ARI Research Note 91-20

Methods for Providing Direct Feedback About Decision Processes for Command and Control Classroom Exercises

Marvin L. Thordsen and Gary A. Klein
Klein Associates, Inc.

Rex Michel and Edward Sullivan
U.S. Army Research Institute

Field Unit at Fort Leavenworth, Kansas
Stanley M. Halpin, Chief

Systems Research Laboratory
Robin L. Keesee, Director

January 1991

United States Army
Research Institute for the Behavioral and Social Sciences

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

A Field Operating Agency Under the Jurisdiction of the Deputy Chief of Staff for Personnel

EDGAR M. JOHNSON
Technical Director

JON W. BLADES
COL, IN
Commanding

Research accomplished under contract for
the Department of the Army

Klein Associates, Inc.

Technical review by

Edwin R. Smootz

REPORT DOCUMENTATION PAGE

Form Approved
OMB No. 0704-0188

1a. REPORT SECURITY CLASSIFICATION Unclassified	1b. RESTRICTIVE MARKINGS --
2a. SECURITY CLASSIFICATION AUTHORITY --	3. DISTRIBUTION/AVAILABILITY OF REPORT Approved for public release; distribution is unlimited.
2b. DECLASSIFICATION/DOWNGRADING SCHEDULE --	
4. PERFORMING ORGANIZATION REPORT NUMBER(S) KATR-863-88-06Z	5. MONITORING ORGANIZATION REPORT NUMBER(S) ARI Research Note 91-20
6a. NAME OF PERFORMING ORGANIZATION Klein Associates, Inc.	6b. OFFICE SYMBOL (If applicable) --
7a. NAME OF MONITORING ORGANIZATION U.S. Army Research Institute Field Unit at Fort Leavenworth, KS	
6c. ADDRESS (City, State, and ZIP Code) P.O. Box 264 Yellow Springs, OH 45387	7b. ADDRESS (City, State, and ZIP Code) P.O. Box 3407 Fort Leavenworth, KS 66027-0347
8a. NAME OF FUNDING/SPONSORING ORGANIZATION U.S. Army Research Institute for the Behavioral and Social Sciences	8b. OFFICE SYMBOL (If applicable) PERI-S
9. PROCUREMENT INSTRUMENT IDENTIFICATION NUMBER MDA903-86-C-0170	
8c. ADDRESS (City, State, and ZIP Code) 5001 Eisenhower Avenue Alexandria, VA 22333-5600	10. SOURCE OF FUNDING NUMBERS

PROGRAM ELEMENT NO.	PROJECT NO.	TASK NO.	WORK UNIT ACCESSION NO.
63007A	793	144	S6

11. TITLE (Include Security Classification)
Methods for Providing Direct Feedback About Decision Processes for Command and Control Classroom Exercises

12. PERSONAL AUTHOR(S) Thordsen, Marvin L.; and Klein, Gary A. (Klein Associates); Michel, Rex; and Sullivan, Edward (ARI)

13a. TYPE OF REPORT	13b. TIME COVERED	14. DATE OF REPORT (Year, Month, Day)	15. PAGE COUNT
Final	FROM 88/02 TO 90/05	1991, January	41

16. SUPPLEMENTARY NOTATION
Mr. Rex Michel of the U.S. Army Research Institute Fort Leavenworth Field Unit was the Contracting Officer's Representative (COR) on this project.

17. COSATI CODES		
FIELD	GROUP	SUB-GROUP

18. SUBJECT TERMS (Continue on reverse if necessary and identify by block number)
Team decision making; Decision making; Command and control; Immediate feedback; Training; Staff operations

19. ABSTRACT (Continue on reverse if necessary and identify by block number)

This report summarizes research that explores the possibilities for providing immediate, real-time feedback to officers in classroom training exercises at the Command and General Staff College at Fort Leavenworth, Kansas. Six issues were addressed by the project: (1) can team decision strategies be tracked in real-time military command and control exercises? If so, (2) Can direct feedback be provided to the participants? (3) What is the nature of the feedback that can be provided? (4) How quickly can the feedback be provided? (5) Is the feedback considered helpful by the instructors and participants? (6) What are the limitations of the application and what can be done to increase the possibility for a successful application of the techniques? It was determined that team decision strategies can be tracked in real-time military command and control settings and that illustrative and pattern feedback can be provided approximately 30 minutes after completing the exercise. In addition, charts mapping the deepening of an idea and tables of other quantifiable factors can be provided 2 to 24 hours following an exercise. Several potential limitations as well as factors that can increase the probability for a successful application are discussed.

20. DISTRIBUTION/AVAILABILITY OF ABSTRACT ☒ UNCLASSIFIED/UNLIMITED ☐ SAME AS RPT. ☐ DTIC USERS	21. ABSTRACT SECURITY CLASSIFICATION Unclassified
22a. NAME OF RESPONSIBLE INDIVIDUAL Rex Michel	22b. TELEPHONE (Include Area Code) (913) 684-4933 / 22c. OFFICE SYMBOL PERI-SL

DD Form 1473, JUN 86 *Previous editions are obsolete.* SECURITY CLASSIFICATION OF THIS PAGE
UNCLASSIFIED

METHODS FOR PROVIDING DIRECT FEEDBACK ABOUT DECISION PROCESSES FOR COMMAND AND CONTROL CLASSROOM EXERCISES

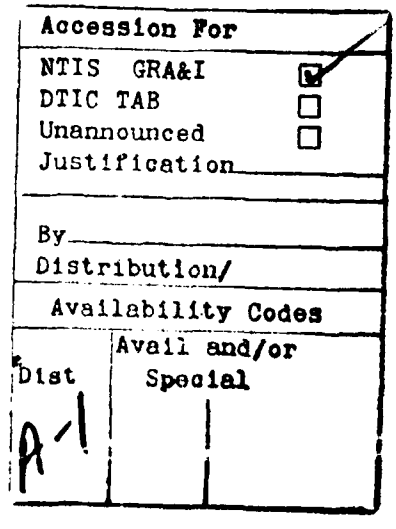
CONTENTS

LIST OF TABLES

CONTENTS (Continued)

Page

LIST OF FIGURES



METHODS FOR PROVIDING DIRECT FEEDBACK ABOUT DECISION PROCESSES FOR COMMAND AND CONTROL CLASSROOM EXERCISES

Introduction

Many team situations permit the participants to "play back" recent occurrences so they can evaluate what they did right and wrong. A classic example is the post mortem that usually takes place immediately following the completion of a hand of cards. In the course of this replay, the participants evaluate the cards played, options taken and bypassed, correct and incorrect plays, in an effort to understand what transpired. One situation in which this luxury is rarely available is in the course of team decision making. These situations are usually too complex and fast moving to permit the level of detailed analysis that normally accompanies things such as the replaying of a hand of cards. Granted, evaluations of the quality of the decisions often occur, but seldom do they touch on the processes of the decisions. This is what we were attempting to accomplish with this project: provide a means of quickly playing back the planning processes in such a manner that they could be seen and evaluated by the participants.

We wanted to determine whether Klein Associates' methods of knowledge elicitation and data collection would permit examination of real-time, military team decision strategies such that this immediate feedback to the participants could be provided. Immediate feedback, as it does in card playing, should provide the military team an opportunity to discuss the quality of their performance. In addition, the feedback our methods provide gives an objective, unbiased basis for these discussions which can be used by an instructor or trainer as well as the team members themselves to guide the discussion.

The concept of using our knowledge elicitation methods to generate training feedback emanated from earlier Klein Associates' projects. Because of this, some of our earlier work and the sequence of events leading to this project are worth reconstructing.

Our initial studies of decision processes were carried out in the context of examining proficient performance. We developed methods for extracting experts' tacit knowledge and applied these knowledge elicitation techniques in a number of domains, including cardiopulmonary resuscitation (Klein & Klein, 1981), computer programming (Peio & Klein, 1984), data analysis (Klein, 1985a), and petro-chemical control room operation (Klein, 1985b). This work led us into a series of studies more directly focused on the decision-making process as it occurs in real-world situations. Our first effort was an investigation of decision making by urban fire ground commanders (FGCs) at the scene of a

fire (Klein, Calderwood, & Clinton-Cirocco, 1988). Our choice of a data-gathering method for this study was guided by our desire to model as closely as possible the natural decision making of FGCs, while meeting the demands of scientific rigor. The method chosen which we call the Critical Decision Method (CDM), was a retrospective protocol analysis based on the FGC's reconstruction of his step-by-step decisions and commands at an incident. Incidents were chosen on the basis of their having present a command challenge, a criterion suggested by Flanagan's (1954) critical incident method. The fact that the reported incidents contained these non-routine decisions fulfilled two major requirements of the critical incident method -- that recall of non-routine events tends to be superior to that of more routine cases, and that the most difficult cases will tend to reveal important aspects of expertise that would not otherwise be apparent (Flanagan, 1954).

These studies have shown a common form of recognitional decision making. We have modeled the decision strategies we observed as Recognition-Primed Decisions (RPDs). (The model is presented in detail in Klein, in publication.) These RPDs can be considered to be analogous to Rasmussen's (1985) level of rule-based performance. The experts we studied were using their experience to judge the familiarity of problems, and to recognize the typical way of reacting to those problems. The decision makers would evaluate the action that seemed to be called for; the extent of this evaluation seemed to depend on the amount of time available and the presence of atypical dynamics that needed to be considered more analytically. In other words, when faced with a decision point, our experienced subjects were able to recognize the situation, recognize the typical reaction, perform some evaluation of the feasibility of that reaction, and then carry it out. They did not appear to be doing any comparisons of different options, looking for strengths and weaknesses.

While we have been studying expertise since 1978, we had our first opportunity to study team decision making strategies in the fall of 1986 by observing Class I, wildland firefighters at a large working fire in Idaho (Taynor, Klein, & Thordsen, 1990). Based on results from this study, we became interested in extending these examinations to team decision processes in a military command and control environment. This was begun by studying battalion level staff planners working with the Army Training Battle Simulation System (ARTBASS) at Ft. Hood, Texas in the summer of 1987 (Thordsen, Galushka, Klein, Young, & Brezovic, 1990). One of the outcomes of this project was that we found the planners tended to employ a process where they would evaluate an option or idea by gradually examining deeper and deeper branches of the idea for workability. Eventually they reach a point where the idea is either accepted, rejected or left hanging due to some distraction. If it is rejected the decision maker either moves on to a totally different option or idea or goes back up the

deepening chain to a point (theoretically) above the source of the flaw and then follows another branch, once again testing its merits all along the way. This process is not unlike the concept of progressive deepening as laid out by de Groot (1978). In addition, we found we were able to chart the deepening of these decision processes used by the group. An example of one of these progressive deepening charts is provided in Figure 1. A limitation was that approximately three months of intensive data analysis was required before we could construct these charts. However, because of the wealth of information captured through the process of making these charts, we were interested in determining whether the same process could be accomplished to provide feedback to participants in "near real time." Consequently, we used the results of the Fort Hood exercise analysis to begin developing data collection and reduction techniques to greatly accelerate the production of these progressive deepening charts. These techniques are described in the Methods section.

Based upon the outcome of a two-hour pilot study performed on a graduate-level seminar class at Wright State University, Ohio, we felt we were ready to try the technique at the Command and General Staff College (CGSC). Through the ARI Field Unit at Ft. Leavenworth, we made arrangements for a field test of the technique to address the following questions:

1) Can the team decision processes in a real-time command and control setting be tracked?

2) If yes, can direct feedback be provided?

3) What is the nature of the feedback that can be provided?

4) How quickly can this feedback be provided?

5) Is the feedback considered to be helpful by the students and the instructors?

6) What are the limitations of the application and what can be done to increase the chances for a successful application of the technique?

Performance feedback is typically given in terms of the rated quality of some product the students produce. Rarely is an attempt made to give process feedback. We felt our method could provide objective feedback on how the students went about accomplishing their task. Although no "school solution" exists as a criterion measure of process performance, describing and discussing the process used should help the students learn valuable cause-effect lessons concerning the relationship between the way they do things and the quality of their products.

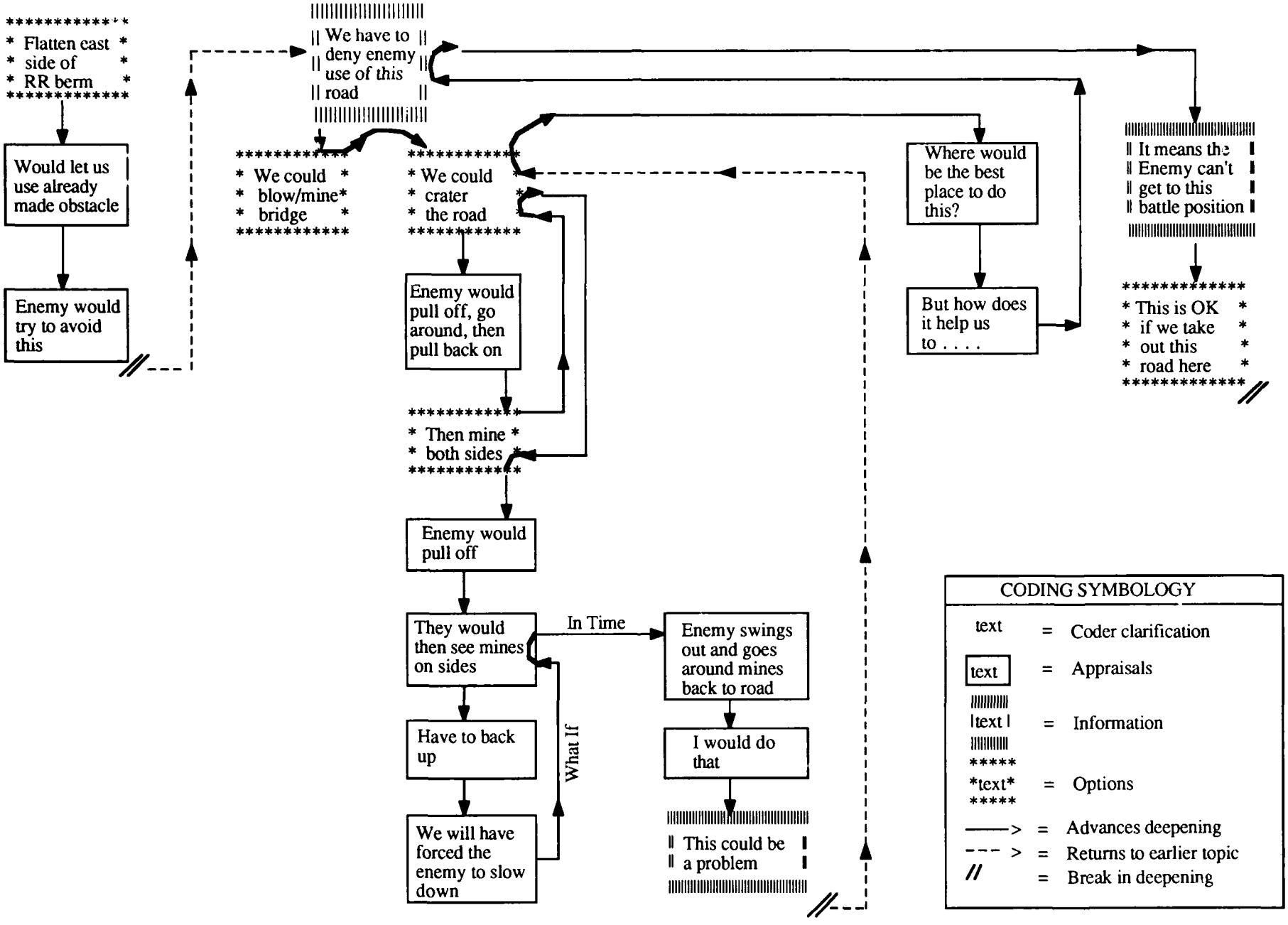


Figure 1. Progressive deepening chart example.

Method

Subjects

The research involved students from class A399, Advanced Warfighting, at the Command and General Staff College (CGSC), Fort Leavenworth. This was an experimental class that was being offered for the first time. In addition to instructing the students in advanced warfighting, it was intended to experiment with the use of computerization in the classroom, to encourage doctrinal discussions, and to work with the concept of synchronization of the battlefield.

The class was composed of 62 students. During the course of the class, they took part in two "Quick Decision Exercises" (QDX) and one Classroom Planning Exercise (CPX). The QDXs were short 3-4 hour exercises during which the students performed pre-battle planning tasks (preplanning). The CPX was a five day exercise during which a major battle was simulated using a game board technique controlled by the instructors and CGSC staff. During these exercises the students were assigned positions on corps, division, and brigade staffs and were responsible for pre-battle planning, fighting the battle and replanning during the battle. We observed both QDX pre-battle planning exercises and the second through fifth days' fighting and replanning of the ongoing battle during the CPX.

Procedure

Our task was to observe the planning cells in such a way that general feedback about their decision making could be provided as well as more detailed information about the nature of the processes they employed. We were able to collect the data for the general feedback with fairly straightforward observation and note taking. Generation of the detailed process feedback required more attention to capture the correct balance of planning content and process during the observation.

Planning content in this situation refers to the actual issues and items being addressed by the staffs, such as the use of close air support, the placement of mine fields, the availability of engineering support, and so forth.

Process refers to the category of decision strategy to which the content belongs. For example, the statement "we could place a mine field at grid X" is likely to involve the process of generating an option, while if the commander states "place a mine field at grid X" it is more likely that the process involves making a decision.

Tracking both content and process was necessary so the feedback could provide descriptions of the processes (e.g., making a decision) that were directly anchored to specific content examples ("place a mine field at X").

Normally the best way to capture the detail required is to use audio recordings of the exercises. Unfortunately it takes too long to transcribe the recordings to provide fast feedback and the planning sessions were often too noisy to allow clean recording. Therefore, we had to capture all observations by hand notation.

A major difficulty with hand notation as opposed to transcripts is that there is no means to reconstruct anything that may have been missed. In addition, there are limits as to how much detail can be captured effectively at any given time. If the content is tracked too closely, it is easy to miss the underlying process, and if the process is concentrated on too much, it is very easy to lose track of the content. There is a balance between content and process that must be achieved to optimize the data collection.

To help achieve this balance, a notational format was devised (Appendix A) for the detailed observations. These coding sheets had a reasonable, but limited space for content information, ten "check" columns to track process information, and one column for identifying who was being observed at any given point. The limited space for content forced the recorder to be precise in the content tracking while the process checks forced the observer to maintain concurrent awareness of the processes that were taking place during that particular phase of content.

The check columns for the process information were designed to track the following ten categories:

Option Generation: The generation of options and alternatives by the planners. For example: "We might want to blow this bridge as soon as the enemy is at xxx."

Information: The introduction of information into the planning environment. For example, "This armor unit is now at grid X, coming down towards the city." The planners may immediately act on this information, store it for future use, or forget it. Nevertheless, it was still available for their use at one time.

Decision: The process of clearly making a decision. The requirement of "clearly" is met when the decision is made from either a position of strength (the ranking officer) or through consensus (agreement among the team decision group). For example, the commander states, "Have the helicopters go up and serve as observers to call in the artillery," or the entire

planning group reaches an agreement that what they must do is to "have the helicopters go up and serve as observers..." If neither rank nor consensus are present in an apparent team decision, more often than not the discussion reopens later, and the apparent "decision" will turn out to have been just another option that was under consideration.

Appraisal: Any general discussion, debate, argument, etc. that serves to further the state of the plan, but does not introduce additional information, make decisions, or generate options. Sometimes this includes "kicking a dead horse" discussions, since these are judged to help the individual planners reinforce their mental mind sets of the plan. For example, "O.K., say they go North...does that appreciably change the battle?"

Action: This refers to activity or a request for activity. This is usually in conjunction with information introduction and option generation. For example, if the operations officer tells the intelligence officer to check with corps to find out where the lead element of the enemy force is located it indicates an understanding of missing information (thus coded as information) and an instruction to locate the information (action). A similar coding for option and action would exist if someone had been instructed to work out the details of a particular option.

Situation Assessment Shift: Any change in the planners' overall assessment of the current situation to the extent that it requires a shift in goal states. For example: A division is planning a counter attack when they receive new intelligence indicating the enemy has advanced faster than they expected. The division then has to abandon the counter attack plan because of a lack of execution time.

Situation Assessment Elaboration: Any change in the planners overall assessment of the current situation that does not require a shift in goal states. For example: A division is planning a counter attack when they receive new intelligence indicating the specific identity of the advancing threat force and more detailed information about its makeup. The division continues its counter attack planning, with a greater understanding of the force it will be opposing.

Simulation Intrusion: Anytime the participants knowledge of the existence of the "game" or the artificiality of it causes the content discussions to focus on issues concerning the simulation. For example: "The controllers know where our strength is, so I bet they don't send the enemy there...just to train us...for the academics."

Problems: Identification of a potential problem or contradiction. This is normally used in conjunction with appraisal and information. For example, (appraisal and problem): What happens if the 9th goes North and the 79th goes South...will that mess us up?

Breaks: Any change in the focus of the topic of the planning discussion. For example: The operations officer and intelligence officer are discussing mine field placement. The fire support officer comes in and asks about divisional fire support assets and the Operations and Intelligence Officers begin discussing this issue with him. This is a break, because the focus of the planning at that point has been changed.

This process categorization is derived primarily from our indepth analysis of a battalion simulation-driven planning exercise. We recorded the verbal interactions of the planners and analyzed the transcripts in detail. One of the products of this analysis was the development of process categories to describe the types of interactions (Thordsen, et al.). The process categories were further elaborated as a result of our observation of the two Quick Decision Exercises (QDX) earlier in the A399 course.

As mentioned above, the rationale for including these check items on the form was to help the observer maintain the balance between content and process. This assisted in tracking the level of detail necessary to construct the progressive deepening charts, identify general patterns, and track quantifiable factors without becoming so overwhelmed that important information was missed. Thus, the data collection form was used to generate three of the four types of feedback discussed in the Results section. The other type, the illustrative incidents, were gathered from general note taking.

Results

The results obtained are presented here in four sections:

- Feedback of Illustrative Incidents
- Feedback of General Patterns
- Progressive Deepening Charts
- Other Quantifiable Factors

These results are observations that either were or could be presented to the participants as "snap-shots" of their recently completed activities. It requires some participation on their part to then evaluate the pros and cons of their actions to learn from the post mortem of the exercise, or more commonly called the after action review (AAR). The illustrative and pattern feedback can be back briefed with approximately 30 minutes of preparation time. The deepening charts require about two hours preparation each and the other quantifiable factors require about one day's preparation.

It is important to note that our observations were directed at the quality of the process of their team decision making, and <u>not</u> the quality of the tactical decisions.

<u>Feedback of Illustrative Incidents</u>

One method of observation, as mentioned earlier, used general observation and notational means and concentrated on compiling <u>examples</u> of illustrative incidents that transpired during the planning sessions. For the final briefing, these incidents were reiterated by the observer while the participants were encouraged with questions and statements to critique the incidents. Some examples of these observations are presented and each is followed by a description of the lesson that could be learned as determined by the observer.

Example 1

<u>Use of Resources</u>. One individual playing a staff member of an armored calvary regiment (ACR) and who felt positive about using computer aids, showed the observer Moveplan: an aid for calculating and planning movement. He also demonstrated a related aid on enemy movement. However, at a critical moment in the ACR unit action where it was important to determine whether the ACR or the enemy would win a race to the Hahne River, the engineer used his thumb and pinky on a paper map to estimate they were "a finger spread away, maybe 45 minutes to an hour." While this was taking place, no one even looked at the Moveplan computer terminal, much less thought of turning it on or using it.

Lesson 1

This example was used to demonstrate that even though there were tools at their disposal, they did not consider using them at a time when they may have been most helpful. They may want to consider making sure all the decision support systems are turned on and ready to use at the beginning of each session. The observer did not critique this further but left it up to the participants to decide whether it was appropriate to use the machine or rely on their rules of thumb.

Example 2

Decision Making. At 1457 hours there was a need for a sudden shift in plans at corps headquarters. In response to this need, the corps commander made a magic carpet ride (i.e., took a one-minute walk to the ACR that would have taken 1-3 hours by helicopter in real time) and asked if the ACR could move east and defend at the Hahne River rather than the Fulda, thus allowing another division to counterattack. Basically, he asked the ACR to change their defenses even though there were less than two hours before the major enemy attack would hit them. [In this particular case, the corps commander was trying to find some mission for the regiment rather than admit to an earlier mission failure and assign them a more appropriate missions such as preparing to stop the next threat echelon or cutting supply lines].

The ACR commander objected and argued that it was too late to change their plans at that point. His operations officer also argued that this would leave a big gap between the ACR and the division for the threat to slip through.

The instructor had been observing all this and asked the operations officer to clarify whether in fact the corps commander wanted him to move two squadrons from the Fulda to the Hahne in less than one hour. "What do you think?" was the question he then posed to the operations officer. The operations officer grasped at a solution -- "We'll slow them up with artillery." "Maybe in EA Sally," the regiment commander added hopefully. However, the operations officer and the commander both remembered the difficulty of using artillery without precise knowledge of the enemy's location.

At 1521 hours the operations officer abruptly changed his mind, decided not to defend at the Hahne River, and ran off (magic carpet) to inform the corps commander. At this point, almost 25 minutes had gone by since he agreed to move forward. These were 25 minutes that could have had a major impact on the time management of the corps.

Following all this, the instructor then discussed with the ACR staff the folly of moving from an 80% good solution (defending the Fulda River) to an attempted 100% solution (defending the Hahne) when there was little chance for the latter to work and a great chance for total failure due to the time restrictions.

Lesson 2

This was presented as an example of a decision process, albeit a poor one. In addition, it was pointed out that while the instructor did a superb job of refocusing the students to the tactical realities of accomplishing the mission at hand, he did not address why the commander accepted the mission in the first place.

Example 3

Reinforcement of Lessons Learned. A division was making plans to strike the 9th Guards Tank Army (GTA) in the morning when it became light. The instructor intervened and asked--"What is your goal now?" Their response was "Hold them until morning." The instructor then followed with a second question--"Who has better night fighting ability?" Their response was "We do." They immediately changed their plans to begin aggressive actions in the evening.

Lesson 3

While the contradiction in the example was obvious at the time to the students, it was repeated to them in the briefing as a means of reinforcing the lesson previously learned.

Example 4

Confusion. Part of a planned deception was to convince the enemy that he was experiencing success along certain parts of the front. Early in the battle, enemy forces landed 60 helicopters in the friendly rear area. There was confusion about what to do and various options were examined, but the problem was that the commander was not sure what he wanted to have happen. The source of confusion involved the two somewhat contradictory goals of the deception plan-- 1) to give the enemy success and lure him in, and 2) to prevent the enemy from getting too strong. In other words, there had to be a precise calibration of how much success it was appropriate to allow the enemy to experience. It was a delicate balancing act.

Lesson 4

This example brings up strong tactical considerations, but the reason for briefing it to the unit was to provide them an analogue that they could refer to in future similar situations. The corps and the division were unclear about how much force to apply and retrospectively, this balancing act was too hard for these students to pull off (the deception failed). They would have been better off just fighting hard. But, in spite of these issues, the real problem was the confusion caused by their lack of clarification of ambiguous, subjective terminology (e.g., what is success?) before the definitions had to be tested.

Example 5

Indecisiveness. The corps staff was planning Combat Aviation Brigade (CAB) strike against enemy elements. However before the plan was completed, a lower echelon officer came in and complained about insufficient aggressiveness on the part of the corps commander and staff. (The enemy was expected to cross the Fulda River around 0600 and the friendly main effort was going to wait and hit them at 0900. The CAB was part of the main effort). The officer objected--"Why let two full-strength enemy divisions come barreling into you?" When he left there was consternation on the part of the corps staff.

The corps commander complained about needing to change the plan. Nevertheless, he asked his plans and operations people to generate some courses of action for review for their potential impact, especially regarding the use of artillery and air assets. He considered taking out the bridges on the Fulda River at 0200 hours. His staff explained to him that Air Force planes do not fly at night; helicopters do, but they work best against moving targets, not stationery ones. The discussion noted that hitting a bridge would slow but not kill the enemy so they would still have the same number to fight. The question was raised about using F-111 fighter bombers and maybe using smart bombs. (All of this showing how hard such planning is when the students lack some of the basic knowledge about the systems they are controlling). Later on, the staff was debating what to do...how to redirect the 52nd Division. Eventually the plans and operations people briefed their plans. (All this was eating up critical time needed to prepare for the strike and to synchronize CAB, electronic warfare, and various fire support nets). Later yet, the instructor yelled at them to get the order out. Eventually they did but it was almost two hours after they were diverted. In the mean time the 9th GTA had sped up and by the time the helicopters lifted off the first of the three target elements had already "gone to ground", they were no longer moving and thus less vulnerable. The strike went on against the

remaining two target elements and only 20 tanks were reported hit. The strike was judged a failure.

Lesson 5

This example was used to demonstrate graphically to the students how easily they got caught up in their attempt to please the dissident officer at the expense of time management. The corps commander indicated afterwards in an interview that he went through with the assessment of the other two courses of action just to comply with what the dissident officer wanted. Ironically, the plan he selected was the original plan they were working on when the officer came in. The plan failed, largely because of the delay in execution.

Example 6

Hidden Ideas. A CAB staff member made the tongue-in-cheek comment "We're just waiting to get hit so we'll know where to fight."

Lesson 6

Even though this was said sarcastically, it may have been a good idea. That is, it may have been appropriate to send units east of the Hahne and Fulda Rivers to make contact with the enemy and determine the approach they were taking.

Example 7

Knowledge. Out of curiosity about an approaching threat force, the observer asked a staff officer about the relative force strengths. The officer initially tried to calculate the number of troops in each division and then stopped and said it was really a question of the number of vehicles. With the help of another staff member he then estimated 270 vehicles for the 79th enemy division and started to tally his own resources but never completed the task.

Lesson 7

This example pointed out that the lack of relative force ratio knowledge and implied that they could not have been systematically working out a synchronized defense. The force ratio knowledge would have been necessary to determine the the proper defensive posture and placement.

Example 8

Communication and Rumors. A unit was questioned via radio about whether enemy forces were attacking the eastern edge of their headquarters area. As this question was repeated among the staff it was reinterpreted as a factual piece of information. At this point, the staff became extremely disgusted that the enemy had slipped past the defenses and was upon them. "Forget all our plans," someone said. "This was another case of the untrustworthy computer system." However they soon realized that the enemy was not upon them and nothing implausible had happened. They had twisted a simple question into a rumor they themselves had created.

Lesson 8

In this particular case the inaccurate information was corrected before any real damage was done, but it is a good example of how easily information can be twisted and misrepresented. This type of incorrect information could be the source of major problems in other situations.

Example 9

Synchronization and Timing. It was 1415 hours, and an armored calvary regiment was maneuvering to get to the Fulda to defend against the enemy. They anticipated the enemy would arrive there in one or two hours. At 1421 hours the operations officer started asking for the location of the lead enemy echelon so an aviation attack could be launched at them. He wanted to use suppression of enemy air defense (SEAD) and attack helicopters.

The intelligence officer was not able to pinpoint the lead enemy elements. The operations officer then told the intelligence officer to get this information from corps. In the meantime, the operations officer began drawing engagement areas (EA) and considered moving up maneuver companies. All the while he was fighting against the lack of time. Eventually he found that one of the EA he was plotting was no longer good because some enemy elements were already there in a defensive posture with their anti-air in place.

Lesson 9

This example suggested that the synchronization training did not help them fully anticipate their needs. They worked the maneuver problems and ignored the need to slow the enemy until it was too late.

Direct Feedback of General Patterns

The second observation method involved collecting information that permitted feedback regarding general patterns that were observed. The following items were back briefed to a division staff following the CPX exercise. Some of these cases will be similar to the above illustrative examples, and they are repeated here to show the different approaches and perspectives that can be used for the briefings. In some cases, it may be appropriate to use both.

Overall: Generally, the division staff worked well together. Teamwork was very effective.

This observation was made based on the fact that we had tracked the various sources of input and the amount of information that was contributed by each. Based on these observations, we noted that a wide range of individuals participated in the planning session and the individuals who were supposedly "in charge" contributed the most. At the same time, input of the other individuals was always encouraged and given serious consideration. We have seen this not work well on other occasions at a corps level exercise at Ft. Leavenworth, a battalion ARTBASS exercise at Ft. Hood, Texas, and at the company and platoon level at Ft. Knox, Kentucky.

Communications: The communications and sources of input into the plan were very diverse and appeared to be in desirable proportions. For example, over the course of 5 hours and 7 minutes of observation on one day, input from seven major and eleven minor participants was observed.

There also appeared to be a fairly good balance of input from these multiple sources. The proportions from each appeared to be in line with the responsibilities inherent in each of the positions for the task at hand. This was determined by deriving estimates through a quick analysis of the data on the observation forms. A more detailed evaluation of these figures is presented in the results section addressing other quantifiable factors (e.g. Tables 2 and 4).

Decisions: We have come to expect in team decision settings that there will be few clear identifiable decisions. We first noticed this while collecting data on wildland firefighters (Taynor, Klein, & Thordsen, 1987) and later during the analysis of the data from the battalion ARTBASS exercise at Ft. Hood, Texas (Thordsen, et al.).

While an individual decision maker such as an urban fireground commander tends to make many, rapid decisions, the process appears to develop differently in the team decision setting. These team "decisions" tend to be options that are deepened by different individuals in the group until they reach levels that are adequate for the task at hand. This is what we noticed in this exercise as well. The result is basically a decision; however, if you asked the individuals involved, there is a good chance no one individual in particular will feel he or she is the one who made the decision.

In addition, most deliberation of options was serial, i.e., concurrent comparison of multiple options did not take place. Generally, an option was selected and improved upon until it was functionally acceptable or if it could not be made acceptable, it would be rejected and they would begin working on another option. Only one occasion of concurrent option comparison was noted during one particular 5 hour and 7 minutes period of planning.

Simulation: All in all, the game board simulation seemed to create very few major problems. There were a few occasions when elements of the simulation (artificiality, etc.) crept into the discussion and diverted the work for short periods of time, but these were relatively rare. We were able to directly track these from the coding sheets since we were watching for specific occasions where the simulation interfered with the overall purpose of the exercise.

The most disruptive factor, as appears to often be the case, is "time warping." This takes place when the time of the battle is altered in any manner that violates real time. Fortunately, time was not warped by the controllers to any extreme in this exercise. When warping did occur (and sometimes when it did not) it served as an easy "scapegoat" for anytime the students were not able to adequately track the threat's progress. On the other hand, the students themselves often time-warped via their "magic carpet rides" around the battlefield. This is a situation where an individual will walk across the room or hall to talk to some other person and be back in their headquarters in five minutes for "trips" that would take 2-3 hours in real time on the battlefield. In the long run, these practices can have implications regarding training. If the actual time is abbreviated, the natural flow of the process has to be compressed or circumvented to "catch up" to the accelerated time location. Conversely, if "time outs" are inserted, the participants will often do additional planning and processing that they would not normally have the time to accomplish. This can generate confusion for the students. On the other hand, the point can be argued that some forms of training may require that the time flow be altered. The optimal decision as to time warping depends on

the training goals of the program. Nevertheless, it is a decision that should always be addressed because of its potential impact (pro and con) on the training experience.

Use of Computer Assistance: Use of automation seemed to be primarily limited to the Maneuver Control System (MCS). The students appeared very willing to use the system; however, they appeared to need more practice with the system so they could be familiar with all of its strengths and limitations. A main issue of confusion concerned the difference between updating the data base versus sending message alert updates via the electronic mail function. Even where they got past this problem, there was still confusion about who was to do the actual updating of the data base. There was much emphasis in the class upon using the computer aids, and not surprisingly, when you asked the students, most spoke very highly of the computer systems and yet they did not use them during the exercise.

Synchronization Matrix: The synchronization matrix was developed at the Command and General Staff College as a means of graphically portraying the temporal relationships among the actions required by the various battlefield operating systems in executing a plan. The results of working with the synchronization matrices was evident. The students appeared to have a good feel for the overall battlefield. The students seemed to be very aware of the fact that updating the matrix during the actual battle was not feasible. However, while using the entire matrix is not realistic during the battle, they might find it helpful to pull out key elements of it to use as checklists during their replanning, to help assure they are taking key points into consideration. As good as the matrices are, we do urge caution in that they have the potential to lull one into a false sense of security due to the great amount of detail they require to be successfully successfully completed. This amount of detail can misguide one into believing you have covered everything, when in fact, there will always be some things that are missing. Another point of caution is that this same amount of detail can potentially result in an information overload condition where there is so much detail that critical material gets buried in the volume. In other words, there may be a need for training the students to down-size the matrix to a manageable level based upon the situation.

Information Seeking and Acquisition. The students communicated very well within their staff. They did not do as well if they had to actively seek out information from outside sources. This was relatively easy to track by observing when they indicated a lack of information (e.g., "Do we know the resolution of this battle yet?") and watching whether anyone actively tracked down this missing information. In this

particular exercise, instead of actively seeking information, the participants waited for the reports on the resolution of specific battles until long after this information was required.

This behavior is not unusual. We have noted the same thing in other military planning session we have observed (Thordsen, et al.). Players did not actively seek needed information if it was not close at hand, even though the consequences could have been devastating. The bottom line is that they have to be much more aggressive in their acquisition of information.

Time Management. A lot of the planning was taking place very close to deadlines. For example, they planned a counter attack where the key attacking force had to be moving within 30 minutes to have any chance of hitting the threat's flank. It is very easy to be overtaken by events when the planning cell is not looking far enough ahead. This can be tricky, because the natural inclination is to wait until you have all the information necessary to create a relatively risk free plan. The problem is that in a battle situation, you will seldom be able to collect all the needed information to develop a risk free plan and still have time to implement it as well. They have to understand that they will often have to plan with uncertain and missing information if they hope to have enough time remaining for a successful execution.

Knowledge of Task Responsibilities and Duties. An important aspect of the makeup of this particular "division staff" was that they were generally working in their natural roles. For example, the operations officer was in fact a combat arms officer. We have observed several classes at Ft. Leavenworth, and generally they have the students switch roles during the exercises. This tended to result in a significant amount of confusion on the part of the individuals about the responsibilities and duties they were expected to perform. We believe that the fact that the individuals were fairly well matched to the positions in this case improved how well they worked together and communicated. Since they were already familiar with their jobs, they could concentrate on fighting the battle rather than having to simultaneously train themselves in less familiar positions.

Background. All in all, the division staff did not appear to fall into a common trap we have often observed where members of the staff allow their perception of the battlefield and resources to be strongly dictated by their background, such that it becomes detrimental. This can result in a form of "tunnel vision" where they effectively used resources they were familiar with (e.g., armor) while simultaneously ignoring less familiar but equally available resources (artillery, infantry, engineering support, air, etc.). This staff

appeared to do a fairly good job of using the resources available to them and not just as an afterthought. This may have been due to the synchronization emphasis in Class A399.

Progressive Deepening Charts

We were able to provide feedback about illustrative incidents and general patterns immediately following completion of the exercises. This was a primary goal and challenge of the study. However, we also wanted to determine whether we could generate charts mapping the progressive deepening patterns of the decision makers. In this particular case the questions were: 1) Can we generate progressive deepening charts in real time as an exercise is taking place?, and if not, 2) Can the charts be generated immediately following the exercise?

Several attempts were made to map the deepening processes of the decision makers as the exercises were taking place. In general, these real-time attempts were not very successful. However, we did find that we could map the deepening process from the material on the data collection sheets relatively soon after the exercise. We found that one analyst charting 20 minute segments of the exercise will take approximately three hours for the first one and about two hours for every additional one.

Two examples of progressive deepening charting are included here as Figures 2 and 3. These are both from one division's planning processes during the CPX.

Figure 2 maps a 19-minute section of a general discussion concerning possible enemy actions and friendly alternatives. It is important to note that this discussion took place early on and was largely a "brain storming" session, focusing on identifying the problems rather than attempting at that time to fully develop solutions for the particular problems. As can be seen, there are isolated segments of vertical deepening but in general the flow is wide. Still there is no concurrent comparison of options during the entire time. As mentioned, the planners were not yet attempting to develop solutions for any particular problems. Because this is the nature of the task at hand, the charts would be expected to have more of a horizontal (wide) rather than a vertical (deep) flow. The same can be said of Figure 3, where once again they are attempting to identify the problems rather than resolve them. In this five-minute example, the deepening is fairly shallow and it goes back and forth.

Regardless of whether the deepening charts appear wide (identification of problems) or deep (attempts to resolve particular problems) they are still useful to help the participants "replay the hand." In other words, they can look at the charts and see the options that were generated, where and when they stopped pursuing them, identify information that was

presented during the discussions, follow what they did with the information after it was presented and when and why they changed direction in their discussions, and so forth.

While these results were not presented to the participants during the AAR, we feel they can be generated quickly enough to do so and that the planners would find them informative and useful. Unfortunately, at this time we do not know if there is any special expertise required for the observer-analyst to be able to collect the correct information and quickly create the deepening charts. The two individuals who were the primary data collectors in this exercise have done much knowledge elicitation in various content domains and are quite knowledgeable in the principles and techniques of observation. They possess, however, only limited domain knowledge in Army command and control based upon a few past observations and limited reading on the subject. Ideally, we hope the method can be easily taught to interested domain experts.

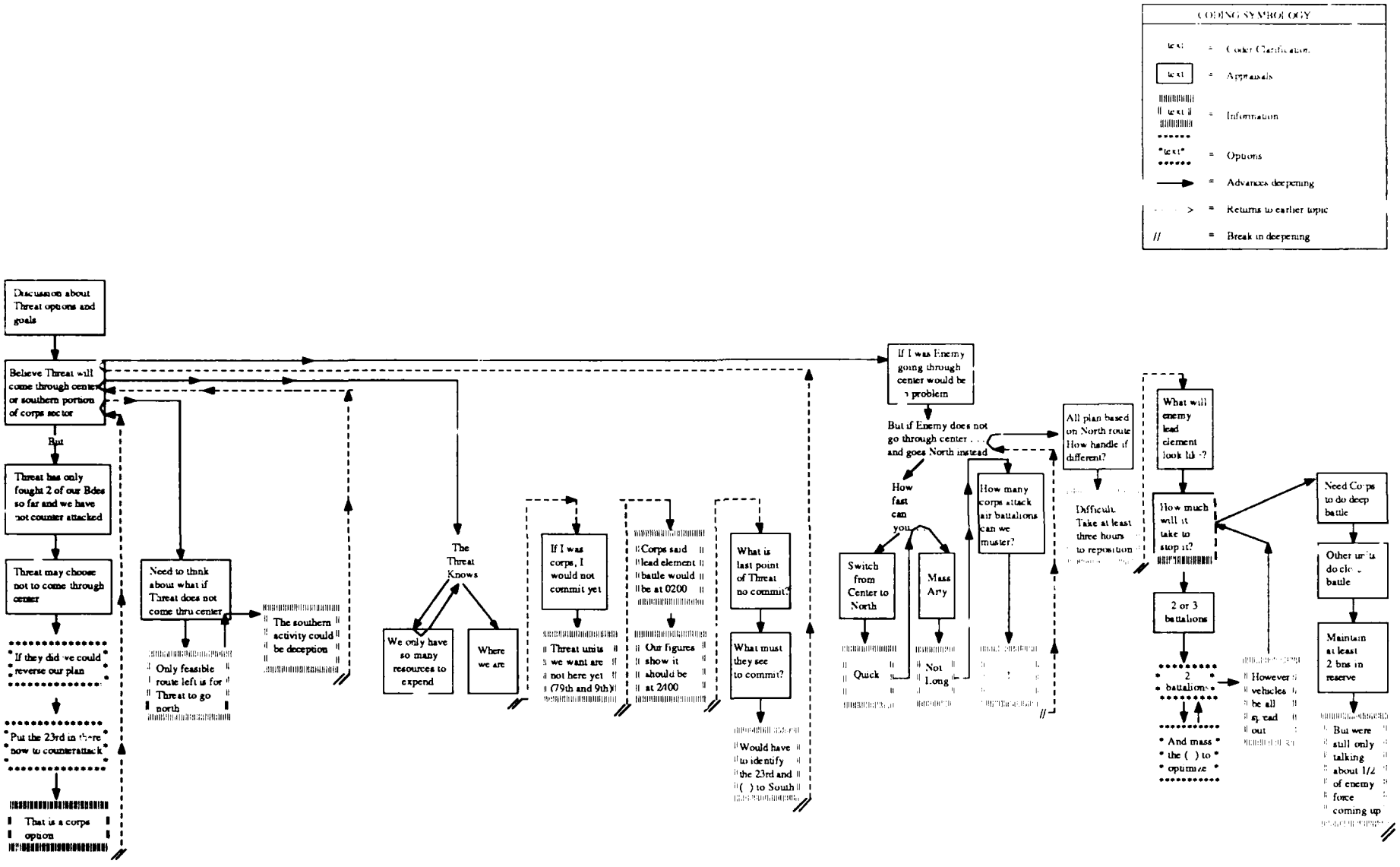


Figure 2. Progressive deepening for a 19 minute segment of planning.

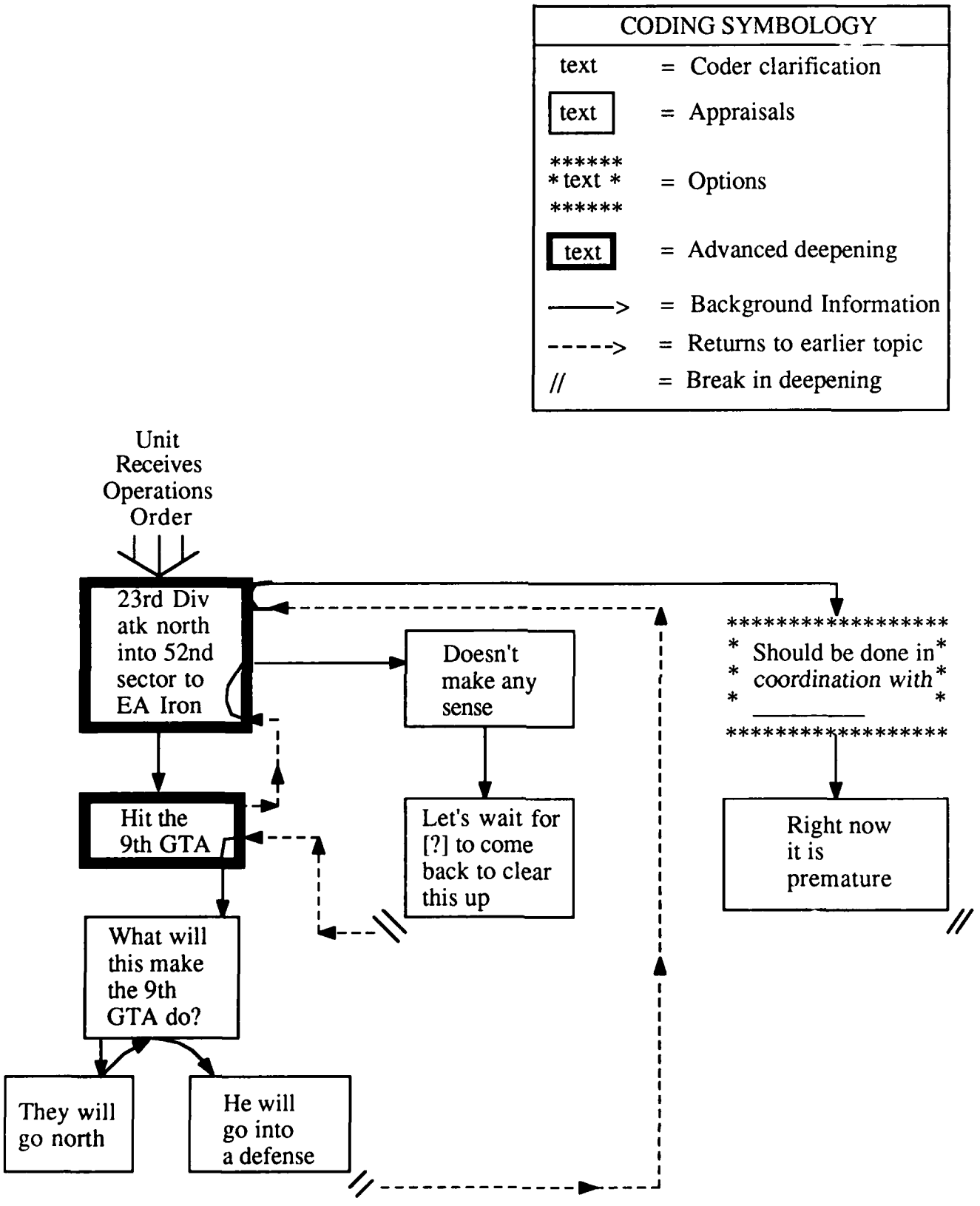


Figure 3. Progressive deepening for a five minute segment of planning.

Quantifiable Factors

In addition to the direct feedback and progressive deepening charts, we are able to provide some quantitative data concerning other aspects of the planning process. This information captures more discrete elements of the activities rather than following the flow of the planning as we have seen in the previous results. It serves to provide a different type of feedback for the participants.

Table 1 shows the frequency of occurrence by type of process for the same 19 minute period that is mapped in the Figure 2 progressive deepening chart. As can been seen from this table, over 97% of their effort involved discussion (appraisals), treatment of information, and the generation of options. There were no decisions, situation assessment (SA) shifts or elaborations during this period. While this may at first seem surprising, keep in mind that this segment occurred early in the planning while they were still trying to identify the problems rather solve them. With this understanding, the values do not seem unusual.

Table 1

Process Categories for the 19 Minutes of Progressive Deepening from Figure 1

Process Categories	Number Occurring	Percent
Appraisal	20	51.2%
Information	14	35.9
Option Generation	4	10.3
Action	1	2.6
Decisions	0	0.0
Situation Assessment Shifts	0	0.0
Situation Assessment Elaborations	0	0.0
Simulation Intrusions	0	0.0
TOTAL	39	100.0%

Table 2 lists the frequency of participation for the various staff members taking part in this same 19 minute segment of planning. Involvement is defined here as the number of times the individual participated in the session during the 19 minutes. As can be seen from the table, the G3 had the most involvement with the G3-Operations, the instructor, and the division commander taking fairly active roles. Finally, the assistant division engineer (ADE) had a small involvement in the session. While the quality of each individual's involvement cannot be determined

from this type of information, it can be very helpful in determining whether or not the appropriate individuals are involved to an extent commensurate with their positions and the situation.

Table 2

Individual Participation for the 19 Minutes of Progressive Deepening from Figure 1

Position	Times Participated	Percent of Total
Division G3	12	32.4%
Division G3-Operations	8	21.6
Instructor	8	21.6
Division Commander	7	18.9
Division ADE	2	5.4
TOTAL	37	99.9%

Table 3 gives the breakdown across types of process categories for six hours and seventeen minutes of planning for one division on one day. Even over this longer period of observation, appraisal, information introduction, and option generation still comprise almost 86% of the processes. There were only ten identified decision points during the session. This is not surprising to us since in previous research on team decision making processes we realized that the decisions are generally so distributed that it is rare that they are clearly identifiable. This tends to hold true not only for the observers but for the participants as well. They will know a decision has occurred, but seldom does any one individual in particular feel he made the decision.

Table 3

Process Categories for 6 Hours and 17 Minutes of Planning

Process Categories	Number Occurring	Percent
Appraisals	133	38.9%
Information	127	37.1
Option Generation	34	9.9
Action	17	5.0
Problem Identification	12	3.5
Decision Points	10	2.9
Simulation Intrusions	6	1.8
Situation Assessment Shifts	3	0.9
Situation Assessment Elaborations*	-	-
Breaks in Focus of Planning**	[60]	-
TOTAL	342	100.0%

*SA Elaborations were not coded for the entire session.
**Breaks are not included in the N or percent calculations

Another interesting aspect of the planning process is pointed out by the Breaks category listed in Table 3. A break refers to any change in the current focus of the planning session to a totally different focus. They can be thought of as points where the subject is changed. Occasionally these breaks are intentional (e.g., "OK, lets leave the mine field placement for later until we are more certain about their avenues of approach"). Unfortunately, this smooth transition is generally the exception and not the rule. That is, the focus of the planning is usually changed unintentionally because someone asks a question or makes a comment that is out of the current planning context, prompting everyone to immediately begin to address the new issue and leave the previous topic behind. Sometimes the planners never return to the previous topic. During the six hours plus of planning that are addressed by Table 3, 60 of these breaks were identified. The quick analysis, however, did not allow us to determine how many of the topics were resumed later. While breaks appear to be a natural element in team decision making sessions, we believe there are benefits to be gained by making the participants aware of the existence of this phenomenon.

Table 4 provides the breakdown of all individuals taking part in the six hour and seventeen minute session. Participation is defined here as any time an individual contributes in an overt fashion (i.e., vocally, indicating by pointing to the map, etc. As with the results outlined in Table 2, this does not address

the quality of the involvement of the individuals. However, it does help identify who was involved and to what extent.

Table 4

Individual Participation for 6 Hours and 17 Minutes of Planning

Position	Times Participated	Percent of Total
Division G3	90	27.9%
Division Commander	62	19.2
Division G2	57	17.6
Division G3-Operations	40	12.4
Division G3-Plans	15	4.6
Aviation Bde Commander	15	4.6
Division ADE	13	4.0
Division Instructor	8	2.5
Brigade Instructor	5	1.5
Corps G3-Operations	5	1.5
Corps FA Bde Commander	5	1.5
Corps Aviation Officer	2	0.6
Unidentified	2	0.6
Corps G3-Plans	1	0.3
ACR Commander	1	0.3
Division Asst G3	1	0.3
Division G4	1	0.3
TOTAL	323	99.7%

As noted above, these results differ qualitatively from the three previously outlined types of data. Subjectively, it does appear that benefits derived from these quantitative results would require more processing on the part of the participants since the data are presented outside of the context of the sessions. Nevertheless, we believe that this material would be very helpful to the participants. For example, in the session covered by Table 4, it can be seen that the Division G3, Commander, G2 and G3-Operations, participated the most. With this information, you can then ask yourself if these are indeed the people you hope would be the primary participants. On the other side of the coin are some of the people who participated fewer times, individuals you would like to see take more active roles? The primary difficulty is that it requires a minimum of one day to generate this data in addition to any time invested in generating the feedback for the illustrative and pattern material and constructing the progressive deepening charts.

Discussion and Conclusions

In the introduction, six questions were outlined that needed to be addressed. They were:

- Can the team decision processes be tracked in a real-time command and control setting?
- If yes, can direct feedback be provided?
- What is the nature of the feedback that can be provided?
- How quickly can this feedback be provided?
- Is the feedback considered to be helpful by the students and the instructors?
- What are the limitations of the application and what can be done to increase the chances for a successful application of the technique?

Each of these questions will be individually addressed in this section.

1. Can team decision processes be tracked in real-time command-and-control settings?

We were able to successfully track most of the team processes taking place in the second (QDX) and third (CPX) exercises we observed. In general, after the initial acclimation period, tracking the processes proved to be fairly complex, but manageable. By the completion of the three exercises, we were confident that we would be able to apply the same or similar procedures to other command and control settings.

2. If tracking can occur in real-time, can relatively immediate, direct feedback be generated for the participants?

While the basic tracking of the exercises was manageable, it was more difficult to accomplish this tracking in a way that permitted us to compile it quickly into a presentation format. The observational methods that we have developed through Critical Decision Method (CDM) interviews and other field observation projects were quite adequate in this setting. However, additional notational methods and tools had to be developed during the course of the three exercises to format the collected data in a fashion that permitted relatively immediate feedback.

3. What is the nature of the feedback.

Four types of feedback were generated: illustrative incidents, general patterns, progressive deepening charts, and other quantifiable information.

The illustrative incidents involved using specific examples of good and bad performance drawn from the exercise. By presenting these incidents to the participants, we provided them the opportunity to see their work from a third-party perspective and to provide their own critiques of the same. In addition, the observers prompted this critiquing by asking questions and providing their own observations.

The general pattern feedback was accomplished by identifying general patterns of behavior (teamwork, communication, decision making, time management, etc.) that were evident from the coding sheets. This material was presented to and critiqued by the participants during debriefings. As with the illustrative incidents, the observers also prompted the critiquing by asking questions and providing their own observations.

The progressive deepening charting was accomplished by reconstructing the decision strategies of the team from the coding sheets. This process lays out each piece of content that is part of the process. This allows one to visually follow the flow of the option generation, information treatment, decision making, etc. of specific segments of the planning sessions.

Several other quantifiable factors were extracted from the coding sheets that addressed the nature and frequencies of the processes used and the identity and level of participation of different participants. This information is more discrete and context free than the other three types of material we were able to track.

4. How quickly can this feedback be provided?

The illustrative and pattern feedback were generated within 30 to 60 minutes following the completion of the exercise. Feedback generated via progressive deepening charting were generated with 2-3 hours preparation time per chart. The more detailed, discrete, non-context data were generated with approximately one day's preparation time.

5. Is the feedback considered to be helpful by the students and instructors?

No systematic means of eliciting acceptance responses were employed. Some informal positive feedback was obtained from two of the instructors but no quantifiable answer to this question was obtained.

6. What are the limitations of the application and what can be done to increase the chances for a successful application of the technique?

During the course of the three observation trips, we identified several factors that were important to the success or failure of the data collection. Many of these factors can be limitations if they are not taken into account before or during the application.

Balance between content and process. It is very important to record the correct balance of content versus process to be able to provide proper feedback. There is a fine line between the amount of mental effort the observer directs toward tracking the content of the task versus the processes used by the planners. Being aware of this balance and finding the appropriate recording instruments to help the observer walk this fine line appear to be very critical.

General domain knowledge. A certain amount of general domain knowledge is required in advance to permit intelligent observation. Ideally, this methodology could be applied by any individual in any domain who is trained to do the observation. However, we have found that at least a basic knowledge of the domain is required. This includes, at a minimum, an understanding of the terminology and goals of the group being observed. The observer does not have to be an expert in the domain. However, a good comprehension of these "basics" is necessary. Unfortunately, at this time we do not have any estimate of how long it would take a domain-knowledgeable individual (e.g., an Army officer) to learn to apply the method to produce the products covered in #4 above.

Specific situation knowledge. A large amount of specific situation knowledge is required to accomplish the tracking. Once you have the prerequisite amount of general domain knowledge, how much specific information about the task being performed is required to successfully track the process? We initially attempted to track the processes of the first QDX without a detailed understanding of the exercise in which the group took part. This did not work well at all. In fact, without being able to follow the specific exercise closely, it was almost impossible to track the process. Therefore, while only a general knowledge of the domain basics are required, a thorough understanding of the specific task situation is necessary. It appears that without this knowledge, a large amount of time is spent attempting to comprehend the content of the planning session, thereby throwing off the previously mentioned balance between observation of content versus process.

Fatigue. Because of the enormous amount of detail that must be tracked, fatigue can become a limiting factor for the observers. Every sentence or statement needs to be condensed to its essential content. The nature of the process used for each of these must be determined either at that time or shortly thereafter (within 5-60 seconds). While this identification is taking place, the next sentence or statement is usually occurring. The observation requires a lot of "dual tasking" (listening to the content and coding the process) on the part of the observer. Our experiences were that a single observer can maintain this level of performance for approximately 1 hour and 15 minutes before a short break (10-15 minutes) is required. We believe it would require at least two observers working with alternating breaks to track a long session without interruptions in the data collection.

Real-time factors. Observation of the processes involved in the planning tasks is very dependent on the planning taking place in real-time. If the exercise is "warped" ahead, it can (and usually does) disrupt the planning process to the extent that tracking it becomes somewhat meaningless. Also, if "time outs" are inserted where the process picks up without any time elapsed after a substantial break, the tracking process also suffers. In the former case, the natural flow of the process has to be compressed or circumvented to "catch up" to the accelerated point in time. In the latter, the participants often have time to do additional planning (and processing) that they would not normally be able to do. This additional processing usually takes place outside the planning group where it cannot be observed and tracked. While these factors were not as evident with the A399 class's CPX, they were observed during the two QDXs and during a corps level exercise which took place in November of 1986. However, as mentioned earlier, the need for real-time high-fidelity depends upon the training goals. There may be occasions when maintaining real-time is extremely important and other times when the training goals are such that sacrifices in this aspect of realism are appropriate.

Realism. If the exercise is not realistic, the participants do not take it seriously and do not become as involved in the process. The CPX and the two QDXs did not seem to suffer from this problem.

Observable actions. It is absolutely necessary that some form of overt action be occurring. If individuals are off to themselves, silently working on their own particular segments of the plan, there will be nothing overt to observe or track. In other words, there has to be some degree of interaction and discussion between the participants for the observers to observe.

This should not be taken to mean that overt action must be forced but rather that if overt action is not normally present then it may not be an appropriate situation in which to apply these techniques.

Non-intrusiveness. It is probably safe to assume that there is no such thing as total non-intrusiveness. This is especially true if observers are in the same room with the planners, let alone if they can be seen taking notes or are asking occasional questions. However, we believe the intrusiveness can be minimized by spending some initial time observing the general "flow" of how the participants work together and attempt to become part of that flow. This is important, to allow the observer to know when to ask questions and who to ask. Nevertheless, the process is something like the concept of merging with the traffic on an interstate. It is important to understand that an outsider never has the right-of-way and is always responsible to yield. Along another but related line intrusiveness can be affected by how well the observer is accepted by the group.

At this time, we do not have any suggestions for additional changes in the collection instrument or procedures. This is not to say that changes will not be appropriate. We envision these taking place through an iterative process where each application will point out additional means of improving the technique and instrument.

SUMMARY

Because of the importance of feedback for training, it is critical that command and control training programs formulate procedures for obtaining and communicating feedback about student performance. Even for experiential training such as classroom exercises, it is essential to present informed feedback. In the area of command and control, this becomes even greater, because students undergoing classroom exercises without obvious cause-effect reinforcement need understanding of both the decisions that were made and the decision processes themselves. It is important that students learn what tactics should have been chosen, but it is also important to use the exercise to show them effective and ineffective decisionmaking strategies.

To accomplish the goal of providing decision process feedback, trainers need techniques to use in real-time to offer feedback at the conclusion of an exercise, or soon thereafter. This project was designed to develop such techniques.

The project was successful in identifying four types of meaningful feedback that could be provided in a timely fashion.

First, general observation and notation allowed the compilation of illustrative examples that transpired during the planning sessions.

Second, specific differentiation between content versus process observation permitted feedback regarding general patterns observed in the planning processes.

Third, we were able to generate charts mapping the progressive deepening patterns of the decision makers.

Fourth, we were able to summarize additional quantitative data concerning other aspects of the planning process. This information captured the more discrete elements of the activities such as levels of participation.

Together, these four techniques offer instructors a capability of using experiential classroom exercises to teach effective team decisionmaking strategies.

It is important to point out that none of these four techniques has been carefully evaluated to determine the effectiveness of these types of feedback. The goal was simply to track the team decisionmaking in real-time and to develop feedback procedures. The ability to collect the necessary data and prepare it for feedback was proven. It will require additional research to assess the full utility of the four techniques. Nevertheless, this project was an important beginning to the task of enabling instructors to improve the way that trainees engage in team decisionmaking.

REFERENCES

de Groot, A. D. (1978). Thought and choice in chess (2nd ed.). NY: Mouton.

Flanagan, J. C. (1954). The critical incident technique. Psychological Bulletin, 51, 327-358.

Klein, G. A. (1985a). Knowledge engineering analysis of data extraction strategies. Technical Report prepared for Perceptronics.

Klein, G. A. (1985b). Working paper for Beville Engineering, Inc.

Klein, G. A. (In publication). Recognition-primed decision. In W. Rouse (Ed.), Advances in Man-Machine System Research, 5. Greenwich, CT: JAI Press, Inc.

Klein, G. A., Calderwood, R., & Clinton-Cirocco, A. (1988). Rapid decision making on the fire ground. (ARI Technical Report 796). U. S. Army Research Institute for the Behaviorial and Social Sciences, Alexandria, VA. AD A199 492.

Klein, H. A., & Klein, G. A. (1981). Perceptual/cognitive analysis of proficient cardio-pulmonary resuscitation (CPR) performance. Paper presented at the Midwestern Psychological Association Meetings, Detroit, MI.

Peio, K. J., & Klein, H. A. (1984). Skilled performance: Computer software. Paper presented at the Proceedings of the 28th Annual Human Factors Society Conference, Dayton, OH.

Rasmussen, J. (1985). The role of hierarchical knowledge representation in decision making and system management. IEEE Transactions on Systems, Man, and Cybernetics, 2, SMC-15, 234-243.

Taynor, J., Klein, G. A., & Thordsen, M. (1990). Distributed decision making in wildland firefighting. (ARI Research Note 90-42). U.S. Army Research Institute for the Behavioral and Social Sciences, Alexandria, VA. AD A225 413.

Thordsen, M., Galushka, J., Klein, G. A., Young, S., & C. P. Brezovic (1990). A knowledge elicitation study in military planning (ARI Technical Report 876). U.S. Army Research Institute for the Behavioral and Social Sciences, Alexandria, VA. AD A219 969.

CODING SHEET

DATE________ LOCATION__________________________ CODER__________ PAGE_____

WHO	CONTENT/COMMENTS	OPT	INF	DP	APP	SIM	ACT	BRK	ELB	SFT	PRB

CHECK COLUMN ABBRIEVATIONS

OPT = Option Generation

INF = Information

DP = Decision Point

APP = Appraisal

SIM = Simulation Intrusion

ACT = Action

BRK = Break In Focus

ELB = Situation Assessment Elaboration

SFT = Situation Assessment Shift

PRB = Problem Identification