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A COMPUTER GRAPHIC-BASED AID FOR ANALYZING TACTICAL SIGHTINGS OF ENEMY FORCES

Franklin L. Moses and Richard P. Vande Hei

BATTLEFIELD INFORMATION SYSTEMS TECHNICAL AREA

U. S. Army
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Computer and computer-driven graphics are being explored for potential utilization by the battlefield staff. One such effort is designed to assist in detecting patterns by replacing manual plots of sightings with efficient and flexible computer graphic techniques and associated algorithms. An interaction of the analyst with these displays and algorithms for analyzing sightings forms the basis for the present evaluation of a battlefield interpretation aid.

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20. Questions were asked about direction, speed of movement, and changes in location of battlefield activity in a classical division attack scenario. Six "aided" participants derived answers by specifying activity on a graphic display from which the computer calculated distances, speeds, etc. Six "unaided" participants derived answers from the displays without the use of computerized calculations. Responses in the aided condition were substantially more accurate than responses in the unaided condition. Measures of time did not meaningfully discriminate between the conditions. Accuracy results suggest that analyst-controlled computerized algorithms should be used for determining enemy patterns for computer graphic displays of sightings. The aid could be improved by better adaptation to equipment, thorough training and design refinements. However, results are sufficiently promising to suggest provision for accommodating mass/movement and related temporal/spatial analysis algorithms in requirements documents.

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Tactical Operations and Displays

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FOREWORD

The Battlefield Information Systems Technical Area of the U.S. Army Research Institute for the Behavioral and Social Sciences (ARI) is concerned with the application of Behavioral Science principles and techniques to the solution of problems involving information processing, decisionmaking, and operator/user performance in military information systems and contexts.

One major objective is to determine basic capabilities and limitations of man as an information processor and to devise complementary and compensating processing aids and techniques. Some functions are best accomplished by man, some by computer, and some by an interactive relationship between man and computer. ARI Technical Paper 258, "Computer-Based Displays as Aids in the Production of Tactical Intelligence," illustrated basic graphic display concepts with a set of situation maps derived from a large tactical exercise scenario. The present publication extends these concepts and evaluates an interactive graphic aid designed to assist staff analysts in analyzing and understanding patterns of enemy activity. The effort represents one phase in the exploration of concepts for automated aids to assist analysts and decisionmakers in understanding enemy intentions and capabilities and provides part of the necessary technological base for research leading to applications recommendations.

Research in the area of staff aids for tactical data systems is conducted as an in-house effort. The entire effort is responsive to requirements of Army Project 2Q762722A765 and to special requirements of the U.S. Army Combat Arms Combat Development Activity (CACDA), Fort Leavenworth, KS, and the U.S. Army Intelligence Center and School, Fort Huachuca, AZ. CACDA special requirements include Human Resource Needs 76-163 (Automated Display Requirements and Procedures for Mass and Movement Analysis) and 76-165 (ADP Methods for Utilization of Analytic Aids and Logic Models in Intelligence Processing).

J. E. UHLANER,
Technical Director

A COMPUTER GRAPHIC-BASED AID FOR ANALYZING TACTICAL SIGHTINGS OF ENEMY FORCES

BRIEF

Requirement:

To evaluate a computer calculation procedure coupled with automated graphics to assist in understanding movement and patterns of enemy activity.

Procedure:

Questions were asked about direction, speed of movement and changes in location of battlefield activity in a classical division attack scenario. In one research condition, answers were derived by six "aided" participants who specified sightings on a graphic display from which the computer calculated distances, speeds, etc. In the second condition, six "unaided" participants derived answers from the displays without the use of computerized calculations. Answers and time needed for solutions were recorded. Accuracy of responses was calculated.

Findings:

Responses from participants in the aided condition were substantially more accurate than responses from participants in the unaided condition. However, measures of time did not meaningfully discriminate between the aided and unaided performance.

Utilization of Findings:

Results suggest that analyst-controlled computerized algorithms should be used for determining consistent enemy patterns from computer graphic displays of sightings. The laboratory research forms the basis for concluding that such pattern analysis algorithms linked with graphics are preferable to either processes using computerized graphics alone or manual techniques involving grease-pencil drawings of sightings. Further development of graphic-based aids for mass/movement and related temporal/spatial analyses of enemy forces is necessary. However, present data are sufficiently promising to justify some provision for such aids in requirements documents.

A COMPUTER GRAPHIC-BASED AID FOR ANALYZING TACTICAL SIGHTINGS OF ENEMY FORCES

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A COMPUTER GRAPHIC-BASED AID FOR ANALYZING TACTICAL SIGHTINGS OF ENEMY FORCES

INTRODUCTION

Computer graphics can aid in simplifying the recognition of patterns of spatially and temporally distributed events. Graphic displays could be used in reducing time and effort in detecting patterns of tactical battlefield activity. For example, consider how computer graphics could assist the intelligence analyst in detecting a shift of battlefield emphasis over a 24-hour period. The current manual procedure requires time-consuming grease-pencil plots of symbols on numerous map overlays representing time slices of reported activity. These plots of related information are examined to determine whether there are consistent patterns. In contrast to the slow and tedious manual plots, computer graphics could rapidly generate time slices of related information required for detecting patterns of activity. The current manual procedure also uses the information in plots of activity for calculating time and distance relationships that describe patterns of movements. With computer graphics, the intelligence analyst could specify on displays the activity which he wants included in computerized time/distance calculations. The present research was designed to evaluate a computer graphics/calculation approach as applied to the military situation.

There is no clearly defined technique agreed upon for determining patterns. However, the intelligence analyst's manual procedures provide guidelines and clues for operationally defining what he does to detect patterns. Introspectively, the analyst indicates that he chooses clusters of seemingly related activities over time and then does a set of rough approximations of their "centers of mass." However, this determination of related clusters is only part of identifying patterns. There always is some "random" movement in battlefield activity. An analyst can be misled by cluster relationships which are not substantiated by reasonable time and distance measures such as average speed of travel, average projected time of arrival at specific places, or possible/probable destinations.

Given a computer-based display of sightings, the analyst could expend less effort on clerical tasks. In addition, the computer could help him with time/distance calculations for comparing sightings. The analyst could concentrate on looking for time/distance related trends such as pre-positioning of logistics, lead armor activity, positioning of artillery, and other evidence of shifts in enemy operational intent. In summary, methods which use computerized graphics for determining patterns and resultant trends would help the military analyst to weigh events differentially.[1]

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[1] Bowen, R. J., Feehrer, C. E., Nickerson, R. S., and Triggs, T. J. Computer-based displays as aids in the production of Army tactical intelligence. Army Research Institute, Technical Paper 258, February 1975.

The present research required that intelligence analysts use time/distance measures to summarize possible relationships of clusters which they identified on graphic displays of battlefield events. The research assessed whether the analyst's information-processing burden would be reduced by computerized algorithms which calculate geometrical centers of activity clusters and their time/distance relationships. Some analysts were provided with this graphics/calculation aid and others were not.

The immediate objective was to evaluate an interactive graphic aid (GRAID), identify its weaknesses, and determine its potential. Computerized displays were used to present activity symbols in both the unaided (i.e., manual) and aided conditions. The comparison required the unaided group to summarize movement characteristics of patterns without computer calculations; the aided group could request computer calculations and graphic displays of centers of clusters and their time/distance relationships. The research hypothesis was that an interactive graphic aid for calculations (aided condition) relevant to pattern analysis would allow analysts to draw inferences more quickly and more effectively than would be possible with graphic displays alone (unaided condition).

METHOD

PARTICIPANTS

The seventeen participants were Army officers (Captains & Majors) from the intelligence community who had varying degrees of familiarity with prescribed military procedures for abstracting patterns of battlefield activity. Eight participants were randomly assigned to the aided research condition and nine participants to the unaided. Six participants in each condition completed the tasks satisfactorily, and their performance provided the basis for the statistical analysis.

TASK

Participants were presented with a series of questions (Appendix A) aimed at characterizing components of the complex pattern analysis process. The questions asked about predicted locations, change of directions, and speeds. There were 20 individual and multipart questions in the context of a scenario of battlefield events in a hypothetical situation.

The scenario involved a classical Soviet motorized rifle division attacking on a narrow front (13KMS) for a 36-hour period. The attack scenario focused on a two-axis (two-regiment) thrust attacking out of training cover and deception maneuvers. This training included an entire Soviet division on Soviet-controlled territory. During these division maneuvers, one regiment made a major thrust in the north into friendly controlled territory. This regimental thrust was an extension of the cover and deception plan intended to force the friendly commander to emphasize importance of the battlefield to the north while rendering the southern sector vulnerable to the actual Soviet attack (one regiment on line and one regiment following with an eventual exploitation mission).

The scenario incorporates realistic logistical/tactical time phasing and use of terrain. It culminates with the preparation for a deliberate river-crossing exercise complete with realistic assembly area selection and accompanying fire support/logistical activities.

COMPUTERIZED AID

The aid involved two user-selected clusters of sightings that could be compared for average space and time differences. With the sightings overlayed on a map, each cluster could be delimited by enclosures containing sightings from a two-hour time period or some multiple of this length. The computer calculated two centers of unweighted mass (i.e., two "central" points) based on the geometrical relationship of sightings within each enclosure. A calculation was then done to determine: (1) the vector distance between the centers and (2) the time between the half-way points of the time intervals from which clusters were selected. The display of sightings showed centers of mass designated by "Xs" and distances between them be vectors. In addition, time and distance figures were printed on the display.

APPARATUS

The principal apparatus for participants was two 19" color television displays (Conrac, Inc.),[2] a typewriter-like keyboard and a displayed cursor/ pointer connected to a trackball. This apparatus was interfaced with a computer-based graphic system (Anagraph, Amcomp, Inc). The keyboard and trackball were used by participants to "talk" to the system. The computer generated all alphanumeric and graphic information for the displays except for a map background representing a 12 x 16 kilometer area. This map image was transmitted to the computer by a color-television camera (GBC CTC 3XP) and could be combined with the computer-generated images before display. The research station also provided the participant with a booklet concerning details of scenario sightings (Appendix B), a hardcopy map of the relevant area, grease pencils, and a participant-experimenter intercom. The experimenter had television monitors linked to the participants' displays.

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[2] All commercial designations and trademarks are used only for precision in describing the experiment. Their use does not constitute endorsement by the Army or by ARI.

PROCEDURE

Each participant sat three feet in front of the displays and was told that the experimenter could monitor these images. The left-hand display showed the map for the scenario and could also show any symbols representing scenario sightings. Sightings were represented by rectangles, triangles, and asterisks labeled with a letter-number identifier. The symbols corresponded to three broad classes of sighting types (armor; artillery; wheeled vehicles and bridging equipment), and the letter-number pairs corresponded to information in a booklet correlated with symbols on the display. Only one sighting type could be displayed at a time.

The right-hand display initially presented computer-assisted instructions. These began by telling participants that one of several possible approaches to pattern analysis was being evaluated. Their task was to use pattern analysis for answering specific questions about a battlefield scenario. Pattern analysis was defined and examples given. As part of the instructions, the right-hand display also explained the keyboard typing formats required for requesting displays of sightings or answering questions. During the actual task, the same display became the source of pattern analysis questions and prompting messages for formats. Whatever participants typed appeared on this screen, and the computer could display messages concerning any format errors. Instructions and prompting messages were displayed in green, questions and participant-generated requests and answers were in white, and error messages appeared in red.

Instructions required participants to practice using the keyboard for displaying sightings and for answering procedural questions. They displayed a sample two-hour activity slice and a combination of several contiguous two-hour slices which appeared in red. By requesting a pair of two-hour or greater time intervals, participants saw that red symbols in one interval contrasted with green symbols in the second interval. During the instruction phase, questions about procedures for using the system were presented to both the aided and unaided participants.

Participants in both the aided and unaided conditions learned how to use the computerized displays for viewing sightings. In addition, each participant in the aided task learned to control the trackball and its cursor. They were told how the cursor could be used to specify sightings for center of mass and time/distance calculations as an aid to analyzing patterns. After seeing an example, they practiced using the cursor to mark corners of enclosures around sightings and to correct the marks. The last part of the practice for aided participants required them to follow a simple pattern analysis procedure. They had to try each sample procedure and reply to each question in the instructions before the computer allowed the session to continue.

All participants were instructed to stress accuracy in their performance but to work at a smooth pace. In the unaided research condition, the participants used mental judgments and calculations to answer questions. In contrast, aided participants were required to take full advantage of the computerized aid for analyzing pairs of sighting clusters. Each participant was asked to answer questions at face value and not to overinterpret the task. The rate at which instructions and the research task proceeded was paced by the individual. The instructions took about three hours and each task about five hours. Any problems which arose could be discussed via the participant-experimenter intercom. After the research session, each participant discussed the research and answered a written questionnaire (Appendix C) as part of a debriefing.

EXPERIMENTAL DESIGN

The design consisted of a two-way analysis of variance in which the independent variables were conditions (aided vs. unaided) and questions (16 items). Conditions was a between-subjects factor (six subjects per condition), and questions a within-subjects factor. The analysis for this design is given in Table 1.

Table 1

ANALYSIS OF THE ACCURACY OF ANSWERS TO QUESTIONS

Source of Variation	Degrees of Freedom	Mean Square	F-ratio
Between Subjects			
Aided vs. Unaided Conditions (C)	1	34.60	46.1*
Subjects within Groups	10	.75	
Within Subjects			
Questions (Q)	15	2.48	2.7
QxC	15	1.30	1.4
Error	150	.93	

*$p < .001$

RESULTS

Dependent measures were (1) time required to answer each question and (2) accuracy of answers. Correct answer criteria were based on standard military doctrine. Each participant's answers to questions were converted to accuracy data by taking absolute deviations from the correct answers. These data were rounded to the nearest .5 km because of variations in the overlay of plots of activity in relation to the map background. A total of 16 answers were included in the analysis as a result of subtracting four practice questions and eliminating questions 7 and 8 because observations and interviews with participants showed that the two questions had no consistent interpretation. Responses to questions in the aided condition were significantly ($p < .001$) more accurate than responses in the unaided condition. A summary of the accuracy data shows the magnitude of errors (Table 2).

The time spent on questions in the aided and unaided conditions varied greatly, and no significant differences were found in the ANOVA. An attempt to reduce this variability was made by using a log transform of time spent on each question. An ANOVA on the log data also showed no significant differences between research conditions and no significant condition/question interaction effect. Therefore, neither raw time nor log time for doing questions could meaningfully discriminate between the two performance conditions.

DISCUSSION

The analysts who organized graphic displays of battlefield activity into patterns with the aid of computerized calculations were more accurate than analysts who used only graphic displays. However, aided analysts needed the same amount of time for the tasks as analysts who relied on their personal estimates for relating changing activity. Speed of performance may have been confounded with characteristics of the particular computer graphic system as well as with related thought processes demanded by the tasks.

In debriefing statements, participants supported the use of computerized graphic displays of activity as a basis for doing pattern analysis either with or without a computer calculation aid. Participants said that graphics made it possible to see various spatial comparisons quickly and to use color for distinguishing sightings during one time period from sightings at a different time. Studying several configurations of graphic information was one way of helping patterns to emerge. Although many participants had limited experience with computerized systems, they generally favored automated displays and their data favored the value of the aided condition.

Tale 2

ACTUAL ANSWERS TO QUESTIONS AND THE ABSOLUTE MAGNITUDE OF RESPONSE ERRORS (IN KM) ACROSS SUBJECTS

		Mean Error		Variance	
Question	Answer[a]	Aided	Unaided	Aided	Unaided
5	5.5	0.0	.8	0.0	.5
6	10.8	.3	1.6	.1	1.1
9	5.5	.2	1.2	.1	.2
10	1.6	.5	1.3	.8	.5
11	map coordinate[b]	0.0	1.8	0.0	6.6
11a	map coordinate[b]	0.0	.9	0.0	.5
12	9.0	1.0	2.5	1.6	1.9
13	2.4	.2	.5	.1	0.0
14	map coordinate[b]	1.6	1.0	.8	.5
14a	map coordinate[b]	.3	.3	.1	.1
15	1.5	.1	1.6	0.0	.7
16	2.6	0.0	.9	0.0	.5
17	1.9	0.0	.4	0.0	.1
18	6.6	.4	2.2	.9	5.9
19	6.4	1.2	1.5	.6	.3
20	2.2	0.0	.9	0.0	.2
		$\bar{X}$ = .36	$\bar{X}$ = 1.21		

[a] For computational purposes, answers were converted to distance measures (in km) where necessary.

[b] Answers required the location of activity as opposed to time-distance differences.

PARTICIPANT QUALIFICATIONS

The participants varied in their ability to perform the pattern analysis tasks. Despite claims of one or more years' experience with pattern analysis, five persons (three aided and two unaided) of the original 17 had enough difficulty with the tasks to justify eliminating their data. These five, far more than any of the other participants, showed a lack of attention to detail which resulted in a tendency toward global analyses. A related problem was a tendency to emphasize sighting types and locations with too little concern for directions of movement and the times at which events occurred. Some of the five eliminated participants also disregarded instructions to be discriminating and used many extraneous sightings in problem solutions. In general, accuracy in performance appeared to be worse when hunches and interpretations overshadowed careful consideration of factual information.

ACCURACY DATA

With the computer-aided calculations, time-distance comparisons were significantly more accurate than those comparisons made without aid. The meaningfulness of the difference in accuracy may be evaluated in terms of the proportion of error in relation to the magnitude of correct answers. For example, if a correct answer is 100 kilometers, then a 1-km error (proportionally 1%) probably is not important. In contrast, if the correct answer is 5 km, a 1-km error (proportionally 20%) is likely to be important. Such criteria applied to the current research results indicate a meaningful difference between the aided condition and the graphics-alone (unaided) condition. Mean proportional errors for each question averaged across unaided participants ranged from .15 to 1.1; mean errors for the aided group ranged for 0 to .3. Imagine such errors in the context of trying to estimate the arrival time of troops at a particular location, the distance between two artillery targets, and other such problems. The aid obviously did not eliminate error, but it did lead to generally smaller errors and more consistency than use of graphics alone.

TIME DATA

Reducing the time needed to perform pattern analysis was an important consideration in designing a computerized aid. For the plotting of sightings, computer graphics naturally is faster than manual methods which require grease pencils and acetate overlays. However, one may wonder why the application of computer calculations to the graphic displays did not reduce the time needed for answering questions. The importance of automated displays for sightings should not be overlooked, but the aid is not optimal until the time for deriving patterns is reduced.

The research procedures are a source of suggestions about how to reduce time for using the aid. In the research, familiarity with the apparatus and practice time were limited. If any aid were to be implemented, analysts should be given time to thoroughly learn the system so that speed in its use can be stressed without accuracy losses. In addition to practice, time for pattern analysis might be reduced by using computer algorithms which show the analyst examples of patterns that are tactically relevant to a situation. Kahneman[3] has suggested that the performance of any specific activity is associated with the allocation of a certain amount of effort; allocating less effort is possible, but the allocation of more effort may seem beyond an individual's ability. Therefore, the analyst's ability may have to be extended with adaptive computer routines. Perhaps the computer could "learn" from prior pattern analysis which analysts have done and then make suggestions that reduce the time needed for specific future evaluations. Further work is needed before any conclusions can be made about how to optimize the time requirements of the aid.

IMPROVING THE AID

Graphics used in support of the calculation aid might be improved by more descriptive symbols and by allowing more flexible requests for displaying battlefield events. For example, the symbols might actually represent different vehicle types (e.g., truck or jeep). Displays also might contain individual direction vectors to help in analyzing information. Requests for displays of sightings should not be limited to broad groupings (e.g., armor; artillery; wheeled vehicles) of information types. Two possibilities suggested by participants were the capability to request a specific sighting type (e.g., tanks in contrast to the more general category of armor) and the capability to specify a mix of several types of sightings at one time (e.g., trucks and tanks). Of course, such display changes have implications for use of color, shapes, and other codes for differentiating sightings from one another.

The tested algorithm for the aid could be improved by making speed and distance estimates more realistic. For example, average speeds for different classes of data (e.g., jeep vs. tank) could be included in the calculations relating one cluster of activity to another. In addition, weather and terrain conditions might change estimates of movement times and speeds. Graphic displays of the effect of changing conditions on movements should be far more quickly and easily assimilated than the presentation of such information in hardcopy or in alpha-numeric form.

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[3] Kahneman, D. Attention and effort. Englewood Cliffs, NJ: Prentice-Hall, 1973.

A more sophisticated aid also would have additions to its basic center of mass calculations. The use of a geometrical center for equally weighted data elements made the calculations easy to implement, but answers based on such calculations are a limited reflection of real world conditions. For example, if one were analyzing armor patterns, then tanks might be included with armored personnel carriers in the computer's calculation of a center of mass. However, an equal weighting of these elements would not represent a completely accurate summary of the information if one were interested in combat power. Either the computer should contain weights according to potential combat power contributions or an analyst should be allowed to influence calculations by inputting his judged importance of data. Estimating value of information or assessing worth is a complex process.[4] One practical approach is to provide tables of "standard" relationships among possible data elements so that the computer could calculate and display reasonable relationships. Then, using the video display, allow the analyst to move the calculated center(s) to take into account any special weighting factors. This approach takes advantage of complex human judgments while allowing the computer to assist in the numerous basic calculations.

CONCLUSIONS

The analysts who organized graphic displays of battlefield activity into patterns with the aid of computerized calculations were more accurate than analysts who used only graphic displays.

The successful laboratory results suggest that the use of computerized algorithms linked with graphic displays of battlefield activity can enhance performance in pattern analysis tasks. Such algorithms for data manipulation appear to provide substantially better analyses than are possible with processes using computerized graphics alone. By inference, the computerized techniques would also provide a speed and accuracy advantage over manual techniques involving grease pencil drawings of sightings. Of course, care should be taken in generalizing from somewhat artificial laboratory conditions to field applications. Nevertheless, serious consideration should be given to further development of aids for utilizing graphic displays in mass/movement and related temporal/spatial analyses of enemy forces. Pending outcomes of these additional developmental efforts, the present results appear sufficiently promising that some provision should be made in requirements documents for accommodating such aids. The likely benefit from the aids would be more accurate and consistent analyses than are currently possible from data concerning enemy concentrations, movements, and destinations.

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[4] Johnson, E. M. and Huber, G. The technology of utility assessment. IEEE Transactions on Systems, Man and Cybernetics, 1977, SMC-7 (No. 5), 311-325.

APPENDIXES

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APPENDIX A. QUESTIONS USED IN RESEARCH

*1. For all the hours between 250401 and 251600 (251401 + 2), in what predominant direction were enemy wheeled vehicles moving? (N; NE; E; SE; S; SW; W; NW) Don't forget --- use the answer format "@)" / "ENTER", Then you answer, and then "ENTER" !!!

*2. Between the hours of 250401 and 251800, what is your estimate for the number of kilometers traveled by the lead armor elements? (Please use the intercom for any questions about the task !!)

*3. What is the armor rate of march (in km/hr) between 251401 + 2 and 251601 + 2 hours?

*4. For forward wheeled reconnaissance activity at 251601 + 2 vs. 252001 + 2, how large is the change in emphasis (in kilometers)? Secondly, what is a single six-digit coordinate indicating the vicinity of this change? Format: km/location (note: slash always separates parts of single answer!)

5. What is the distance between the principle center of mass for armor sightings at 251801 + 2 and the principle center of mass for armor sightings at 252201 + 2?

+6. Assuming that the logistical vehicle movement toward the NE has been regular between the hours of 252201 + 2 and 26001 + 2: How fast are these vehicles moving on the average in kilometers per hour? (Notebook of sighting reports important to solution!)

+7. How many kilometers separate artillery sightings at 252001 + 2 vs. 26001 + 2 hours? (Remember your notebook of sighting reports for this as well as various future questions!)

8. How many kilometers separate the wheeled vehicle sightings at 252201 + 2 vs 260401 + 2 hours?

9. How much and in what direction has aggressor center of mass changed for all wheeled vehicles (sighting for vehicles and bridg. equip.) in comparing 260001 + 2 with 260601 + 2 hours? Answer in kilometers/ direction.

10. How many kilometers separate the two centers of mass for all artillery sightings -- north of the 30th latitude line -- at 260001 + 4 vs. 260601 + 4 hours?

11. What is the exact armor geographical center of mass for all such sightings at 260001 + 2 as well as the center of mass for all such sightings at 261001 + 2 hours? Enter both answers as six digit coordinates in the format: ------/------.

*Practice question
+Eliminated

12. What is the rate of march (in kilometers per hour) at which the enemy has moved the center of mass of his artillery from 252201 + 2 (vic 470295) to 260001 + 2?

13. Only consider the artillery sightings reported as having no direction of movement at 260601 + 2 vs 261401 + 2. For purposes of determining change in area of battlefield emphasis, what is the distance and apparent direction of shift in emphasis for these sightings? answer: km/direction.

14. What are the two *exact* wheeled reconnaissance activity centers of mass for 261001 + 2 (vic 5528) and 261601 + 2? Enter both answers as six digit coordinates in the format: ------/------.

15. G2 seeks fixed logistical targets. How far and in what direction has the *exact* geographical center moved for all wheeled vehicle sightings north of 30th latitude line, at 251801 + 12 vs. 260601 + 2 hours? (Exclude canal recon. sightings!!) - Answer in kilometers/direction.

16. How far and in what direction has the **artillery** center of mass moved -- for all sightings north of the 30th latitude line -- between 251601 + 12 and 260801 + 12 hours? (Remember to give your answer in kilometers/direction.)

17. How far and in what direction has the **armor** center of mass moved for all such sightings between 261001 + 6 and 261601 + 6 hours? (Remember to give answer in kilometers/direction.)

18. What is the average rate and direction of armor advance in aggressor's south sector between 262001 + 2 and 262201 + 2? (Give your answer in kilometers per hour/direction.)

19. What is the average rate of march and direction of logistical activity in aggressor's southern sector at 262201 + 2 vs. 270201 + 2 hours? Give answer in kilometers per hour/direction.

20. G2 is trying to determine the enemy shift in artillery center of mass. What is the distance and direction of center of mass shift for 252001 + 6 vs. 262001 + 6? Answer format is: kilometers/ direction.

APPENDIX B. EXAMPLES OF DETAILS OF SCENARIO SIGHTINGS PROVIDED TO PARTICIPANTS
(Page 1 of 3)

Data Descriptors

Armor (0001-0200)

Locator	Dir.	Number	Sighting Type*	Coordinates	Condition	Date/Time
A1	?	2 doz.	MRTs	560335	On side road Highway 44	270002
A2	None	2	MRTs	555330	Stopped off Highway 44	270016
A3	?	Many	TNKs	510325	Heard Moving	270040
A4	?	1 (?)	MRTs	545320	On road - no lights	270003
A5	?	10 (?)	MRTs	555320	On road - no lights	270005
A6	?	Sev.	MRTs	505315	Sand area	270051
A7	E	9	MRTs	550300	Toward Highway 44	270036
A8	None	6 or 7	MRTs	545280		270121
A9	None	2	MRTs	555275		270120
A10	E	20+	TNKs	450260	Off Highway 33	270021
A11	N	Doz. +	MRTs	550260	Stopped off Highway 44	270101
A12	N	4	MRTs	565260	On Highway 44 - No Lights	270108
A13	E	5	MRTs	450250	Off Highway 33	270110

* MRT represents Motorized Rifle Transporters

APPENDIX B. (Page 2 of 3)

Data Descriptors

Artillery (0001-0200)

Locator	Dir.	Number	Sighting Type	Coordinates	Condition	Date/Time
A1	None	?	MSL	470340	Off road - under cover	270115
A2	E?	3	Gun-Rcl	550340	Off road	270020
A3	NE	Half doz.+	AT Guns	530330	On Highway 44	270001
A4	None	?	MORT	540330	Stopped near Highway 44	270010
A5	SE	6	MORT - 82mm	540325	Pulled by trk - Highway 44	270006
A6	None	6	Guns - AD(?)	520310	In place - sand area	270050
A7	S	6	MORT - 120mm	560310	Trk pulled - Highway 44	270025
A8	S	?	AT Gun	555300	Trk pulled near Highway 44	270125
A9	None	3	AT - 57mm	560300	Stopped on Highway 44	270015
A10	None	3	Guns - Rcl	550280	Off road	270020
A11	None	2(?)	AD Gun(?)	515280	In place on sand area	270030
A12	S	3	AT	565275	On Highway 44	270022
A13	E	6	MORT - 82mm	550265	Toward Highway 44	270036
A14	None	6 (?)	AT-82mm (?)	450250	Stopped near RR Tracks	270028

APPENDIX B. (Page 3 of 3)

Data Descriptors

Vehicles (0001-0200)

Locator	Dir.	Number	Sighting Type	Coordinates	Condition	Date/Time
A1	N	Several	Cars-military	585345	On Highway 44	270005
A2	NW	10	TRKS	530335	On Highway 44	270010
A3	E	Several	TRKS	535330	On Highway 44	270016
A4	None	?	AMPH	575330	Stopped off 44	270013
A5	None	?	TRKS	570325	Stopped off 44	270005
A6	N	3	CYCLES	560305	On Highway 44	270050
A7	N	2	Cars-military	560290	On Highway 44	270045
A8	None	10 (?)	TRKS	450255	Stopped near RR Tracks	270033

APPENDIX C. PATTERN ANALYSIS POST-EXERCISE QUESTIONNAIRE (Page 1 of 6)

Your responses to the following questions will aid us in evaluating the approach to information analysis that you have been working with today.

1. Do you feel that your background and experience was appropriate for the role you were asked to assume in today's exercise? Yes___No___
Comments:

____

____

____

2. Today's exercise ran for a number of hours during which you were required to undertake a series of rather tedious tasks. Do you feel that your performance was adversely influenced by the factor of fatigue and that the time is too long to expect a user to operate with our system? Yes___No___ Comments:

____

____

____

3. Do you have any suggestions for improving the instructions. Please comment:

____

____

____

4. Did you have sufficient time to learn to operate the keyboard and generally become familiar with the contents and configuration of the data base? Yes___No___Comments:

____

____

____

5. Did you have any "mechanical" problems with the task that seriously hampered your ability to obtain and manipulate the information? (for example, getting information, using the keyboard, etc). Yes___No___
Comments:

6. Did you have a problem adapting to the color code? Yes____No____
Comments:

7. Were "prompts" and "reminders" for operating the system adequate?
Yes___No___Comments:

8. Would a supplementary list of instructions have been more helpful than the summary confirmation made available? Yes___No___ Comments:

9. Were all the tasks that you were requested to perform during the exercise realistic? Comments:

10. To what extent were the questions typical of what you believe pattern analysis should do?

____

11. To what extent were the "multiple analyses" at the end of the task more or less realistic than the earlier single analyses?

12. Can you suggest any additional pattern analysis tasks which could or should be incorporated into this type of exercise?

13. Please comment on any tasks you were asked to perform during today's exercise which you feel could have been better performed if more information was available in your data base?

14. Please comment on any information concerning the enemy which you would have liked but were unable to obtain during today's exercise?

15. To what extent were the data typical of what you believe would be seen in a TOC before such an offensive. Please give specific examples:

____

____

____

16. Can you suggest more useful ways of organizing the sighting data than one we used? Yes___No___. Would you explain a "yes" answer, please:

____

____

____

____

_____Number of years experience related to pattern analysis.

__________Evaluation Condition.

Please do not discuss details of your participation in today's evaluation with others who may work with us at a later date.

GRAID CONDITION

Did the computerized aid for pattern analysis performance help you to do the job? Make it easier? and so on.

a. What advantages/disadvantages does it have compared to manual methods?

b. What improvements/changes would you suggest for the aid?

Additional Comments

Use the space provided below to elaborate on responses to previous questions and/or to make any additional comments relating to today's exercise.

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