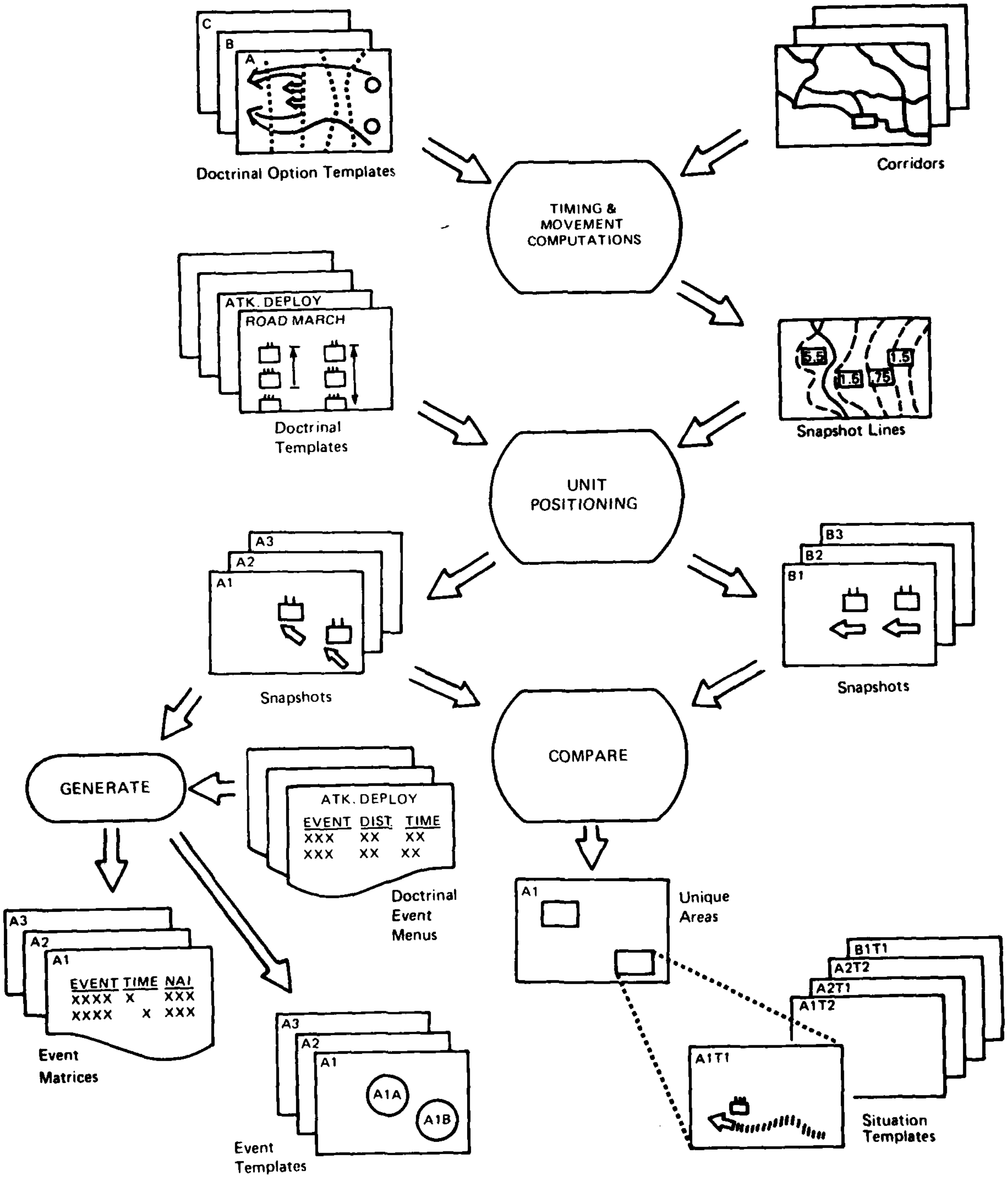


Figure 4.4-1. Enemy Templating

By interactive, automated support the analyst constructs each snapshot on the graphic terminal using a unit positioning algorithm, doctrinal templates, terrain displays, as well as doctrine and the predefined routes. Snapshots are built using a 1:250,000 scale which gives a viewing area of 100 by 75 kilometers. Generally regimental size units are plotted except for special types of battalions. Automated graphics enable the analyst to select the desired symbology and position it on the display screen thereby creating a snapshot. Choice of colors permits the analyst to differentiate between and highlight the symbols which represent the units of interest in that snapshot.

Event matrixes are generated by comparing one snapshot to the following, using enemy doctrine and the specific route/terrain features to determine detectable events and their probable locations. Doctrinal event menus prepared in advance which itemize likely events by action type are used by the analyst to make the preparation of event matrixes more efficient. The event matrix is built on the alphanumeric terminal and stored for future use. The corresponding event template is built on the graphic terminal by causing the system to display events on a map background, and circling groups of individual events.

Situation templates are built online interactively also. Snapshots developed for the same geographic area and scale are compared using a machine assisted technique for symbol matching. Snapshot A1 is compared to all other snapshots of all options. Areas of unique enemy activity/unit locations are marked for situation templating, shown in Figure 4.4-1. Each area is developed separately at a 1:50,000 scale and becomes a sitution template. More detail is included in the situation template than shows on the snapshot (e.g., battalions rather than regiments and more terrain features). The technique for constructing the situation template is similar to that used to build snapshots. Again, use of different colors allows highlighting the unique configurations against the total picture of all units anticipated to be in the field of view.

4.5 G-3 USE OF IPB PRODUCTS

Effective use of terrain, weather and intervisibility is applicable to planning for the blue as well as red forces. IPB products, terrain and mobility corridor analysis and templates are useful to the G-3 staff also. Figure 4.5-1 illustrates in general how decision support templates are built as aids in the preparation of the commander's operation order or plan. The illustrated process depends upon G-2/G-3 collaboration beginning with the selection of a snapshot which shows the enemy situation plot at the time appropriate for blue force counteraction. The snapshot would be selected upon completion of the intelligence estimate described in Section 4.3.1 above. In this process the snapshot is updated for currency as required by the G-2 analyst.

Toward determining feasible blue force actions in response to predicted red force configurations, the effects of the current and/or forecasted weather are used by the G-3 analyst to update the terrain mobility and intervisibility corridors. The methods for inputting weather effects data to cause the rerating of ground mobility and intervisibility mosaics for weather are discussed further in Section 3.3 of this report. Input of the blue force situation is obtained from the current situation and force status data. Relocation of friendly forces to meet the expected threat is analyzed by seeking the optimum mobility corridors and computing transit times just as movement of red forces was analyzed to build snapshots. The G-3 staff officer can thus evaluate the feasibility of one or more schemes of maneuver--i.e., is there sufficient time to execute?

Similarly, the Fire Support Element can perform analysis of possible reallocation/relocation of FA units. The intention is again a measurement of feasibility of alternatives rather than exact positioning of firing batteries or assignment of a specific target to a specific firing unit. The interim products generated in this manner are referred to as decision alternative templates.

IPB PRODUCTS USE BY G3

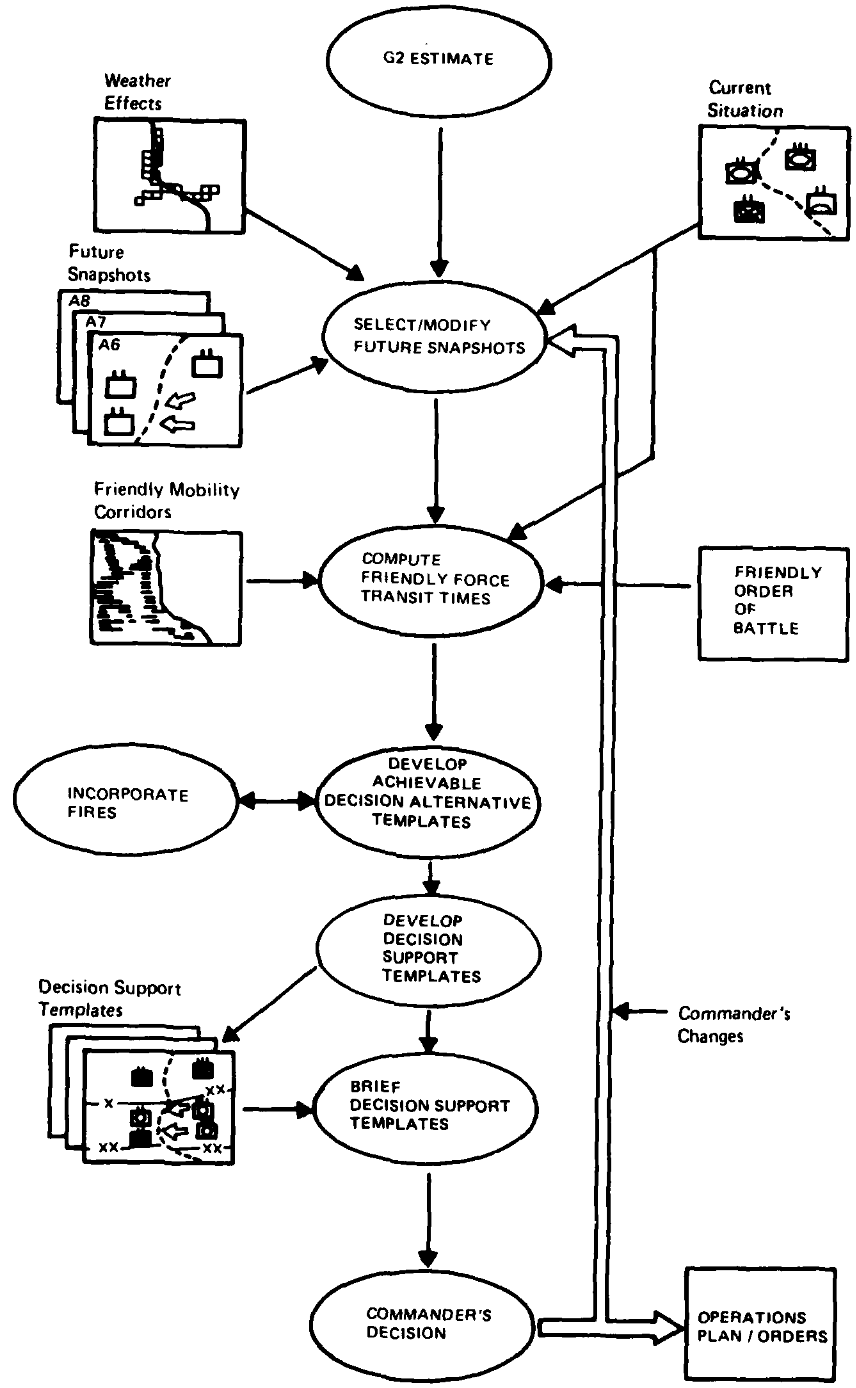


Figure 4.5-1. IPB Products Use by G-3

The IPB interactive terminal capability is used to draw lines for boundaries of areas of responsibility and to build symbols representing blue forces and to position them just as snapshots were built. Thus, friendly force deployment can be planned similarly to red force deployment. The result is one or more decision alternative templates. Each of these templates portrays the enemy unit locations as predicted by the G-2 staff and the friendly unit locations desired to defend against that predicted force configuration. The decision alternative templates are constructed during hostilities once enemy intent is discerned. They utilize snapshots as a starting point, and are constructed interactively.

More specific illustration of use of IPB products to support operations planning by the G-3 (maneuver) staff officer is shown in Figure 4.5-2. Selection of the snapshot from the blue force viewpoint is predicated upon picking the most opportune situation for countering the enemy deployment. Then a more detailed analysis is conducted using situation templates associated with that snapshot. The snapshot/situation templates providing blue force information and the intelligence estimate showing the red force are the inputs to automated assistance for combat force ratio analysis. The ratio corresponding to the planned blue force situation versus predicted red forces is determined, and the number of blue combat forces necessary to meet a doctrinal ratio (or as input by the analyst) is calculated for the attack area. Adjustments are made to the planned blue force graphics accordingly.

Terrain features (modified as necessary for weather) and intervisibility are used to position the required number of friendly units most advantageously to meet the enemy threat. The result is a template with the optimum number of friendly units plotted--i.e., the completed scheme of maneuver without regard yet to availability of friendly forces.

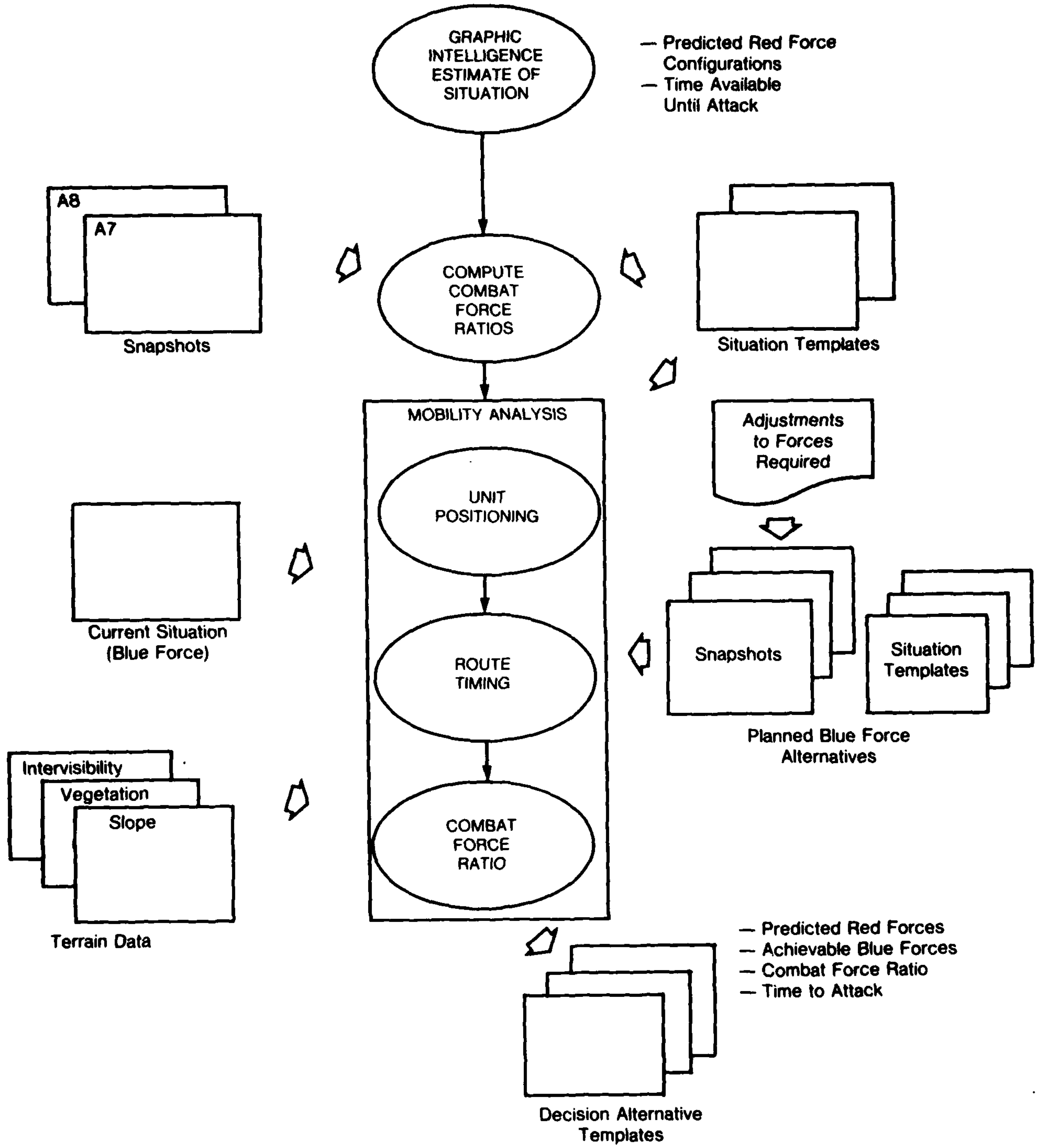


Figure 4.5-2. Operations Planning - Maneuver

The same IPB capability used to compare snapshots to current enemy situation display (Section 4.3.1) can be employed to compare this optimum maneuver position template with current friendly situation display. The result is rapid identification and elimination of units already positioned to meet the scheme of maneuver. What remains are units that are available to move to new, optimum positions.

Mobility analysis is performed to determine best routes and time required. The route timing process is used to produce a timeline profile from a unit's present position to its planned future position. The technique accounts for doctrinal movement rates and terrain conditions as affected by weather. It is used to calculate rate of movement along cross-country corridors, roads and river and stream crossings. Figure 4.5-3 is an example of the displayed results of a route timing calculation.

Infeasible movements or insufficient available forces to meet requirements for a given alternative are indicated as shortfalls on the graphic by blinking the unit symbols not possible to achieve within the available time. The combat force ratio is recomputed to reflect what units can be deployed into the planned locations. The overall result is the achievable maneuver situation referred to as the decision alternative template (see Figure 4.2-12 of Section 4.2.8).

Planning by the Fire Support Element responds to maneuver planning and is concurrent. Figure 4.5-4 illustrates how the IPB products could be used to support the FSE. Target development or the identification of future targets with approximate times and locations is one use of IPB. The succession of snapshots and situation templates shows where the main attack, greatest threat, more vulnerable enemy units/locations are likely to be and, combining this with the commander's guidance, may be used to place prioritization on the future targets. Target descriptions are determined from review of snapshots, event matrixes/templates

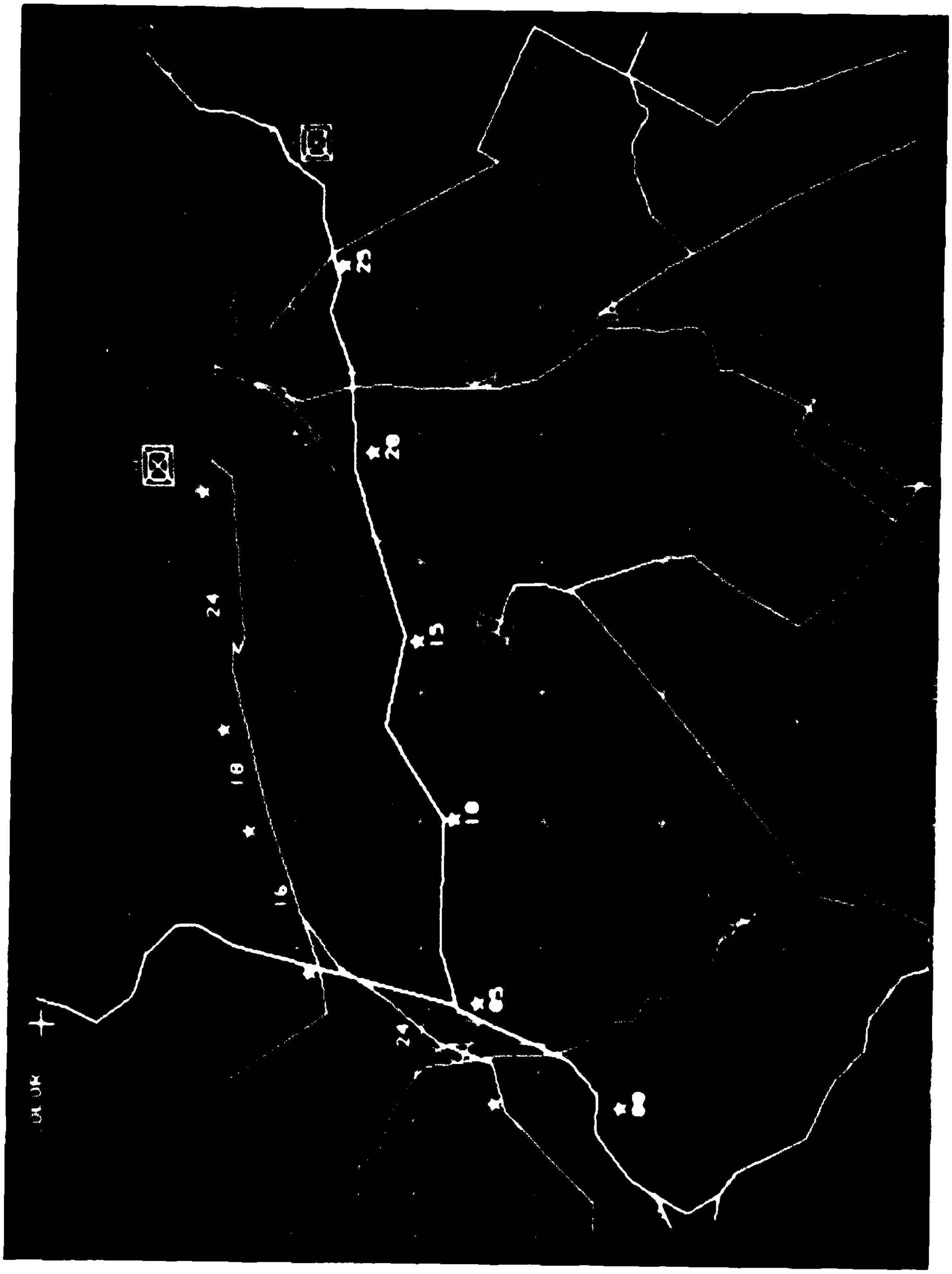


Figure 4.5-3 Route Timing Calculation Results

OPS PLANNING – FIRES

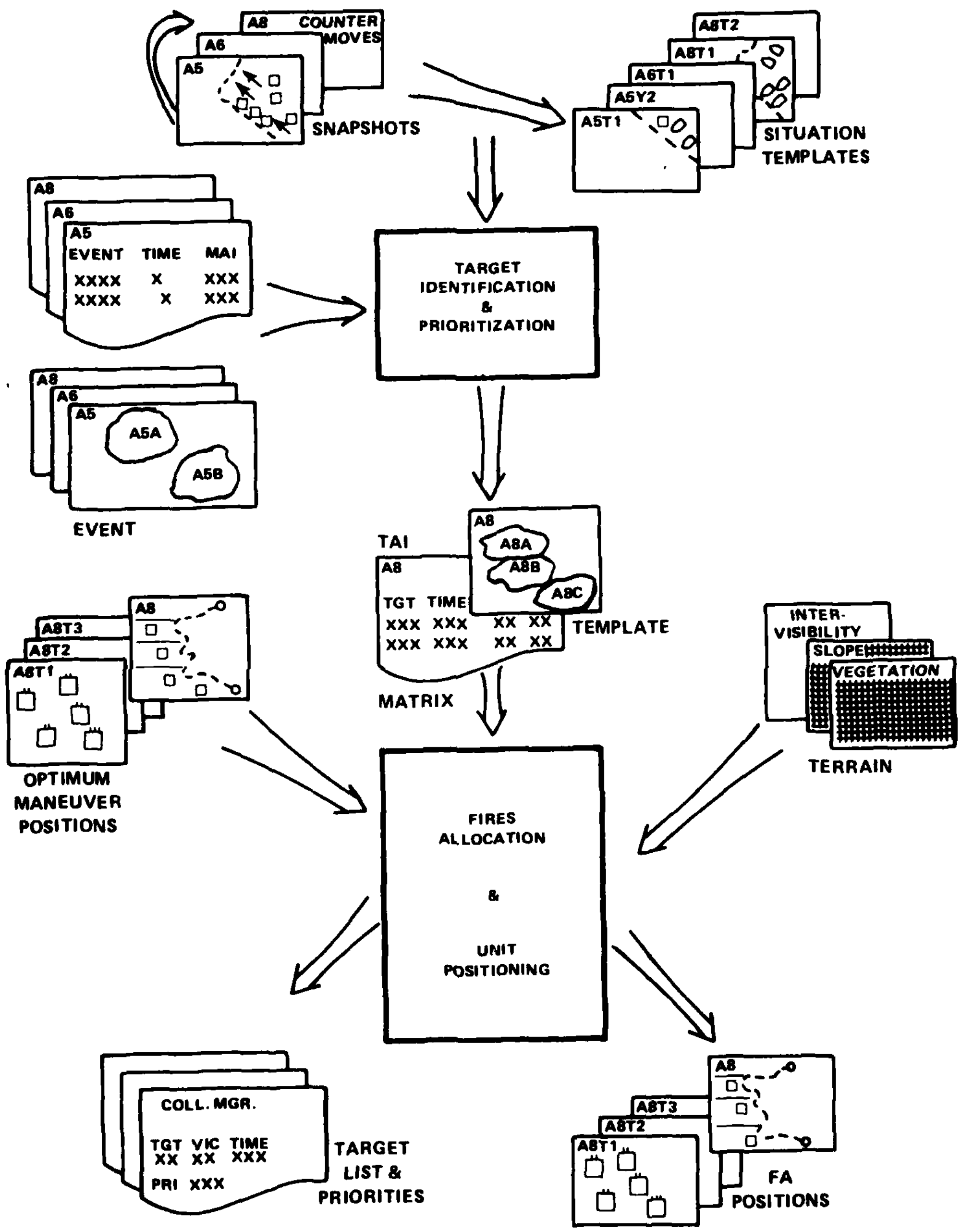


Figure 4.5-4. Operations Planning - Fires

and situation templates and knowledge of enemy doctrine. Target analysis matrixes are built on the alphanumeric terminal and target templates on the graphic terminal similarly to event matrixes and event templates.

Future target locations, terrain and intervisibility factors and the maneuver position templates are used to analyze possible optimum positioning (allocation) of blue fires units. Concentration of fire power to support the combat unit facing the main attack and coverage of the greatest number of targets are important considerations which can be included in the analysis using IPB products. A template is prepared with optimum FA unit positions which is compared to current FA unit locations. Mobility analysis is performed for the unmatched units just as was done for the maneuver units. Again, the result is a decision alternative template.

4.6 COMMANDER'S DECISION SUPPORT

The decision support template is a graphic portrayal of probable enemy courses of action and corresponding friendly courses of action. The purpose of decision support templates is to present alternatives to the commander in a manner which facilitates comparison of advantages and disadvantages such as risk, time available and combat power ratios.

The template is constructed by merging the planned routes (for the appropriate enemy options), the line of contact and military boundaries from the current situation graphics data base on a map of the area. Using one of the maneuver courses of action as represented by a maneuver decision alternative template, the analyst adds to the graphics display:

- Line(s) of defense and/or phase lines
- Time available (to execute this course of action)

- Number of units on each avenue of approach
- Combat power ratio on each avenue of approach
- Symbols generally depicting key elements of the operation, i.e., attack positions, defended areas, landing zones or drop zones.

Since decision support templates, in themselves, are not intended to present accomplished decisions to the commander, the next subfunction is to prepare one or more of these templates to the commander for his consideration and comment. The essence of each friendly course of action is presented to the commander in graphic and A/N format. The ensuing discussion between the commander, G-3 and G-2 may require modification of one or more decision support templates. The analyst will make online changes during the discussion. The results are useful graphic and alphanumeric expressions of the commander's decisions regarding operating plans.

SECTION 5. WORKSHOP DEVELOPMENT

This section will describe the work done to develop the basic workshop tools required for the demonstrations. The scenario data developed under prior programs had to be augmented as described in Section 5.1 to provide the realistic operational environment in which to demonstrate the 4-step templates. A representative portion of the demonstration sequence is described in Section 5.2. Section 5.3 covers the methods used in converting the various forms of input data comprising the demonstration materials into digitized form. These augmentations to the basic capabilities resident within the Tactical Systems Facility provided the tools required to conduct the workshop.

5.1 SCENARIO DEVELOPMENT

The following subparagraphs and their related appendices describe the TIAX Experimentation Scenario.

The TIAX scenario is based on (1) the Army's SCORES II A European situation developed by USACAC and (2) an extension to it developed by IBM in its DIVRAS contract (see DIVRAS Final Report, contract number DAAG39-77-C-0055, dated 3 August 1977 submitted to Directorate for Battlefield Systems Integration, Headquarters, USADARCOM).

5.1.1 Situation Overview

The TIAX battle is set in the Ft. Worth, Texas area. During February a series of hostile actions are taken by the aggressor forces along the international border. Joint Task Force Central Texas Command composed of 1st, 2nd and 3rd Corps is alerted to move to border defense positions as a precautionary measure. 1st Corps moves the 23rd Armored

Division and the 52nd Mechanized Division into prepared defensive positions. The 53rd Mechanized Division is placed in Corps reserve; the 171st ACCB and the 20th Infantry Division are ordered to move from Arizona.

On March 6 the aggressor attack is initiated on the central front by four enemy armies; the 12th, 5th and 6th Combined Arms Armies (CAA) and the 1st Tank Army. The main attack in the area of the U.S. 1st Corps is carried by the aggressor 1st Tank Army along with divisions of the 5th and 6th Combined Arms Armies on its flanks.

Figure 5.1-1 indicates the situation on D+2. The enemy 1st Tank Army divisions have made rapid progress along a major avenue of approach lying to the east of Granbury and running from the northeast to the southwest toward the Brazos River. The 1st Tank Army Commander on D+2 commits the 103rd Tank Division in an attempt to force a breakthrough across the Brazos River and circumvent the main defense line of the 23rd Armored.

The U.S. 1st Corps Commander has recognized this danger and committed the 53rd Mechanized Division. The 53rd Division has assumed responsibility for the FEBA on a front of approximately 30 kilometers stretching from just north of Granbury to a line 15 kilometers south of Folger. The 53rd MD has assumed operational control of the 1 BDE/52 and 3 BDE/23. The 53rd Division is on line when the initial attack by the 103 TD begins on D+2.

On D+2 the 53rd Division is faced by three aggressor divisions, the 103 TD, the 80F TD and the 15F MRD. The attack by the 103 TD on D+2 has resulted in two regiments of the 103rd being established on the west side of the Brazos River per Figure 5.1-2. Advances by the 80F and the 15F Divisions have been limited; however, the initiative has been maintained by the enemy through D+2.

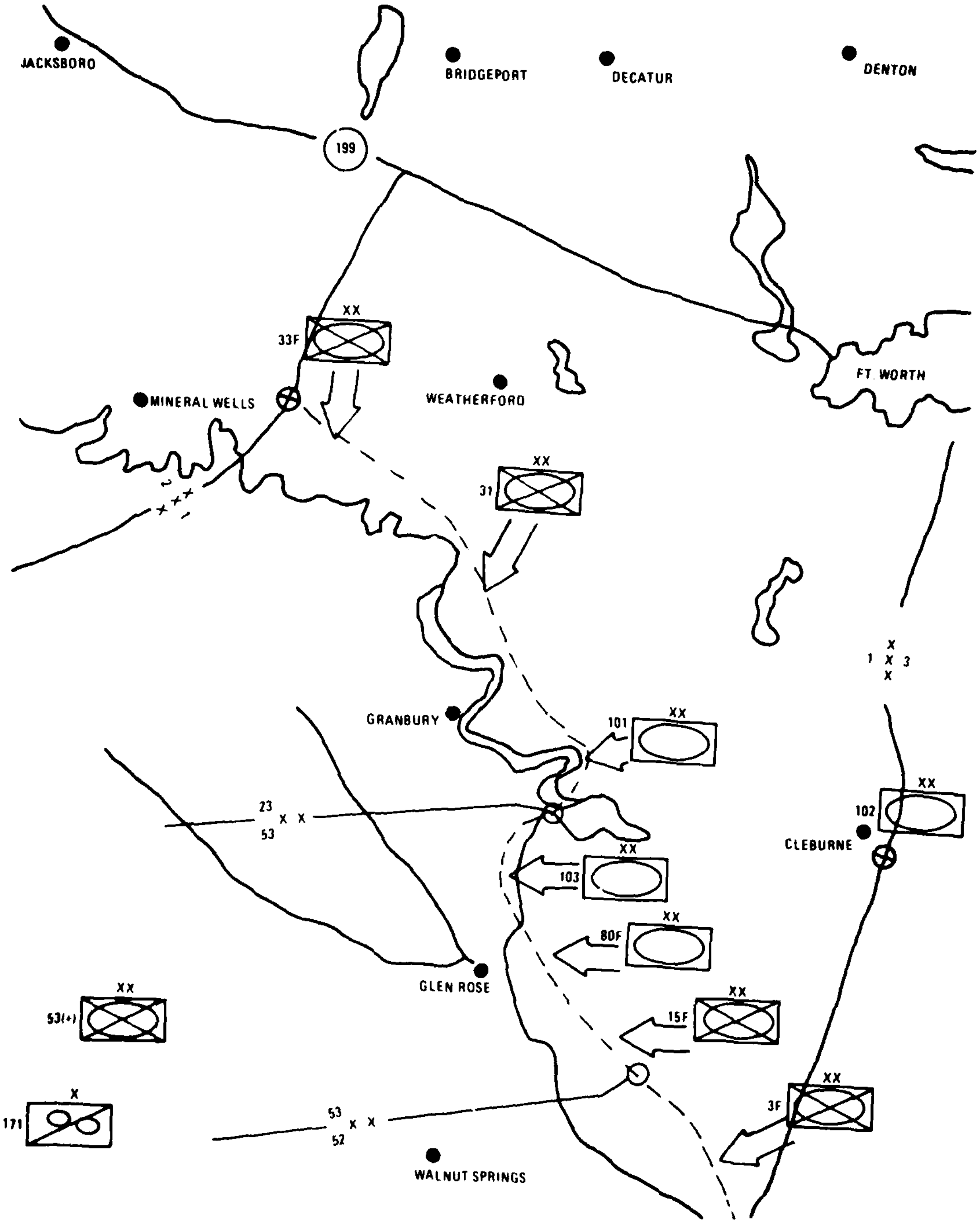


Figure 5.1-1. Enemy and Friendly Troop Disposition As of D+2

ENEMY AND FRIENDLY TROOP DISPOSITIONS AS OF D+3

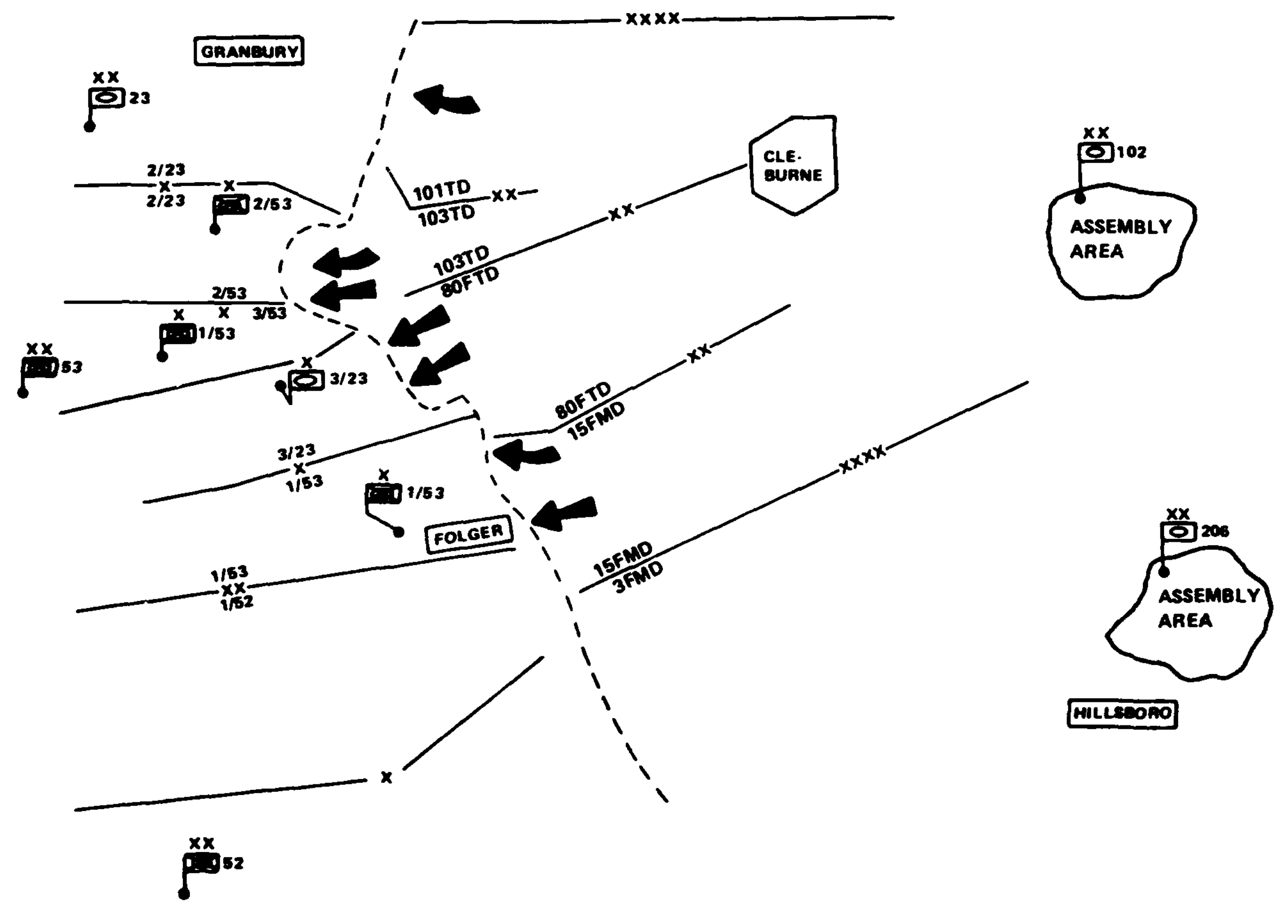


Figure 5.1-2. Enemy and Friendly Troop Dispositions As of D+3

By the morning of D+3, the 53rd Division has contained the 103rd Tank Division's attack by rapid repositioning of forces laterally. To the north of Granbury, the enemy army has maintained pressure on the 23rd Armored with the 33F and 31st Motorized Rifle Divisions. In the Granbury area the enemy 101st Tank Division has made modest advances towards the eastern approaches to the Brazos River.

The 1st Tank Army Commander on D+2 had developed further attack plans calling for commitment of his two reserve divisions to follow up the attack by the 103rd. The plans commit the enemy 102nd and 206th Tank Divisions against the U.S. 53rd Division in an attempt to overrun and destroy it before it can reconsolidate after the 103rd attack. The two options planned are a double envelopment operation or a penetration operation which are discussed further in the following paragraphs.

5.1.2 Double Envelopment Operations Plan

A principal option open to the enemy to defeat the U.S. 53rd Division is a double envelopment attack. The 1st Tank Army Commander recognizes that the U.S. 53rd Division has concentrated the bulk of its forces in the center and that the FEBA in the vicinity of Granbury and in the area southeast of Folger are lightly defended by U.S. forces. The double envelopment plan calls for the two reserve divisions to advance rapidly along major east-west road corridors, achieve river crossings in the north (Granbury) and south (southeast of Folger) and envelop retreating U.S. 53rd Division forces in the White Bluff area.

The 102 Tank Division, committed from its assembly area east of Alvarado, moves on two road nets (1) a northern route through Burleson and along interstate route I20; and (2) another route through Joshua and along highway U.S. 22. The two main columns rejoin on their deployment line 10 kilometers east of Granbury, advance and attack on an 8 kilometer front against the U.S. force defending the Brazos River crossings.

The 206th Tank Division, committed from its assembly area east of Hillsboro, moves on two road nets (1) a southern route through Hillsboro and along highways U.S. 31 and State 7; and (2) another route heading north from the assembly area and then turning west on highway U.S. 34. The two main columns rejoin on their deployment line 10 kilometers behind the line of contact, advance cross-country and attack on an 8 kilometer front against the U.S. force defending the area to the southeast of Folger.

The attacks are to be reinforced with artillery, missile and combat engineer forces attached from enemy higher echelons. Specifically, two 130 mm artillery regiments are assigned by the Front Commander and two combat engineer battalions also. If the enemy successfully surprises the U.S. 53rd Division so that no U.S. forces are repositioned, he can obtain highly favorable combat power ratios of both artillery and maneuver forces.

The enemy 103, 80F and 15F Divisions are to maintain pressure in an effort to tie up currently engaged U.S. forces in the center.

Once across the Brazos at Granbury, the 102nd Division plan calls for it to overrun the U.S. first echelon brigade position 8 kilometers to the west, advance by road and cross-country operations directly west, and then turn south to entrap the U.S. 53rd forces at White Bluff.

Once across the Brazos south of Folger, the 206th Division plan calls for it to overrun the U.S. first echelon brigade position 3 kilometers to the west, advance by road and cross-country operations directly west, and then turn north to entrap the U.S. 53rd Division forces at White Bluff.

The movements planned by the two divisions are timed so that their attacks east of the Brazos occur simultaneously and their arrival at positions from which to conduct attacks on U.S. forces at White Bluff occur simultaneously.

5.1.3 Penetration Option Operations Plan

The enemy 1st Tank Army commander plans to continue the main attack in the center area where some advance has already been achieved. By employing fresh second echelon divisions in this area he can take advantage of the battle weary forces of the 53rd Division and the foothold his two regiments of the 103rd TD have on the western banks of the Brazos River. The plan calls for the 102nd TD and the 206th TD using the most direct routes from the assembly areas to cross the river in the vicinity of Glenrose and north of Folger. The attacking units will breakthrough and destroy the main elements of the 53rd Division reaching the immediate objective in the White Bluff area.

The 102nd TD will proceed from its assembly area east of Alvarado on two road nets (1) the northern column from Alvarado to Joshua then southwest along highways U.S. 22, State 945 and U.S. 43 to an area north of Turner Bend; and (2) another route to Cleburne and Turner Bend on highway U.S. 67. The two columns advance from these deployment lines 8 kilometers east of the line of contact to the river crossings north of Glenrose and attack the 3rd Bde of the 23rd Armored Division and the 2nd Bde of the 53rd Mechanized Division on a 10 kilometer front.

The 206th TD will proceed from its assembly area on two road nets also (1) north to highway U.S. 37 then west on that road; and (2) through Hillsboro and along highways U.S. 31 and State 7. The two columns advance from their deployment lines between Turner Bend and Folger, some 8 kilometers east of the line of contact, to attack on an 8 kilometer front north of Folger against the 3rd Bde of the 53rd Division and 3rd Bde of the 23rd.

While the 101st F TD and 3rd F MD maintain pressure on the flanks, the two second echelon divisions are to pass through the 103rd F TD, 80th F TD and 15th F MD. The attack will be significantly augmented by the same artillery, missile and engineer units as in the double envelopment plan. Artillery will be concentrated in the center of the 1st Army's area and a suppressive, intense preparatory fire will support the second echelon forces.

Once the penetration of the front line forces has occurred the plan for the 102nd Division is to proceed through the U.S. first echelon brigades to the west about 8 kilometers, then advance by road and cross-country terrain toward I20 destroying the 2nd echelon units.

The plan also calls for the 206th Division to advance westward, overrun the U.S. first echelon brigade positions about 5 kilometers to the west, then turn northwesterly to entrap the remaining forces of the 53rd Division near White Bluff.

5.1.4 Force Movements - Locations/Times

Computation of Rates of Advance

Converting the operational scenario and the enemy general plans into snapshots and situation templates requires timing computation and periodic unit position determinations. Force movement for both enemy options was calculated in the same manner. In accordance with enemy doctrine the key criteria used was that both second echelon divisions had to depart the attack line at the same time, i.e., H hour. In the scenario H-hour is D+3 at 1200. Maps of 1:50,000 scale, terrain overlay data prepared by

ETL and additional enemy doctrine were used to guide the computations. Appropriate attack areas were selected for each option, deployment lines plotted 8 kilometers behind the attack lines, avenues of approach were chosen and suitable river crossings noted. Cross-country terrain data and highway characteristics for the planned routes were used to determine rates of advance.

Mobility category ratings prepared and documented in TIAX Phase I for mixed tracked and wheeled vehicles were used to calculate elapsed times over segments of highways. Cross-country mobility category ratings were used between deployment lines and attack lines. A standard 2 kilometers per hour speed was used from attack lines to the rear of the blue brigade areas when the cross-country rates were resumed. The timeline was also prepared from attack line to the objective area even though advance rates in the MBA are realistically more a function of resistance by the defending forces than terrain.

The time required for crossing the Brazos River is a function of the types of water crossing obstacles encountered. The main crossings at Granbury, north of Glenrose, and north and south of Folger are assumed to be made via scissors and ponton bridging.

General Scenario Data

In both the double envelopment and penetration options, the 130 mm artillery forces attached from the front echelon are the first to reach their deployed positions.

Combat engineer forces (ponton bridge battalions and assault crossing battalions) from the Army echelon move forward early to support operations of the division forward detachments and main force advanced guards.

The forward detachment of each tank division, consisting of a reinforced tank battalion, operates approximately 50 kilometers ahead of the main force. Its function is to seize and hold important lines and objectives such as major road junctions, strong points and bridgeheads and hold them until arrival of the main force.

An advance guard force consisting of a reinforced tank battalion advances on each road corridor used by the divisions. Each advanced guard force marches approximately 1.5 hours ahead of the main force regiments. It consists of several elements and in addition to performing combat reconnaissance and route preparation, its mission is to make contact with and overcome opposing force resistance without interrupting main force movement and to permit the Division Commander time to deploy the main force from the march.

Each second echelon division in the TIAX scenario advances along two road corridors. Each road corridor is laterally separated by at least 3 kilometers. The main force on one road consists of two tank regiments at a combined road column length of 65 kilometers. The main force on the other road consists of one tank regiment and one motorized rifle regiment at a combined road column length of 80 kilometers.

Double Envelopment

Figure 5.1-3 is a timeline depicting the advance of the 102 and 206 Division main forces in the double envelopment option. Details of positions and timings for these forces are provided in Appendix B.

The 206 TD regimental advanced guard forces leave their assembly area at H-7.7 or 0420 on D+3. The 206 TD main force lead elements leave the assembly area at H-6.2 hours. The advanced guard units reach the deployment line at H-2.8, move into this area and wait for the main

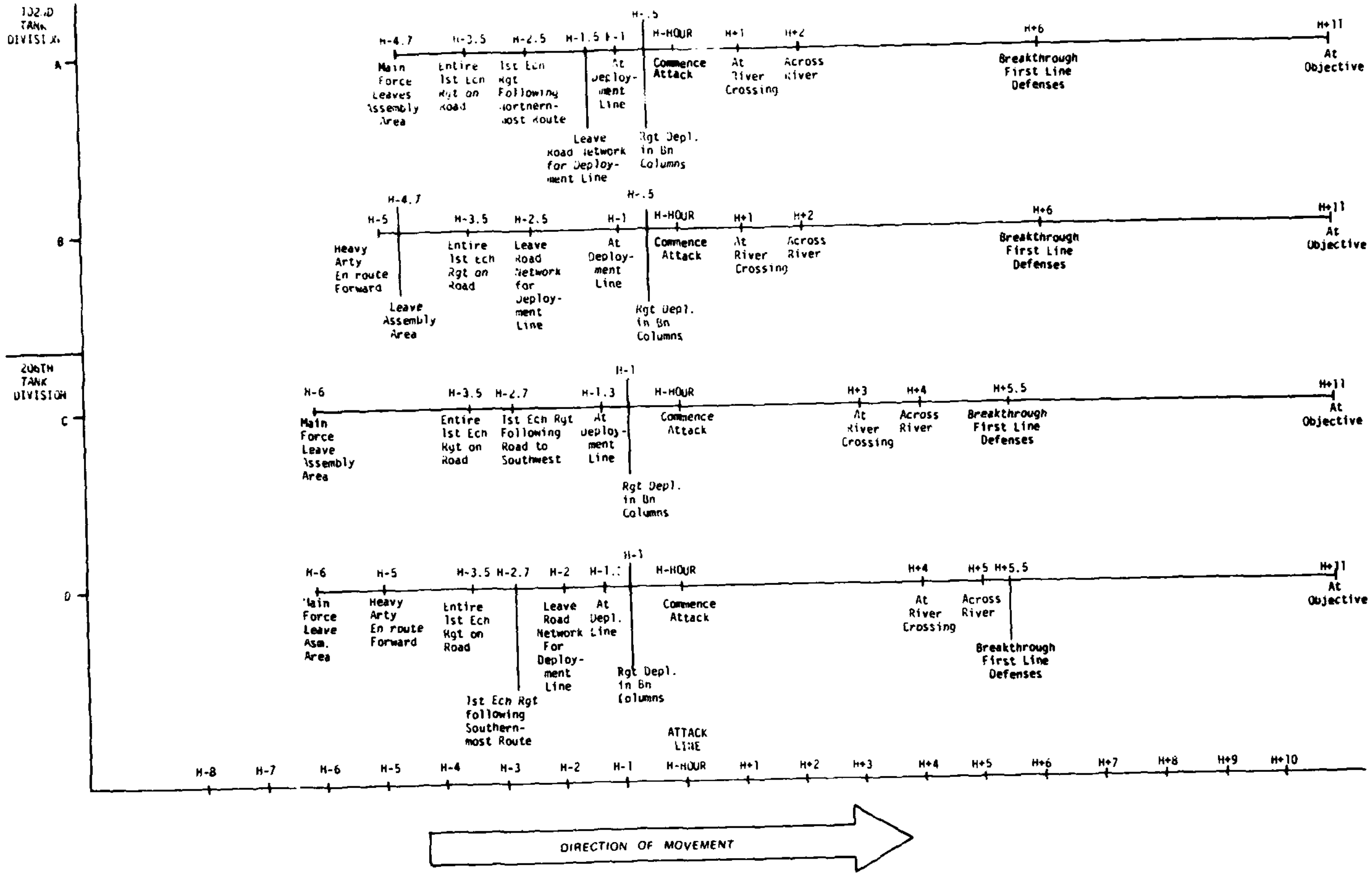


Figure 5.1-3. Double Envelopment Option (A) Timeline

forces arrival at the deployment line at H-1.3 hours. Prior to this time, the division forward detachment has arrived within one or two kilometers of the line of contact at H-3.5 hours. All elements of the 130 mm artillery regiments have reached their final firing positions by H-2.6 and have completed setup operations by H-1.8.

In the next 80 minutes after H-1.3 hours, lead maneuver regiments deploy into combat formation, advance to the commitment line and commence the main attack on U.S. forces at H hour.

By their plan of maneuver, they intend to accomplish a breakthrough on the southern flank and reach their objective west and south of White Bluff by H+10.9 hours, a total elapsed time from leaving the rear assembly area of 18.7 hours.

The 102 TD regimental advanced guard forces leave their assembly area east of Alvarado at H-6.2 one and one-half hours after the 206 Division's advance commenced. The 102 TD main force lead elements leave the assembly area at H-4.7. The advanced guard units reach the deployment line at H-2.6 hours followed by the main force's arrival at the deployment line by H-1 hours. Prior to this time, the division forward detachment has reached a point one to two kilometers from the line of contact at H-3.5 hours. All battalions of the 130 mm artillery regiments have reached their final firing positions by H-2.3 hours and completed their setup by H-1.8 hours. In the next 60 minutes after H-1, the lead regiments deploy into combat formation, advance to their commitment line and commence their main attack at H hour, simultaneously with the attack of the 206 TD. By their plan of maneuver, they intend to achieve a breakthrough on the northern flank and reach their objective west and north of White Bluff by H+10.9 hours, a total elapsed time from leaving the rear assembly area of 17.2 hours.

Penetration Option

The timeline shown in Figure 5.1-4 depicts the advance of the 102 and 206 division main forces in the penetration option. Enemy unit locations corresponding to the timeline are contained in Appendix B. Both times and locations refer to the head of a column.

In reference to Figure 5.1-4, each division advances in two columns which are identified as columns A and B for the 102nd Division and C and D for the 206th Division. Note that the initial movement of either force from the assembly area is Column D of the 206th Division. This early departure is caused by the lower mobility ratings of the route followed.

The movement of the 102nd Division for the penetration option begins when the Advance Guard for Column B leaves the assembly area at H-8.5 (or 0330 on D+3). It reaches the deployment line at H-5.2 and awaits the arrival of the lead elements of the Main Force at H-3.7. Column A elements depart one hour later and reach the deployment line at H-3.8 and H-2.3, respectively. The reasons for the differences in the timing of the two columns are (1) Column A moves over better roads than Column B and (2) Column B has to make river crossings between the deployment line and attack line. The two columns reach the objective area at different times for the same reasons. Total elapsed time for the 102nd Division to close is 16.7 hours.

The two columns of the 206th Division also move at different rates over the two routes selected. The Advance Guard of Column D leaves the assembly area at H-12.2 whereas Column C Advance Guard leaves at H-7.5. The lead elements of the Main Force of Column C reach the deployment line 8 kilometers behind the attack line at H-1.5 and Column D at H-0.7.

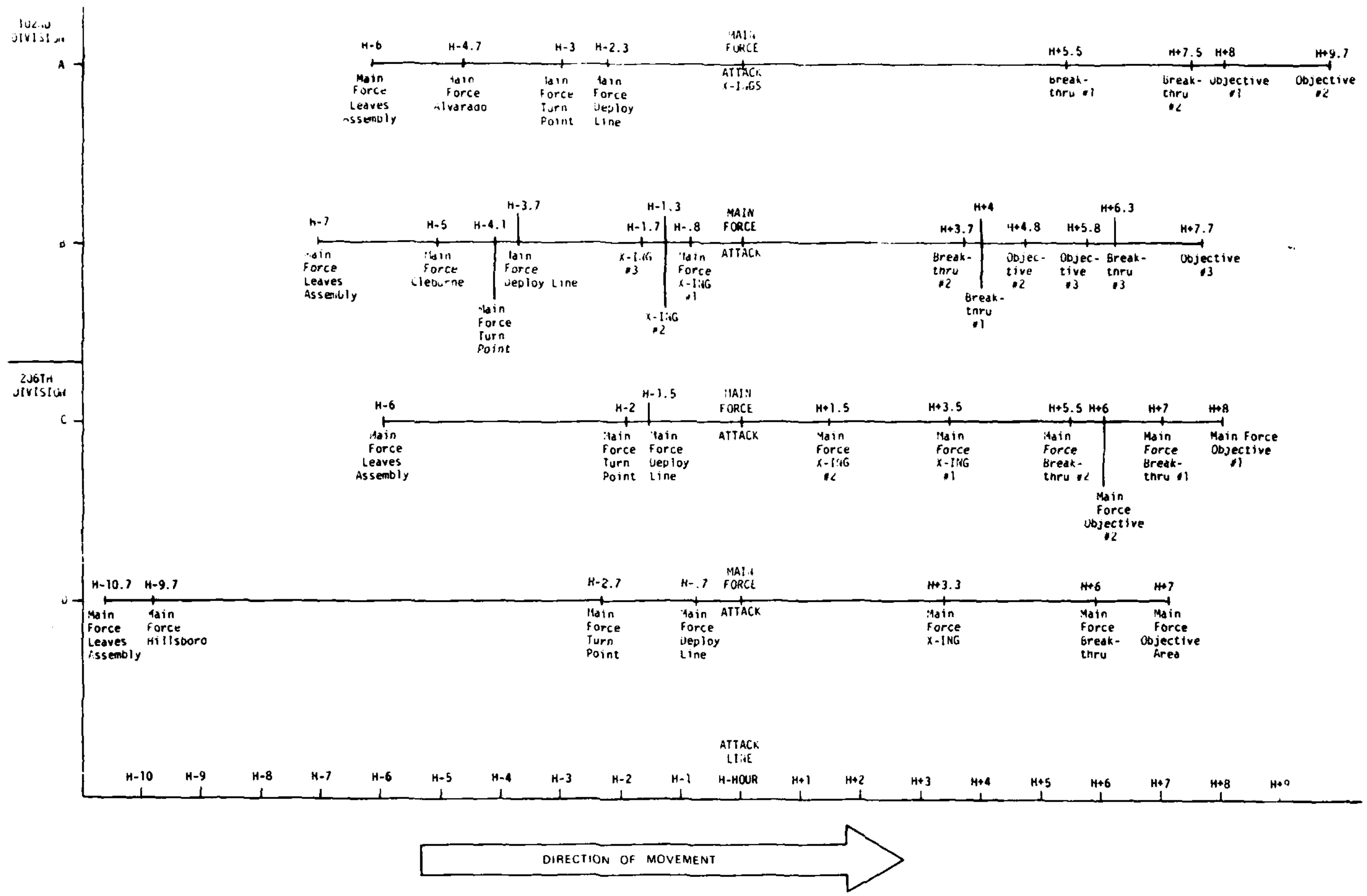


Figure 5.1-4. Penetration Option (B) Timeline

Column D moves forward to the attack line over GO category terrain to the north of Folger while Column C moves in attack formation through some GO and INHIBITED inhibited category terrain. Similarly, the timeline shows time variances between the attack line and the objective area due to terrain mobility category ratings. Total elapsed time for the 206th Division is 18.7 hours.

After the timing for each column was calculated and depicted on the timeline the times for snapshots were selected. The locations for the key (detectable) elements of each division were calculated using the same factors. The locations expressed in Military Grid Reference (MGR) terms are listed in Appendix B.

Non-divisional units are not shown on the timeline but their positions are included in Appendix B. All artillery units had to be in firing positions by H-1.3 so that preparation fire could begin at H-45 minutes. The 130 mm artillery regiments leave their initial positions at H-7.8 and H-9.1 and their lead elements arrive at the firing area at H-3.5 and H-6.0, respectively. The engineer augmenting units leave their initial positions at H-10.2 and H-13.7, and the lead elements reach their locations near the river crossing sites at H-3.3 and H-9.7, respectively. These times were based upon the tail of the movement columns clearing the roads (intersections) used by the second echelon divisions 30 minutes before the arrival of the Main Force. Mutual interference was also avoided between the artillery and engineer reinforcements by route selection and timing.

5.2 DEMONSTRATION SEQUENCE

The completion of the scenario definition enabled the start of a detailed script development. This was necessary in order to provide a realistic operational environment in which to demonstrate the 4-step templating process. The scenario was developed in seven sequences. Each sequence illustrated different aspects of IPB and concluded with a decision point for the IPB analyst. A script was then defined for each sequence. Figure 5.2-1 is an extract of a sequence script. It defines the data that appears on each of the three displays at a given time and the action sequence. Sequences are broken down into scenes and every scene is numbered and correlated to the scenario story line.

When the script was fully defined it became possible to convert the ETL terrain and map overlay to digitized formats acceptable to the demonstration system as well as providing direction for construction of necessary templates and snapshots. This digitization and build process is defined in the following subparagraph.

5.3 DATA CONVERSION

As in the TIAX Phase A demonstrations, the acetate overlays provided by ETL/TAC were treated as two different types of input: (1) line vector data, which consists of the road, stream, railroad, etc., overlays, and (2) pattern data, which consists of irregularly shaped areas that identify the characteristics of vegetation, soils, slopes and their composites.

The general data conversion processes for these two types of data are shown in Figure 5.3-1. These conversion processes were used to gain insight and experience in conversion techniques utilizing a

SCENE #	CURRENT SITUATION	IPB A/N	IPB GRAPHIC	STORY LINE
1 OPENING SITUATION	1:250 Basic Situation - • Enemy first echelon units of the 101 TD, 103 TD, 80 FTD, 15 FMD and 3 FMD shown in stabilized positions on line of contact (show imperfect picture--some units missing). • Blue units in their stabilized positions. *The 2d echelon enemy divisions have reached a point where lead maneuver regiments of the 102 TD are partially out on the road with their rear guard elements still in the assembly areas.*			Analyst has been engaged in continuously monitoring the current situation picture. Assume that this picture is updated by others in the ASAC on an asynchronous basis as new reports are received. He has been tracking movements of 2d echelon forces along roads in the rear areas and has picked up some indicators that the 102 and 206 TDs have been committed to action.
	1:250 Update will show: *8 km long vehicle column is* moving south on US 43 (15 km behind FEBA and parallel to it) Smaller combined arms patrol activity reported along key terrain and at strong points approximately 6 km east of FEBA at PL 210825 and PL 220750.	Call Situation Template Listing of all stored templates that include the point identified by graphic cursor. A1T2 B1T2 A2T2 B2T1 A3T3 B3T1	Position cursor on point indicating head of reported mover column.	He sees on the current situation picture that an 8 km long vehicle column moving south on US 43 (15 km behind FEBA) is now approaching a key turn (junction of US 43 and S222). He wants more information on this mover column. He also sees on the current situation picture that there is increased enemy patrol-reconnaissance activity along roads immediately behind FEBA in 103 TD area. Analyst begins to suspect that enemy is attempting Option B (penetration). He selects the B option situation templates to examine first and calls Situation Template B1T2.
2	Call blow up of corresponding area of Current Situation.		Call Situation Template B1T2	B1T2 Engineer Regiment on B1T2 is templated at the junction of US 43 and S222 providing a good match with mover column on current situation screen. He next examines Current Situation screen to see if there have been reports of reinforcing artillery which he would expect per the B1T2 template. He finds none signifying that if they are there, friendly sensors have not yet found them.
3	Call blow up of corresponding Current Situation area		Call Situation Template B2T1	B2T1 Analyst finds no match on B2T1 with the mover column on the Current Situation screen. Analyst next examines Current Situation screen to see if there have been reports of combined arms patrol activity in this area. He finds this activity on the Current Situation screen at PL 210825 and PL 220750.
4	Receives indication that a new Situation Update is pending.			Analyst aborts his comparisons at this point to view the new Situation Update.

Figure 5.2-1. Example of Workshop 1 Sequence Script

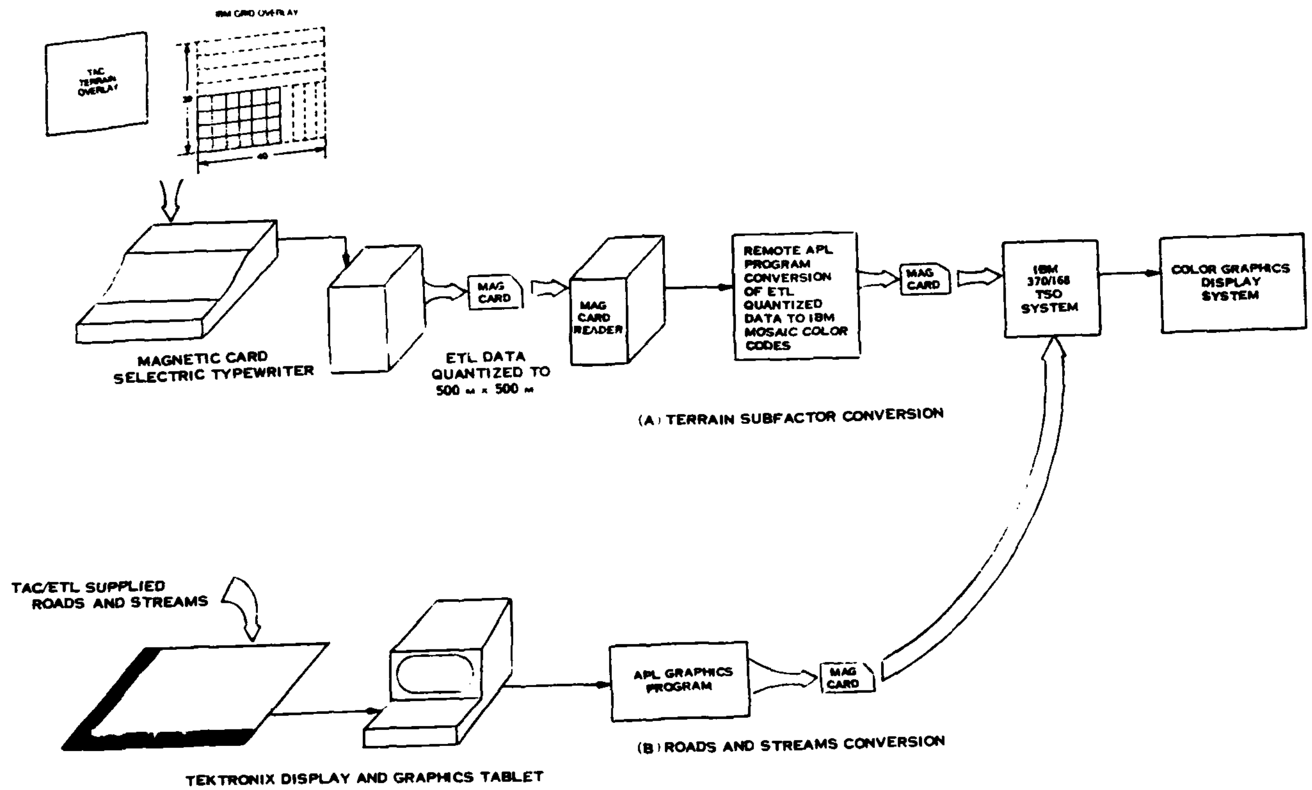


Figure 5.3-1. Data Conversion Process Flow

graphic tablet (equipment felt to be necessary in the field for local digitization of data as required).

Part A of Figure 5.3-1 shows that the 1:50,000 acetate overlays provided by ETL/TAC are translated into terrain mosaics consisting of 1,200 squares (30 vertical by 40 horizontal). The translation was made by (1) laying a transparent grid on top of the acetate overlay, (2) determining the dominant terrain characteristic, and (3) recording it on a magnetic card. This magnetic card data was then read into an APL program which converts each block to the IPB 5-part mobility scale (GO, INHIBITED, SLOW, VERY SLOW, STOP) and color code. The APL program produced another magnetic card which was entered into the 370/168 and, in turn, the colorgraphic display system.

A technique used for digitizing the line vector data is depicted in the (B) part of Figure 5.3-1. Here, the acetate overlay or map is mounted on a Tektronix tablet. A "spark" pen is used to trace the roads, streams, etc., which are displayed on the Tektronix display as they are being traced. When a tracing is complete, an APL graphics program converts the data to proper formats and the results are also recorded on magnetic cards. These cards are then entered into the 370/168 computer system and become available for manipulation and/or display on the colorgraphics.

The IPB template graphics and alphanumerics were built "online" as shown in Figure 5.3-2 as opposed to the "offline" generation of the maps and terrain mosaics described above. Here, templates were generated and modified as needed. Current situation inputs were entered through a separate but similar process.

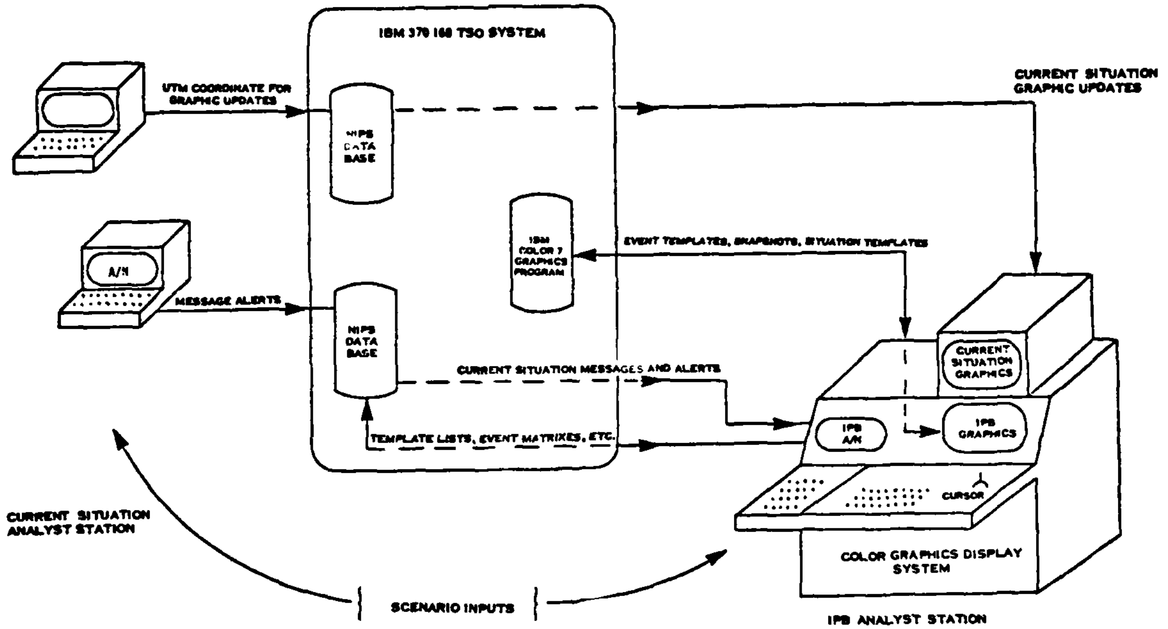


Figure 5.3-2. Information Flow - TIAX Phase II

SECTION 6. WORKSHOP EXPERIMENTATION AND RESULTS

6.1 THE WORKSHOP APPROACH

The term "workshop" as employed in the TIAX Program describes a development approach that has received wide Army acceptance during prior programs. The technique features use of a general purpose demonstration facility (in this case IBM's Tactical Systems Facility at Gaithersburg, Maryland) to present demonstrations of automation tools and techniques applicable to military operations.

Groups of Army personnel having experience in the functions being demonstrated are brought in to review and critique the application. Their suggestions for improvement are incorporated into subsequent demonstrations, when feasible.

A software functional description is developed that details the functions the software must include in order to support the application. Also, the entire workshop effort is documented in a narrative report. This documentation is provided to the appropriate Army agency having responsibility for requirements definition. The workshop procedure and the documentation enable a more thorough definition of requirements than can be obtained through conventional analytic approaches.

6.2 WORKSHOP 1 ATTENDEES

Sixteen workshop sessions were held during the period July 27, 1979 - November 1979. Approximately 100 DoD personnel representing the following organizations attended:

Corps of Engineers
Directorate for Battlefield Systems Integration (DARCOM/BSI)

Corps of Engineers Engineering Topographic Laboratory (ETL)
Intelligence and Security Command (INSCOM)
Office of the Assistant Chief of Staff, Intelligence (OACSI, DA)
Training and Doctrine Command (TRADOC)
U.S. Army Intelligence Center and School (USAICS)

A Phase II Interim Report was published August 17, 1979, that included Workshop 1 results through that date. Those results/comments have been consolidated with reactions received for the period August 10, 1979 - November 9, 1979. Workshop 2 results are included in subsequent sections.

6.3 WORKSHOP 1 COMMENTS AND RESULTS

Several end products have been produced in formulating Workshop 1 demonstrations:

1. The design of the basic templates described in TC30-27 as they would be employed in an automated environment. Examples of these designs are presented in Section 4.0.

2. Scenario data for timed movement of enemy tank regiments through road/cross-country corridors in accordance with published doctrinal procedures. This is described in Section 5.1 and Appendix B.

3. Digitized maps of a European area utilizing Texas place names and coordinates. A 1:250,000 scale map of major road networks was created as backdrop for an area 75 x 100 kilometers, and 6 1:50,000 scale maps were built to depict 15 x 20 kilometer fields of view within the 75 x 100 kilometer area. Maps are also displayable in mobility codes.

4. Terrain overlays in TIAX format. Cross-country matrixes (CCMs) in the 5-color code--500 meter square format defined in Phase A were created from ETL data for about half of the 75 x 100 kilometer field of view.

5. Demonstration sequences in which the IPB templates are utilized in an operational (scenario) context to portray their use by G-2 analysts in the course of battle.

The principal result was the demonstration itself and the reaction/ comments of the Army personnel who participated. Comments received from participants in the workshop sessions can be grouped into three general categories:

I. Clarification of approach or system capability.
II. Suggestions for additional system capabilities.
III. Recommended improvements in conduct of the workshop.

Significant issues raised by workshop participants are grouped within these categories along with the consensus response to the issue.

Category I - Additional Information/Clarification Questions

Issue: The size of the computer system, the amount of file storage, and number of vans required to support the TIAX/Automated system in the field.

Response: TIAX/Automated IPB will not be implemented as a standalone operational system. The capabilities being demonstrated in the course of these workshops, when validated as requirements, will be incorporated into the All Source Analysis

System (ASAS) as currently defined by USAICS. The size of the computer system to support ASAS must consider IPB functions along with others planned for inclusion.

As a point of information the processing power to support IPB functions as demonstrated to date is estimated at approximately 400,000 to 600,000 operations per second with 1 megabyte of main storage.

Issue: Should not the TIAX/Automated IPB functions as demonstrated to date be thought of as tools for use more by the commander than the IPB intelligence analyst?

Response: The IPB products are most logically developed within the G-2 staff, and the primary use of IPB is to identify enemy intent early in the operation, a basic intelligence function. However, the result of this process is a decision support template whose main purpose is to clarify the commander's major decision options.

Issue: Given that all the required basic data (terrain subfactor overlays, doctrinal templates, map backgrounds, et al) is available for an area of operation, how long would it take to develop the situation-oriented IPB products?

Response: The time would vary across a wide range due to variations in the situation, the amount of work already done, the time available for planning, degree of detail required, options available to the enemy, terrain features in the area, etc. However, assuming IPB computer aids to the analyst are available in the system, an option similar to those demonstrated in the workshop should be planned out and appropriate IPB products generated within 6-12 hours.

Category II - Suggested Additional Capabilities

Issue: The analyst will want a simple way to get additional information about units portrayed on the situation display--such data as unit identification (if not shown) or unit readiness plus the time/source of the report that placed the unit where it is shown.

Response: This would appear to be a capability oriented toward supporting the current situation analyst, but it would also be of definite value to the IPB analyst as well as the G-3 staff as blue force alternatives are considered. It is included in the Software Functional Description.

Issue: In computing the Combat Force Ratio (CFR), the analyst should be able to introduce a time parameter, e.g., what will the CFR be at n hours hence?

Response: The system capability to perform a geographic search of enemy/friendly units within a prescribed area at a specified time, and put the resulting data through a USAICS supplied algorithm for computing combat force ratio, will be included as a software requirement in the software functional description. A lesser capability now exists in the demonstration systems. The analyst encircles the sector of front and areas of blue and red units he wants included in the CFR computation on a graphic representing the intelligence estimate at some future time. Thus, the time parameter is inherent in the process.

Issue: The IPB analyst as portrayed in the Workshop 1 demonstration must carry a lot of situation status information "in his head". Could additional system support be provided him in terms of a method of accruing probabilities toward options as he makes partial matches with his situation templates?

Response: It is true that the analyst must keep close track of the current situation and the extent to which it "matches" any of several preplanned options. It was felt that he would be aided in this process by having participated in the planning phases wherein the IPB prestored templates and other products were developed, at least some by himself. In other words, he would be quite familiar with his stored IPB graphics, thus could concentrate on how the actual situation was developing.

Category III - Suggestions to Make Workshop More Effective

Several suggestions of this type were received and have already been incorporated. For example, the demonstration sequence was simplified following initial reactions that there was too much happening too fast to allow adequate understanding of the process. Also, it is pointed out to participants that the demo period of 30 minutes spans a scenario period of about 3 hours, thus the analyst will have more time in real life for careful comparisons. Several improvements to the vu-graphs used in the briefing have also been made as a result of questions or suggestions.

6.4 WORKSHOP 2 COMMENTS AND RESULTS

Fifteen workshop sessions were held during the period November 13, 1979 through January 30, 1980. Approximately 120 DoD personnel representing the following organizations attended:

Atmospheric Sciences Laboratory (ERADCOM)
BETA Joint Project Office
Combined Arms Combat Development Activity (CACDA)
Communications Research and Development Command (CORADCOM) Headquarters
Corps of Engineers Headquarters
Corps of Engineers, Vicksburg Waterways Experimentation Station
Directorate for Battlefield Systems Integration (DARCOM/BSI)
Deputy Chief of Staff for Operations and Plans (DCS/OPS)
Defense Mapping Agency
Electronic Research and Development Command (ERADCOM) Headquarters
ERADCOM Intelligence Materiel Development and Support Office (IMDSO)
Corps of Engineers Engineering Topographic Laboratory (ETL)
U.S. Army Forces Readiness Command (FORSCOM) Headquarters
18th Airborne Corps Headquarters
3rd Corps Headquarters
Harry Diamond Laboratories
Intelligence and Security Command (INSCOM)
MITRE
Naval Surface Weapons Center
Night Vision Laboratory (ERADCOM)
Office of the Assistant Chief of Staff, Intelligence (OACSI, DA)
Training and Doctrine Command (TRADOC) Headquarters
U.S. Army Intelligence Center and School (USAICS)

Workshop 2 consolidated and summarized all of the IPB(A) demonstrations developed to date. Demonstration segments on terrain, G-2 use, G-3 use, and IPB product build were selectively presented to workshop groups depending on their particular interests.

The Workshop 2 series began with a 4-day visit by an Army IPB Evaluation Team at IBM's Gaithersburg facility the week of November 13, 1979. Comprehensive briefings and demonstrations covering all IPB demonstration segments were conducted in the course of the visit. The results of the Evaluation Team's effort are summarized in the next section.

6.4.1 The IPB Evaluation Team

The Army's purpose in convening an IPB Evaluation Team was to (1) evaluate the IPB(A) laboratory capability against requirements as defined in TC30-27 to determine how well the IPB processes described in the manual are supported by automation; (2) investigate whether or not a field test is required, and (3) if so, determine the functions to be tested and recommend the type, location, and general approach to testing.

An Evaluation Plan had been developed and circulated prior to the meeting. The general approach to the evaluation was as follows:

1. Evaluate lab support to IPB processes as defined in TC30-27.

2. Consider operational issues (ease of operation, utility, training); technical issues (data storage, other ADP functions); and field test issues (test objectives, nature of test, testing agencies, location).

3. Develop recommendations.

Subsequent paragraphs summarize evaluation results in terms of the five basic steps defined in TC30-27.

Threat Evaluation

This was an evaluation of the makeup and completeness of doctrinal templates and related items in the IPB(A) system to perform threat evaluation. The workshops successfully demonstrated a variety of doctrinal templates capable of being displayed and manipulated at several map scales on the graphic screen. Additional doctrinal templates can, on short term notice, be constructed at the analyst console to reflect new doctrine.

To use IPB(A) operationally there must be order of battle factors as part of the threat evaluation data base. The workshops demonstrated some capability for displaying and manipulating this type of information. It was recognized that only limited contract effort had been budgeted in this area on the basis that in a fielded system, the order of battle factors would presumably be obtained from TOC functions complementing the IPB function and not from IPB itself. A question was raised about how could the analyst know that all order of battle units have been accounted for when building situation templates. The process should provide a better technique/procedure for accomplishing such checks.

Areas of Interest/Areas of Influence Determination and Evaluation

This was primarily an evaluation of the IPB techniques/tools of use to the analyst in defining areas of interest/areas of influence. Map scales of 1:250,000 and 1:50,000 are required with a possible 1:1,000,000 or two depending on echelons to be tested. The quantity of 1:50,000 map sheets with terrain classifications deemed necessary for field test simulating a Division echelon was 23 map sheets representing an area of approximately 10,000 square kilometers.

Terrain Analysis

This was primarily an evaluation of the analyzed terrain products, their display as graphics and the capabilities provided to the analyst for their manipulation. The IPB(A) concept successfully demonstrated the concepts for automated terrain analysis, terrain overlay production, modification and application. It was emphasized that the techniques and products demonstrated are for employment in evaluating the movements of large scale forces (regiment or larger). The basic resolution of the terrain graphic products is 500 meters when displayed at the 1:50,000 scale. There was discussion of the Army's newly created concept and MOS designation for a Terrain Analysis Technician (TAT). This specialist is intended to provide the Army with a better capability for evaluating effects of terrain and weather on ground mobility in a battle situation.

Weather Analysis

The demonstration showed the ability to display the weather graphics required to support the IPB process. Additional weather graphic displays can be readily built by the analyst. The need was emphasized to have the Staff Weather Officer (SWO) and his team (WETM) establish a close working relationship with the Terrain Analysis Technician (TAT) in manually integrating weather and terrain so that it can be input into IPB(A).

It was decided that for a field test there would be no requirement to display weather effects on:

- NBC operations
- Heliborne operations

- Airborne operations
- Seaborne operations

Threat Integration

This was an evaluation of the content and completeness of situation dependent IPB products including mobility corridors, route timings, templates, event and target matrices and decision support templates.

The IPB(A) approach successfully demonstrated the concepts of automated template production, manipulation, modification and application. It demonstrated as well the capability to modify on short term notice any of these products to reflect more up-to-date weather, terrain and current situation reports. The symbology of color coding, choice of patterns of varying density and symbol conventions were judged to be easily interpretable.

Proposed Field Test Approach

The Evaluation Team was in general agreement on the following points concerning field test plans:

- The test should be a command post exercise (CPX)

- A division level exercise (with evaluation of higher echelons through information filtering) should be conducted

- The test should be joint TRADOC/FORSCOM/INSCOM exercise

- Recommended test location was Ft. Hood (TCATA) with alternative at Hunter-Liggett (CDEC)

- o Should have Department of Army Staff, BETA-JPO, and Army Research Institute participation.

6.4.2 Comments and Results

The most frequently used Workshop 2 demonstration segments showed G-2 staff utilization of preplanned IPB graphics during hostilities plus examples of IPB products supporting G-3 functions. A short ad hoc build segment was frequently added at the end to demonstrate some of the lab system's automated capabilities in template construction. When the viewers were predominantly from agencies involved in map/terrain data development, the terrain demonstration segment was employed.

The following comments and replies are a summary of the issues raised by Workshop 2 participants along with the concensus response:

Issue: Considering the educational and skill level of today's volunteer Army, is it likely that personnel can be trained to operate the IPB analyst's console in the manner demonstrated?

Response: In our view the IPB console operator would be a military intelligence officer or intelligence experienced non-com. The terminal operation aspects are relatively simple--a few hours of training have proven sufficient to learn that. The more important and difficult element of console operation requires a knowledge of tactical intelligence, thus the need for a military intelligence MOS. The automated approach to IPB closely parallels the manual method; IPB as a process is nothing new to intelligence operations, just a more systematized way of approaching what has been done all along. Therefore, conventional intelligence training techniques augmented with a short course in console control functions would appear to be adequate training for automated IPB.

Issue: Must IPB use a color display, and, if so, can industry provide a militarized color display for Army use in the field?

Response: For the IPB applications studied to date in a corps or division environment, we feel that color is essential. Analysis of the current state-of-the-art in militarized display hardware was not part of the immediate study scope, thus we cannot offer an authoritative answer to the hardware issue. Remember that the IPB application as demonstrated here will be a set of functions among others to be included in the Army's All Source Analysis System (ASAS) planned for fielding in the mid 1980's. The hardware for that system will be militarized and by that time will surely include militarized color displays.

Issue: What are the digital storage requirements for the map and terrain data needed for IPB support?

Response: For the map and terrain data and all other IPB graphics needed to support the IPB processes as designed to date, approximately 5 megabytes for a division and 30 megabytes for a corps area of operations. These requirements are well within the digital storage capabilities of both military and commercial ADP systems today.

Issue: Can the doctrinal templates be changed to reflect known differences practiced by the enemy at hand? Can terrain/road data be changed to indicate local battle damage effects?

Response: Both of these types of data and indeed any graphic data on the screen can be interactively changed by the operator and stored. He has a full set of interactive controls allowing him to change color, delete, suppress, move, or re-orient any addressable element on the graphic screen by identifying it with his cursor and exercising the desired function keys. He can also build graphics and store them for future recall. It is probable that in the ASAS procedural controls will have to be placed on operator modifications to basic data such as a map, but there are no system limitations.

Issue: Are the mobility corridor build process and similar automation aids exercised in the software or are they predefined results?

Response: The corridor build processes (both road and cross-country) are executed by the final system software. The operator can trace any corridor pattern on any of the Combined Obstacles Matrixes and, upon inputting echelon and the appropriate functions keys, cause the system to shade the resulting mobility corridors in multiple colors for choke point analysis. Subsequent operator action changes the multicolored corridors to a single color indicating overall throughput for that designated corridor. Typical of other software capabilities now included in the lab system are the route timing algorithms; graphic initiated queries to the data base with responses either on the graphic or alpha screen or both; alpha queries to the data base with responses on the graphic or alpha display or both; display of UTM coordinate for indicated cursor locations; and a full set of interactive graphic capabilities, e.g., draw lines, build symbols, move, delete, etc.

Issue: What would be required to make the intervisibility algorithm operate from vantage points up to 100 feet in altitude in order to support other intervisibility applications?

Response: This change may be made with relatively little effort. However, in general, the capability is not a general purpose tool for air operations.

Issue: What criteria have been developed for establishing TAI's (Target Areas of Interest)?

Response: The approach taken to date has been to identify as TAI's certain specific targetable items including troop/vehicle concentrations, artillery positions, CP's, etc. In discussions with the Evaluation Team the point was made that TAI's are not only those types of specific targetable items. Frequently they are terrain dependent items including choke points, key road junctions, key bridges, fording sites, etc.

Issue: What is the level of detail required for the current situation and IPB template display? Is the amount of information shown in the workshop representative of this requirement?

Response: The IPB process (and its automated support processes) can be geared to any level of detail desired. The less detail, the less time required in building the graphics. It would seem that the appropriate level of detail for the IPB graphics files would match the level of detail displayed on the current situation, which would vary with the specifics of the situation. The workshop uses very detailed templates to illustrate capability. Template detail will of course be at the option of each operational unit.

APPENDIX A

IPB DEFINITIONS

APPENDIX A. IPB DEFINITIONS

OPTION	One of several alternative enemy battle plans - covers period from his position during planning cycle to his achievement of major objectives.
DOCTRINAL TEMPLATE	A graphic showing composition (unit make-up) and disposition (ground spacing) of an enemy unit based on doctrine without consideration of terrain or weather factors. Will vary depending on enemy mission (i.e., attack, defense, etc.).
SNAPSHOT	Graphic of postulated overall enemy and friendly unit locations at an instant in time in a single option on analyzed terrain. Some 5 to 10 snapshots along mobility corridors may be required to represent the execution of one option from inception to objective.
CURRENT SITUATION	Actual current enemy and friendly unit/force locations - as known or estimated in real time.
SITUATION TEMPLATE	A portion of a situation snapshot showing only those postulated unit locations at a point in time which enable analyst determination that the enemy is indeed pursuing this option--i.e., will allow him to distinguish between this and other options.
EVENT ANALYSIS MATRIX	Time ordered sequences of events (enemy activity that is recognizable in near real time from a single report or small group of reports) that immediately follow the time period represented by the snapshot they relate to. They focus on recognizable, near-term activities in time sequence.

<u>NAI</u> (NAMED AREA OF INTEREST)	Specified portion of terrain that will contain one or more of the events predicted in the event analysis matrix. They are normally identified during planning cycle, and their locations are shown on event templates.
<u>EVENT TEMPLATE</u>	Graphic layout of the NAI's associated with a specific event analysis matrix. Indicates NAI number and location as well as sequence number of each NAI within that event analysis matrix.
<u>TARGET ANALYSIS MATRIX</u>	A/N tabular listing similar to event analysis matrix but listing potential targets that FSE should plan for and monitor closely during time period immediately following the enemy's achieving the associated snapshot force disposition.
<u>TAI</u> (TARGET AREA OF INTEREST)	Same as NAI's except showing areas listed in the target analysis matrix.
<u>TARGET TEMPLATE</u>	Graphic layout of the TAI's associated with a specific event analysis matrix.
<u>DECISION SUPPORT TEMPLATE</u>	A situation snapshot selected at a point far enough ahead in the option to allow time for friendly force actions, and updated to reflect current knowledge of both enemy and friendly situations. Generally, several alternatives are compared contrasting varying preparation times, geographic factors, maneuver options, and targeting plans. The analyses also develop what is achievable within the time constraints. The Decision Support Template is the result of these analyses, and represents an achievable friendly force action in a snapshot format.
<u>MAP BACKGROUNDS</u>	These are outline maps including only major map features such as large bodies of water, rivers, bridges, primary and secondary roads, city and built-up area outlines.

<u>LINES OF COMMUNICATION OVERLAY</u>	This overlay provides mobility classifications for the roads, bridges, and railroads. A network of roads on this overlay is differentiated by colors to show mobility of mechanized forces.
<u>BUILD-UP AREAS OVERLAY</u>	This is an overlay indicating the geo-outlines of metropolitan areas, cities and large towns. These areas are treated as blocked or no-go zones when merged into the crosscountry movement overlay. When merged with lines of communication in the combined obstacles overlay, built-up areas may become traversible in one of the road mobility categories.
<u>TERRAIN FACTOR OVERLAY</u>	Individual overlays for slope, vegetation, soils and wetlands (hydrology) are included in this set. The first three are prepared for display as mosaics in which differing color and intensity are used to show mobility in up to 5 gradations. The basic mobility grade of each elemental square is entered for a "hot July day." Variants are prepared to represent changes for other seasonal conditions (i.e., vegetation state in winter; soil classification in wet season or in sub-freezing temperatures.
<u>WETLANDS OVERLAY</u>	The wetlands overlay is a representation of large bodies of water, rivers and streams. Segments are differentiated by color to show mobility of mechanized forces making crossings in up to 5 gradations. Variants are prepared to represent changes to mobility grades of crossings under extreme flooding conditions or freezing.
<u>CROSSCOUNTRY MOVEMENT OVERLAY</u>	This overlay is a composite of the four terrain factor overlays plus the effects of the built-up areas overlay. An algorithm technique will be designed to automatically combine the individual factors.

COMBINED OBSTACLES OVERLAY — This overlay is a composite of the cross-country movement overlay and lines-of-communication overlay. Merging of lines-of-communication factors further modifies the composite mobility picture or its inverse, the combined obstacles overlay.

OBSTACLE PLAN OVERLAY — This is a graphic representation of the friendly commander's barrier plan showing planned interdiction, mining and demolition blocks to deny or severely impede or rechannel enemy advances.

MODIFIED COMBINED OBSTACLES OVERLAY — This is a version of the combined obstacles overlay further modified to reflect the effects of an implementation of the friendly commander's obstacle plan.

MOBILITY CORRIDORS OVERLAY — This overlay is derived by analysis of basic battalion mobility over crosscountry terrain and over lines of communication. The analyst, working directly on the graphics display of combined obstacles, has the capability to construct and grade by mobility category the corridors available to enemy units.

INTERVISIBILITY OVERLAY — A composite of terrain, vegetation, elevation and atmospheric factors which depicts local average line of sight visibility for 500 meter grid boxes.

INTERVISIBILITY CORRIDORS OVERLAY — A graphic overlay derived from the intervisibility overlay that illustrates in any selected direction the grid boxes to which there is visibility from a chosen vantage point.

WEATHER OVERLAY — This is a graphic presentation which is used to show boundaries of general meteorological conditions (precipitation, fog, wind condition) over the areas of interest to the Corps and Division for use in selecting factor overlays for mobility or intervisibility.

Doctrinal Option Templates

A large scale graphic showing an overall enemy movement or operation (e.g., penetration or double envelopment) based on doctrine without consideration of terrain and weather factors. It portrays doctrinal spacing and composition forces along multiple avenues of approach from start point to objective. It indicates gross rear assembly areas, deployment lines, lines of contact and objective areas; it indicates gross frontages, width and separation of avenues of approach and width and separation of forces at the line of contact.

Doctrinal Event/Target Menus

Tabular listings which doctrinally describe key events/key targets that are characteristic of enemy operations and maneuvers and can be related to particular phases of an enemy option sequence. A separate event and target menu, consisting of critical indicator/critical node type items is prepared for each major action type. They reflect enemy doctrine without consideration of terrain and weather. Their purpose is to enhance/speed-up the preparation of situation dependent Event and Target Matrices and Templates, serving both as a reference for the analyst as well as a means of saving key strokes in building event/target matrixes.

Planned Routes Template

A graphic depicting the avenues of approach/routes of an enemy force as it would move from an initial static position to the achievement of its objective. It reflects a selection of routes based on analysis of enemy objectives, enemy doctrine, and specific terrain and weather effects on mobility. It is based on corridor rating/route timing computations to establish comparative transit times along candidate routes and selection of optimum routes.

Snapshot Lines Template — A graphic depicting the key points in an option where snapshots will be developed. The key points are translated into a succession of contoured snapshot lines which are transverse to and intersect the routes of this option. The lines represent the locations of the lead units across the entire movement at the successive key points. Incremental times are shown between snapshot lines. The template is based on the Planned Routes Template and therefore reflects terrain and weather effects on mobility.

Decision Alternative Template — A graphic showing planned allocation of friendly units against postulated overall enemy unit locations. It is developed during the planning phase when time permits. It shows enemy/friendly force concentrations and combat power ratios for an anticipated battle situation. It indicates friendly unit doctrinal locations rather than locations placed on an analyzed terrain. More careful unit placement as well as determination of what is achievable are refinements left to the Decision Support Template build step during hostilities. It indicates enemy unit planned locations as derived from the appropriate snapshot template.

APPENDIX B - ENEMY UNIT LOCATIONS

This appendix contains the locations of key elements of the two second echelon divisions from assembly areas to line of contact expressed in MGR coordinates. These locations were estimated using the movement rates and timing discussed in Section 5.1 and were used to develop the snapshots built for Workshop 1. In addition non-divisional unit locations are listed for significant force elements. To develop some situation templates the artillery regiments were plotted at the battalion level once they reached firing positions. Locations beyond the line of contact were determined on a sample basis in order to develop one snapshot later than H hour which was used for decision support template analysis.

Figure B-1 contains unit locations for the double envelopment option. Figure B-2 shows location for non-divisional units for the double envelopment. The locations of maneuver units of the 206th TD beyond H hour are contained in Figure B-3. Figures B-4 and B-5 show for the penetration option the locations of the units organic to the two second echelon divisions and the non-divisional units respectively.

	COLUMN A					COLUMN B				
	102 TD ADV GD	102 TD MRL BN	102 TD CP	102 TD TANK RGMT	102 TD TANK RGMT	102 TD ADV. GD	102 TD FA RGMT	102 TD FROG BN	102 TD TANK RGMT	102 TD MR RGMT
H-12										
H-11										
H-10										
H-9										
H-8										
H-7										
H-6	PL830780	PL840752	PL825755	PL830780	PL855748	PL773755	PL817756	PL820738	PL773755	PL800730
H-5	PL705930	PL830780		PL830780		PL630910 PL520910	PL817755	PL820738	PL773755	PL800730
H-4	PH680110		PL830780	PL705930		PL440955	PL520910		PL650900	
H-3	PL405975	PL705930		PH680110	PL855748 PL810835	PL385930	PL420950	PL650900	PL475930	PL740840
H-2			PL705930	PH485050		PL380925	PL360930	PL440920	PL440930	
H-1		PH485050 PL370790	PH485050	PL370940	PH610110		↓	↓	PL400930 PL360915	PL500925
H-HOUR	PL325970	↓	PL405950	PL325970	PL410980	PL305940	↓	↓	PL305940	PL380950

	COLUMN C					COLUMN D				
	206 TD ADV GD	206 TD FA RGMT	206 TD FROG BN	206 TD TANK RGMT	206 TD MR RGMT	206 TD ADV GD	206 TD MRL BN	206 TD CP	206 TD TANK RGMT	206 TD TANK RGMT
H-12										
H-11										
H-10										
H-9										
H-8	PL905438	PL915433	PL913407	PL905438	PL952430	PL905420	PL935395	PL947395	PL905420	PL928406
H-7		PL915433								
H-6				PL905438			PL935395	PL947395	PL905420	
H-5	PL575670 PL520695	PL750635	PL913407	PL850550	PL952430	PL670505	PL785465		PL785465	PL928406
H-4	PL420660	PL520695		PL580670		PL500630		PL785465	PL730470	
H-3	PL420625	PL410665	PL580670	PL500690	PL780620	PL450600	PL730470		PL590560	PL870430
H-2	PL370630	PL350660	PL475650	PL475660		PL420605	PL520590	PL730470	PL520590	
H-1		↓	↓	PL430625	PL415645		PL415620	PL520590	PL465600	PL500595
H-HOUR	PL350560	↓	↓	PL380610 PL350560	PL400630	PL390550	↓	PL415585	PL415560 PL390550	PL430620

Figure B-1. Enemy Unit MGR Locations - Double Envelopment Option

	FORCES ATTACHED TO 102nd TANK DIVISION						FORCES ATTACHED TO 206TH TANK DIVISION					
	FRONT 130 MM ARTY RGM'T				FRONT ENGINEERS		FRONT 130 MM ARTY RGM'T				ARMY ENGINEERS	
	RGMT #7	1/7 FA BN	2/7 FA BN	3/7 FA BN	PONTON BRIDGE BN	ASSAULT CROSSING BN	RGM'T #8	1/8 FA BN	2/8 FA BN	3/8 FA BN	PONTON BRIDGE BN	ASSAULT CROSSING BN
H-12	PM645030				PM720050	PM730032	PM685075				PL910980	PL935945
H-11												
H-10							PM685075				PL910980	
H-9												
H-8	PM645030											
H-7						PL405975						PL525720
H-6	PM475045				PL405975	PL395900	PL485860				PL525720	
H-5												
H-4	PL360830				PL375950	PL335875	PL330720				PL410650	PL500650
H-3	PL325880				PL350970	PL330915	PL305715				PL375580	PL440570
H-2		PL325880	PL325890	PL335905	PL325970	PL305940		PL310675	PL300685	PL290700	PL350560	PL390550
H-1		↓	↓	↓	↓	↓		↓	↓	↓	↓	↓

Figure B-2. Enemy Unit MGR Locations - Double Envelopment Option

	COLUMN C				COLUMN D			
TIME	206 TD FA RGMT	206 TD FROG BN	206 TD TK RGMT	206 TD MR RGMT	206 TD MRL BN	206 TD CP	206 TD TK RGMT	206 TD TK RGMT
H HOUR								
H+1								
H+2								
H+3			PL280575	PL345590			PL330515	PL370570
H+4								
	PL310565							
H+5		PL410620			PL365575	PL365550		
			PL240575	PL280560			PL265515	PL300525
H+6								
H+7								
H+8								

Figure B-3. Enemy Unit MGR Locations - Double Envelopment Option (206th Tank Division from H Hour to Brigade Breakthrough Line)

TIME	COLUMN A					COLUMN B				
	102 TD ADV GUARD	102 TD CP	102 TD MRL BN	102 TD FROG BN	102 TD TK RGMT(-)	102 TD MRR	102 TD ADV GUARD	102 TD TK RGMT(-)	102 TD FA RGMT	102 TD TK RGMT
H-12										
H-11										
H-10										
H-9										
H-8	PL790790						PL773755			
H-7		PL825755	PL840752	PL820738	PL790780	PL855748		PL773755	PL817765	PL800730
H-6	PL585910	PL810795	PL810770				PL425792	PL800737	PL818754	
H-5	PL425905				PL620914		PL330760	PL490795		
H-4										
H-3	PL260815				PL395890	PL685897	PL236775	PL300765 PL310733	PL262750	PL440795
H-2										
H-1	PL294834		PL295835	PL315855	PL250830	PL470935		PL240775	PL242765 ↓	PL450800

TIME	COLUMN C					COLUMN D				
	206 TD ADV GUARD	206 TD FA RGMT	206 TD CP	206 TD TK RGMT(-)	206 TD MRR	206 TD ADV GUARD	206 TD TK RGMT(-)	206 TD MRL BN	206 TD FROG BN	206 TD TK RGMT
H-12						PL906420				
H-11										
H-10							PL905420	PL936395	PL913407	
H-9										
H-8	PL906438	PL915433								
H-7										
H-6	PL740643	PL761620	PL947395 PL940450	PL905438 PL905438	PL952430	PL595643	PL767540	PL735585	PL743555	PL928406
H-5	PL550674			PL830560		PL560642	PL665625			
H-4										
H-3	PL365710	PL400693		PL745640	PL915450	PL440665	PL575645			PL795505
H-2										
H-1		PL275688 ↓	PL341708	PL341708	PL595670		PL425645	PL460660	PL473637	PL658635

Figure B-4. Enemy Unit MGR Locations - Penetration Option

TIME	FORCES ATTACHED TO 102nd TANK DIVISION						FORCES ATTACHED TO 206th TANK DIVISION					
	FRONT 130 MM ARTY				FRONT ENGINEERS		FRONT 130 MM ARTY				ARMY ENGINEERS	
	RGMT #7	1/7 FA BN	2/7 FA BN	3/7 FA BN	PONTON BRIDGE BN	ASSAULT CROSSING BN	RGMT #8	1/8 FA BN	2/8 FA BN	3/8 FA BN	PONTOON BRIDGE BN	ASSAULT CROSSING BN
					PM720050	PM730032						PL935345
H-11												
											PL910980	
H-10							PM685075					
H-9					PL215845							
H-8	PM645030											
							PL565930					
							PL469828					
H-7						PL215785						
	PL565930											
H-6							PL255758					
											PL520695	PL530680
	PL437908							PL255753	PL265745	PL310765		
	PL395900											
H-5												
	PL315795								PL275763	PL280750	PL315685	PL457674
										PL275742		
H-4												
	PL255776											
											PL288677	
H-3												
												PL290655
H-2		PL231790	PL244773	PL245784								
H-1												

Figure B-5. Enemy Unit MGR Locations - Penetration Option