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for the Behavioral and Social Sciences

Research Report 1591

Assessment of the Operations Planning Tools (OPT) During a Division-Level Command Post Exercise

Jon J. Fallesen
U.S. Army Research Institute

April 1991

U.S. ARMY RESEARCH INSTITUTE FOR THE BEHAVIORAL AND SOCIAL SCIENCES

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This report documents the findings of an assessment of the Operations Planning Tools (OPT) during a command post exercise. The OPT prototype was developed to identify soldier-based requirements for tactical planning aids. OPT was designed to provide support for battlefield visualization, wargaming estimates, and information management. For the assessment, OPT was set up in the planning cell of a permanent exercise facility of a National Guard division headquarters. Because there was no time for training on OPT before the exercise, contractor personnel operated OPT at the direction of the plans staff. Data were collected by observing the plans staff perform their duties and from post-exercise surveys. OPT was used throughout the weekend exercise and received favorable comments from all respondents. The assessment prompted ideas for improvement in OPT, including the need to regulate attrition and for a rapid capability to designate multiple units in wargaming interactions. The assessment also demonstrated the need to have established procedures for using decision aids in the context of the normal operating environment.

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Research Report 1591

Assessment of the Operations Planning Tools (OPT) During a Division-Level Command Post Exercise

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Human Factors in Training and Operational Effectiveness

FOREWORD

The Fort Leavenworth Field Unit of the U.S. Army Research Institute for the Behavioral and Social Sciences (ARI) is dedicated to helping generate requirements for command and control (C2) systems based on the needs of soldiers and their capacities to use the systems. The broad research framework that supports this effort includes the development of prototype tactical decision support concepts and the assessment of those prototypes. The research on soldier-based requirements is producing carefully determined cognitive requirements for tactical planning tools such as Operations Planning Tools (OPT). OPT was conceived, prototyped, and evaluated in a laboratory setting in 18 months. Based on the favorable results, the Combined Arms Command requested that additional feedback be obtained on OPT in an operational setting. This report documents that feedback and provides recommendations for continued development.

This research was conducted as part of the ARI research task entitled "Enhancing Command Staff Performance in Combat Operations." The work was performed in accordance with the Memorandum of Agreement between Combined Arms Combat Development Activity and ARI on "Development and Implementation of the Future Battle Laboratory," dated 30 June 1989. The results and status of OPT development and assessment are provided in regular reports to the Command and Control Integration Council, Combined Arms Command.

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The 35th Infantry Division (Mechanized) staff is to be commended for excellent cooperation on this project. The environment in which OPT was assessed greatly contributed to the obtaining of useful feedback on the Operations Planning Tools (OPT). The willingness of the 35th Division to try new and unproven ideas and to provide valuable opinions about the potential requirements for OPT afforded a choice opportunity for research. Special thanks go to Colonel Guerrein, Major Lanning, Major Culbertson, and Major Becker for their encouragement and instrumental support.

The efforts of EER Systems and Science Applications International Corporation were vital to the use of the OPT prototype in an operational environment and paramount in making assessment of OPT possible. Acknowledgment goes to James P. Flanagan for helping to identify assessment topics and for serving as a sounding board during the post-exercise analysis.

ASSESSMENT OF THE OPERATIONS PLANNING TOOLS (OPT) DURING A DIVISION-LEVEL COMMAND POST EXERCISE

EXECUTIVE SUMMARY

Requirement:

The Command and Control Integration Council (C2IC) asked that operational user feedback be obtained on a set of planning tools called OPT (Operations Planning Tools). The purpose of this report is to document the findings from the use of OPT during a command post exercise and to provide recommendations for future work.

Procedure:

Permission was obtained from the 35th Infantry Division (Mechanized) to use OPT in one of their command post exercises. OPT was prepared for use and was supported during the 38-hour exercise by contract personnel. Questionnaires were developed for obtaining ratings on various issues of usefulness. The questions also solicited suggestions for changes. These questionnaires were completed by and received from twelve personnel from the plans cell and elsewhere. The use of OPT, spontaneous comments from the staff, and problems encountered were recorded by an observer who was present for about three-fifths of the exercise.

Findings:

OPT was willingly used by the staff to verify combat power ratios and estimate attrition for various courses of action. Printouts of OPT-depicted courses of action and projected results were used throughout the exercise in staff briefings and meetings with the Commander. The staff did not interact with the OPT operators as much as was hoped. This was because of the staff's inclination to do general planning that did not require analysis and to their unfamiliarity with OPT.

The results from the questionnaires were highly favorable, indicating that the staff felt that planning with OPT was faster, more thorough, and more accurate. There were few negative concerns about OPT expressed by the staff. However, the Chief of Staff observed that his staff relied too heavily on OPT outputs without trying to verify or determine why results were projected as they were.

The use of OPT in the exercise allowed ideas for improvement to be obtained from the staff users, as well as the observation of the use of OPT on operational planning problems. The major change needed in the tool itself is to regulate attrition by the inclusion of event, time, or distance factors instead of basing losses on the numbers of segments on an attack route. From the findings, recommendations are also made on the need to have procedures for using OPT within the staff's planning process, to make an assessment of OPT's impact on the overall command post, and to make policy decisions about the future status of OPT.

Utilization of Findings:

The findings from this assessment will be used by the Command and Control Integration Council to determine follow-on efforts for OPT. The development process for OPT and the findings also have useful implications for the development of other command and control tools and decision aids.

ASSESSMENT OF THE OPERATIONS PLANNING TOOLS (OPT) DURING A DIVISION-LEVEL COMMAND POST EXERCISE

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ASSESSMENT OF THE OPERATIONS PLANNING TOOLS (OPT) DURING A DIVISION-LEVEL COMMAND POST EXERCISE

INTRODUCTION

Research Requirement

In September 1990 the Command and Control Integration Council (C2IC) asked that the Army Research Institute obtain feedback on a set of planning tools called OPT (for Operations Planning Tools). The C2IC desired information on OPT from an operational standpoint to better understand the tools' potential primarily for combat use. They were also interested in OPT's potential for training applications and eliciting requirements as part of the combat developments process. Also the C2IC wanted to determine if OPT was a feasible candidate for tactical computer systems or if it would help identify aiding requirements for such systems. The purpose of this report is to document the findings from the initial use of OPT during a command post exercise and to provide recommendations for future combat developments.

OPT and the C2IC

The C2IC was initially briefed on the OPT concept in July 1989 (the concept is also documented in McKeown, Fallesen, Perkins & Ross, in preparation). Initial feedback on the feasibility of the aid was presented to the Council in July 1990 and again in September 1990. This feedback came from a user assessment of OPT that was conducted in the ARI command and control laboratory by Science Applications International Corporation (SAIC). SAIC was the co-designer of the tools with ARI and implemented them on the Tactical Planning Workstation (see Flanagan & Fallesen, in preparation).

The laboratory assessment involved Battle Command Training Program (BCTP) observer-controllers as subject matter experts; these officers used OPT to generate and compare tactical courses of action. The results of that assessment are documented in Perkins, Flanagan, and Fallesen (in preparation). An independent assessment of OPT was also performed by the Center for Army Tactics (CTAC) and reported to the Council in August 1990[1].

The assessments yielded highly favorable reports. They indicated high potential of OPT for aiding important aspects of planning. The relative maturity of the software prototype was also considered a plus for near-term usability. Based upon the CTAC recommendation, the decision was made by the combat

[1] ATZL-SWT, Memorandum for Chairman, C2IC, Subject: Analysis of Operations Planning Tools (OPT), 21 July 1990.

developers to undertake installation of the OPT software and other features of the Tactical Planning Workstation on the Army Tactical Command and Control System (ATCCS) compatible common hardware. In addition the decision was made by the Council to obtain feedback on OPT in an operational setting.

Overview of OPT

OPT supports the development, exploration, evaluation, and comparison of tactical courses of action. OPT was developed as a prototype decision support system for use in research to generate soldier-based requirements for planning aids. The staff planners are required to set up basic parameters for OPT much as they do for manual course of action analysis. OPT accepts general representations of tactical concepts from the staff planners. The representation parameters include force arrays, movement routes, movement times, and unit locations, among others. OPT uses these parameters to estimate and display movement times, combat power ratios, and attrition projections. OPT also provides a display of the battlefield situation in terms of friendly and enemy unit locations, dispositions, and strengths. Unit locations and battlefield geometry are displayed on the viewer's choice of tactical map backgrounds (vegetation, shaded relief, elevation contours, cross-country mobility, and no background).

The staff planners define tactical concepts by identifying the movement route through the terrain, the type of attack, the type of defense, the units involved in combat, the beginning force strengths, the time to start movement time, and the duration of any delays along the route. OPT uses a simplified model of combat that produces results on battle duration, combat power, and force attrition. The user can adjust many of the model's parameters based on updated combat experience or other factors. OPT does record keeping for planning and wargaming that would otherwise have to be done manually. OPT produces and stores its results to facilitate modification or refinement of tactical concepts and to be used in course of action comparison, assumption testing, and "what if" analysis.

OPT was designed and developed based on a front end analysis which included consideration of tactical planning tasks, examples of performance on the tasks, examination of the cognitive processes involved, technological capabilities, and development constraints. The research activities included observation of command and control performance problems (e.g., Defense Systems Incorporated, in preparation; Fallesen, Michel & Carter, 1989; PERI-SL, Memorandum for Chairman of C2IC, Subject: Command and Control Performance Problems, July 1988; Thordsen, Galushka, Klein, Young & Brezovic, 1989), development of tactical computer system information functions (e.g., Flanagan & Fallesen),

experience in developing a related decision aid called COAAT (Course of Action Assessment Tool) (Ross, 1989), and analytical work to identify cognitive requirements for aiding tactical planners (e.g., Carter, Archer & Murray, 1988; ARI, 1990).

The rationale for the development of OPT is described in McKeown et al. where certain problems in command and control and tactical planning are identified as:

(1) limited time available to do planning,
(2) variability in planning procedures,
(3) inappropriate balance of breadth and depth in concept development and assessment,
(4) insufficient level of detail or thoroughness of analysis, and
(5) difficulties in battlefield visualization.

Tactical planning is a tough business from many aspects: because of the vast complexity of the problem domain, because of short time constraints, and because of the limited abilities of humans to perform consistently at high levels. It is important that these limitations be considered in decision aid evaluation to see if the decision tools provide the support for which they were intended. As a result of these characteristics of the planning task, the specifics of a situation, and human limitations, the detailed effort that should go into producing good plans is often curtailed.

OPT Design Criteria

Functions that computerized tools are capable of supporting were identified from an understanding of task requirements, typical performance on the task, cognitive problems of performance, and some constraints on how users best interact with computer systems. The functional goals of OPT and OPT-user interaction criteria (taken from McKeown et al.) are reviewed below. Three types of functional support and five OPT-user interaction criteria are described. These criteria were used for the identification of assessment issues to be observed and for questionnaire construction.

Presentation support for aiding visualization. Computers deal well with detailed information, e.g., keeping track of unit designations, types, strengths, locations, and dispositions. Also, computers are good for displaying this information over terrain maps with battlefield control measures. The display of information about units and terrain, along with projected battle events, helps to provide a visualization of time and space relationships of the battle. OPT was designed to support this need.

Computational support for aiding estimates. A computer's ability to handle large quantities of data, processing that data in pre-specified ways quickly and performing those processes repetitively in a highly reliable fashion, makes the computer a better candidate for mathematical computations than the human. The typical human, who is prone to errors in mathematical computations, oversight of factors, and memory limitations, usually prefers not to engage in tasks requiring a great many calculations. OPT off-loads the memory and computational work from the human and provides rapid computations of combat power ratios, time-distance estimates for movements, and unit attrition estimates.

Organizational support for information management. Computers are generally better at storing coded information more accurately and completely than humans. Once stored, the computer can be used as a tool to retrieve information and process it in various ways. The computer should represent information in natural and familiar ways, otherwise it may do more harm than good. OPT was designed to provide a means to store quantitative and visual results from course of action evaluations in ways that are familiar to planners. Once the information is available and organized, it can be processed and manipulated more readily than if done by manual means. OPT can be used for exploring or refining courses of action, comparing courses of action, generating branches or sequels, testing various assumptions, and estimating acceptable performance levels through sensitivity analyses. The ability to easily manipulate objects stored as information allows the planner to refine tactical concepts and test them iteratively.

Adaptable. The philosophy of OPT is to support performance in a manner that is adaptable to the way a planner wants to do planning, not the way that the computer has been pre-programmed to do it. Different staffs and individuals use different approaches to planning. Situation and time availability also dictate how planning can and should proceed.

User control. Control of the planning process is retained with the soldier, not shifted to the computer tool.

Reduce workload. Many computer tools shift the nature of what the user has to do from mental work to data entry. In these tools the type of work may have been changed to simplify the human task, but the workload may not have been decreased and quite possibly may have been increased. An increase in errors is also likely when using these tools. OPT was designed to minimize the workload of data entry to the greatest extent possible. It is also important to keep data entry to a minimum so OPT can be used when there is very little time available for planning.

Familiarity. OPT is based on simple models of combat and wargaming. These may already be familiar to the user through training and doctrine experience. If the user is not familiar, OPT's simplicity allows the models to be readily understood.

Improve performance. OPT's main purpose is to improve performance. The functions that OPT supports suggest that OPT could be useful for speeding planning, increasing the completeness or thoroughness of planning, increasing planning accuracy, decreasing uncertainty, and increasing the quality of the plans in other ways.

ASSESSMENT PROCEDURE

Key staff members from the 35th Infantry Division (Mechanized) (Chief of Staff, G3, G3 Plans, and Advisor) were given a 1½ hour demonstration of the capabilities of OPT about five weeks before the assessment exercise. Based on the group's recommendation, the Commander agreed to have OPT present and used during a Wagon Wheel (division level) command post exercise.

Two weeks prior to the exercise, representatives from Science Applications International Corp. (SAIC) began to prepare for the specific exercise scenario (SAIC, 1990). Enemy and friendly task organization data and control measures were entered into the workstation's data base by the contractor[2].

Two days prior to the start of the exercise, SAIC placed two workstations in the Plans Cell of the 35th ID(M) training facility (see Figure 1). One workstation was available for OPT analyses and the other was present to perform data base updates. At the end of the exercise, SAIC reported that one workstation was all that was needed (SAIC, 1990). A color printer was available to make printed copies of OPT screens.

Throughout the 38 hour exercise SAIC representatives were present to operate OPT at the guidance and command of the Plans staff. Two shifts of two SAIC personnel manned OPT during the exercise. On each shift, one of the operators, who was very knowledgeable about tactical planning, was present to support the use of OPT. The other shift operator was there to provide technical computer support. Contractor personnel were used to operate OPT because there was no desire to put a training or manpower[3] burden, which would have distracted from the training objectives, on the 35th staff.

Two questionnaires were developed for completion by the staff who directly interacted with OPT and other key staff who used the products from OPT. A 28 item Plans Questionnaire was used to capture impressions from the Plans staff. Ten of the questions from the Plans version were dropped to create an 18 item Key Staff Questionnaire.

An ARI representative was present during 22 hours of the exercise to observe how OPT was used and record spontaneous staff reactions to it.

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[2]Since the Workstation and OPT were developed for a research environment for issues that focused on planning and not all issues of tactical computer use, OPT has limited data entry features.

[3]Any new computer system to support planning will require some training and manpower for operation. The focus of this assessment was on the use and capabilities of the tool, not on the operation of it.

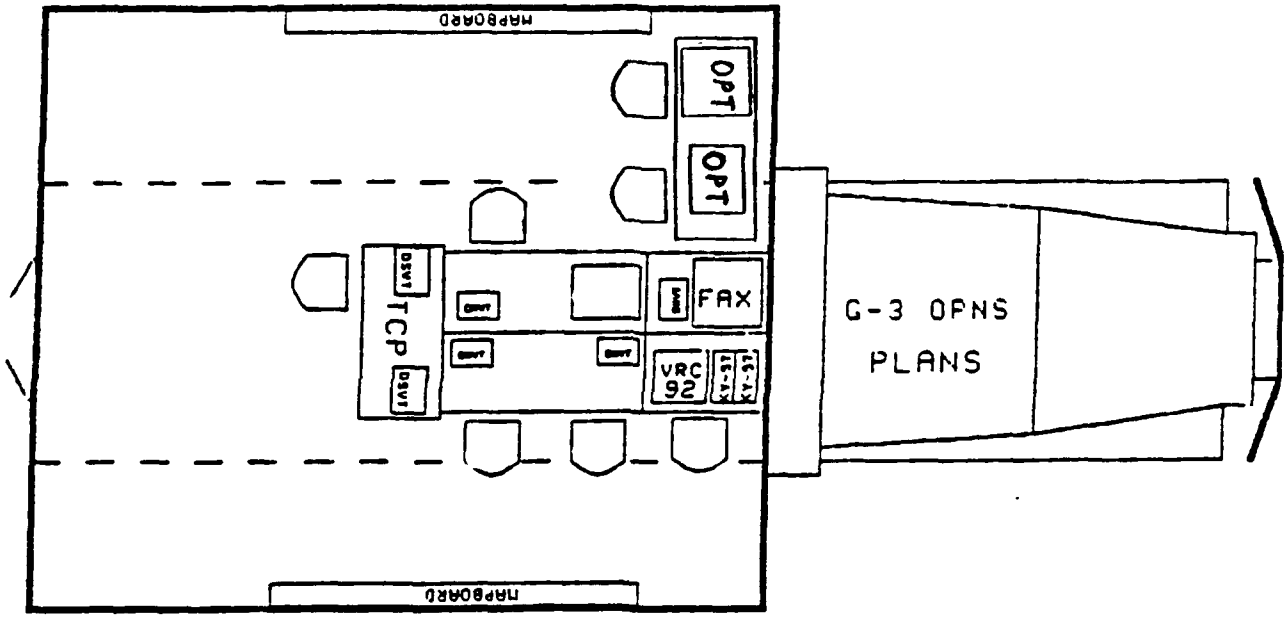

Figure 1. Location of OPT equipment during the exercise.

RESULTS AND DISCUSSION

General Impressions

OPT was quickly recognized as being credible and useful by the 35th ID staff. Even with little prior familiarization, the staff recognized value in OPT and used OPT from the beginning of the exercise. Color print-outs of the OPT situation graphics were used in the first meetings of the staff and briefings to the Commander. The staff continued to request and use OPT print-outs throughout the exercise.

Many spontaneous comments were overheard which indicated positive reactions to OPT:

'This is great, we'll give up a G2 rep to come down and work with this right away.'
'Mistakes [in base combat power values] which we had overlooked were corrected by using OPT.'
'This is good stuff, without a doubt.'
'OPT is being used, the print-outs are good.'

Questionnaire Results

Seven Plans staff questionnaires were completed and returned. The Plans questionnaire was also completed by a former plans non-commissioned officer (NCO) (currently assigned to the Division Artillery [DIVARTY]) and an observer-controller (who was with an active duty Division as the G3 Division Plans officer) who had received demonstrations on OPT. Three Key Staff questionnaires were completed. Two other officers returned a questionnaire with only demographic information completed, indicating that they did not have sufficient familiarity or knowledge of OPT to respond to the questions.

Following are the results from the questionnaires, annotated with responses from each of the groups. Table 1 presents the characteristics of the respondents. Table 2 presents the questions with the responses indicated in **bold** type. For questions with a 3 or 5 point Likert-type scale, the frequency of responses are indicated next to or below each response category. On the five point scales, the number to the far right of the frequencies represents an average score for the question. The negative end of each scale was assigned a value of one with each successive response category progressing by one.

Table 1. Characteristics of Questionnaire Respondents.

#	Rank	MOS/OSC	Yrs in Grade	Yrs in Service	Duty Position	Months in Position
1	MAJ	11C 13E 13D	3½	17	Plans OIC	11
2	MAJ	14	1	12	AD Plans	12
3	MAJ	13A 35D	2	17	Threat Analyst	8
4	MAJ	21J	2	27	-	36
5	MAJ	13E	4	23	Opns Duty FA	1
6	MAJ	92B00	4	19	G3 Log Plans	5
7	MSG	76Z50	3	22	NCOIC G3 Plans	24
8	MSG	13Z50	7	29	DIVARTY CSM	6
9	MAJ	13 54	3	14	OC	4
10	MAJ	13A	7	23	AFSCoord	36
11	CPT	11B 35D	2	14	G2 Ops	4
12	COL	11A	3	23	Chief of Staff	36
Average			3½	20		15

Table 2. Responses to OPT Functional Requirements Questionnaire. (Responses in **bold**.)

1. Which statement best represents how much you used OPT during the exercise?

0	Not aware that it was used.
6	Aware that others used it.
1	Used it one time, for a few minutes.
0	Used it one time, for over 30 minutes.
3	Used it two to five times.
1	Used it more than five times.
1	Recipient of products.

2. How did you use OPT or the results from OPT during the exercise?

Future operations planning
Update map board in G2
Developing courses of action
Force ratios
Wargaming
Developing plans and Fragos
Graphics and results for briefings

3. How adequate was your understanding of the OPT capabilities for what you needed to do with it?

Highly Adequate	Rather Adequate	Borderline	Somewhat Inadequate	Decidedly Inadequate	
1	**6**	**1**	**2**	**0**	**[3.6]**[4]

4. How well did OPT meet your needs during the exercise?

Remarkably Good	Quite Good	So-so	Not Very Good	Unusually Poor	
1	**8**	**0**	**0**	**0**	**[4.1]**

[4] The bracketed values represent the average rating using a scale from a low of 1 to a high of 5.

Table 2 continued.

5. How useful was OPT for each of the following (use the response categories below):

Of No Use	Not Very Useful	Of Use	Of Considerable Use	Extremely Useful

	Average rating of Usefulness[5]
a. Providing a comparison of courses of action?	4.7
b. Calculating combat power for selected forces?	4.6
c. Arraying forces for a course of action?	4.4
d. Changing mission assignments for forces during contingency planning?	4.2
e. Estimating movement times?	4.2
f. Assisting in visualizing the battle field situation?	3.9
g. Providing a timeline for battlefield synchronization?	3.8
h. Assisting in understanding potential battle events?	3.6

6. How useful would OPT be for briefing the reasoning behind a course of action recommendation?

Of No Use	Not Very Useful	Of Use	Of Considerable Use	Extremely Useful	
0	0	2	5	5	[4.2]

7. The amount of time OPT took to produce the products was generally

Much Too Slow	Somewhat Slow	Just Right	Somewhat Too Fast	Much Too Fast	
0	1	7	1	1	[-][6]

8. To include OPT in the staff planning process was

Very Difficult	Moderately Difficult	No Problem	Moderately Easy	Very Easy	
0	0	2	7	1	[3.9]

[5] OPT features of question 5 a-h (and question 17 a-r) have been ordered according to relative usefulness.

[6] Response categories were not assigned numerical values since they do not represent a linear scale, whereby a weighted average could be computed.

Table 2 continued.

9. Compared to how planning is usually done, OPT led to performance that was

__9__ faster
__0__ slower
__1__ not significantly different

10. Compared to how planning is usually done, OPT led to performance that was

__8__ more thorough
__1__ less thorough
__1__ not significantly different

11. Compared to how planning is usually done, OPT led to performance that was

__5__ more accurate
__1__ less accurate
__3__ not significantly different

12. For a course of action recommendation briefing, having OPT's assistance would make a briefer feel

__11__ more confident than usual
__0__ less confident than usual
__1__ not significantly different

13. How confident are you that OPT produced accurate and valid results?

Highly Confident	Rather Confident	Borderline	Somewhat Not confident	Decidedly Not confident	
0	7	1	0	0	[3.9]

14. How confident are you in the courses of action determined with OPT's assistance?

Highly Confident	Rather Confident	Borderline	Somewhat Not confident	Decidedly Not confident	
1	7	2	0	0	[3.9]

15. How understandable were the OPT results?

Very Difficult	Moderately Difficult	No Problem	Moderately Easy	Very Easy	
0	1	3	6	2	[3.8]

Table 2 continued.

16. How satisfactory was the system in being flexible to meet varying task and time demands?

Very Satisfactory	Satisfactory	Borderline	Unsatisfactory	Very Unsatisfactory	
3	5	0	0	0	[4.4]

17. Mark the OPT features that are most useful.

9 a. OPT estimates friendly and enemy attrition.
9 b. OPT calculates friendly and enemy combat power.
8 c. OPT supports development of a course of action from a previously saved one.
8 d. OPT calculates travel time.
7 e. OPT calculates distance travelled by units.
7 f. OPT calculates relative combat power.
7 g. OPT calculates proportion of go, slow-go, and no-go for a route.
7 h. OPT displays summary data for a particular course of action.
6 i. OPT displays summary data for comparing multiple courses of action.
4 j. User has option to modify combat power values.
4 k. OPT repositions units across segments (phases).
3 l. User defines routes.
3 m. User decides on level of detail for analysis (number of routes, number of segments per route).
3 n. User can modify travel time of units (delay factor).
3 o. User assigns missions for units.
2 p. User can modify movement planning factors.
2 q. OPT displays timeline legend for indicating time of day on a route.
1 r. User decides on mission start time.

18. Which of the OPT features need to be modified? How?

Allow units to be deleted or added for graphics presentation.
More rapid changes in data base modifications (for example adding adjacent units, newly assigned units, and separate brigades)
Might be better to produce maps on a view graph.
Need a map scale greater than 1:80,000.

19. What features should be added?

Expand movement planning to develop movement plans (by non-transportation planners).
Data transmission of OPT products to other staff sections.
Air battle data.
Chemical effects.
Barrier planning.
Radar capabilities overlay.

Table 2 continued.

20. Can OPT be integrated into your current organization?

9 Yes
1 No

If no, what changes to organization should be made?

Space and manpower requirements need to be assessed.
Need to study whether a dedicated operator is needed.

21. Can OPT be integrated into the current staff procedures without changes to those procedures?

7 Yes
1 No

If no, what changes to procedures should be made?

All members of the plans cell need to participate in planning. The workstation with one operator may inhibit the interactive process. OPT needs to support the collective process.

22. What other applications can you think of for OPT besides planning courses of action.

G2
G3 operations for planning branches to current plan.

23. List any mistakes in planning that OPT might have caused?

None identified.

24. Name any factors that were not taken into account by OPT in its analyses that should have been included.

Air to ground damage, and damage inflicted by ADA.
Minefields and obstacles.

How did you include these factors in your analyses and estimates?

Guesses.

Table 2 continued.

25. What are the principal advantages of OPT?

When little time is available, OPT will allow more thorough planning.
More COAs can be analyzed.
Iterative work on the final COA.

Time savings.
Speed allows wargaming many COAs and fine tuning.
Speed and accuracy.

Neat, legible output.
Clarity, accuracy.

Graphics for briefing.

26. What are the principal disadvantages of OPT?

Addresses travel times but not pass times.
OPT was too fast in producing products for what the staff was used to.
OPT was slow in producing products compared to the potential of computers.
The tool has the potential to become the replacement for thoughtful analysis, 'computer' says so it must be true.

27. If your unit were to go to battle in the next month would you want OPT along with you?

10 Yes
0 No
1 Not sure
0 Yes, with the following changes (please list):

28. Provide any additional comments here.

OPT staff was extremely willing to work with the 35th staff.
Potential is certainly present, would like to use it over a period of time.
Would like more hands-on operation.

Discussion of Questionnaire Items

Understanding

OPT was understood at least "adequately" for what the staff needed to do with it by 7 of the 10 Plans cell respondents. The Plans NCOIC and G3 Plans Logistics officer felt their understanding was "somewhat inadequate".

Use of OPT

OPT was used in the ways it was envisioned to be used in design: for developing courses of action, wargaming, refining courses of action, and briefing.

Responsiveness

OPT was rated as being "remarkably good" or "quite good" at meeting the planners' needs during the exercise.

Current Features

The responses for question 5 and 17 indicated that the most useful features in OPT are friendly and enemy combat power and summary data for a particular course of action. Surveyed features listed in question 5 all had an average usefulness rating of 3.6 or better. Half of the features identified in question 17 were rated by 6 or more staff as "most useful." At least one person or more judged every OPT feature to be "among the most useful." The usefulness of OPT for briefing the reasoning behind a course of action (question 6) was rated an average of 4.2 on the 5 point usefulness scale (nearest "of considerable use").

Graphics

One respondent thought that because of OPT's graphics that it was too slow compared to what is possible with computers. One other reported that additional graphical capabilities would be desirable, such as map scales greater than OPT's largest scale of 1:80,000 (e.g., 1:50,000) and graphical selection of more than one unit at a time for arraying forces or other processes.

Incorporation into the Staff Process

The majority of the respondents (8 of 10) felt that it was at least "moderately easy" to use OPT in the planning process.

Speed

Nine of 10 of the respondents felt that OPT led to performance that was faster than typical planning. The majority of the respondents (7 of 10) felt that the time OPT took to produce results was "just right." One respondent felt that it was "much too fast" because the staff was not used to getting the results that quickly. Several respondents indicated that the time savings or speed were the principal advantages of OPT.

Thoroughness

Eight of the 12 respondents indicated that OPT led to performance that was more thorough than usual (1 no different, 1 less thorough, 2 no answer). Several respondents felt that because of its speed, its principal advantage was to allow more courses of action to be analyzed more thoroughly.

Accuracy

Five of 8 respondents felt that planning with OPT led to more accurate performance. One of the eight felt that performance was less accurate because the staff relied too heavily on the computer results and did not put enough effort into the wargame themselves. (Refer to further discussion later.)

Confidence

Eleven of 12 respondents thought that an officer giving a briefing would feel more confident having used OPT. Seven of 8 were "rather confident" that OPT produced accurate and valid results. Seven of 10 felt "rather confident" about the courses of action determined with OPT's assistance. One felt "highly confident" and two were "borderline".

Understanding of Results

Eight of 11 respondents felt that the results were "moderately easy" to "very easy" to understand. Three respondents thought there was "no problem" with understanding the results, while one had "moderate difficulty."

Flexibility

Eight respondents felt that OPT was at least satisfactorily flexible to meet variable task and time demands.

Modifications to OPT Features

Several suggestions were obtained from the questionnaires for modifications to OPT.

Unit Display

One recommended modification was to allow selective deletion or addition of units for graphics presentation. Currently this capability exists by either moving the unit outside the display window or by not including the unit in the task organization. This may not be a critical requirement, but it should not be difficult to implement this feature along with other task organization capabilities (such as the Task Organization and Status Tool [TOAST], Fallesen, Flanagan & Packard, 1988; Packard, 1990).

Another desirable feature would be to be able to allow additions to the task organization, such as adding adjacent units or a separate brigade. This could be a capability that would be incorporated with data base handling features of the task organization. It would be desirable to have these directly accessible during the use of OPT. For the research purposes for which OPT was designed, it was not the intent to provide complete data handling capabilities. It is anticipated that a fielded, host system, such as the Maneuver Control System (MCS) would provide these data entry capabilities.

There are several desirable changes beyond including or excluding certain units. It would likely facilitate ease of operation and time savings if groups of units could be designated in OPT and some operation performed on the specified group. It would be desirable to have both table and graphical forms of a group selection feature. With the feature on the unit menu, initial strength values could all be set or reset at once. In the graphics, a group select feature could be implemented by allowing all units within an area to be designated by drawing around the group of units. The graphical selection capability would be useful to assign a group of units to a movement route segment. Another implementation would be to handle units based on organizational hierarchy, such as all battalions under the control of a brigade. Any of the means for group selection should also allow the removal of any unit from the group, such as leaving one unit to hold an area while the rest of the units in the group move ahead.

View-graph Output

One respondent felt that view-graph output would be desirable. This is feasible with the current hardware, software,

and printer that were used during the exercise. The printer can accept rolls of clear acetate material in addition to the paper that was used during the exercise. It is somewhat inconvenient with the current printer to switch between paper and acetate during an ongoing operation or exercise. View-graph output may mean giving up paper print-outs, unless two printers are available. Large screen displays would be another approach for displaying OPT results to a larger group.

Movement Plans

OPT now allows the designation of rudimentary movement routes for maneuver elements. OPT could be used in its present form to support movement plans, using its terrain and road maps, time and distance calculations, time start and delay inputs, and multiple route capabilities. What OPT does not handle is the record keeping involved in movement tables. OPT's current structure may not have the precision needed to compute complicated movement plans. However, in its current form it could be used to support movement planning by providing time-distance estimates for routes and displaying multiple routes. OPT does not generate movement tables automatically.

Transmission of OPT Products

One respondent felt that it would be desirable to transmit OPT products to other staff cells electronically. The Tactical Planning Workstation was designed with this capability in mind. Products could be transmitted as graphic or free text messages, if corresponding hardware and software are available at the multiple sites. This is a reasonable requirement to support the joint development of courses of action and plans from different sites.

Additional Battlefield Operating Systems

Several respondents indicated that they would like OPT to include consideration of other elements of the battlefield, like the air battle, chemical effects, obstacles and barriers, and radar coverage.

Planning and wargaming must consider these aspects, but it is unclear how to put these factors on comparable terms to maneuver combat power values. The art of wargaming has not advanced to the point where there are good theories, rules, or estimates for how to include all battlefield aspects into combat power calculations and attrition estimates. OPT currently has a capability to allow an adjustment factor to be used by the planner to add or subtract to the combat power estimate, based on

the planner's judgment about how these other factors will affect combat power. Currently there is no standard approach that can be taken and embedded into the OPT algorithms.

Another consideration against increasing the number of factors that OPT uses is that OPT could grow to violate its design goals. OPT could become a big, 'data-hungry' tool that is slow, complicated, and unwieldy. The desired advantage of OPT compared to analytical models and expert system approaches is its simplicity of entering in starting parameters and understanding the results. Several factors should be considered further for addition to OPT: the effects of artillery and counter battery fires, close air support, and obstacles and barriers. Further functional and cognitive analysis of the planning for these factors may indicate that some or all need to remain as manual planning factors, relying on the expertise of the commander, G3, and special staff officers. At a minimum, standing operating procedures need to be developed for how to address these factors in conjunction with using OPT, with or without embedding them as part of the OPT tools.

Group Planning

One of the listed disadvantages of OPT is that it could interfere with the collective, interactive staff planning process. The design of OPT was considered with this in mind. OPT was considered to be flexible enough to support a process, similar to a manual one where several officers are gathered around a map or at a desk with a calculator, computing maneuver comparison factors for courses of action. In this mode of use OPT serves as an organizer, a worksheet, and a visualization aid for the group's work. Typical planning groups have been observed by ARI observers during command post and war fighter exercises to vary in size from 1 to about 8. In the case when there are four or more planners, the task is typically to share information for a short time or to present a concept. The real development of concepts and evaluation of them, typically involve one to three planners, which OPT has been shown to support (Perkins et. al). However, the comment does suggest the need to develop SOP for the use of OPT as part of the group planning process, to make sure that it does not inhibit group planning, regardless of the preferred size of a given planning staff.

Over-reliance on Computers

The Chief of Staff made the observation that he was concerned that his staff was relying too heavily on the results of OPT; that they were not questioning the results that were obtained or trying to determine why the results were coming out the way they did. When he asked them to explain the OPT results

they answered 'because that is what the computer said.' The OPT operators or developers were not present at these meetings to clarify any possible misunderstandings. The Chief was concerned that the staff was losing training benefit by not dealing with these considerations. The staff's response caused the Chief to respond negatively to the questions on OPT's impact on the thoroughness and accuracy of planning. As noted below on Stage of Planning, the plans cell did not plan in a detailed fashion and it is uncertain whether OPT or other conditions of the exercise were responsible. Notionally OPT provides an opportunity to consider more detail than a staff might do otherwise. OPT was never conceived to be a stand-alone decision maker or analyzer; the nature of tactics makes that undesirable. With the limited time available that was afforded for orientation to the staff prior to the exercise, the staff may not have realized that the quality of the output is directly related to the extent of interaction with the tool.

The users of OPT must fully understand the applications and limitations of the tool. If someone misapplies a tool, that does not necessarily make the tool bad, though the tool should discourage misuse. The point about fully understanding the limitations of a decision aid cannot be emphasized enough. Our military computer software must be programmed in advance of any conflict; some changes may be made or left as data inputs for a specific situation. The responsibilities will remain with the user to understand the tool, to use it in appropriate situations, and to use it in the appropriate manner. The users should understand the possible consequences of doing otherwise.

Observation of OPT

Observed Use

OPT was used in course of action development and evaluation. The use tended to be more for evaluation, rather than for the development of the tactical concept. General concepts seemed to be initially developed outside of the planning cell and thus away from OPT. OPT was used primarily to verify a concept. The results would be taken from OPT and discussed at the next staff meeting. Details of interest included such things as movement time, sufficiency of combat power, and level of attrition over phases of the operation. The latter was of interest in estimating ending strengths.

Demonstrations of OPT were given on about ten occasions to division staff members and officers participating in the control of the exercise (SAIC, 1990). This audience ranged from a general officer to noncommissioned officers. The demonstrations were done on a non-interference basis with the exercise.

Down time

There were a number of times when the OPT software did not operate as expected. Most of these occurences were attributed to a faulty cable connection. No data were lost because of the failures and recovery could be effected within two minutes. There also appeared to be some unexplained failures. It is important that these be rigorously logged and documented in the future, so that reliability of the OPT software can continue to improve.

Map Data

The map coverage of Western Europe that was available in the current prototype version of OPT met the needs of the particular 35th Wagon Wheel exercise. A representative from the Command and Control Directorate, Combined Arms Command, recommended that OPT be modified to use standard Army map data. This is desirable for further development, sensitivity analyses, and other field uses.

Data Base

Data handling features that were identified by the 35th staff, had already been recognized by the OPT developers as being desirable. If OPT were integrated into a tactical computer system, such as the Maneuver Control System, these features should be available from that host system. The data and data manipulation features from other host software could be used to provide OPT with additional capabilities and vice versa.

Procedures for Using OPT

From observing the processes of the staff and how OPT was used, it became evident that procedures were lacking for how OPT should be used. This was partially due to the short timeframe for preparation and coordination. Although most of the surveyed staff indicated that OPT was "moderately easy" to include in the staff process, the interaction was lower than expected. For the future use and development of OPT (as well as other decision aids) procedures need to be developed for guiding the use of the aid by the staff. These should be comparable to standing operating procedures (SOP). Examples of procedural issues to be addressed include the following:

• During what aspects of a continuous staff process is it best to use OPT (mission analysis, development of the concept, wargaming, contingency planning, synchronization, or final orders preparation)? How should or could OPT be used during these different phases of planning?

• For what future time period or future event is planning being done? What is the start point for OPT analysis? Do you start and wargame from the current situation or make some projections for a given time period? What should the time projections be based on?

• What estimates should be made about the enemy force locations, intentions, and strengths (or what assumptions) prior to starting analysis with OPT?

• What information should be collected and available on friendly force locations, missions, and strengths (or what assumptions made)?

• What are the critical events that should be focused on?

• How should routes, branches, and courses of action be named and annotated for easiest recognition of the essence of the concepts?

• How can the testing of various assumptions and comparisons be most efficiently explored, tracked, and controlled? How can the concepts be controlled in terms of whether they are represented in OPT as a route, branch, or new course of action?

These are similar to questions that have been raised in the past regarding how to do planning and wargaming as a manual process. The same questions are even more important with OPT, because OPT provides quantitative comparisons that should be based on carefully considered assumptions. Until the staff becomes fully familiar with OPT's capabilities, there needs to be a guiding procedure that helps them integrate OPT fully into the process to get the most benefit.

Stage of Planning

The staff was not doing detailed planning during this particular exercise. Prior planning had been done before the exercise started for anticipated battle events. During the weekend exercise, planning focused on the next phase of the exercise which was to be conducted in about three months. It was hoped that there would have been more interactive involvement with OPT by the staff planners. The plans cell appeared to be undermanned during the exercise; typically only two to five staff would be present in the cell. A planner was available only a small proportion of the time to work directly with the OPT operators.

During the exercise, typical planning with OPT occurred in the following manner. For a certain course of action or branch, a G2 representative would come in and construct a template of the

enemy. In one case, he entered a single enemy template by directly interacting with OPT, instead of having one of the contractor support personnel do it. The G3 plans officers (officer in charge-night shift leader, or assistant G3 plans-day shift) would provide general guidance to the OPT operators. General planning parameters were given, such as,

> 'Look at the worst case of all the enemy against one of our brigades.'
>
> 'Assume starting strengths of x for enemy forces and of y for friendly.'
>
> 'Set the enemy's route of attack into the heart of the brigade.'

Sometimes the plans officers would indicate the need to use OPT for analyzing a concept and then several hours would go by before the planner had the available time to coordinate with the OPT operators. The operators were given free latitude to modify and refine the concept within the parameters established. A plans officer usually waited for the OPT operator to indicate that the results were finished and ready, before checking on the status of the analysis.

In one instance, The SAIC operators had not annotated the course of action with any narrative, descriptive information about the concept. Generic names (e.g., COA 1) seemed to cause some hesitation about which course of action or which branch a certain name represented, until the specific routes were displayed.

It was reported by the Plans Officer that the Commander and Chief of Staff requested that the OPT results (especially, combat power calculations) be corroborated by manual computations. However, no one was ever observed making these manual computations in the Plans cell during the exercise. There were comparisons prior to the start of the exercise between OPT and the manual calculations of combat power ratios that were generated in preplanning. Right at the start of the exercise, combat power values were compared between OPT and the manually computed values. The values were similar but not exact. The difference was due to differences in the base combat power values. The OPT values were based on more recent material (CGSC, 1989). The plans staff checked on this material and updated their figures to the same values that OPT was using[7]. This may have helped to establish OPT's credibility with the planners and so they saw no need for further verification.

[7] There is also a capability in OPT for the user to adjust base combat power values.

Attrition Calculations

In the use of OPT during the exercise, it was noticed that attrition results depended on the number of segments[8] in which forces were engaged. If in one course of action, forces are in contact across four segments, they will experience more attrition than if they are in contact on three segments, even if all other factors are equal. Attrition algorithms are applied to each segment without regard to duration or distance. This consideration is not addressed by current doctrine or training, but became apparent to the SAIC and ARI representatives as OPT was used during the exercise. Attrition algorithms should be developed so that they are affected by the forces involved and the type and number of encounters anticipated. Ways to address this involve:

- Standardizing comparisons by time or distance on a segment.
- Applying attrition only to specific engagements.
- Applying attrition to a higher unit of analysis of the overall route rather than for segments.

This is a critical issue that must be resolved and take precedence over further development or use of OPT.

Sensitivity Analysis

A representative from the Future Battle Laboratory observed a portion of the exercise and recommended that a comparison be made between OPT and other battle attrition models, such as those used in training simulations. It was not possible to do this during the exercise, as the plans that were being worked on for tactical engagements involved future time periods that the training simulation did not play out. It may be feasible to do a sensitivity analysis, off-line from a training exercise.

Usefulness

There were two indications from the 35th ID staff concerning their overall impression of OPT's value. During the exercise, several staff members indicated that they hoped that they would be able to use OPT again in their next command post exercise. Also the final question on the questionnaire asked:

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[8] A segment is a subdivided portion of a movement route. The planner can use segments to differentiate types of combat or to optimize terrain mobility.

"If your unit were to go to battle in the next month would you want OPT along?"

Ten of 11 staff officers indicated yes that they would.

SUMMARY AND CONCLUSIONS

The rationale and requirements for OPT were assessed by matching selected questions to the design criteria and comparing the responses. OPT rates quite high on meeting the cognitive design criteria.

Functional Support Criteria

Supports Visualization

Questions 5f, 5g, 5h, and 17q (see Table 2) were most related to the visualization aspect of OPT. Ratings on question 5 indicated average usefulness ratings nearest to "of considerable use," with no one indicating "of no use." Print-outs were used more by the staff than the Workstation displays. The print-outs were used to present "snap shots" of projected situations and the estimated outcomes from those situations in staff meetings and briefings to the Commander.

Supports Computations

Questions from 5 (a, b, e), and 17 (a, b, e, f, g, h, i) addressed the usefulness of the computational features of OPT. Answers to question 5 on usefulness indicated average ratings nearest to "extremely useful" and "of considerable use." Responses to the "most useful" features indicated that the computational aspects were all selected by six or more of the nine respondents (the seven aspects being chosen by an average of 7½ respondents).

Supports Organization

The organization provided by OPT which supports the rapid exploration of modifications to concepts or refinements to them, was addressed by several questions. The usefulness ratings of question 5 (c and d) were nearest to "of considerable use." Questions 7, 9, 10, and 25 indicated that OPT supported rapid and thorough planning. Specifically responses to question 17c indicated that 8 of 9 selected 'the development of a course of action from a previously saved one' as among the most useful features. Four respondents felt that 'OPT's ability to reposition units across segments' (question 17k) was among the most useful features.

OPT-User Interaction Criteria

Adaptable

Questions relating to the adaptibility of OPT included 8, 17m, 20, and 21. Three of 9 respondents selected "user decides on level of detail for analysis" (question 17m) as being among the most useful features. OPT was also rated as being "moderately easy" to include in the staff planning process. Nine of 10 felt that OPT could be integrated into the current unit organization, and 7 of 8 felt that OPT could be integrated into current staff procedures. From observations it was concluded that better transition of OPT to the staff and a SOP would improve how OPT is used.

User Control

Items pertaining to user control from question 17 (j, l, m, n, o, p, r) addressed specific OPT features. All seven of these features were indicated as among the most useful by at least one respondent. The most selected feature of these seven was the ability for the user to modify combat power values. The least selected was the ability for the user to specify the mission start time. The features under the user control were selected less often as being among the most useful than the automatic OPT features. This is probably because the more popular features are directly related to the output of OPT and the calculation of the output.

Reduce Workload

The reduction of workload was not directly covered in the questions, because contract personnel were used as operators of OPT. The respondents did indicate that OPT allowed time savings, which suggests reduced workload compared to performing the tasks manually.

Familiarity

Six of 12 of the staff felt that OPT results were "moderately easy" to understand (question 15) and 2 others thought they were "very easy" to understand. Had the OPT products been unfamiliar or difficult to understand, the staff would not have as readily adopted them and used them in meetings. Seven of 10 felt that their understanding of OPT capabilities (question 3) was "rather adequate" or "highly adequate."

Improve Performance

Questions relating to the impact on performance included 4, 7, 11, 13, 14, 25, 26, and 27. OPT received an average rating of "quite good" (4.1) for meeting needs during the exercise. Performance was rated by 5 of 9 as "more accurate" (3 of 9 as "not significantly different"). Seven of 8 were "rather confident" in the accuracy and validity of results produced by OPT, and the same rating was received for confidence in the courses of action determined with OPT. Listed advantages indicated their feeling that OPT improved performance, though the Chief of Staff was concerned that the plans staff relied more on OPT than on "thoughtful analysis."

RECOMMENDATIONS

The purpose of this assessment was to obtain feedback in an operational setting and to obtain information on additional requirements for staff planning tools. Recommendations are made on what enhancements should occur in the tool, what procedures need to be developed for use of OPT by an operating staff, what impact OPT will have on the overall command post organization and system, and what policy issues need to be addressed.

Enhancements to the Tool

OPT must have the following enhancements:

- Distance or time factors to control and standardize attrition (most important).

- Compatibility with standard Army map programs.

- Compatibility with data available in standard Army tactical command and control system data bases.

It would be desirable to have the following enhancements:

- Easier and quicker means for designation and selection of multiple units for templating, order of battle, arraying forces, segment assignment, setting starting unit strengths, representing unit movements, and displaying selective parts of the forces.

- Improved terminology (e.g., in the course of action networks replace the computer term of "child" with the tactical term "branch").

- A means to display (e.g., through a pop-up menu) the narrative description of courses of action or branches in the top level display, where selections are made.

Modifications to the Procedures

Procedures must be developed to guide the use of OPT in staff planning. At a minimum the following are needed:

- Operating procedures or policy to control and standardize OPT comparisons; at a minimum, a procedure or a checklist for making comparable assumptions among courses of action, or to make explicit the differences in assumptions or concepts among the courses of action.

- Procedures to familiarize users and operators with the

capabilities and limitations of OPT, and associated training standards. An implementation or transition program should be established for any decision aid that will be tested or used in operational settings.

The following is desirable to emphasize in procedures:

- Standard procedures for annotating courses of action and branches, using the descriptive fields available in OPT.

Command Post Impact Assessment

Since the OPT concept has been shown to have merit, it would be useful to perform an impact assessment on the effects that OPT may have on the command post. The assessment should consider the effects of the tool on staff procedures (as also suggested by SAIC, 1990), personnel requirements, manning, training, and workspace layout. It should be noted that if wargaming was not previously done, then staff workload will increase, though the thoroughness and resulting quality may be improved. If wargaming was done prior to the use of OPT, then workload and task duration are likely to be decreased.

Policy Issues

The status of OPT and if and how it will be used in the future must be addressed.

On-going actions already resourced involve the installation of OPT software on the ATCCS common hardware. Conceptually the tool would provide the most benefit if it were integrated with emerging MCS capabilities for maps and data. Additional benefits can be envisioned by integrating OPT with the Battlefield Planning System (BPS). Considerations should be given to how OPT could and should be used. Possible roles for OPT include:

- A prototype device for further requirements analysis.

- A candidate as an interim operational tool as a stand-alone component on the common hardware.

- A candidate as an integrated component of a fielded, tactical computer system.

All, some, or none of these may be desired. If all or some are desired, then enhancement plans and timeframes should be established to plan for the most efficient accomplishment of system goals.

Another policy issue is to clarify the role of combat power analysis in wargaming. This is critical to the underlying basis for OPT. Some respondents felt that OPT could do more to include other combat factors. Currently OPT follows the instructional materials on combat power analysis. It would be desirable to have policy established, if appropriate, on the issue of combat power values and whether and how to incorporate combat multipliers, such as close air support. OPT now has the capability to include an adjustment for other factors, but there is no clear procedure on how to make judgments and how to employ the adjustments.

These policy issues should be addressed by the combat developments community.

Final Remarks

The acceptance and apparent success of OPT so far have probably been due to several factors:

- Deep understanding about the human role in tactical planning that the development team actively sought to establish.

- Experience with similar aids, and willingness to take a critical approach in learning from them.

- Constant strides to keep the tool simple--simple to understand and simple to use, letting the computer do what it is good at doing and relying on the planners to apply their expertise to the mission at hand.

The final "report card" on OPT is not in yet. Although, OPT has generally done well from "makes-sense" and "ball-park estimate" standpoints, it has not been verified from an analytical standpoint. There is room for improvement in several areas of use as indicated above. The modularity and simplicity of OPT should facilitate the implementation of these improvements as they are further specified and developed.

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