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Problem-Solving Under Time Constraints: Alternatives for the Commander's Estimate

A Monograph
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ABSTRACT

PROBLEM-SOLVING UNDER TIME CONSTRAINTS: ALTERNATIVES FOR THE COMMANDER'S ESTIMATE, by MAJ Timothy D. Lynch, USA, 73 pages.

The paper examines the individual commander's decision making process to determine the optimal decision making system for military problem-solving under time constraints. This study first examines implications of decision making theories on the military decision making process. Next, the paper examines historical development and current doctrinal procedures as outlined in FM 101-5, Staff Organization and Operations. Three problem-solving systems are then analyzed under varying time constraints using four criterion: flexibility, adaptability, critical event determination, and battlefield operating systems (BOS) synchronization. The three approaches are then compared to determine the optimal problem-solving system for use under time constraints.

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INTRODUCTION

> ...[I]t is essential that all leaders--from subaltern to commanding general--familiarize themselves with the art of clear, logical thinking. It is more valuable to be able to analyze one battle situation correctly, recognize its decisive elements and devise a simple, workable solution for it, than to memorize all the erudition ever written about war....[H]e must learn to cut to the heart of a situation, recognize its decisive elements and base his course of action on these. The ability to do this is not God-given, nor can it be acquired overnight; it is a process of years. He must realize that training in solving problems of all types, long practice in making clear, unequivocal decisions, the habit of concentrating on the question at hand, and elasticity of the mind, are indispensable requisites for the successful practice of the art of war. (Infantry in Battle, 1939: 14, 1)

At the heart of a commander's professional competence is his ability to make sound, timely decisions on the effective employment of his unit. However, despite significant changes in the battlefield, the US Army's decision making process has not changed significantly since its inception in 1910. The process therefore should be examined to see if it's methods are still effective on the fast-paced Airland battlefield.

Recent investigations reveal some pertinent observations. A 1964 Command and General Staff College (CGSC) study on the use of the commander's estimate found that well over half of the officers polled rarely used the process, almost never used it in CGSC instruction, and weren't planning to use it after graduation (Hollis, 1976: 50).

Recent Army Research Institute (ARI) findings confirm these observations. They find the process is not followed. It's sequence of steps is not always practical due to the dynamic nature of the situation. Sufficient time is not available to complete a thorough estimate. Available planning time has decreased while necessary time to complete a detailed estimate has increased. Abbreviated procedures are not standardized. Little guidance is provided on how to tailor the process under variable time constraints. Human information processing biases and limitations affect the process. Finally, wargaming techniques in the analysis step have little confirmed basis for battle outcome predictions (1939: 1).

My experiences in two battalions and during classroom exercises at CGSC and the School of Advanced Military Studies (SAMS) substantiate these observations. The process does not adjust well to a dynamic situation with short decision times.

This paper investigates the military problem-solving process. First, several definitions are necessary. This paper defines the problem-solving process as the procedures the commander uses to recognize and define a problem, gather information, develop and analyze possible solutions, and select the best solution to the problem (FM 101-5 Staff Organization and Operations, 1984: 5-1). For the purposes of this work, the commander's decision is defined as a synchronized intent, scheme of maneuver, and fire support plan.

Decisions under time constraints occur in any situation where less than optimal time is available for planning. For example, a former G3 plans officer observed that his division had trouble executing doctrinal estimate procedures in less than six hours (Fastabend, 1989). Israeli ordinary battle procedure prescribes 7.5 hours as the optimal time required for a division commander to arrive at his concept. Hasty procedures are used if less than 7.5 hours are available (Kennedy, 1989). For this paper, four periods of time are defined and related to decision making procedures: optimal time (in-depth estimates can be accomplished following doctrinal procedures); light time constraints (procedures are shortened but each step is still accomplished); moderate time constraints (requiring major innovations in decision making procedures); and severe time constraints (with little or no decision making time available).

Next, some assumptions are necessary concerning the environment and capabilities of the commander, his staff, and his unit. These assumptions isolate the commander's problem-solving process for study. First, the Army needs one problem-solving doctrine. This promotes standardization and unity of effort. Second, the study assumes the staff is well-versed in the commander's problem-solving system. This removes staff training as a detractor in the estimate process. Next, good SOPs are in effect for acquiring necessary input and producing detailed orders once the commander's decision is made. This further isolates the problem-solving process of the commander by accounting for problems created by the inputs and outputs of his problem-solving system. Next, doctrinal procedures for problem-solving apply to individual decision making procedures.

One more assumption pertaining to time is important. Time usage is critical during the planning process. FM 100-5, Operations; FM 101-5; and the Mission Training Plans (MTPs) for brigade and division staffs emphasize that no more than one third of the total time between mission

receipt and mission execution is devoted to planning and issuing the order. This means less than one third of the available time is devoted to the estimate process. The commander must establish his own time schedule to meet these constraints. This study assumes the commander can meet this deadline.

An additional concept requires definition. The seven battlefield operating systems (BOS) are functions which serve as a common base for the grouping of subordinate combat activities (Long, 1989: 47). The BOS provide a structure for integrating and synchronizing critical combat activities on the battlefield. The BOS consist of intelligence; maneuver; mobility, countermobility, and survivability; fire support; air defense artillery; command and control; and combat service support (FM 100-15, Corps Operations, 1989: 3-4).

With this as a foundation, the paper examines the individual commander's decision making process. The specific research question is, "What is the optimal decision making system for military problem-solving under time constraints?" To answer this question, this study first examines implications of command and control and decision making theories on the military decision making process. Next, the paper examines historical development and current doctrinal procedures as outlined in FM 101-5. Three problem-solving systems are then evaluated under varying time constraints to determine the optimal problem-solving system. The paper closes with some conclusions and implications about the estimate process.

Military Implications of Problem-Solving Theory

This section examines the military implications of several decision making approaches as they relate to the estimate process. It explains the nature of problems and command and control as a prelude to discussing four general approaches to decision making. Then implications of normative, cognitive/behavior, informational, and uncertainty approaches are discussed in order to build a theoretical foundation for the commander's estimate process. The normative approach establishes the analytical base for the estimate. The information-oriented approach illustrates movement and use of information in the estimate process. A cognitive/behavioral approach highlights the commander-centered nature of the process. Risk/uncertainty models illustrate the key role these

factors play in battle. Finally, a behavior-based conflict model of decision making demonstrates the effects of time-related stress on the commander.

JCS Publication 1, Dictionary of Military and Associated Terms, defines command as the exercise of authority and direction by a properly designated commander over assigned forces in the accomplishment of the mission (1987: 77). A military objective is attained by the unified, effective application of combat power by the commander. The commander solves military problems by using decision making methods to decide on his concept of effective application of military power. The decision is the concept of operational employment of the commander's forces.

Problem-solving can be differentiated from decision making. Problem-solving is thinking activity directed toward reaching some goal, the thought process that precedes terminal choice. It generally involves thoughtful effort to get around or overcome an obstacle (Ebert, 1975: 12-13). The experiences that the mind learns, organizes, and that organizations and individuals develop, can be labeled problem-solving approaches (Reitzel, 1958: 6, 22). Decision making is the choice process; choosing from one of several possibilities. It may involve decision making at its culmination, or at other points in the process (Ebert, 1975: 12-13).

Problems themselves can be categorized as puzzles or difficulties. Puzzles are solved, with only one correct answer. Difficulties are surmountable, their solutions involve analysis and judgment. Military problems generally contain both puzzles and difficulties (Reitzel, 1958: 39-41).

Problems can also be categorized as encounter decisions or set-piece decisions. Encounter decisions occur in situations where immediate action is called for and little or no time is available for decision making. Processes used to make these types of decisions are shown below (Reitzel, 1958: 8-9).

Process A:

1. Understand the problem
2. Devise a plan of attack on the problem
3. Check back to see that the solution fits the situation
4. Carry out the plan

Process B:

1. Questioning
2. Carefully observing
3. Associating ideas
4. Predicting

These decisions depend on habitual or routine responses that the commander has filed away throughout his years of experience. Conscious thinking degrades processing these trained, triggered, problem-solving responses (Reitzel, 1958: 37-38). The Naval War College's book, Sound Military Decision, echoes Clausewitz's thoughts on this as it remarks that, "... the competent commander grasps the whole complex situation without loss of time....Because he is mentally prepared, he sees things in their true proportion...and cooly chooses the same course of action he would adopt if he had had time for careful deliberation" (1942: 138).

Set-piece decisions are made in situations where there is sufficient time to plan future actions. They require organized, logical, analytical methods. Military problems come in both set-piece and encounter forms, and any combination of the two.

Sound Military Decision exemplifies the normative process when it concludes

> The best method of reaching sound decision is through systematic thought which employs logic, i.e. sound reasoning, as its machinery....Through the deliberate practice of testing and weighing, the faculty of arriving swiftly at sound decisions is strengthened and brought more quickly into play when time is a matter of immediate concern (1942: 22).

The publication advises that the best solution to a problem is found by establishing the correct basis for the solution (the objective), grasping salient features of the problem, deducing the actual solution through the use of reasoning power in consideration of various possible solutions, and selecting the best solution at the conclusion of analysis (1942: 20-21). The decision is the operational employment of the commander's forces.

William Reitzel offers a logical thought process similar to the estimate process (Reitzel, 1958: 9).

Process C:

1. Identify the problem
2. Clarify goals (objectives)
3. Find promising alternatives
4. Analyze alternatives
5. Appraise alternatives in relation to goals
6. Select an alternative

This model is called concurrent option comparison or concurrent analysis (Klein, 1989: 56). It is a normative model which allows simultaneous analysis of multiple Courses Of Action (COAs) to determine a "best" solution. Most military problem-solving processes involve comparison and contrast of multiple courses of action during the problem solving process under multiattribute utility analysis. The French, German, Israeli, US, and Soviet systems are examples of this.

The decision making system depends on available information. The Army Command and Management text explains that information must be timely, accurate, complete enough to allow required decision making to occur, free of distortion, and sufficiently economical to acquire and process. Information (i.e. the commander's critical information requirements) is obtained from sources (unit sensors, staff officers, higher and subordinate commanders), interpreted (by the commander and the staff), processed into a suitable form for use (Intelligence Preparation of the Battlefield products, friendly COAs), distributed at the right time ("Situation and Course of Action", orders), and stored for future use.

Information flow examination provides prioritized information requirements, delivered at a rate the decision maker can handle. Operations on that information are prioritized so that it is processed in the most effective way for the commander's needs. This leads to the development of critical information requirements, prioritized task lists, and SOPs for moving, portraying, and storing information. Appendix A, Forrest Crain's Battle Staff Planning Guide, illustrates the use of the information approach based on critical information requirements and time constraints.

The cognitive/behavior approach highlights the commander-centered nature of the problem-solving process. Simon's behavior approach contains three phases: intelligence, design, and choice. Intelligence includes scanning the environment; maintaining an awareness of the occasion for decision; integrating environmental cues; and gathering, categorizing, and processing information. The design activity includes

development and examination of COAs available to the decision maker, assessing likely consequences of decision alternatives, and understanding of the values or attractiveness of consequences. The choice activity involves using the information he has gathered to compare alternatives and choose one that he believes will best accomplish his goals (Ebert, 1975: 16).

The Klein Recognition-Primed Decision Model (RPDM) represents a cognitive/behavior approach. According to the RPDM, commanders use past experience to recognize a situation as familiar (intelligence function). This gives them feasible goals, cues, expected actions, and typical COAs for that situation. No concurrent analysis is done, but decision makers do first consider if there are any potential problems in carrying out the COA (design function). If and only if things seem reasonable do they act (choice function) (Klein, 1989: 58). The RPDM can lead to a "best" solution. The RPDM will be examined in more detail later.

An outgrowth of the cognitive approach is "satisficing." This occurs when the decision maker chooses the first acceptable alternative that satisfies the goal, as opposed to the best alternative. There are several differences between optimizing and satisficing strategies. Optimization strategies are used frequently when dealing with large numbers of requirements that must be met. A thorough search generates as many good alternatives as possible. Selection is accomplished by first reducing the solution set to several best alternatives, followed by repeated reexamination, so as to make comparative judgements, finally resulting in the choice of the "best" alternative. There is a tendency, when using optimization methods, to use weighted, additive models that give the decision maker the opportunity to consider possible trade-offs.

Usually in "satisficing" strategies, small numbers of requirements must be met. There is sequential testing of alternatives, stopping at the first minimum satisfying one. Alternatives are tested only once in haphazard order, generally using unweighted threshold models (cutoff points) in their analysis (Janis, 1977: 30-31). Lack of time for optimal decision making can lead to "satisficing." A commander may pick a satisfactory alternative because he does not have the time required to analyze all possible available alternatives.

Commanders also operate within limited or "bounded" rationality, meaning they do not have all the information, cannot predict with 100%

accuracy the future state, and cannot recognize all alternative ways of reaching a goal. Commanders attempt to make the best decisions they can within the limits of rationality and in the light of the size and nature of risks involved in uncertainty.

Martin Van Creveld, in his 1985 book Command in War, said that command in war is an endless quest for certainty about the state and intentions of the enemy, one's own forces, and the environment (264). He asserts that command and control should seek to reduce risk through multiple processes that adapt to the measure of uncertainty in the task. Decision making in uncertain and/or risky situations (a stochastic environment) is complicated by lack of control over the elements of risk, a lack of information required to reduce uncertainty, and a lack of time.

Organizations based on a stochastic view of battle expect to face uncertainty, deal with risks, and exploit opportunities. Authority is decentralized to distribute problem-solving. Vertical and horizontal coordination is necessary. The role of pure chance makes random outcomes possible in any situation. They know a single event can substantially alter the probabilities of subsequent outcomes. The author assumes army organizations are structured for risk taking and commanders are willing to take risk. Further investigation is needed to determine if army organizations are structured for risk taking and what happens if the organization is so structured but the leader is not so inclined (Janes, 1989).

Additionally, opportunities appear as a result of chance or the intentional influencing of conditions to improve probabilities of more favorable outcomes that can be exploited. A commander must place his forces in such a disposition that he can take advantage of these opportunities. Wargaming multiple alternatives and considering branches and sequels assists in this (Orr, 1983: 87-88).

There are several decision making approaches that are related to risk and uncertainty. Probability theory is based upon the inference that certain things are likely to happen in some predictable pattern. Game theory is based upon the premise that a person will develop a strategy that maximizes gain or minimizes loss regardless of what the adversary does (Koontz, 1984: 199). Gaming theory suggests that both capabilities (what is possible) and intentions (probabilities with which possible actions

will be used) should be analyzed in uncertainty situations (Reitzel, 1958: A-2-3).

Risk analysis attempts to develop, for every critical variable in a decision, a probability distribution curve that represents the range and probability (chance) that a certain event will occur. The decision maker is better able to assess the chance of accomplishing a "best estimate" and can see the chances that might exist if he is satisfied with a lesser return (Koontz, 1984: 201-2).

John Sutherland's model provides a good example of how military decisions are related to uncertainty. His severely stochastic and indeterminant categories of problems fit situations which require military decisions. In the case of severely stochastic conditions, control is gained by manipulating initial conditions to attain the highest probability of achieving a favorable outcome or the lowest probability of achieving unfavorable outcomes. In the case of indeterminant conditions, one must proceed intuitively, ensuring effective response against unprecedented situations by functional flexibility and creativity (Sutherland, 1983, 51-54).

Decision making processes within the command and control domain assist the commander as he attempts to influence outcomes through the ability to take advantage of opportunities as they arise. The commander influences outcomes by placing his forces in the best possible position to exploit these opportunities with distribution of his combat power. Relative combat power effects of the battlefield operating systems are synchronized if they are delivered at the right time and place to achieve desired effects. The commander's dilemma is that there are usually several possible courses of action that solve each synchronized power distribution problem (Orr, 1983: 48-58).

Military decisions are often made under pressure. Another decision making approach espoused by Janis and Mann deals with decision making in conflict situations. They suggest that there are functional relationships between psychological stress, decision conflict, and decision maker actions. For example, they suggest that the more the commander is dedicated to a COA, the harder it will be to change. Janis and Mann also suggest the worse things get, the more the decision maker will have the tendency to stop searching for alternatives and ignore enemy information. If things get too tough, the commander's decision process may crumble. A

commander will tend to continue to search for alternatives and solve problems only if he thinks a satisfactory solution can be found (1977: 50-51).

Success depends on the ability to recognize opportunities and decide on how best to apply relative effects of combat power at the most opportune time and place. Theoretically the estimate process should be able to provide a method of logical analysis of all factors and alternatives in a comprehensive manner that results in the best solution, independent of environmental pressures. To that end, the military decision making process must be flexible enough to assist the commander in analyzing his situation so that he can find at least a satisfactory solution. This decision process must operate effectively under all types of time constraints. But often the commander depends on uncertain information and unknown future intentions. He must make due with a satisfactory solution, risk loss of his forces, and decide based on little analysis under severe time constraints.

The best decision making system may even be one that includes several methods. It might include a logical normative approach and methods for individual and group-centered information management. It should account for uncertainty. Also, it should work under stressful, time-constrained conditions. Ultimately, this decision making system may have a more scientific basis under optimal time conditions. The system may approach an intuitive art under severe time constraints.

Historical Development of the Military Decision Making Process

This section traces the historical development of the military decision making process from its inception in Napoleonic methods to the present edition of FM 101-5. It covers three developmental phases: European development and initial explanatory usage, transition to a decision making process, and current usage.

The modern estimate was born in Europe. Napoleon developed a systematic estimate process (see Appendix B, written estimate from Napoleon's Leipzig Campaign in August, 1813). He habitually analyzed multiple enemy and friendly COAs (Phillips, 1937: 8). The Prussians adopted a similar system after their loss at Jena-Auerstadt in 1806. They used "The Applicatory System" at their Kreigsakademie to teach the art of

command and train officers for the general staff. Other countries took interest in the Prussian model after their victories in 1866 and 1870 (Cullen, 1970: 7-9).

"The Applicatory System" immigrated to the United States in 1875. The American Secretary of War, Emory Upton, toured the world in 1875 to study foreign armies. He brought "The Applicatory System" home because it impressed him as a tool for teaching sound decision making (Nenninger, 1974: 11-15). Details of "The Applicatory System" gravitated to Fort Leavenworth after The School for Application of Infantry and Cavalry opened in 1881. However, no specific estimate method took root until the 1890's (Nenninger, 1974: 50-55).

Fort Leavenworth instructors initially developed the estimate process to help students explain their solutions to tactical problems. Instructors began to emphasize tactical problem-solving in 1894. They used an applicatory method of instruction similar to the German method. Tactical problems (later called "situations") that stressed the systematic issuance of orders included map maneuvers (war games) and tactical rides (terrain exercises) (Nenninger, 1974: 69-72).

Eben Swift made a major contribution to the development of the estimate during his instructor tenure from 1893 through 1897. He developed a systematic method for issuing orders, basing it on German techniques of troop leading. The order became a standard part of the applicatory method at Fort Leavenworth. Students studied maps, made an estimate of the situation, made a tactical decision, and produced an order, using the format of the field order as a guide (Nenninger, 1974: 72-75). Swift's 1906 book Field Orders, Messages, and Reports produced an approved, codified, written field order for the Army (Cullen, 1970: 14):

Left Side of paper:	Right Side of paper:
Task Organization	1. Information of the enemy and general situation 2. Your own plans [mission] 3. Your own disposition for carrying out your plans [scheme of maneuver, sub-unit missions] 4. The destination of the trains 5. The position of the commander

General guidance was to keep the orders short and simple, concentrate on the task at hand, and don't put in anything that can be left out (Swift, 1907: 224-231). This was the first step toward the development of the formalized estimate.

Instructors then developed a process that helped students justify their field order decisions. They moved backward through the decision-action sequence from the commander's orders to the decision making step, producing a complete system of orders formats, decision making, and troop leading procedures (Seigle, 1967: 12,2).

Several Fort Leavenworth instructors also influenced the development of wargaming, a major part of the estimate. Swift, around 1905, refined and adopted German Kreigspiel (wargaming) for use by the US Army (Nenninger, 1974: 75-76). Farrand Sayre, during his instructor tenure from 1906 to 1908, was most responsible for development of map maneuvers in Leavenworth's curriculum. John Morrison, Director of the Military Art Department from 1907 to 1912, also engaged students in vigorous wargaming (Nenninger, 1974: 130-136, 196). This may have influenced its later inclusion as part of the current process.

Another Leavenworth instructor, Roger Fitch, officially documented the initial format for the process. Fitch published the format in his book, Estimating Tactical Situations and Publishing Field Orders, in 1909 (Cullen, 1970: 14). It became official Army doctrine in the 1910 version of the Army Field Service Regulations (FSR):

> To frame a suitable field order the commander must make an estimate of the situation, culminating in a decision on a definite plan of action. He must then actually draft or word the orders which will carry his decision into effect. An estimate of the situation involves a careful consideration from the commander's viewpoint, of all the circumstances affecting the particular problem. In making this estimate he considers his mission as set forth in the orders or instructions under which he is acting, or as deduced by him from his knowledge of the situation, all available information of the enemy (strength, position, movements, probable intents, etc.), conditions affecting his own command (strength, position, supporting troops, etc.) and the terrain insofar as it affects the particular military situation. He then compares the various plans of action open to him and decides upon the one that will best enable him to accomplish his mission (FSR, 1910: 59).

This paragraph contains the essence of the current version that we use today.

The estimate process transitioned from explanatory usage to a fully developed decision making system between 1910 and 1968. Several items are worthy of note (See Appendix C for a detailed description of changes from 1910 to 1984). The outline-type format has not changed since its first use in 1932. Subsections were added to flesh out situational information. For example, references to Observation and fields of fire-Cover andf concealment-Obstacles-Key terrain-Avenues of approach (OCOKA) information appear beginning in 1950. Relative combat power has been a key concept since the first version in 1932. Analysis of the effects of multiple enemy COAs on multiple friendly COAs has been a standard since 1940. Wargaming appeared in concept in 1954, and was formally added to the process in 1968. The estimate was first tied to a military decision making process in 1960. Finally, in 1968 the process was formally integrated into a problem-solving methodology (Michel, 1989: 4-14).

There have been only minor changes to the estimate process since 1968. The continuous nature of the commander's estimate was stressed beginning in 1972. Few concrete suggestions were ever made concerning use of the estimate under time constraints. The 1977 Draft of FM 101-5 was the only version to ever place great stress on operations under time constraints. It was never published, probably due to its radical departure from accepted standards. The current 1984 version is very similar to the 1968 edition (Michel, 1989: 4-14).

Several patterns emerge from historical review of the estimate process. The original process grew from the belief that leaders needed to be trained to make good decisions according to some standardized method. The US Army process developed from the need to explain field order solutions to academic problems. It is still a good vehicle for basic training in decision making. The estimate then grew, finally transitioning to a problem-solving process in 1968. There have been no significant changes to the estimate since 1968, even though there have been at least two major changes in Army doctrine and further changes in the complexity and tempo of the battlefield. Today's commander's estimate is a detailed, analytical thought process. The steps can be compressed but not ignored, despite severe time constraints. With that in mind, a review of the current version of the process is needed.

Discussion of the Current Process

FM 101-5's opening section provides the reader a flavor of the basis for US Army military decision making when it states:

> Military decision making is both an art and a science. ...[S]ound...decisions result only from a thorough, clear, unemotional analysis of all the facts and assumptions relating to the situation. A systematic approach to problem solving assists in applying thoroughness, clarity, judgment, logic, and professional knowledge to the task. (FM 101-5, 1984: 5-1)

Although these comments emphasize analytical problem-solving, they do not emphasize rapid decision making under stressful conditions and time constraints.

The commander's decision process, as found in Appendix E, FM 101-5 (1984) is formally titled The Commander's (Operation's Officer's) Estimate. This section first examines the estimate process itself. Then doctrinal linkages to the BOS and 71 series manuals are examined. Last, functional issues regarding COA development, wargaming, and analysis; and doctrinal techniques for use under time constraints are discussed.

Our current commander's estimate is the central activity of several commander-centered processes including troop leading procedures (TLP), the military decision making process, and the staff estimate process (see Appendix D for an illustration). TLPs sequence unit and leader tasks from mission receipt through execution. The estimate fits in step three of the TLP, "Make a Tentative Plan" (FM 71-2, 1988: 2-14--22). The Military Decision Making Process (MDMP) complements TLPs. This commander-centered process is used to make tactical decisions (FM 101-5, 1984: 5-4). The commander interacts with the staff through information transfer and development of staff estimates in step four of the MDMP.

The commander must ensure that timely decisions are made. During critical situations the commander may be forced to complete his own estimate based on personal knowledge of the situation. He may have to make decisions without the benefit of staff interaction (FM 101-5, 1984: 5-6). This key point illustrates that the commander's estimate process, step five in the MDMP, is the hub of unit actions.

The commander's estimate contains five paragraphs, each equating to a logic step in the decision making process. Paragraph one (step one) is

The commander's estimate contains five paragraphs, each equating to a logic step in the decision making process. Paragraph one (step one) is "Mission." It is the unit's restated mission and becomes the basis for all further estimates (E-2). Curiously, it does not include a discussion of the higher commander's intent, mission, or level of assumed risk. The French, Israeli, and German methods stress understanding of these vital subjects. Additionally, no critical decision criteria are identified in this paragraph that can later assist in comparison of COAs. Finally, no intent is listed with the restated mission or degree of risk that the commander is willing to assume. It would seem that this paragraph does not contain all the information required for the basis of a sound decision.

Paragraph (step) two is "The Situation and Courses of Action." It is an analysis of considerations affecting the area of operations and possible enemy and friendly COAs. This section also contains analyses of both the enemy and friendly situations. The final portion of this section analyzes relative combat power and develops enemy capabilities (COAs) and friendly COAs (E-2--5).

Analysis of paragraph two reveals some interesting observations. Relative combat power is dealt with in general terms only. No integrated method guides quantitative or qualitative analysis of combat power.

The "Enemy Capabilities" section specifically states

> The intelligence officer normally identifies enemy capabilities and...if justified...provides his evaluation of the relative probability of adoption of these capabilities. The intelligence officer also must strive to inform the commander about what he believes the enemy intends to do. The commander considers all enemy capabilities presented by the intelligence officer...[and] may accept, revise, or discard them, or develop additional capabilities (E-4).

This means the commander may consider one or more COAs. Often this does nor happen.

Finally, this paragraph ends with friendly COA development (E-4--5). The friendly COAs could be developed to oppose only one enemy capability if the commander only considers one "predicted" enemy capability. Or multiple friendly COAs can be developed to oppose multiple enemy COAs.

This paragraph does not identify specific critical factors to be used later in COA analysis and comparison. For instance, the Israeli Army's estimate identifies permanent and influencing factors. The Israelis always discuss effects of permanent factors (relative strength, terrain,

time, and space). They also discuss effects of influencing factors (any other factor that significantly influences the mission) (Kennedy, 1989).

This paragraph also fails to consider mission changes due to changes in the situation. For example, the German estimate has the commander ask himself if the enemy situation has changed significantly since the mission was issued. If the situation has changed significantly, the commander has the authority to develop a new mission. He then reports the new mission to his commander and continues to plan (Phillips, 1937: 42-43).

Paragraph (step) three of the estimate process analyzes COAs through wargaming. The first step identifies enemy COAs that will be used in analysis (wargaming). FM 101-5 does not state emphatically that multiple enemy COAs will be identified or used in analysis (E-5--7). This could lead to the use of only one enemy COA for wargaming. In contrast, problem-solving under conditions of uncertainty should drive the commander to consider multiple enemy COAs, as long as time is available.

The second step in the wargaming process is to analyze each friendly COA against each selected enemy capability (E-5--7). All formulated friendly COAs must be analyzed through wargaming. Ideally the commander wargames each friendly COA against multiple enemy COAs, but this is not required. The description of the wargaming process gives the impression it is a commander-only operation, not involving multiple staff officers. Friendly COAs are analyzed against each of the selected enemy capabilities. Wargaming outputs are listed without discussion of the techniques necessary to arrive at the outputs. This step also states that it is not possible or practical to reach any decision until friendly COAs are compared in the next step of the estimate (E-6).

The fourth and fifth paragraphs (steps) in the estimate process are the comparison of COAs and the decision. FM 101-5 suggests two methods for comparing COAs. One method is to list advantages and disadvantages of each COA. A second method is to isolate certain significant factors and discuss each COA in light of them. Note that this suggestion appears at the end of the estimate, not in the earlier paragraphs. But the commander is not instructed early in the process to develop these critical factors. The commander uses the COA that offers the "best" probability of success as a basis for his decision (E-8). No mention is made of choosing a "satisficing" option, although the author's experiences and other evidence suggest this is what happens. The key output of the process is the

decision marking the commander's concept, later to be developed in detail and issued as an order. This concept is a clear, concise statement of the general scheme of maneuver and supporting fires, sub-unit tasks, and an elaboration of the decision (E-8).

Several manuals were reviewed for their linkages to the estimate. Most manuals from company to corps level discuss the estimate in some detail. These manuals emphasize use of multiple enemy COAs wargamed against multiple friendly COAs. They address the commander-centered nature of the process. They also emphasize the total staff effort involved in wargaming, the idea of a methodical and continuous process, and the need to act rapidly. No particular wargaming methods are offered. Only the company/team manual briefly discusses the influence of time constraints. FM 71-1, Tank and Mechanized Infantry Company Team, states that it will almost be impossible to have enough time to complete the whole process. It also recommends the use of reverse planning and memorization of the process and tools so that the thought process becomes instinctive (1988: 2-16--27). FM 100-15, states that the commander always has to do each step in the process (1989: 4-11). The brigade manual differs from the other manuals in that it contains little or no information on the estimate. This evidence suggests that recent combat unit manuals, except the brigade manual, have made some effort to incorporate essentials of problem-solving doctrine into their manuals.

Several staff officers provide the commander with information concerning the BOS during the estimate process. Examination of the umbrella manuals for each of the seven BOS reveals inconsistencies in their linkages to the estimate. The air defense, engineer, cavalry, and combat service support manuals contain no links to the estimate. The aviation, NBC, and field artillery manuals link their representative staff officer to the estimate in the wargaming process, something FM 101-5 fails to do. No manual discusses wargaming methods or techniques to be used under time constraints.

The key disconnect is in intelligence FMs. The predictive flavor of FMs 34-1, 34-3, and 34-80 decreases the emphasis on multiple enemy COA consideration. FM 34-1, Intelligence and Electronic Warfare Operations, states that intelligence estimate conclusions should contain the COAs most likely to be adopted in order of relative probability of adoption (1987: B-6). It also states that Intelligence Preparation of the Battlefield

(IPB) is a means for predicting enemy intentions and likely COAs before the battle (1987: 3-3--3-4). FM 34-3, Intelligence Analysis, echoes the ideas in FM 34-1. Emphasis on predicting enemy COAs can lead to the single-COA mentality, a poor mindset in an uncertain environment. Additionally, FM 34-80, Brigade and Battalion Intelligence and Electronic Warfare Operations, states that at brigade level enemy capabilities are normally drawn from higher headquarters' estimates and restated in terms of the brigade's area of operations (1986: 4-2).

FM 101-5 contains ambiguous guidance for use of the estimate under time constraints. The MDMP diagram states that during time-critical situations the commander may be forced to complete his estimate and issue verbal orders without staff input (1984: 5-6). An additional chart depicts actions taken by the commander and staff under optimal time conditions. No chart appears concerning actions under time constraints. The chapter on decision making states that under time constraints the commander must take action to ensure timely decision are reached. No details are given. The chapter states that some MDMP actions can be done concurrently. It does not recommend which ones. The remaining guidance on the estimate suggests that the entire process must be done, in the sequence listed, in order to ensure a sound decision is reached. No shortcuts are offered. There is no emphasis placed on speed or rapid decision making.

Analysis of the estimate leads to several observations. It is a detailed, logical thought process. The process is continuous due to the constantly changing nature of the battlefield. Relative combat power is developed in a vacuum, prior to development of enemy COAs. This causes duplication of effort due to the need to recompute relative combat power once enemy COAs are developed. The estimate does not consider commander's intent. It does not specifically cause the user to develop critical factors for analysis during the process. The estimate does not clearly spell out that friendly COA analysis is based on the use of multiple enemy COAs. No substantive shortcuts are given. Most FMs released from 1988 to the present reflect a more thorough but not standardized treatment of the estimate. Any umbrella BOS manual published prior to 1988 contains few links to the estimate. Wargaming methods are not discussed in detail.

Three Problem Solving System Options for Use Under Time Constraints

This section presents three problem-solving options for use under time constraints. These options are based on the number of enemy and friendly COAs used in the problem-solving process.

The French system, entitled "La Methode de Raisonnement Tactique" (The Tactical Reasoning Method) (Larchet, 1989), is a version of concurrent COA analysis under conditions of uncertainty. It forces the analysis and comparison of multiple enemy versus multiple friendly COAs, even under time constraints. It strives for depth of analysis, but is willing to trade off analytical depth for consideration of multiple COAs. For later use in the analysis section of the paper this option is labeled the 3-3 ("3 enemy COAs analyzed with 3 friendly COAs") Option.

The French 3-3 Option prescribes the problem-solving process for use by commanders from platoon to division level (Larchet, 1989). It breaks the reasoning process into three phases: situation analysis; the search, analysis, and comparison of possible COAs for enemy and friendly forces; and the decision (TTA 152, 1985: 56-70). See Appendix E for an outline of the process.

The French "3-3" Option

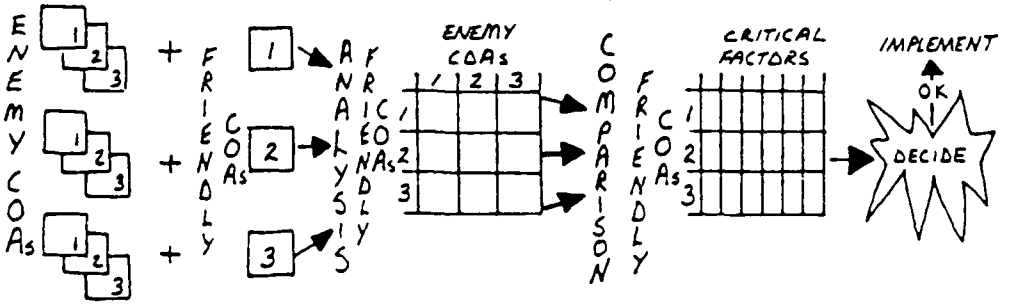


Figure 1.

The "analyse" (analysis) step concentrates on gaining an understanding of the situation and environmental effects on both enemy and friendly forces. Effects of terrain, weather, population, and time are studied. The commander gains an intuitive feel for the intent of the higher commander. The mission of the unit is studied to gain a complete understanding of what is required.

The "analyse" step also studies the capabilities of enemy and friendly forces. This leads to a qualitative and quantifiable understanding of the balance of power between enemy and friendly forces based on time and

space relationships. Outputs from this step include intelligence requirements, constraints on both enemy and friendly forces, and enemy actions that can prevent the unit from accomplishing its missions (TTA 152, 1985: 56-65).

The "recherche de manoeuvres" (COA Analysis) step develops friendly and enemy COAs. Then each friendly COA is analyzed in consideration of each enemy COA to determine advantages, disadvantages, and risk. The results are then compared and a conclusion is reached concerning what the concept of operation should be (TTA 152, 1985: 66-69).

At least two enemy COAs are considered. Typically three enemy COAs are generated. These COAs are developed by the intelligence officer. He must accept the higher commander's intelligence analysis and enemy COAs, even if his own analysis leads to different conclusions (Larchet, 1989).

The operations officer develops at least two friendly COAs (typically three are also used). He must also use any COAs passed to him from the higher commander, and any COAs his own commander wants developed. Initially enemy and friendly COAs are worked separately. As COA analysis progresses, the intelligence and operations officers work jointly on COA analysis and comparison (Larchet, 1989).

The third step is the "decision." It is a general concept of operation, along with an enumeration of possible friendly weaknesses and complementary actions that offset those weaknesses. Variations (branches and sequels) are also laid out and then the concept is developed into some greater detail (TTA 152, 1985: 70). At battalion and above, the French "decision brief" is given to the Chief of Staff. He keys on time-space factors, the influence of terrain, and the balance of power of forces. He also keys on where the effects of physical mass and BOS can be concentrated to achieve the greatest effect (Larchet, 1989).

The main effort is often not designated until intelligence efforts confirm enemy actions (Larchet, 1989). In problem-solving terms, this is generally called the "hedging option." As a result of this, subordinate units tend to receive many "on order" or "be prepared" missions. The process does not change as planning time decreases. As time constraints decrease planning time, the level of detail and depth of analysis decreases. But at least two enemy and two friendly COAs are always considered, preferably at least three of each.

The next problem solving system, the Klein RPDM, represents forced single COA analysis. It will be referred to as the 1-1 ("one by one") Option because only one enemy COA is analyzed against one friendly COA at a time.

The Klein model is based on a behavior approach. Klein studied what some decision makers actually do in problem-solving situations. His evidence from the study of battle commanders and forest and city firefighters under time constraints revealed that in some domains more than 85 percent of their decisions were made in less than one minute and that concurrent option comparison hardly ever occurred. Decision makers didn't construct two or more options and then struggle to pick the best one. They tended to construct one option, perform a short analysis, then decide and act (1989: 58).

The Klein 1-1 Option

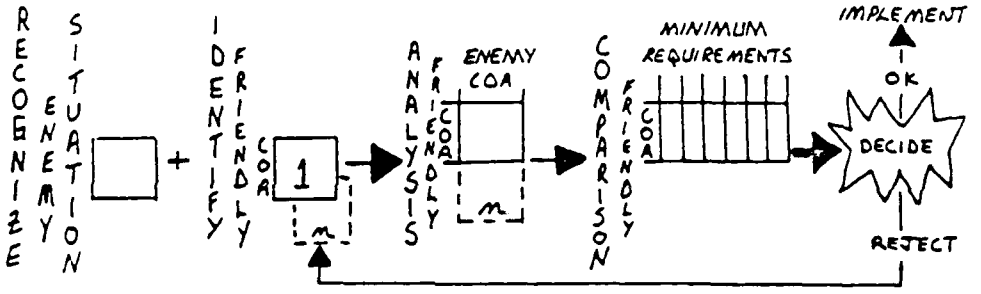


Figure 2.

The use of Klein's model varies based on available planning time. Basically, an option is generated, tested for feasibility, and then either implemented or rejected. If it is rejected, a second option is considered, and so forth until a suitable option is found. All options are not necessarily evaluated using the same criteria (1988: 16). See Appendix F for a detailed layout of this problem-solving process.

In the simplest case, the automatic RPDM, the decision maker uses knowledge and cues to recognize a situation as familiar or typical. Automatic recognition includes identification of goals, cues to monitor, and other types of expectations. Automatic recognition also leads to recognition of a typical reaction, and this is implemented (1988: 17).

The more complex case, the verified RPDM, occurs as more time becomes available. This enables the decision maker to evaluate the option, even perhaps imagine it being carried out. Still, no other options are

considered, even though they may be available in some "action queue," unless the evaluated option is rejected (1988: 17).

The most complex RPDM form involves serial considerations of options. There is more in-depth evaluation. The favored option may be modified before implementation. The favored COA might also be evaluated, modified, then rejected and another COA chosen. The point is that the COA selection and evaluation process continues in a sequential manner. No COAs are ever compared with one another (1988: 17).

The commander uses his experience to recognize patterns, identify situations as similar to previous experiences, and to create possible COAs. The most typical COA is considered first. Sometimes verification and evaluation are possible, but only in a serial fashion. The RPDM may be useful in explaining some aspects of intuitive decision making and is supported by the use of heuristics. The RPDM does not ensure optimal results (Klein, 1988: 19-20).

The third option lies between forced single COA and forced multiple COA analysis problem-solving. It uses a combination of single and multiple COA analyses, based on available time and resources. It is a liberal interpretation of the current US Army commander's estimate.

The 3-2-1 Option

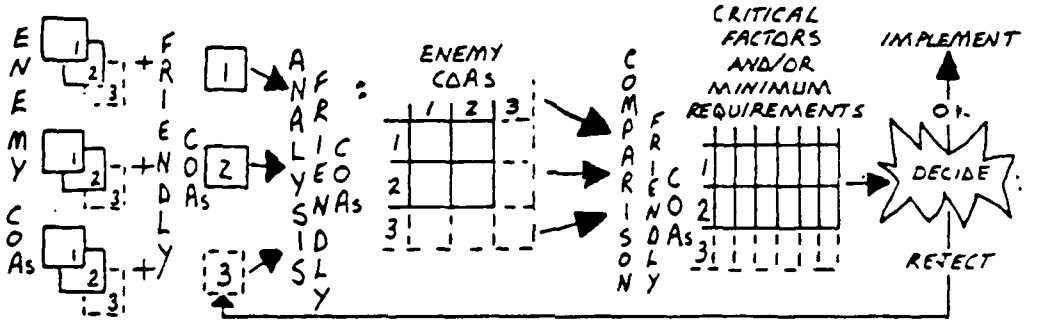


Figure 3.

Under optimal time conditions or light time constraints the third option, labeled the 3-2-1 Option ("3 by 2 by 1"), is similar to the French model. Concurrent analysis is used to examine multiple enemy COAs and multiple friendly COAs. The commander can decide by comparing the advantages, disadvantages, and risk associated with friendly COAs. See Appendix G for details.

Several things can occur to the 3-2-1 Option under light to moderate time constraints. First, the three enemy and three friendly options can still be analyzed, but at a more shallow depth. Next, two or three enemy and two friendly options can be analyzed and compared. Finally, two or three enemy options can be examined against one friendly COA. Or, as usually happens, two or three friendly options can be studied against a single enemy COA.

Under severe time constraints the 3-2-1 Option resembles the 1-1 Option. The most likely enemy COA is wargamed against a single friendly COA. When almost no time is available, the 3-2-1 problem-solving process allows the decision maker to shift to a completely intuitive process. The commander intuitively grasps the situation in one moment, akin to Clausewitz's coup d'oeil. An alternative is "chosen" from memory, and pushed forward to consciousness. The commander observes, orients, and decides in an unconscious flash.

Evaluation Criteria for Option Analysis

The French 3-3 Option, the Klein 1-1 Option, and the 3-2-1 Option will be analyzed using four criteria. This section defines the four criteria. They are flexibility, adaptability, critical event determination, and synchronization.

The first criterion, flexibility, measures the ability of a system's effectiveness to serve a variety of different commanders. Commanders have different personalities, expertise, experience, intuitive powers, analytical skills, communications skills, and leadership skills. Commander skill levels start with the inexperienced "novice", those that have just taken their unit's colors but have yet to experience making tactical decisions for the unit. Novices start with a base level of knowledge and bring their previous experiences with them to the unit. The "expert" has commanded long enough to develop an in-depth, intuitive feel for his unit's capabilities. He has logged many organizational successes and failures in his memory. Commanders with varying degrees of skills fall between these novice and expert categories.

In essence, the greater the number of persons that can use the problem-solving system, the greater its utility for the US Army. The optimal decision making process must be flexible enough to effectively

serve both the novice and the expert. It must be comprehensive enough to provide the novice a sound framework for solving set-piece and encounter problems, puzzles and difficulties. It must also be flexible enough to enable the expert to use it without degrading his well-developed intuitive skills.

The second criterion, adaptability, measures the problem-solving system's effectiveness for analysis of a wide variety of different missions. For example, units receive missions including attack, defend, opposed river crossing, passage of lines, delay, and withdraw. Each mission has its own relative degree of complexity, and optimum planning time. Other factors that complicate mission planning include the amount of available planning time, environmental conditions, and interoperability concerns with allied forces.

Adaptability relates to mission complexity. The more complex the mission, the greater the amount of planning time needed. The decision making system must be able to adapt to the complexity of the assigned mission. It must provide vigorous analytical capabilities for decision support of complicated missions. It must also be simple enough to be used without degrading planning for simple missions. Finally, the decision making process must work across a time continuum from optimal available time to periods of light, moderate, and severe time constraints.

The third criterion, critical event determination, measures the ability of the system to help identify critical events or critical factors that will affect the unit. These critical events include actions of enemy or friendly units, or environment-related events. Some examples of enemy and friendly critical events are main efforts for attack or defense, use of chemicals or nuclear fires, and commitment of reserves. Enemy critical event determination is linked to a good intelligence process. Critical event determination also directly relates to determination of branches and sequels. Critical events also include identification of enemy and friendly vulnerabilities. Finally, environmental critical events include effects of weather changes, light conditions, and trafficability problems.

The greater the number of critical events the decision making system can surface, analyze, and adjust for, the more effective the system will be. This criteria is directly related to the depth of the analytical ability of the process. The problem-solving system needs an effective situation analysis process to identify key friendly and enemy forces, and

environmental factors. The problem-solving system should also have an effective wargaming process to analyze effects of enemy and friendly force interactions in order to identify probable branches, sequels, and other key events.

The last criterion, synchronization, measures the decision making system's ability for BOS synchronization. This is important to give the commander the best opportunity to apply the relative effects of combat power at the most decisive time and place.

This criterion is also related to wargaming. Under time constraints the commander may not have the ability to gather the appropriate staff members to conduct in-depth wargaming of all COAs. The decision making system should enable both the novice and the expert to conduct rapid and/or comprehensive wargaming of COAs to assist in BOS synchronization. The more the decision making system provides in-depth ability to synchronize the BOS despite time constraints, the more effective the system will be.

These criteria concentrate on several aspects of the decision making system. The system must be flexible enough to be effective for commanders of varying expertise. It must adapt to the complexity of the mission. It must be able to identify critical events during situation and COA analysis, the more, the better. Finally, the process must be able to assist in BOS synchronization. The greater the analytical effectiveness under time constraints, the more effective the system is. This suggests there may be a trade-off between analysis of multiple COAs and BOS synchronization.

Option Analysis

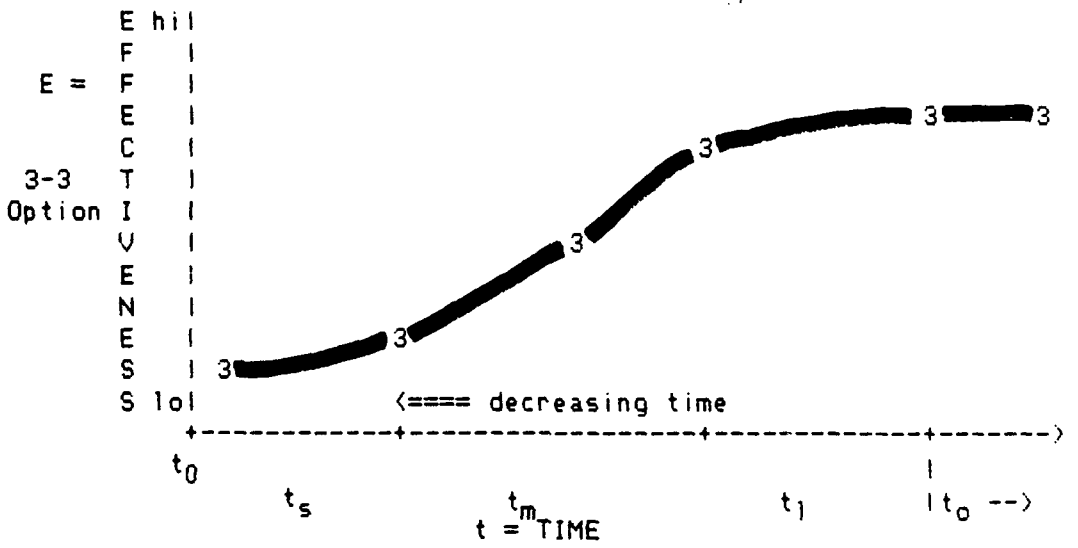
This section analyzes the three options and compares results to determine which option is better suited for use under time constraints. The French 3-3 system will be analyzed first, then the 1-1 Klein approach, and finally the 3-2-1 system. The order of analysis for the four evenly-weighted criteria will be flexibility, adaptability, critical event determination, then synchronization.

Experimentation to produce quantifiable hard data is beyond the scope of this paper. Therefore, analysis will be of a subjective nature only. Several organizations are working on ways to analyze the US Army's

decision making process. For example, the Fort Leavenworth ARI Unit currently experiments with manual and computer-aided support for the decision making process. CATA conducts focused National Training Center rotations on command and control. Combined Arms Training Activity plans to orient their attention on battalion and brigade command and control at a focused NTC rotation in December, 1989. Other organizations continue to study the problem-solving process also. These studies will assist in more objective analysis of command and control and the form of the estimate process that is more objective. This paper will only deal with subjective analysis.

The French 3-3 Option forces the decision maker into analysis of multiple options. The minimum number of options to be analyzed is two enemy and two friendly COAs. The French prefer three enemy and three friendly COAs. As available planning time decreases, first the three options are analyzed in less depth. At a point during moderate time constraints, the 3-3 Option drops one enemy and one friendly option. As available planning time continues to decrease less depth of analysis is accepted. Under severe time constraints the French still prefer to analyze multiple COAs.

Evaluation of the French 3-3 Option



Time Constraints

t_0 = no planning time
t_s = severe time constraints
t_m = moderate time constraints
t_1 = light time constraints
t_o = optimal planning time

Figure 4a.

3-3 Option Effectiveness by Time Period and Criterion

Criterion Effectiveness Rating
L = low degree of effectiveness
M = medium " "
H = high " "

Ec = Effectiveness as a function of (c)riterion
Et = Effectiveness as a function of (t)ime period
EO = Overall Effectiveness

3-3 Option	tO	ts	tm	tl	to	Ec
FLEXIBILITY	L	L	M	M	M	L
ADAPTABILITY	L	L	M	M	M	L
EVENTS	L	M	M	H	H	H
SYNCHRONIZATION	L	L	M	M	H	M
Et	L	L	M	M	M	L-M
						EO

Figure 4b.

Not only does the 3-3 Option's flexibility decrease over time, but also it has built-in inflexibility. The expert decision maker is forced to analyze three enemy and three friendly COAs, even when he can possibly intuitively develop an optimal solution. Forced multiple COA analysis does assist the novice decision maker as it forces him to examine multiple COAs. As available time reduces through light time constraints, the lack of flexibility leads to less depth of analysis, degrading the overall effectiveness of the system. During moderate time constraints the 3-3 Option is still inflexible, even though it shifts to analysis of two enemy and two friendly COAs. Flexibility decreases gradually because the 3-3 Option forces multiple COA analysis to occur during less planning time. As available planning time decreases through severe time constraints, the demand to analyze multiple COAs degrades system effectiveness through lack of depth of analysis. As available planning time approaches zero, the intuitive, sequential nature of human thought is blocked by the system's need to strive for multiple COA analysis. This has a negative effect on the decision making process.

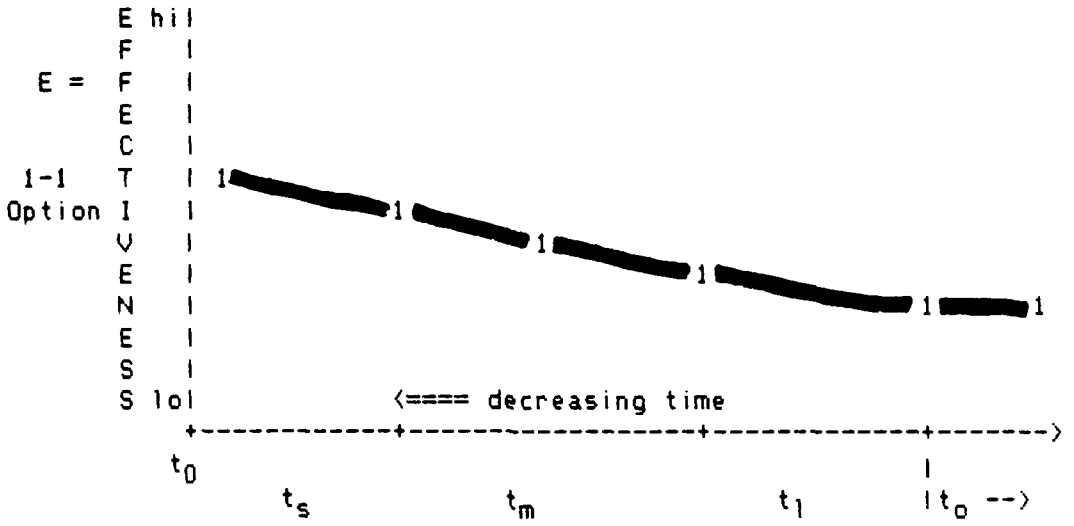
Adaptability of the 3-3 Option also decreases over time. Under optimal time the 3-3 Option is only moderately adaptable because it forces multiple COA analysis to occur. Under light constraints, available time decreases. The more difficult the mission, the longer the optimal planning time. Reduced overall planning time leads to degradation of planning for difficult missions. The decision maker must still perform multiple COA analysis, even if, for example, only one enemy COA is likely. Under moderate time constraints planning time is further reduced. Forced COA analysis continues to reduce effective planning time for difficult missions. Under severe time constraints the forced examination of multiple COAs further decreases the ability of the commander to concentrate on one COA. Forced concurrent COA analysis also blocks the commander's intuitive ability to make decisions when there is no planning time.

For the 3-3 Option, critical event determination decreases from high to medium effectiveness as available time decreases. Forced COA analysis makes the commander examine multiple alternatives and force interactions. Results of the analysis should reveal more critical events than the analysis of only one COA would produce. This appears high to moderately effective at light and somewhat effective at moderate time constraints. Under severe time constraints once again the intuitive nature of the decision making process is degraded and forced concentration on more than one COA decreases system effectiveness.

Ability to synchronize also slowly degrades over time. The more the system forces the user to examine multiple COAs, the less time is available to visualize synchronization actions. Multiple COA analysis does give the user the ability to visualize many actions that lead to synchronization of combat power. But as planning time is degraded, the user is forced to concentrate on generating more COAs and less on synchronization. Under severe time constraints there is little or no attempt at synchronization because the user is still forced to generate multiple COAs.

The Klein 1-1 Option will be examined next. Recall that the 1-1 Option is a forced, sequential analysis of one option at a time. This is difficult for the novice due to his lack of experience. The expert probably has to force himself not to use this type of problem-solving technique under optimal time constraints.

Evaluation of the Klein 1-1 Option



t = TIME

Criterion Effectiveness Rating

L = low degree of effectiveness
M = medium " " "
H = high " " "

Time Constraints

t_0 = no planning time
t_s = severe time constraints
t_m = moderate time constraints
t_l = light time constraints
t_o = optimal planning time

Effectiveness by Time Period and Criterion

Ec = Effectiveness as a function of (c)riterion
Et = Effectiveness as a function of (t)ime period
EO = Overall Effectiveness

1-1 Option	t0	ts	tm	tl	to	Ec
FLEXIBILITY	H	H	M	M	M	M
ADAPTABILITY	H	H	M	M	M	M
EVENTS	L	L	L	M	M	L
SYNCHRONIZATION	M	M	M	H	H	M
Et	H	H	M	M	M	M
						EO

Figure 5.

There are at least two ways to look at the sequential COA analysis technique. Single COA analysis is risky. The decision maker could pick an alternative and later decide, if he has the time available and analyzes the

COA, that it is defective. Then another option must be generated and the process starts all over. This can consume alot of planning time. Another view is that forced single COA analysis can lead to "progressive deepening" (greater analysis of that single COA). The problem-solving system must be able to serve both the novice and the expert, and be able to respond across the entire time continuum, whether or not the first COA chosen to analyze is the best one.

Flexibility in the 1-1 Option increases as the available time decreases. Both the novice and the expert can use the 1-1 Option throughout the time continuum. Under light time constraints forced single COA analysis is what the expert intuitively wants to do and what the novice probably finds easier to do. Flexibility is only rated as moderately effective in periods of light time constraints because only one COA may be analyzed at a time. As available time decreases, forced sequential, single COA analysis allows the decision maker to concentrate on one COA. Multiple COA generation is not necessary unless analysis leads to the conclusion that the COA under examination is of no use.

Adaptability effects due to time constraints are similar to those of the flexibility criteria. If one only has to concentrate on one COA, more time is available for planning, especially for difficult missions. As time available decreases, it grows closer to and then becomes less than the actual planning time needed for the difficult mission. At that point less depth in analysis is necessary to enable the decision maker to finish the plan in the time allowed. Under severe time constraints, forced single COA analysis probably comes close to the intuitive workings of the decision maker's mind. At that point no matter how much planning time is needed, the decision maker must generate one COA and go with it.

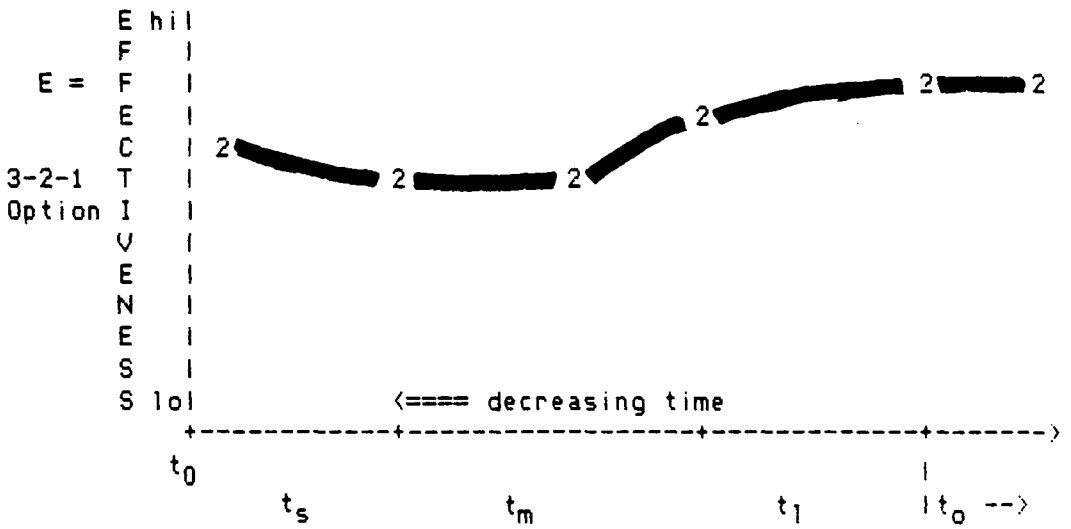
Critical event determination is rated as medium to low. Sequential COA analysis effectiveness under optimum time is rated as medium, due to the sequential nature of analysis. The less COAs available for analysis, the less the probable number of friendly branches and sequels the decision maker will be able to generate. As less time is available, fewer critical events surface from the problem-solving system. Under severe time constraints, the decision maker reacts intuitively and very few critical events are discerned.

Ability to synchronize during the decision making process decreases slightly as time available decreases. Although time available is

decreasing, the decision maker remains focused on one COA. "Progressive deepening" of the analyzed COA can go quickly beyond COA generation and analysis to BOS synchronization. Unless the COA is thrown out, more synchronization time is available. Theoretically, some synchronization time is even available under severe time constraints, because the decision maker remains focused on one COA.

The last option is the 3-2-1 Option. Under optimum and light time constraints this option closely resembles the 3-3 Option, the French approach. Under severe time constraints 3-2-1 Option closely resembles Klein's 1-1 Option. The major difference is that the commander chooses the process he wants to use during the problem-solving. He can start with the 3-3 Option, then switch to consideration of any combination of enemy and friendly COAs. He can decide early in the problem-solving process to use forced sequential COA analysis, or save that method until there is little or no planning time left.

Evaluation of the 3-2-1 Option



t = TIME

Time Constraints

t_0 = no planning time
t_s = severe time constraints
t_m = moderate time constraints
t_1 = light time constraints
t_o = optimal planning time

Figure 6a.

Furthermore, the 3-2-1 Option is linked in such a manner that the commander can, at any point in one method, switch to use any other method. In essence, the 3-2-1 Option represents a bag of problem-solving tricks

similar to the bag of "filed" experiences in the commander's memory. The problem-solving process is chosen or adapted to fit the problem and available time.

3-2-1 Option Effectiveness by Time Period and Criterion

Criterion Effectiveness Rating
L = low degree of effectiveness
M = medium " "
H = high " "

Ec = Effectiveness as a function of (c)riterion
Et = Effectiveness as a function of (t)ime period
EO = Overall Effectiveness

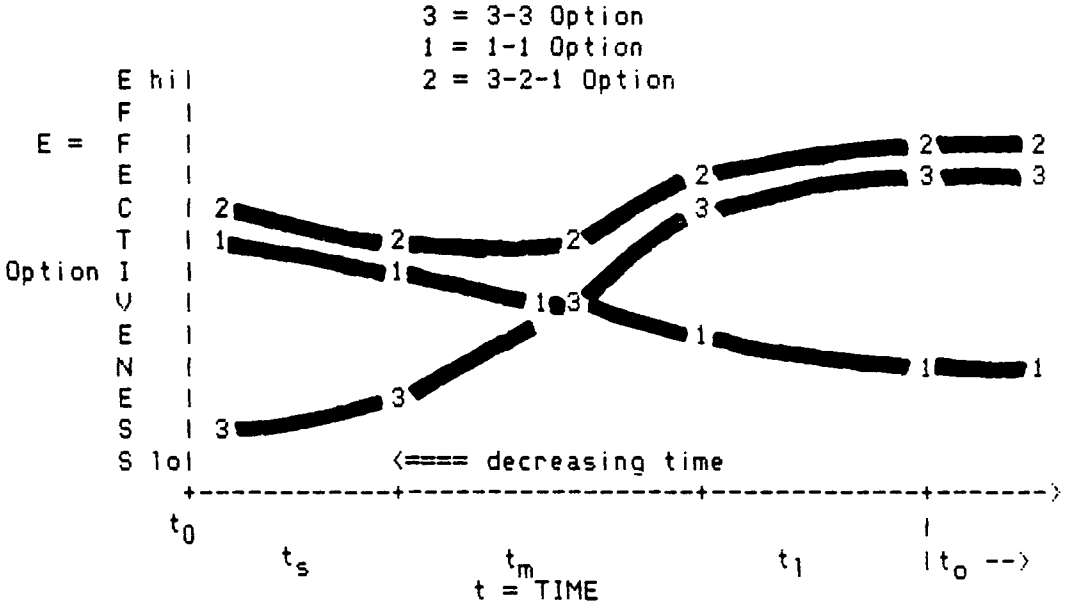
3-2-1 Option	tO	ts	tm	tl	to	Ec
FLEXIBILITY	H	M	M	H	H	H
ADAPTABILITY	H	M	M	H	H	M
EVENTS	L	M	M	H	H	M
SYNCHRONIZATION	M	M	M	H	H	M
Et	H	M	M	H	H	M-H
						EO

Figure 6b.

Some interesting subjective results emerge from the 3-2-1 Option. Flexibility of use for both novices and experts remains at a high to moderate level as available planning time decreases. The expert can shift to a more intuitive approach. The novice can stay with a more analytical approach. Adaptability also remains at a moderate to high level as available time decreases. The commander first analyzes the mission and decides what kind of problem-solving process to use. He can shift to a streamlined method if complex planning is needed. Or he can remain with a simple approach if time constrains his planning. Critical event determination and ability to synchronize decrease as time decreases. But once again, the commander has the option to choose a problem-solving method that produces the kind of critical events that he thinks he needs to plan for in the mission. Under severe time constraints, critical event determination and synchronization will be difficult at best, and contribute only a small level of effectiveness toward decision making.

Comparison of the options focuses on their effectiveness during the different blocks of time.

Overall Option Comparison



Time Constraints

t_0 = no planning time
t_s = severe time constraints
t_m = moderate time constraints
t_1 = light time constraints
t_o = optimal planning time

Overall Effectiveness by Time Period and Criterion

Criterion Effectiveness Rating
L = low degree of effectiveness
M = medium " " "
H = high " " "

Ec = Effectiveness as a function of (c)riterion
Et = Effectiveness as a function of (t)ime period
EO = Overall Effectiveness

Option Comparison	t0	ts	tm	t1	to	Ec
3-3 Option	L	L	M	M	M	L-M
1-1 Option	H	H	M	M	M	M
3-2-1 Option	H	M	M	H	H	M-H
						EO

Figure 7a.

Overall Option Comparison with Numerical Weights

Using number weights: L=1; M=2; H=3

Option Comparison	t0	ts	tm	tl	to	Ec	Overall Ranking
3-3 Option	1	1	2	1.5	1.5	7	Third
1-1 Option	2.5	3	2	1.5	1.5	10.5	Second
3-2-1 Option	2.5	2	2	3	3	12.5	First
						E0	

Figure 7b.

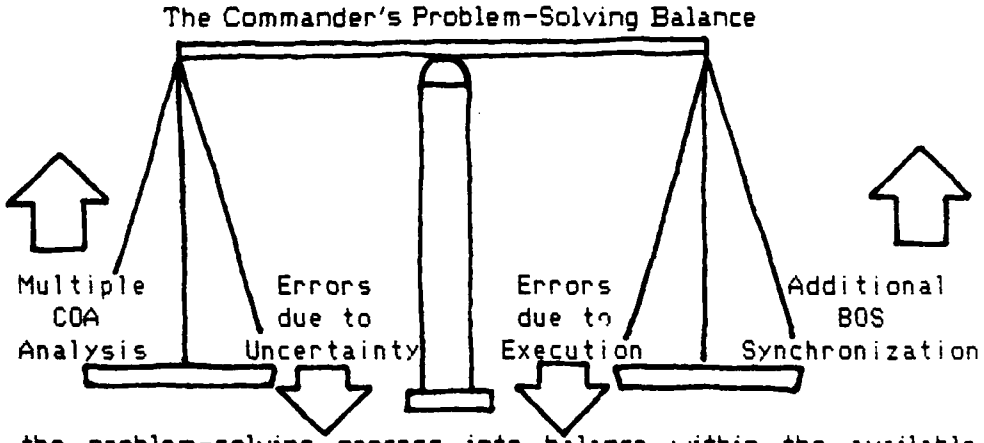
The 3-3 Option has an overall low to medium effectiveness under time constraints. In optimal conditions multiple COA analysis is desired to cope with the uncertainty of the environment. The 3-3 Option retains moderate levels of effectiveness under light and moderate time constraints because it continues to force analysis of multiple COAs. But in severe time constraints the 3-3 Option retains little effectiveness because there is no longer any planning time to afford multiple COA analysis, even though this is forced on the decision maker.

The 1-1 Option has an overall medium level of effectiveness across time. As available planning time decreases, the 1-1 Option becomes a more lucrative problem-solving process. As available planning time approaches zero, the 1-1 Option is the better alternative because it comes close to the natural intuitive thought process of the commander. Intuitive decision making is desired under severe time constraints because little or no time is available to generate more than one COA.

Two major drawbacks keep the Klein approach from being the sole problem-solving process that commanders should use. First, novices have difficulty with the system. They do bring previous experience with them to the unit but not from the commander's perspective. Therefore, their experiences must be adjusted for this lack of correct perspective prior to using any intuitively-created COAs. Second, one cannot predict with certainty whether the first COA analyzed will be optimal, satisfactory, or unacceptable. One could suggest a greater propensity for the commander to generate an optimal COA on the first roll of the mental dice as his experience level increases. Training may enhance this ability. But if the commander cannot, with any great degree of confidence, assure himself

that he can generate an optimal COA on the first try, then maybe another problem-solving method should be used.

This analysis also suggests a there is a trade-off between multiple COA analysis, synchronization of a chosen COA, and two types of errors. Errors of execution are related to BOS synchronization. Errors of execution result from uncoordinated actions and the "fog of war." There will always be some errors of execution due to the "fog of war." But a reduction in errors of execution is possible through improved BOS synchronization.



Bring the problem-solving process into balance within the available planning time. Multiple COA Analysis & BOS Synchronization offset errors due to uncertainty and execution.

Figure 8.

Theoretically, more BOS synchronization and coordination lead to a decrease in errors of execution. Synchronization is accomplished in large measure after the decision is made (after the estimate process is complete). But, the faster the commander arrives at a decision, the greater the time available for BOS synchronization. Also, if the optimum COA is chosen early in planning, progressive deepening can lead to more BOS synchronization. Therefore, on one side of a mental "balance" the commander "weighs" errors of execution due to lack of synchronization and coordination. These errors are alleviated in part by arriving at an optimal solution quickly, through sequential COA analysis.

On the other side of this mental "balance" is the commander's desire to reduce his errors due to uncertainty. Some of these errors are due to the failure to envision enemy probable actions. Again, since the enemy commander's mind operates as an independent variable, the friendly

commander will never be able to account for one hundred percent of these errors of uncertainty. The friendly commander can decrease the effect of these errors through analysis of increasing numbers of COAs. Therefore, the commander "weighs" errors of uncertainty on the other side of the mental "balance", reducing them in part by multiple COA analysis.

The commander is in a quandry. He must reduce both errors produced by uncertainty and errors that result from poor execution. He can do this by either dedicating more time to multiple COA analysis or progressive deepening of one COA. But, there is never enough time to alleviate both types of errors. If there is little time available, the commander may concentrate on reducing errors of execution by using sequential COA analysis. If alot of time is available, the commander may use concurrent COA analysis to reduce errors of uncertainty.

The crunch point comes somewhere between severe and light time constraints. During these moderate time constraints, the commander has to make a trade-off. He must "balance" errors of execution verses errors of uncertainty. As he decreases the possibility of errors of execution through sequential COA analysis, the likelihood of errors caused by uncertainty increases because fewer COAs are analyzed. As he decreases the possibility of errors due to uncertainty through concurrent COA analysis, the likelihood of errors due to execution increases because less time is available to synchronize the chosen COA.

There is no single best solution to the commander's time quandry, his "balancing" problem. Each commander is different. Each situation is *different. Each unit is different. But the commander must attempt to* control these errors, by reducing them to an acceptable level. This may involve choosing a "satisfactory" solution as opposed to a "best" solution to allow more time for BOS synchronization. Or it may involve forced, multiple, concurrent COA analysis to analyse many probable enemy COAs, thereby increasing the possibility of choosing the "best" solution. The optimal problem-solving system must allow the commander to reduce these errors, to the commander's satisfaction.

The 3-2-1 Option is the optimum method for solving tactical problems. Under optimal conditions its ability to shift the number of permutations it examines gives it a higher overall effectiveness than the 3-3 Option. As time becomes more constrained, the ability to choose problem-solving methods continues to make it a more viable method than forced concurrent

analysis in the 3-3 Option. The commander can also switch to the 1-1 Option once he has an option that he thinks is close to the optimum solution. He can then concentrate on modifying the "chosen" COA through progressive deepening to get an optimum product. Also, if the commander, like Napoleon, continuously analyzes his environment, he can have a readily available bag of options prepared to use with any of the problem-solving methods. Finally, as time constraints approach severe levels, he can shift to a more intuitive approach and continue his problem-solving.

Conclusions and Implications

> It is not claimed that this method develops genius or brilliancy. It may even be discouraging to an officer who imagines that the daring and unerring combinations of a Napoleon are now as possible as ever. The object [of the applicatory system] is to develop a school of safe leadership for officers and not to encourage unusual and extraordinary methods. We need fear little from the brilliancy of our enemy if we succeed in this. (Army War College (AWC) Pamphlet, 1911, written under the supervision of General Tasker H. Bliss (AWC, 1911: 4-5)

Some leaders in the US Army will tell you the commander's estimate takes too long; it's not followed, it does not work. The question this paper tried to answer is, "What is the optimal decision making process to produce effective concepts of operation under time constraints?" This paper examined theory and the history, development, and current process used by the commander. It also examined three problem-solving methods against subjective criteria to determine what option worked best.

This paper focused on the commander's role in the estimate process for several reasons. Admittedly the staff plays an important role in COA generation, wargaming, and information management. But it is still ultimately the commander's thought process and decision that counts. The staff works for the commander, often exhibiting characteristics of the commander's own decision making process. The commander does his own independent estimate, albeit with the assistance of the staff, in order to understand the situation, generate guidance and COAs, wargame alternatives, and ultimately decide on how the unit will accomplish its mission. But further research is needed to understand the integrated performance of the commander and staff team, especially under time constraints.

Several conclusions can be drawn from this current research. First, the estimate process originated as a way to explain how students made decisions in tactical problems. It still works as an aid in teaching decision making.

Next, the decision making process should be renamed. It has now evolved into a systematic way of thinking. It contains a group of interrelated parts that work in a dynamic manner toward a single purpose. All actions of one part of the "system" influence other parts. It is linked to the commander's command and control system. It contains multiple ways to solve problems, along with a framework on inputs, processes, and outputs. An improved title that would recognize this broad, holistic perspective is The Military Problem-Solving System.

Analysis of the current form of the military decision making process reveals several points. FM 101-5 leaves an ambiguous impression of how the decision making process should operate under time constraints. Well thought-out diagrams and examples would get the point across better. Development of an abbreviated format would also contribute to emphasis on the time critical aspect of the process. The 71 series FMs and BOS umbrella FMs need to be linked in a standardized manner to the military decision making process. The key BOS disconnect in intelligence manuals needs fixing. These manuals should admit some prediction is necessary, especially under severe time constraints. But they should also emphatically state that multiple enemy COAs should be wargamed against multiple friendly COAs when time permits.

Next, wargaming techniques are not adequately addressed. As a minimum, techniques in ST 100-9, The Command Estimate should be added. An example of how the process is used under varying degrees of time constraints would also further clarify the problem-solving system.

The US Army could also take some ideas from other estimate processes. The commander's estimate needs to incorporate a mission-oriented focus, tied to the commander's intent. It needs a check system to ensure the mission can be changed if the situation facing the commander is radically different than when the order was issued. Also, a method needs to be incorporated that develops critical factors for comparison of COAs during the estimate process.

The commander needs a bag of problem-solving methods that work under varying time constraints, not just one method that only works well without

time constraints. Examination of three problem-solving options leads to several conclusions. The system has to work for the novice and the expert. The Klein method has a place under severe time constraints. Forced multiple COA analysis technique works well under optimal conditions. The current US Army system should provide, if precisely worded, a good base for use under time constraints.

But there should be several techniques for the commander. The 3-2-1 Option, which seems optimal, appears to be the way FM 101-5 deals with time constraints. This should be explicitly spelled out so that commanders know what method to use under what conditions. FM 101-5 should state, for example, under optimal time conditions and light time constraints use forced multiple COA analysis of three enemy and three friendly COAs. Under moderate time constraints use forced concurrent analysis of at least two enemy and two friendly COAs. Finally, under severe time constraints, use sequential analysis of one enemy and one friendly COA. These methods should also be related to the personality and expertise of the commander, the staff, and the unit. The commander should also use techniques that produce both acceptable and optimal COAs. Additionally, if the commander gets in the habit of continuously analyzing his situation, he will be able to react more quickly to new situations. Unit success depends on this ability to recognize opportunities and decide on how best to apply combat power in any situation, under any type of time constraints, so that relative effects of combat power are applied at the most opportune time and place to accomplish the mission.

Analysis also brings up several implications concerning training, expertise, cultural influences, wargaming techniques, and organizations. Commander training in the areas of problem recognition, intent development, and COA analysis could reduce the time required for decision making. A program of problem-solving drills for both the commander and staff could increase expertise in adjusting to new situations. Commanders have to learn to overcome their own cultural biases and the heuristics they depend on when they make decisions. Standardized wargaming techniques, if developed and practiced by the commander and staff, could decrease the time involved in analysis of COAs. Computer decision aids could also be helpful tools. Finally, organizational SOPs for the commander and staff could reduce the time required to implement the decision making process.

The Draft FM 101-5 will be available for comment in 1990. There are no substantial changes in the military decision making process or the estimate from the 1984 version. Additional time-consuming analytical skills have been added along the lines taught in CAS3. The estimate process is still ambiguous with respect to what the commander can do under time constraints. Don't look there to find explicit short-cut methods or quick wargaming ideas. It's even ambiguous in stating explicitly that multiple probable enemy COAs must be analyzed against multiple friendly COAs under optimal conditions. Apparently leaders will have to continue to build their time-constrained problem-solving methods by the seats of their pants, like they do right now. Or maybe the US Army needs to take another hard look at FM 101-5, at what it sells for doctrine on problem-solving. We ought to do it now, before we have to do it for real, under severe time constraints.

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APPENDIX A: CRAIN'S BATTLE STAFF PLANNING GUIDE

BATTLE STAFF PLANNING GUIDE - PART A

Msn Receipt (MR) to Start (MS) (hrs): (0-3) 1/3 Time = (0-1)

Staff	Location CG	M	T	R	MR Info to Cdr	Cdr Guidance (CG) Dev CA / Wargame	Cdr Decision (CD) Staff Products MS
XO					Time Avail	CONOPS2	Time Schedule1
S1							
S2					En Activity1/2	Weather2 Terrain2	Sit Overlay2 PIR2
S3					Mission1 Adj Unit Info2 Area of Opns	Sub Unit Missions2 Task Organization2 Priority Eng Spt 2 Priority Fire Spt2	Opns Overlay2
S4					Assets Avail CSR2	Movement Listing2	Move Overlay2
NBC							
CEO							
FSO							
ENG							
ADA							
ALO							

CG Finalize: Time Sch (-), Msn, Maint & Cl V Priority, WARNORD
Provide: Initial PIR, Intent, Other Planning Guidance
CD Finalize: Concept of Opn, CONOPS, Move, PIR, OPORD
Provide: Briefback & Rehearsal Instructions
Other Guidance as necessary

TIME SCHEDULE	Task	Time	Where		Time	Where
	Mission Receipt			Cdr Decision		
	Info to Cdr			Issue OPORD		
	Cdr Guidance			Briefback 1		
	Issue WARNORD			Staff Rehearsal		
	Staff Recon			Briefback 2		
	Develope one CA			Mission Start		
	Wargame			Mission End		

ORDER	WARNORD	OPORD
Format	Oral	Oral & Sketch
Issue Means	Radio/Wire	Face to Face & Radio/Wire
Distribution	Order Gp A	Order Gp A

1 - Item included in WARNORD
2 - Item included in OPORD

(CRAIN, 1989: 88)

BATTLE STAFF PLANNING GUIDE - PART B

Msn Receipt (MR) to Start (MS) (hrs): (3-6) 1/3 Time = (1-2)

Staff	Location CG	M	T	R	MR Info to Cdr*	Cdr Guidance (CG) Dev CA / Wargame*	Cdr Decision (CD) Staff Products	MS
XO								
S1					Per Shortage Casualty Rpt			
S2					Intel Summary1 Area of Int	Aves of Approach2 En Sit/Assessment2 Critical Terrain Obstacles/Barrier2	Sit Overlay2	
S3					Friendly Act Unit Info Constraints	Battlfld Geometry2 Routes2	Opn Overlay2	
S4					Battle Losses Supply Short	POL Locations2	Move Overlay2	
NBC					Rad Dose Stat			
CEO					Interference			
FSO								
ENG						Obst & Barriers2		
ADA								
ALO					BDA Sorties	Friendly A/C Rpt		
CG*	Finalize Provide							
CD*	Finalize Provide							

	Task	Time	Where		Time	Where
	Mission Receipt	_____		Cdr Decision	_____	_____
TIME	Info to Cdr	_____	_____	Issue OPORD	_____	_____
	Cdr Guidance	_____	_____	Briefback 1	_____	_____
SCHEDULE	Issue WARNORD	_____	_____	Staff Rehearsal	_____	_____
	Staff Recon	_____		Briefback 2	_____	_____
	Develope one CA	_____	_____	Mission Start	_____	
	Wargame			Mission End		
ORDER		WARNORD			OPORD	
Format		Oral			Overlay	
Issue Means		Radio/Wire			Face to Face & Courier	
Distribution		Orders Gp B			Orders Group B	

* Same as in Part A plus items listed

1 - Item included in WARNORD 2 - Item included in OPORD

(CRAIN, 1989:89)

BATTLE STAFF PLANNING GUIDE - PART C

Msn Receipt (MR) to Start (MS) (hrs): (6-9) 1/3 Time = (2-3)

Staff	Location				MR	Cdr Guidance (CG)	Cdr Decision (CD)	MS
	CG	M	T	R	Info to Cdr*	Dev CA / Wargame*	Staff Products	
XO								
S1								
S2					Assess EM/ OPSEC	En Msn/OBJs2; Order of Battle Bridges & Fords SEAD & HVTs EW Tasking2	Sit Overlay2	
S3					SITREP	Tgt Criteria2 Issue Priority2 Asm Area Loc2 A/C Priority2 Eng Spt Req	Opn Overlay2	
S4					UBL % Fill ASR		Log Overlay2	
NBC								
CEO								
FSO							FSpt Overlay2	
ENG						Minefields2 Bridging2	Eng Overlay2	
ADA								
ALO								
CG	Finalize							
	Provide							
CD	Finalize							
	Provide							

	Task	Time	Where		Time	Where
	Mission Receipt	_____		Cdr Decision	_____	_____
TIME	Info to Cdr	_____	_____	Issue OPORD	_____	_____
	Cdr Guidance	_____	_____	Briefback 1	_____	_____
SCHEDULE	Issue WARNORD	_____	_____	Staff Rehearsal	_____	_____
	Staff Recon	_____		Briefback 2	_____	_____
	Develope CA ( )	_____	_____	Mission Start	_____	
	Wargame			Mission End		

ORDER	WARNORD	OPORD
Format	Oral & Written	Overlay
Issue Means	Radio/Wire & Courier	Face to Face
Distribution	Orders Group B	Orders Group B

* Same as in Parts A & B plus items listed

1 - Item included in WARNORD

2 - Item included in OPORD

(CRAIN, 1989:90)

BATTLE STAFF PLANNING GUIDE - PART D

Msn Receipt (MR) to Start (MS) (hrs): (9-12) 1/3 Time = (3-4)

Staff	Location CG	M	T	R	MR Info to Cdr*	Cdr Guidance (CG) Dev CA / Wargame*	Cdr Decision (CD) Staff Products*	MS
XO								
S1								
S2					ECM & ECCM Rpt	En Wpn Sys En A/C Airfields Road	Intel Overlay2 R & S Plan2	
S3						RSR2, ACA2 Imed Eng Tgts2 ADA Priority2 Planned Tgts2 Replace Priority2	Order2 Opns Overlay2	
S4					ASR		Log Overlay2	
NBC								
CEO								
FSO								
ENG								
ADA								
ALO								
CG*	Finalize Provide							
CD*	Finalize Provide							

	Task	Time	Where		Time	Where
TIME SCHEDULE	Mission Receipt			Cdr Decision		
	Info to Cdr			Issue OPORD		
	Cdr Guidance			Briefback 1		
	Issue WARNORD			Staff Rehearsal		
	Staff Recon			Briefback 2		
	Develope CA ( )			Mission Start		
	Wargame			Mission End		

ORDER	WARNORD	OPORD
Format	Oral & Written	Written & Overlays
Issue Means	Radio/Wire & Courier	Face to Face
Distribution	Orders Group C	Orders Group C

* Same as in Parts A, B and C plus items listed.

1 - Item included in WARNORD 2 - Item included in OPORD

(CRAIN, 1989:91)

Appendix B: Napoleon's Method and an Example from the Leipzig Campaign, 13 August 1813

The Tactical Equation

The tactical or strategic equation to be solved in determining the decision is composed of:

- The mission or object.
- The variables (your own force and the hostile force)
- The constants (arbitrary constants), such as:
  - relative combat power
  - terrain
  - time and space
  - dispositions
  - status of supply, etc.

The solution of the equation is a synthesis of what will be done and the details by which it will be accomplished.

Example: Napoleon's written estimate to the French Secretary of War, 13 August 1813.

"It is reported that 60,000 men of the Russian and Prussian Army have entered Bohemia, and that the Emperor Alexander arrived at Prague, the 15th. If this is the case:

First hypothesis: Either the enemy will take the offensive by Zittau, the only exit that is on the right bank. He will be stopped by the forces at Zittau and the corps of General Vandamme, as well as by the reserve at Goerlitz that I can get there in a day and a half, or

Second hypothesis: the enemy will manoeuver on the left bank of the Elbe and will debouche by Toeplitz and Peterswalde to advance on Dresden. In this case Marshall St. Cyr can assemble 60,000 men in two days, and in four days I can be there with 150,000. Finally,

Third hypothesis: [Considered highly improbable by the Emperor, but not omitted by him.] The enemy may engage in operations that cannot be anticipated and will enter Germany, either by Munich or by Nuremburg. In this case he will deliver all of Bohemia in my hands.

In the case the report is in error: If on the contrary, the report of the entry of the Russian Army into Bohemia is false, or if there is but a small body of troops, then in two days I can concentrate 200,000 men against the enemy in Silesia.

Another improbable action: We shall now consider the case where the enemy, forgetting past lessons, may move with 40,000 man on Munich and 25,000 or 30,000 on Wurzburg, which would weaken him by 70,000. Here, then, is my plan so that you may give the necessary orders, etc." (Phillips, 1937: 8-9).

Appendix C: Analysis of the Commander's Estimate, 1910-1984

The estimate's development from 1910 to the present 1984 version will be discussed in terms of purpose, overall format, use of diagrams to embellish the process, area of operations information, considerations of enemy and friendly COAs, wargaming methods, COA analysis and comparison, decision methods, and techniques for use under time constraints. The key sources for this work are the US Army FSR's between 1910 and 1927, and editions of FM 101-5, Staff Officer's Field Manual, beginning in 1928. This section also contains versions of the estimate from 1932 through 1984.

The purpose of the estimate has remained constant. The commander alone is responsible for what his unit does or fails to do. He decides on the concept of operations he will adopt based on sound, thorough, clear, systematic, unemotional analysis of all facts and assumptions relating to the situation. The concept, in essence, consists first of what the unit will do (mission), and second, some details of time, place, task organization of forces, subunit missions (scheme of maneuver), and plan of fire support.

The first paragraph (step) in the estimate has always been the mission. It has always been either derived from higher commander guidance or orders, or has been deduced from the current situation. A comparison of the mission analysis step of estimates of Israel, FRG, Britain, France, and the USA, reveals an interesting difference. Only the German estimate expressly directs the commander to consider if the mission should be changed wholly or in part based on a changed hostile situation (Phillips, 1937: 42).

The overall format has undergone minor modifications. From 1910 to 1932, discussions on the estimate were tied to field orders. There was no standard format. Although outline formats existed in USCGSC instructional texts, the five paragraph outline-type format did not appear until 1932 (FSR, 1932: 45-46). The major focus of each of the five paragraphs has not changed since 1940. Attempts to add detail to the estimate do not appear until at least 1960. Diagrams do not appear to assist in describing the decision process until 1972. Example estimates are only found in versions from 1950 to 1972. Detailed appendices on the commander's estimate appear in the 1982 and 1984 editions.

The information in paragraph two (step two) has concentrated on important situational factors and courses of action since 1940. Additional detail was added From 1940 through 1960 . The basic format has not changed since the 1960 edition. Situational factors including effects of weather, terrain, hydrography, routes of communication, sociological, and all OKOCA factors have been either formally or informally considered since 1950. The primacy of relative combat strength is reflected in all editions since the estimate's inception. Relative combat strength indicators have been referred to either formally or informally as strength, disposition, status of supply, reinforcements, morale, and training since 1950 and actually are mentioned as far back as 1939 (Michel, 1989: 10-11). Versions after 1960 attempted to focus further on various parts of combat power factors such as artillery, anti-tank, and air defense capabilities.

Consideration of multiple enemy and friendly COAs has been with the estimate since its inception. However, up through 1932 the emphasis was on choosing the one most probable enemy COA, then using that one to assist in developing the friendly plan (FM 101-5, 1932: 46). Beginning in FM 101-5's 1940 version, the estimate formally instructed the user to consider multiple enemy COAs evaluated against multiple friendly COAs (126). These manuals, in describing the process, warn the commander to consider multiple enemy COAs as protection against believing he has discovered the enemy's intentions. The 1960 FM 101-5 first defined how COAs were distinguished from one another. The 1968 FM 101-5 was the first to split responsibilities of the commander, and the operations and intelligence officers as far as COA development. The 1968 FM 101-5 also first stressed the three criteria for a viable COA: feasibility, accomplishability, and distinguishability. No new material was added to multiple COA development after 1968 (Michel, 1989: 7).

Wargaming did not appear in any significant form until the 1954 edition of FM 101-5. The 1954 and 1960 versions spoke of commanders visualizing actions or creating "mental pictures" of critical actions between forces (Michel, 1989: 8). The 1968 FM 101-5 first used the term "wargaming," described its process in detail, gave an example, and listed products that resulted from the process. No significant changes were added after 1968 (Michel, 1989: 9-10).

A wide variety of doctrinal ideas on techniques for use of the estimate process under time constraints have been expressed over the years. Ever edition from 1950 on stated that the estimate was universally applicable to any situation or echelon. Only the 1954 edition suggests that steps in the process might be combined (Michel, 1989: 4). The 1968 and '72 versions state that the commander could go to the next step in the process without completing the preceding one. This idea dropped out of editions after 1972 (Michel, 1989: 5). Beginning with the 1968 version, FM 101-5 indicated that no decision could be made until analysis and comparison of COAs was completed (Michel, 1989: 7). The 1982 and '84 editions established the formal estimate process as the best way to make decisions (Michel, 1989: 6). Several versions discussed elimination from consideration the enemy or friendly COAs that were inferior to others being considered (Michel, 1989: 7). But most versions left the reader the impression that the commander had to execute the entire process and use multiple enemy and friendly COAs. Few concrete suggestions were made on how to use the process under time constraints.

The 1977 FM 101-5 (Draft) is worthy of special note. Mr. Rex Michel, from ARI, came across this version while researching the history of FM 101-5. Mr. Michel notes several radical departures from the standard doctrine. This draft viewed the estimate as a much more dynamic, subjective, hurried, "natural" process than any other edition. Speed was the essence of the process. The full blown estimate was viewed as a training aid to develop the commander's problem-solving skills. Decisions could be arrived at before completing all analysis and comparison of COAs.

Although this version continued to stress the use of multiple COAs, it was written from the premise that the commander always had a concept of how to employ his unit. Given more time, the commander could use a more

detailed examination with multiple COAs. Wargaming was described as more of an art than a set of prescribed procedures. An example of decision making under time constraints was used, illustrating the emphasis on speed and identification of critical factors. Finally, the 1977 draft contained no format or example and only spoke in general terms of information requirements. The 1977 Draft of FM 101-5 was never published. The 1982 and 1984 editions contained no "radical" views like the 1977 Draft (4-13).

Several patterns emerge from historical review of the estimate. The original process grew from the belief that few geniuses would be available so a commander needed to be trained to make good decisions according to some standardized method. It is still a good vehicle for basic training in decision making. The US Army process developed from the need to explain field order solutions to academic problems. The estimate's utility was then extended to include all military problems. Progressively more detail was added through the 1968 edition. There have been no significant changes the the estimate since 1968, even though there have been at least two major changes in Army doctrine and further changes in the complexity and tempo of the battlefield. Wargaming was added but techniques have never been adequately addressed. The only edition which appears to seriously deal in depth with use of the process under time constraints was never published. What remains is a detailed, logical thought process of steps that can be compressed but not ignored, despite severe time constraints.

Versions of The Estimate, 1932 - 1984

---- 1932 ----

1. MISSION
2. OPPOSING FORCES
   a. Enemy Forces
   b. Own Forces
   c. Relative combat strength
3. ENEMY SITUATION
   a. Plans open to the enemy
   b. Analysis of the enemy plans
   c. Enemy possible intentions
4. OWN SITUATION
   a. Plans open to you
   b. Analysis of plans open to you
5. DECISION

---- 1940 ----

1. MISSION
2. SITUATION AND POSSIBLE LINES OF ACTION
   a. Considerations affecting the possible COAs
   b. Enemy capabilities
   c. Own courses of action
3. ANALYSIS OF OPPOSING COURSES OF ACTION
4. COMPARISON OF OWN LINES OF ACTION
5. DECISION

-- 1950 -- 1954 --

1. MISSION
2. SITUATION AND COURSES OF ACTION
   a. Considerations affecting the possible COAs
      (1) Characteristics of the area of operations
      (4) Relative combat power
   b. Enemy capabilities
   c. Own courses of action
3. ANALYSIS OF OPPOSING COURSES OF ACTION
4. COMPARISON OF COURSES OF ACTION
5. DECISION

---- 1960 ----

1. MISSION
2. SITUATION AND COURSES OF ACTION
   a. Considerations affecting the possible COAs
      (1) Characteristics of the area of operations
         (a) Weather
         (b) Terrain
         (c) Other pertinent factors
      (2) Enemy situation
      (3) Own situation
      (4) Relative combat power
   b. Enemy capabilities
   c. Own courses of action
3. ANALYSIS OF OPPOSING COURSES OF ACTION
   a. Determine enemy capabilities that have approximately equal effect on all COAs
   b. Analyze each COA against each remaining enemy capabilities
4. COMPARISON OF COURSES OF ACTION
5. DECISION

---- 1968 ----

1. MISSION
2. SITUATION AND COURSES OF ACTION
   a. Considerations affecting the possible COAs
      (1) Characteristics of the area of operations
         (a) Weather
            Military aspects and light data
            Effects on enemy and friendly operations
         (b) Terrain
            Effects on military aspects
            Effects of military aspects on Enemy/Friendly
            Key terrain features and avenues of approach
         (c) Other pertinent factors
      (2) Enemy situation
         (a) Dispositions
         (b) Composition
         (c) Strength
            Committed forces
            Reinforcements
            Air and NBC
            Other considerations
         (d) Recent and present significant activity
         (e) Peculiarities and weaknesses
      (3) Own situation
         (a) Dispositions
         (b) Composition
         (c) Strength
            Committed forces
            Reinforcements
            Air and NBC
            Other considerations
         (d) Recent and present significant activity
         (e) Peculiarities and weaknesses
      (4) Relative combat power
   b. Enemy capabilities
   c. Own courses of action
3. ANALYSIS OF OPPOSING COURSES OF ACTION
   a. List of enemy capabilities that will materially assist in choosing the best COA.
   b. Analysis of each COA verses each listed enemy capability.
4. COMPARISON OF OWN COURSES OF ACTION
5. DECISION

---- 1972 ----

1. MISSION
2. SITUATION AND COURSES OF ACTION
   a. Considerations affecting the possible COAs
      (1) Characteristics of the area of operations
         (a) Weather
            Military aspects and light data
            Effects on enemy and friendly operations
         (b) Terrain
            Effects on military aspects
            Effects of military aspects on Enemy/Friendly
            Key terrain features and avenues of approach
         (c) Other pertinent factors
      (2) Enemy situation
         (a) Dispositions
         (b) Composition
         (c) Strength
            Committed forces
            Reinforcements
             Air and NBC
            Other considerations
         (d) Recent and present significant activity
         (e) Peculiarities and weaknesses
      (3) Own situation
         (a) Dispositions
         (b) Composition
         (c) Strength
            Committed forces
            Reinforcements
             Air and NBC
            Other considerations
         (d) Recent and present significant activity
         (e) Peculiarities and weaknesses
      (4) Relative combat power
   b. Enemy capabilities
   c. Own courses of action
3. ANALYSIS OF OPPOSING COURSES OF ACTION
   a. List of enemy capabilities that will
      materially assist in choosing the best COA.
   b. Analysis of each COA verses each listed
      enemy capability.
4. COMPARISON OF COURSES OF ACTION
   a. List advantages and disadvantages of each COA
   b. Conclusion of best COA
5. DECISION (RECOMMENDATION)

-- 1977 (Draft) --

1. MISSION
2. SITUATION AND COURSES OF ACTION
   Relative combat power
3. OPTIONS
4. SEEING COURSES OF ACTION
5. ANALYSIS AND COMPARISON OF COURSES OF ACTION
   a. Analysis
   b. Comparison
6. DECISION

---- 1982 ----

1. MISSION
2. SITUATION AND COURSES OF ACTION
   a. Considerations affecting the possible COAs
      (1) Characteristics of the area of operations
         (a) Weather
         (b) Terrain
            Effects on military aspects
            Effects of military aspects on Enemy/Friendly
            Key terrain features and avenues of approach
         (c) Other pertinent factors
      (2) Enemy situation
         (a) Dispositions
         (b) Composition
         (c) Strength
            Committed
            Reinforcements
            Artillery
            Air and NBC
            Other considerations
         (d) Recent and present significant activity
         (e) Peculiarities and weaknesses
      (3) Own situation [same as (2) above]
         (4) Relative combat power
   b. Enemy capabilities
   c. Own courses of action
3. ANALYSIS OF COURSES OF ACTION
   a. List of enemy capabilities that will
      materially assist in choosing the best COA.
   b. Analysis of each COA verses each listed
      enemy capability.
4. COMPARISON OF COUPSES OF ACTION
   a. List advantages and disadvantages of each COA
   b. Conclusion of best COA
5. DECISION (RECOMMENDATION)

---- 1984 ----

1. MISSION

2. SITUATION AND COURSES OF ACTION

a. Considerations affecting the possible COAs
(1) Characteristics of the area of operations
(a) Weather
(b) Terrain
(c) Other pertinent factors
(2) Enemy situation
(a) Dispositions
(b) Composition
(c) Strength
Committed
Reinforcements
Artillery
Air and NBC
Other considerations
(d) Recent and present significant activity
(e) Peculiarities and weaknesses
(3) Own situation
(a) Dispositions
(b) Composition
(c) Strength
Committed forces
Reinforcements
Air and NBC
Other considerations
(d) Recent and present significant activity
(e) Peculiarities and weaknesses
(4) Relative combat power

b. Enemy capabilities

c. Own courses of action

3. ANALYSIS OF COURSES OF ACTION

a. List of enemy capabilities that will materially assist in choosing the best COA.

b. Analysis of each COA verses each listed enemy capability.

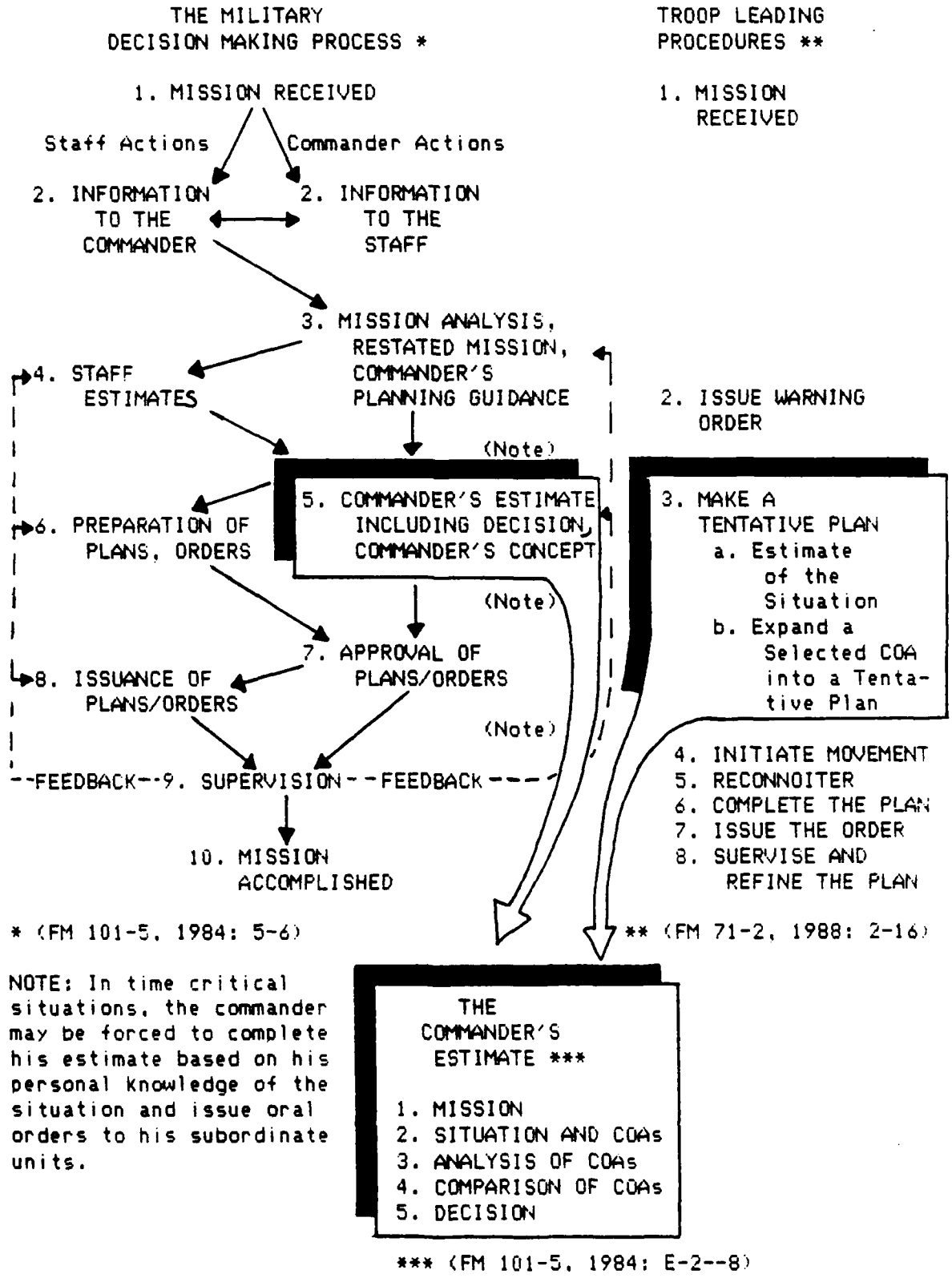
4. COMPARISON OF COURSES OF ACTION

a. List advantages and disadvantages of each COA

b. Conclusion of best COA

5. DECISION (RECOMMENDATION)

Appendix D: The Current System



* (FM 101-5, 1984: 5-6)

** (FM 71-2, 1988: 2-16)

NOTE: In time critical situations, the commander may be forced to complete his estimate based on his personal knowledge of the situation and issue oral orders to his subordinate units.

*** (FM 101-5, 1984: E-2--8)

Appendix E: The French Estimate of the Situation

This is extracted from the French field manual TTA 152, La Methode de Raisonnement Tactique, (The Tactical Reasoning Method), 1985: 55-70.

The general tactical reasoning processes for platoon through division are arrayed in three successive phases:

-The analysis: to understand the framework of limits considered for the exercise of choices; define major efforts; imperatives that must be accomplished; and constraints that must be considered.

-COA analysis: explanation of possible choices, modes of action for friendly and enemy forces, and analysis of confrontation between the two forces.

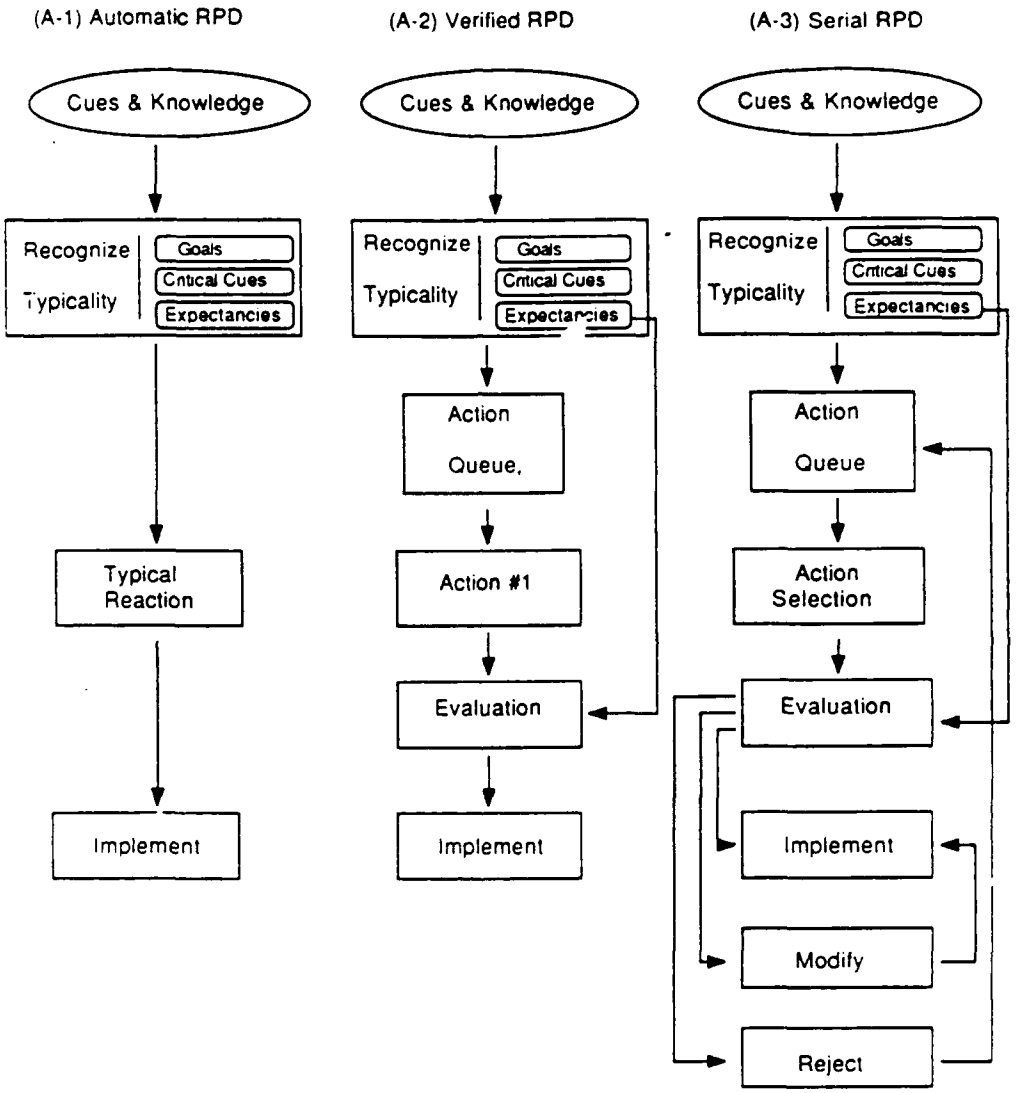
-The decision: the choice of the commander that is the result of the reasoning process.

QUESTIONS	PROCESS	CONCLUSIONS
	THE ANALYSIS:	
What is the general frame of action?	-General situation: friendly (actions directed by higher HQs) enemy -General features Air situation NBC situation State of forces -Type actions open to unit	-Frame of action at the considered level -Constraints -Imperatives -Maneuver styles
Where?	-Terrain study demensions of zone of action essential characteristics road network -Weather -Population	-Favorable and unfavorable aspects of terrain -Constraints -Imperatives
When?	-Date, time	-Time

QUESTIONS	PROCESS	CONCLUSIONS
Why?	-Study the Higher HQs intent	-Discern importance of higher HQs intent to mission of unit
What?	-Study the wording of the mission of the unit for: desired effects on enemy, what is assigned	-Actions that the unit must complete to accomplish the mission -Constraints -Imperatives -Margins of initiative -Major effects sought from primary approach
With who? (friendly forces)	-Capabilities of the unit	-Quantitative and qualitative state of affairs
	-Aptitude for means to comply with the different actions	-tactical consequences -Possible outcomes -Constraints of employment of forces
Against who?	-Capabilities of enemy forces opposing the unit	-Inventory of enemy means in space and time
	-Possibilities of enemy forces in space and time	-Intelligence requirements -enemy constraints -Impacts on major approaches
	-Confrontation of forces in space and time	-Place and time of moments of superior and inferior relative combat power of the unit -Consequences on major effects and approaches

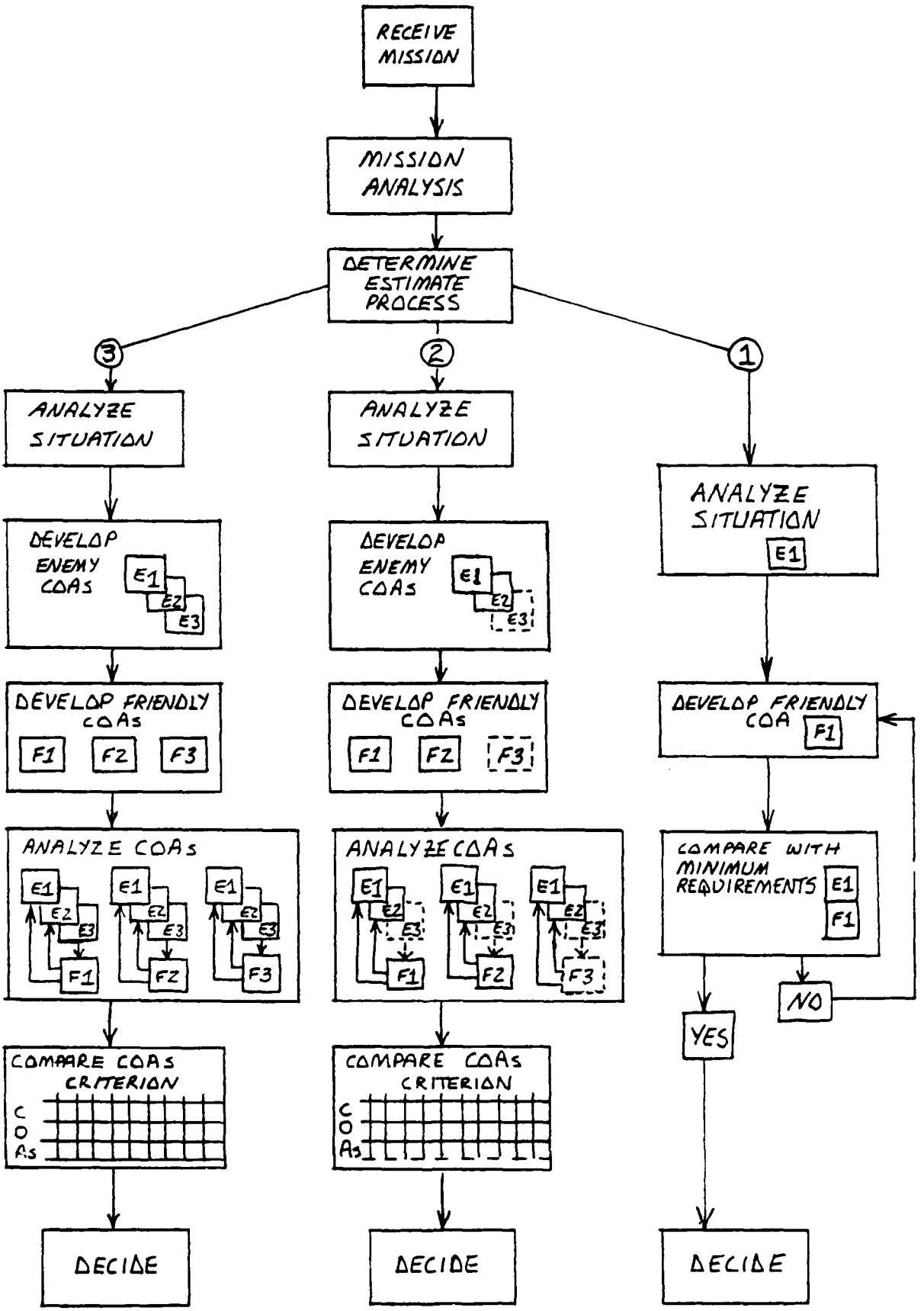
QUESTIONS	PROCESS	CONCLUSIONS
	COA ANALYSIS	
How?	-Friendly modes of action -Elaboration -Examination -Enemy modes of action -Elaboration -Examination -Comparison of modes of action advantages, disadvantages, risk, for each friendly mode of action as wargamed against each enemy mode of action -Proposal for a base action [concept of operations]	
	DECISION	
	-Choice of base action -Eventual verified weaknesses -Complementary actions that can be undertaken -Variants [branches] -Mode of action laid out	

APPENDIX F: KLEIN'S RECOGNITION - PRIMED DECISION MODEL



(KLEIN, 1988: 18)

APPENDIX G: THE 3-2-1 OPTION



Appendix G: The 3-2-1 Option

The estimate process under optimal conditions. This can also be used under light to moderate time constraints by reducing the number of COAs and/or critical factors used.

1. MISSION
   a. Analyze higher commander mission
   b. Analyze higher commander's intent
   c. Analyze own mission
   d. Determine critical factors

2. DETERMINE TIME AVAILABLE
   a. Determine mission complexity
   b. Estimate available planning time
   c. Determine estimate process to be used
   d. Develop timeline

3. SITUATION AND COURSES OF ACTION
   a. Considerations affecting the possible COAs
      (1) Characteristics of the area of operations
         (a) Terrain
         (b) Weather
         (c) Other pertinent factors
         (d) Determine critical factors
      (2) Own situation
         (a) Develop dispositions, composition, strength
            [1] Intelligence
            [2] Maneuver (committed, reinforcements)
            [3] Fire support (committed, reinforcements)
            [4] Air
            [5] Mobility/countermobility/survivability
            [6] NBC
            [7] Air defense artillery
            [8] Command and control
            [9] Combat service support
            [10] Human element
         (b) Recent and present significant activity
         (c) Peculiarities and weaknesses
         (d) Determine critical factors
      (3) Enemy situation
         (a) Develop dispositions, composition, strength
            [1] Intelligence
            [2] Maneuver (committed, reinforcements)
            [3] Fire support (committed, reinforcements)
            [4] Air
            [5] Mobility/countermobility/survivability
            [6] NBC
            [7] Air defense artillery
            [8] Command and control
            [9] Combat service support
            [10] Human element
         (b) Recent and present significant activity
         (c) Peculiarities and weaknesses

(d) Determine critical factors

b. Develop enemy courses of action
   (1) Analyse combat power
   (2) Array initial forces
   (3) Develop the scheme of maneuver
   (4) Determine C2 and maneuver control measures
   (5) Prepare COA statement and sketch
   (6) Determine critical factors
   (7) Repeat as long as time permits

c. Develop own courses of action
   (1) Analyse combat power
   (2) Array initial forces
   (3) Develop the scheme of maneuver
   (4) Determine C2 and maneuver control measures
   (5) Prepare COA statement and sketch
   (6) Determine critical factors
   (7) Repeat as long as time permits

4. WARGAMING (ANALYSIS OF COURSES OF ACTION)
   a. Consolidate critical factors list
      (1) From intent/mission analysis
      (2) From characteristics of area of operations
      (3) From friendly/enemy situation
      (4) From enemy/friendly COA development
   b. List enemy capabilities that will materially assist in choosing the best COA.
   c. Analysis of each COA verses each listed enemy capability.
      (1) Develop enemy/friendly COA matrix
      (2) Gather tools
      (3) Choose enemy and friendly COA to be wargamed
      (4) List assumptions
      (5) Determine relative combat power
      (6) List known critical events and decision points
      (7) Select a wargame method
      (8) Select a technique to record and display results
      (9) Wargame the battle and assess the results
      (10) Determine critical factors
   d. Choose another enemy and friendly COA for wargaming

5. COMPARISON OF COURSES OF ACTION
   a. Develop finalized critical factor list
   b. List advantages, disadvantages for each friendly COA
   c. Conclusion of best COA
   d. Modify COA if necessary

6. DECISION (RECOMMENDATION)
   a. List intent
   b. List scheme of maneuver
   c. List sub-unit missions
   d. List plan of supporting fires
   e. Define end-state conditions
   f. Define acceptable risk
   g. Elaborate

This is a suggested version for use under severe time constraints.

1. MISSION
   a. Analyze higher commander mission
   b. Analyze higher commander's intent
   c. Analyze own mission
   d. Determine minimum requirements and/or critical factors

2. DETERMINE TIME AVAILABLE
   a. Determine mission complexity
   b. Estimate available planning time
   c. Determine estimate process to be used
   d. Develop timeline

3. SITUATION AND COURSE OF ACTION
   a. Considerations affecting the possible COA
      (1) Determine critical characteristics of the area of operations
      (2) Own situation: Develop a "snapshot" of the friendly situation using the BOS and the battlefield framework
      (3) Enemy situation: Develop a "snapshot" of the enemy situation using the BOS and the battlefield framework
      (4) Determine minimum requirements and/or critical factors
   b. Develop enemy most probable COA
      (1) Analyse combat power
      (2) Array initial forces
      (3) Develop the scheme of maneuver
      (4) Determine minimum requirements and/or critical factors
   c. Develop own COA
      (1) Analyse combat power
      (2) Array initial forces
      (3) Develop the scheme of maneuver
      (4) Determine C2 and maneuver control measures
      (5) Prepare COA statement and sketch
      (6) Determine minimum requirements and/or critical factors

4. WARGAMING (ANALYSIS OF COURSE OF ACTION)
   a. Consolidate minimum requirements and/or critical factors list
      (1) From intent/mission analysis
      (2) From characteristics of area of operations
      (3) From friendly/enemy situation
      (4) From enemy/friendly COA development
   b. List known critical events and decision points
   c. Wargame if time permits, or quickly visualize confrontation of forces

5. COMPARISON OF COURSE OF ACTION
   a. Compare wargaming results to minimum requirements and/or finalized critical factors
   b. Accept or reject COA (if reject, go back to step 3.c.)
   c. Modify COA if necessary or if time permits

6. DECISION (RECOMMENDATION)
   a. List intent
   b. List scheme of maneuver
   c. List sub-unit missions
   d. List plan of supporting fires
   e. Define end-state conditions
   f. Define acceptable risk