Exploratory Analysis in the Utility of Logistics Planning Software to Logistics Planners at the Division Level

A Monograph

by

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Contents

Abstract

Exploratory Analysis in the Utility of Logistics Planning Software to Logistics Planners at the Division Level by MAJ Kerry J. MacIntyre, USA, 61 pages.

This monographs examines the ability of the currently available logistics planning software, OPLOGPLAN '98 and the LEW '98, to assist the logistics planner in the creation of division level plans. To define the utility of the logistics planning software, this monograph examines the software's information production capacity and its communication ability. The intent is to determine if logistic planning software communicates critical logistics information to the division logistics planner and if the software helps to integrate logistics into the division planning cycle and division plans.

The software analyzed in this monograph is the only currently available logistics planning software, OPLOGPLN '98 and the LEW '98. Logistics planning software is evaluated individually for the software's ability to assist the logistics planner to support division planning and complete division plans using the military decision making process (MDMP).

The monograph concludes that OPLOGPLAN '98 and the LEW '98, do not assist the logistics planner in the creation of division level plans. OPLOG and the LEW are models that calculate sustainment factors, not decision models. Both software programs are management information systems, designed to manipulate date and provide statistics. They both also have some elements of decision support systems, which provide analysis of information, but neither helps the logistics planner to frame the problem or define a solution.

Chapter One

Introduction

Background.

Determining logistics requirements has been a part of combat operations since man first began organizing for armed conflicts. Logistical planning considerations assumed critical proportions when the first armored and mechanized vehicles became prevalent on the battlefield. Like artillery calculations on the naval ships of World War II, logistics mathematics quickly outgrew man's ability to manually calculate them. The initial Army answer to this was to establish permanent logistics planning tables as the means to decrease calculation times.

Army automation of logistics processes in theaters of operation did not begin until the conflict in Vietnam. In 1965, "the control of stocks in storage and on order was accomplished by a laborious manual process."[1] It was not until late 1967 that in-theater inventory management was fully automated, and the requisition process was assisted by widespread automation. Even then, the computerization of the requisition process existed only at the theater level. Individual units requested supplies manually through the tactical unit's forward operating base to either a Logistical Support Activity or a Forward Support Activity.[2] Compounding planning problems, the unit supply system remained a "pull" system, meaning that the using unit requested supplies as they used them, or drew additional items of a particular commodity based on expected expenditure in the immediate future. At the support activities, "stockage levels were set at a minimum level consistent with operational requirements (based on troop and equipment densities, resupply rates, capacity, and consumption experience)."[3]

Despite improvements in higher echelons of supply automation, division level planners remained tied to manual techniques for another twenty years. The ultimate repository of Army manual logistic tables was the hefty successor to FM 101-10-1 in 1987, so large it was published in two volumes, FM 101-10-1/1 and 1/2. The first volume contained the "organizational structure, personnel, and equipment for divisions, separate brigades, airborne Special Forces groups, and armored cavalry regiments."[4] The second volume was used

> by staff officers at all echelons as a guide for obtaining planning data in support of combat operations. It provided data that could be applied to combat, combat support and combat service support units from theater through company levels.[5]

This volume also provided planning data for engineer, supply, transportation, personnel, health service support, and force requirements planning. Until the 1990's, this book was the 'tome of knowledge' that formed the basis for all logistics planning. An asset in logistics planning, this manual still left logisticians with a laborious, and time consuming logistic planning process.

The Army's first attempt to automate this the logistic planning process began in the early 1990's with the production of the Supply Usage Requirements Estimator (SURE) version 1.0 program. The Combined Arms Support Command (CASCOM) at Fort Lee, Virginia, coordinated this effort between the CASCOM Force Development and Evaluation Directorate and the Information Systems Command, Directorate of Information Management in Fort Leavenworth, Kansas. Running in Lotus 123, SURE 1.0 was the first logistics tool designed for logistic planners that allowed them to "estimate detailed equipment-based consumption for supply classes III (fuel) and V (ammunition), and population-based consumption for classes I (rations), II (general supply), IV (barrier materials), VI (personal demand items), and VIII (medical supplies), and water."[6] Although a major improvement over the manual system through its use of spreadsheets, SURE 1.0 was still limited to calculating the consumption quantities of each unit for only one day. SURE 1.1, the initial upgrade released in March of 1994, did little to correct these deficiencies.

In an effort to make the SURE system a better tool for operational planning, SURE 2.0 was developed in a concerted effort between the Combined Arms Support Command (CASCOM), the Command and General Staff College (CGSC), and the School for Advanced Military Studies (SAMS). Now a Dbase IV data management system, SURE 2.0 instituted "orders-based planning that integrated the concepts of phased operations, parameter sets of operational conditions, and task-organized groupings of units to facilitate the correlation of logistics estimates to operations plans and orders".[7] At this time CGSC, as a result of combing many manuals in an effort to assist with the creation of SURE 2.0, began publishing Student Text (ST) 101-6, the G1/G4 Battlebook. Designed for instructional use only, the G1/G4 Battlebook's quick reference style soon made it popular with students, who continued to utilized it as their primary logistics reference once reassigned to tactical Army units.

SURE 2.0, in the course of its transformation, acquired a new name as well as a new functionality, and in 1994 the first version of Operations Logistics Planner (OPLOGPLN) was released. The current version, OPLOGPLN '98, is a self proclaimed "computer based program designed to assist logistics planners in calculating supply usage estimates in support of operations...designed specifically to support operations typically associated with multi-phase operation plans (OPLAN) and operation orders (OPORD)."[8] OPLOGPLN had the capacity to calculate the projected consumption quantities of an operation for all Army classes of supply except class IX repair parts. CASCOM, as the agent for the Department of the Army Headquarters (HQDA), Office of the Deputy Chief of Staff for Logistics (ODCLOG) for Army logistics planning factors appointed in Army Regulation (AR) 700-8, Logistics Planning Factors Management, designated OPLOGPLN '98 the official automated logistics planning software of the Army.

In 1995, a year after the release of the 1994 version of OPLOGPLN, instructors at the Army Logistic Management College experimented with another idea for a logistics planning software. Frustrated with the unwieldy Disc Operating System (DOS) on which OPLOGPLN was based, the enterprising Support Operations Course instructors created new logistics planning software based on Microsoft Window's Excel spreadsheet format. As most computers utilized Microsoft Office, the instructors felt that an Excel based was easier for logistics planner to use. The product of their efforts was the Logistics Estimation Worksheet (LEW). The LEW utilized planning factors from both ST101-6 and OPLOGPLN to compute supply consumption data for most of the same classes of supply as OPLOGPLN. A more detailed analysis of LEW versus OPLOGPLN will follow in chapter two.

Defining the Problem.

The intent of this monograph is to determine if the currently available logistics planning software, OPLOGPLAN '98 and the LEW '98, assist the logistics planner in the creation of division level plans. To define the utility of the logistics planning software, this monograph will examine the software's information production capacity and the communication ability. My intent is to determine if logistic planning software communicates critical logistics information to the division logistics planner and if the software helps to integrate logistics into the division planning cycle and division plans

Research Questions.

To facilitate the intent of this monograph, the following research questions will be considered.

a. What are OPLOGPLN and the LEW?

What is OPLOGPLN?
What is the LEW?
Are OPLOGPLN and the LEW models?
Are OPLOGPLN and the LEW decision models?

b. How does logistics automation software apply in the division planning system?

What do logistics planners need to do to support the division planning system?
Does logistics planning automation help the logistics planner accomplish this?

c. Does the software provide information that supports military decision making process (MDMP)?

What are the necessary products of the staff estimate and receipt of mission?
Does logistics planning software help the logistics planner provide the necessary products of the staff estimate and receipt of mission?
What are the necessary products of the mission analysis?
Does logistics planning software help the logistics planner provide the necessary products mission analysis?
What are the necessary products of course of action development?
Does logistics planning software help the logistics planner provide the necessary products of course of action development?

What are the necessary products of course of action analysis?

Does logistics planning software help the logistics planner provide the necessary products of course of action analysis?

What are the necessary products of course of action comparison?

Does logistics planning software help the logistics planner provide the necessary products of course of action comparison?

What are the necessary products of course of action approval?

Does logistics planning software help the logistics planner provide the necessary products of course of action approval?

What are the necessary products of orders preparation?

Does logistics planning software help the logistics planner provide the necessary products of orders preparation?

Methodology

The software analyzed in this monograph is the only currently available logistics planning software, OPLOGPLN '98 and the LEW '98. Logistics planning software will be evaluated individually for the software's ability to assist the logistics planner to support division planning and complete division plans using the military decision making process (MDMP).

Assumptions

a. Logistics planning software is limited to the 1998 versions of both OPLOGPLN and the LEW. No other software is currently available for logistics planning or consideration in this monograph.
b. This monograph does not intend to compare Army logistics planning to joint planning doctrine or other military services planning doctrines.

Scope/Limitations

In the planning process, the integration of personnel issues including the movement of replacements and the evacuation of casualties are inextricably linked to logistical planning. This is a valid and necessary part of the planning process, as the movement of personnel has significant impacts on logistics functions such as transportation. It is beyond the scope of this monograph to evaluate the current logistical planning software's ability to support personnel planning issues. Personnel planning factors are discussed only when they affect other sustainment issues such as class I rations or water consumption. Medical discussions are also strictly limited to the sustainment and movements of class VIII, medical supplies, with the military decision making process (MDMP).

Chapter Two

Defining the Logistics Planning Software

"Logistics is the process of planning and executing the sustainment of forces in support of military operations."[9]

OPLOGPLN

OPLOGPLN is a DOS based system that allows the logistics planner to calculate supply usage estimates for varying types of operations. The logistician can calculate supply consumption estimates for all classes of supply. OPLOGPLN allows the user to enter multi-phase operation plans (OPLAN) and operation orders (OPORD). The user creates units based on standard Tables of Organization and Equipment (TOE), then organizes these into a task organization that is assigned to an OPLAN or OPORD. The logistics planner enters the OPLAN or OPORD into OPLOGPLN by specifying the type of mission and number of days spent conducting the mission. The user then determines the mission parameter set, which is a set of characteristics that establishes the terrain and climate (such as southwest Asia or Korea). These mission parameter sets describe the conditions under which the task organization operates. OPLOGPLN generates reports on the amount of supplies consumed by unit, task organization, or phase. It can also summarize supply consumption for the complete order. OPLOGPLN cannot calculate unit logistic capabilities or movement data.

LEW

The LEW is a Windows based system that allows the user to input operational tempo (OPTEMPO), personal planning factors, and vehicle planning factors into an Excel spreadsheet. In the OPTEMPO data sheet, users determine the types of missions by day, time and distance factors, set the personnel strength, and create the vehicle types. Users input cross-country roads, secondary roads, and tactical idle times estimated to transpire each day, which affect the mission profile, and time and distance factors. In the personnel planning data sheet, users provide ration mix, issue cycles, water factors and casualty estimate profiles. The vehicle planning factor data sheet has a default set up for vehicular loss due to maintenance, or permits the user to option of establish maintenance rates. The maintenance default factors are based on historical maintenance models.

The LEW uses these three entry data sheets to calculate specific logistics requirements, and in some cases, compare them with the capabilities of the using unit. The LEW then calculates results for eight data sheets. A brief summary the logistics information in those sheets is listed below.

Personnel Losses: This data sheet provides an estimated number of the personnel killed in action, missing in action, and returned to duty. It lists the number of personnel that need to be evacuated to higher headquarters. The utility of this information for personnel planning will not be addressed in this monograph.

Rations and Water: This data sheet provides the quantity of rations and water required, and the number of vehicles needed to carry these items.

General Supplies and Move: These two data sheets provide the amount of class II, IIIP, IV, VI, VIII (Appendix C) and mail needed by the unit and the number of vehicles needed to move them.

Maintenance: These three data sheets list the readiness and availability of track vehicles, wheeled vehicles and aircraft for the unit.

Fuel: This data sheet lists the fuel requirements for the unit's equipment, the organizational fuel capability and the direct support capability of the using unit. It also computes the capacity shortage or overage for fuel. A unit has a capacity shortfall for fuel when the number of gallons of fuel that the unit can store exceeds the amount of fuel that unit needs to accomplish its mission. A unit has a fuel overage capacity when the amount of fuel a unit can store exceeds the amount of fuel the unit needs to accomplish its mission.

The LEW cannot calculate class V ammunition or class IX repair part consumption quantities at this time.

Models

The Army logistics community calls the two software programs described above "planning tools". This term does not provide clarification of the type of software or the intent of that software design. Understanding the software's design defines the products that the software is able to produce. Knowing what design and type of system OPLOGPLN and the LEW are helps establish what they can provide to the planning process.

OPLOGPLN and the LEW are software models. A model is

> system that stands for or represents another typically more comprehensive system. A model consists of a set of objects, described in terms of variables and relations defined on these and either (a) embodies a theory of that portion of reality which it claims to represent or (b) corresponds to a portion of reality by virtue of an explicit homomorphism or isomorphism between the model's parameters and given data.[10]

Both software programs fulfill this definition. More specifically, they can both be described as behavioral models, in which

> ...the relations are transformations, equations or operating rules and the representation is based on the assurance that the behavior of the model corresponds to the behavior of the system modeled. This is established either by identifying the model's parameters and equations, or showing that the homomorph is not violated.[11]

Models are used to "represent the reality of a real system by duplicating its important features, appearance, and characteristics." [12] OPLOGPLN and the LEW do this by portraying a unit in an operation and estimating consumption quantities.

Knowing that OPLOGPLN and the LEW are models allows the user to understand the limitations inherent in both software programs. The logistics planner must know

> when a model is appropriate and what its assumptions and limitations are, what purpose a model might serve in a particular problem, how to use a model and produce results, and how to interpret the results of the model. [13]

When using these models, the logistics planner must constantly be aware of the advantages and disadvantages of each system. The advantages of using a model are:

> ...they are less expensive and disruptive than experimenting with the real-world system, they allow managers to ask "what if" types of questions, they are built for management problems and encourage management input, they force a consistent and systematic approach to the analysis of problems, they require managers to be specific about constraints and goals relating to a problem, and they help reduce the time needed in decision making.[14]

The disadvantages of using a model are that they can only be as accurate as the data that is input into them, and they can only provide specific information that is subject to interpretation.

One specific type of model often used is a decision model.

> Decision theory offers a rich collection of techniques and procedures to reveal preferences and to introduce them into models of decision. It is not concerned with defining objectives, designing the alternatives, or assessing the consequences; it usually considers them as given from the outside, or previously determined. Given a set of alternatives, a set of consequences, and a

correspondence between those sets, decision theory offers conceptually simple procedures for choice.[15]

OPLOGPLN and the LEW are not decision models as defined above, although they may aid the decision making process indirectly. A decision model would clearly assist the logistics planner in the planning process by producing a clearly defined decision. Decision models have a process to enable the users to distinguish between alternatives. OPLOGPLN or the LEW do not have this capability. Indeed, these two automation systems have little in common with better know decision models, such as decision tables[16], decision trees[17] and program evaluation and review technique (PERT) diagrams[18]. These decision models are focused to enable a manager to draw conclusion, while OPLOGPLN and the LEW are designed to convey information and allow the user to draw the conclusions. OPLOGPLN and the LEW do not provide analysis and decisions. They cannot analyze information; they provide information calculations. OPLOGPLN and the LEW are designed to manage information, not to provide analysis for making a decision. With OPLOGPLN and the LEW, logistics planner must interpret results and draw conclusions. There are automation programs that can do this. They are called management coefficient models and are based on a heuristic decision rule.

> A heuristics decision rule is a rule of thumb based on a manager's previous experiences in tackling a problem. A classic heuristic application is E.H. Bowman's management coefficient model. This unique approach builds a formal decision model around a manager's experience and performance. [19]

A close examination of the traditional decision models, while bearing little similarity to OPLOGPLN and the LEW, shows a close correlation to the military decision making process (MDMP).

Systems

The logistics planner can better understand OPLOGPLN and the LEW's application to the planning process by defining the type of system they are. OPLOGPLN and the LEW have elements of both a management information system and a decision support system. Management information systems are "dedicated to obtaining, formatting, manipulating, and presenting data in the form of information to managers when needed."[20] OPLOGPLN and the LEW perform these functions for the logistics planner. Both logistics software programs also perform as decision support systems. These are further extensions of the management information systems that

> ...aid managers in modeling and decision making. Rather than simply providing information, a DSS allows a manger to perform "what-if" analysis given certain financial or operating parameters.[21]

Both OPLOGPLN and the LEW have the ability to allow logistics planners to perform some degree of "what if" analysis. For example, in OPLOGPLN, the logistician can compute unit consumption based on "what if" the unit was operating in southwest Asia versus Southeast Asia. To this limited extent, both OPLOGPLN and the LEW are decision support systems that help the planner manipulate data.

Chapter Three

The Logistics Planner, Logistics Planning Software, and the Division Planning System

Commanders at all levels know that the success of their tactical plans relies to a large degree on the ability of the logisticians to sustain maneuver forces. Logisticians, in turn, know that they must be able to rapidly and accurately develop and assess logistics plans that will support the commander's tactical plans. Logistics planning is simple in concept but often difficult in execution. [22]

To establish if logistics software provides useful information to the logistics planner, it is necessary to define the purpose of the logistics planner's support to the division planning system, and determine if logistic planning software supports the logistics planner in this endeavor. Logistics planners need to be able to accomplish the following functions to support division planning.

1. Communicate the logistics situation to all division planners to determine its influence on the planning cycle.
2. Ensure the synthesis of logistics into the overall plan throughout the planning process.
3. Overcome planning constraints.
4. Facilitate the commander's decision making process

OPLOGPLN and the LEW should assist the logistics planner in the completion of these four tasks facilitate that division planning system.

Communicate Clearly: Definition of Criteria

Logistics planner must be able to communicate the logistics situation to all division planners in order to evaluate the logistics influence on the plan under consideration. Logistics terminology makes this process difficult. Terminology in logistics doctrine leaves the logistics planner with numerous contradictory logistics terms. Joint doctrine lists twelve logistics considerations for campaign planning that do not directly link to the logistics characteristics, planning considerations, and tactical functions stated in FM 100-5, Operations. Logistics doctrine has a

> barrage of overlapping principles, functions, imperatives, factors and considerations that are given to the logistics planner in developing the logistics portion of an operation plan.[23]

Logistics planners need to be able to communicate their logistics to other division planners in order to achieve a fully integrated plan. Correct terminology helps the logistics planner to communicate logistics concepts. The wealth of logistics verbiage between military regulations and specific logistics manuals makes this and communication between logistic and the division planning staff difficult.

> The manuals do not provide the logistics planner with a guide to follow in building the logistics portion of an operation plan that will give the combat commander a simple, easily understood plan. [24]

Logistics planners must strive to achieve successful communication by addressing "the relationship between logistics and the fundamental decisions of conflict;" and emphasizing "the interrelationship of logistics with planning."[25]

Communicate Clearly: Analysis of OPLOGPLN and LEW

An examination of both OPLOGPLN and the LEW show significant shortfalls in the software's ability to facilitate this communication. First, both systems have sustainment areas that they completely fail to address. OPLOGPLN does not include any computations of class IX repair parts sustainment, maintenance, or transportation capability. The LEW fails to address class IX repair parts and even more significantly, fails to compute Class V ammunition sustainment requirements. Since transportation and class V sustainment are usually the primary considerations on the battlefield, this is a significant shortfall in both systems. Secondly, both systems have a tendency to provide information in physical quantities such as "short tons" or "gallons." Telling the non-logistics members of the planning staff the number of short tons or gallons required by the division or brigade combat teams does not assist in the planning process. The LEW accomplishes the communication process better by translating the quantities of supplies required into truck equivalents. The logistics planner can expect the division planner staff to better picture the division logistic picture if he describes the picture in terms the number of truckloads of supplies rather than the number of short tons required.

Synthesize Planning: Definition of Criteria

Logistics planners must ensure the synthesis of logistics into the overall plan throughout the planning process. Unfortunately, most logistics planners believe that the "battle staff must use an internal decision making process better suited to the reactive nature of logistics support mission."[26] OPLOGPLN and the LEW encourage the logistics planner to subscribe to this mindset. Logisticians continue to believe that logisticians and logistics units must always react to changes in the tactical situation, despite doctrinal guidance to the opposite. Naive logisticians, based on their limited personal field experiences, believe that

> logistics commander's missions are much less precise because they must look at a series of options rather than a clear-cut COA. By this I mean that during every hour of every day of an operation there is a variety of options available to logistics commander. In effect, they have literally thousands of mini-COA's that are in a constant state of flux, depending on the ebb and flow of battle. For the most part the decision are driven by the plans and actions of the units they support. [27]

The logistics planner must not "embrace the reactive nature of maneuver logistics and plan accordingly"[28] but must properly incorporate flexible logistic support into the plan itself. The logistics planner must be an integral part of the division planning staff. Logistics initiatives must be embedded in the plan, and logistic options and decisions must not be separate from other division options and decisions.

> Strategy and tactics and logistics are aspects of the same thing. If completely separated, they become meaningless. Subject to the primary purpose, no distinction in importance can be made between combat function and service or logistics functions. Strategy, tactics and logistics stand at the points of a triangle, or perhaps it would be more accurate to say that they compromise the arc of a circle, without beginning or ending, each arc influencing, and influenced by, each of the other.[29]

Logistics planners should strive to achieve this synchronization.

Synthesize Planning: Analysis of OPLOGPLN and the LEW

OPLOGPLN and the LEW advocate the reactive nature of logistics by their innate design as discussed in chapter two. In OPLOGPLN, the software requires the logistics planner to enter a task organization and a completed OPLAN or OPORD. This leads the logistics planner to believe that the proper use of this automation is to use it after completion of the MDMP process. This does not encourage the logistics planner to use OPLOGPLN to integrate logistics into the planning process. The ease with which the planner can enter varying task organizations and OPLANS should drive the planner to test different options at the beginning of the planning cycle. Yet that is rarely the case, as most logisticians wait until the planning cycle is complete and it is time to write the OPLAN or OPORD.

Limit Logistics Planning Constraints: Definition of Criteria

Logistics planning is limited by the factors that constrain all planning processes. Logistics automation was developed to help the logistics planner to overcome these limitations. These planning constraints are time, complexity, interdependency and resourcing.

The first of these, time constraints.

> limit planning to a very high level analysis that may not address the problem in adequate depth. At the division, and even more so at the corps, detailed planning can be accomplished only if the lead-time is very long or if a significant number of staff planners are committed to the effort.[30]

Logistics planning automation should speed the planning process by allowing a logistics planner to quickly compute requirements.

Limit Logistics Planning Constraints: Analysis of OPLOGPLN and LEW

OPLOGPLN and the LEW do not decrease the time constraint of logistics planning. Logistics planners often only use logistics planning automation at the completion of the cycle, which does not allow it to influence the time. Instead, division planners are seen utilizing Student Text 101-6, G1/G4 Battlebook, to rapidly calculation consumption factors in a time-constrained environment. The reasons for this are twofold. First, the task organization of OPLOGPLN and the personnel and vehicle planning factors in the LEW require specific information that must be researched and established well in advance of initiation of the division planning cycle. Logistics planners do not have time to research the number of personnel in a particular unit or the number of tanks in the division once a mission is received. When logistics planners do not incorporate these "knowns" into the logistics planner software prior to receipt of mission, they have no time to use logistics automation in the planning cycle. The second reason division planners do not use logistics automation in planning is due to a lack of experience with the software of the staff and described in detail in the section following.

The experience of the planning staff is the second factor that affects planning. An experienced staff

> can more accurately envision the relationship between phasing of the tactical plan and logistics support; understand the effects of such variables as weather and enemy action; and anticipate the critical points likely to develop as the battle progresses. [31]

OPLOGPLN and the LEW do not help to compensate for a logistics planner's lack of experience. The logistics planner must be familiar with the automation system and be able to apply the products of automation to the planning process. OPLOGPLN and the LEW require an experienced logistic planner to evaluate their output.

Complexity is the third factor that affects planning, and logistics planning is exceptionally complex. The logistics planner must

> consider each CSS area - supply, transportation, maintenance, field services, medical support, personnel - and weigh each area against force structure, operational status, capabilities, support-to-supported relationships, and deployment. [32]

OPLOG planner and the LEW have the ability to determine consumption data for each CSS area. The logistics planner must interpret the data, provide analysis, and formulate the products. Both automation systems are limited in transportation functions. OPLOGPLN and the LEW can produce an estimated quantity of consumption but neither program addresses transportation issues such as road space, choke points, divisional transportation capability or any other key transportation planning factors. In the analysis process, the LEW has a small advantage over OPLOG planner in maintenance, computing both class IX repair parts requirements, vehicle availability, and estimations on maintenance returns to operational capability.

The fourth factor that affects division planning is the inherent interdependent nature of the process. Logistics planning is

> likewise affected by the interdependent nature of support. Many commodities and services are needed to support a maneuver force. Tradeoffs in one are may have adverse effects in other areas; solving a problem in one system may create a problem in another.[33]

Logistics planning automation with very few exceptions does not show how each commodity is dependent on another. Each logistics function tends be "stove-piped," meaning that a particular function is only addressed individually. This has adverse effects on planning, especially in the area of transportation. Transportation assets are used for all classes of supply, so changes in one logistics commodity affect transportation assets for all commodities.

The final factor that affects division planning is constrained resources. In logistics planning, "requirements for support more often than not exceed capabilities, with the result that there is great competition for CSS resources." [34] OPLOGPLN compares requirements to capabilities in a limited fashion. For fuel, it shows the division's capacity to store and transport class III bulk fuel. The LEW provides a much more in depth analysis of fuel consumption versus capabilities. It provides a complete fuel picture for the division planner, and should serve as a model for what logistics automation should provide to the logistics planners. The LEW fuel section shows the fuel consumption of the major combat vehicles and will adjust this consumption by estimated maintenance losses. It compares the divisional requirements to the organizational and direct support capability of the division. The LEW fuel spreadsheet analyzes the fuel distribution within the divisions task organization and the percentages successfully filled in the planned operation. The section closes with an analysis of the additional assets needed (if any) to support the plan, allowing the logistics to quickly determine what higher headquarters support is needed to make an operation feasible. It also allows a planner to change the plan to better provide the correct fuel support. However, overall logistics planning software provides limited assistance in minimizing the effects of constrained resources.

Enable Decisions: Definition of Criteria

The purpose of all planning is to allow the commander to make decisions regarding a particular course of action that accomplishes a mission. The commander is the decision maker, which is defined as a "person who makes the final choice among the alternatives." [35] A decision is "the means by which the commander translates his vision of the end state into action." [36]

To assist the commander in making decisions, the logistics planner must facilitate the commander's decision making process. What is the decision making process? The Army has defined decision making as

> knowing if to decide, then when and what to decide...Being in command means anticipating the activities that will be put into motion once a decision is made; knowing how irretrievable some commitments will be once put into motion; knowing the consequences of the act of deciding; anticipating the outcomes that can be expected from the implementation of a decision. [37]

Decision making has many tools. Decision theory is one of the "most widely used and useful." [38] Decision theory is an "analytic approach to choosing the best alternative or course of action" [39] It is designed to "help a decision maker choose among a set of alternatives in light of their possible consequences." [40] Decision theory can be separated into three decision models which are "based on the degree of certainty of the possible outcomes or consequences facing the decision maker."[41] The three types of decision models are as follows:

> Decision making under certainty-the decision maker knows with certainty the consequence or outcome of any alternative or decision choice; decision making under uncertainty-the decision maker does not know the probability of occurrence of the outcomes for each choice, and decision making under risk-the decision maker knows the probability of occurrence of the outcomes or the consequences for each choice. [42]

The Army defines its system for decision making as the Military Decision Making Process (MDMP). In reality though, the MDMP is a system of analysis, not a process for decision making as defined by decision making models in chapter two. The logistics planner must facilitate and influence the decision making process.

Enable Decisions: Analysis of OPLOGPLN and the LEW

A complete discussion of the influence of logistics planners and logistics planning software on the MDMP is conducted in the following chapter.

Chapter Four

The Decision Making Process

"Leaders who refer to themselves as warfighters need to be taught that logistics is not an afterthought but an integral part of the decision process." [43]

Logistics planners need to be able to facilitate the commander's decision making process to support division planning. This intent of this chapter is to clarify what the MDMP is and what the MDMP was designed to do, determine how logistics planning fits into the MDMP process, and discuss how logistics automation supports the logistics planner in the MDMP process.

Definition and Purpose of the MDMP

Army doctrine defines Army planning requirements as the following.

> Army operational planning requires the complete definition of the mission, expression of the commander's intent, completion of the commander and staff estimates, and development of a concept of operation. These form the basis for a plan or order and set the conditions for a successful battle. The initial plan establishes the commander's intent, the concept of operations, and the initial tasks for subordinate units. It allows the greatest possible operational and tactical freedom for subordinate leaders. It is flexible enough to permit leaders to seize opportunities consistent with the commander's intent, thus facilitating quick and accurate decision making during combat operations. The plan not only affects the current fight but also sets the stage for future operations.[44]-

The Army method to accomplish this process is the MDMP. For logistics planners, the MDMP is the method for incorporating logistics into the overall plan.

> The logistics planning process involves determining and comparing logistics requirements and capabilities; identifying key points or shortfalls; and developing

ways of eliminating or alleviating conflicting demands. Iterations of this planning process are conducted over time to solve multiple problems.[45]

The MDMP is a method of system analysis. It is not a true method of decision theory as discussed in chapter two. Examining the definition of system analysis provides further proof that this is true.

> Systems analysis is an explicit formal inquiry carried out to help someone (referred to as decision maker) identify a better course of action and make a better decision than he might otherwise have made. The characteristic attributes of a problem situation where systems analysis is called upon are complexity of the issue and uncertainty of the outcome of any course of action that might reasonably be taken. Systems analysis usually has some combination of the following: identification and re-identification) of objectives, constraints, and alternative courses of action; examination of the probable consequences of the alternatives in terms of costs, benefits, and risks; presentation of the results in a comparative framework so that the decision maker can make an informed choice from among the alternatives. A systems analysis that concentrates on comparison and ranking of alternatives on basis of their known characteristics is referred to as decision analysis.[46]

The MDMP does not necessarily tell the commander (decision maker) exactly what choice he must make, but it provides the analysis to enable him to make the decision.

> Systems analysis is the diagnosis formulation and solution of problems that arise out of the complex forms of interaction in systems from hardware to corporations, that exist or are conceived to accomplish one or more specific objectives. Systems analysis provides a variety of analytical tools, design methods and evaluative techniques to aid in decision making regarding such systems.[47]

The MDMP, while seemingly a simple checklist, is actually the derivative of a sound formula used by many large organizations and known as "The Analytic Decision Process."[48] The analytic decision process makes a "good decision," using analytic decision making that is based on logic and considers all available data and possible alternatives.[49] Similarly, the MDMP "is a single, established and proven analytical process."[50] It is important to establish the design and purpose of the MDMP because so many planners treat it as a checklist of products whose sole purpose is to provide a briefing to the commander. Too often logisticians and their fellow planners are provide the commander with a series of briefing slides about what the planners did and looked at. The MDMP should be a compilation of synthesized analysis that produces a bottom line with which the commander can make a decision. By reexamining the roots of the MDMP in this process, it is possible to see what each of the key steps of the MDMP was designed to analyze.

The intent for the remainder of this chapter is to compare each step of the Analytic Decision Process with the steps of the MDMP. This comparison helps to clarify the meaning of and purpose of each step in the MDMP. Once each step's purpose and meaning are defined, the logistics planner's role in that step is clarified. Finally a determination of how current logistics planning software assists the logistics planner in that role is discussed.

Staff Estimates and Receipt of Mission

The first step in the analytic decision process is to define the problem and the factors that influence it. The problem to be decided "must be stated clearly and concisely, which in many cases is the most important and difficult step." [51] A decision problem is "composed of possible actions, possible states of the world and consequences with a goal of choosing the best action."[52] This step corresponds directly to the beginning of the MDMP. The MDMP steps of formulating a staff estimate and the receipt of mission share the same function as the first step of the analytic decision process. While technically, the MDMP begins with the receipt of mission step, the staff estimate process must also be included here as it has a direct bearing on all steps of the MDMP.

The staff estimate is the most critical part of the mission analysis process. It is initiated prior to the actual start of the MDMP and is ongoing throughout the entire process. Each staff section completes a staff estimate. The logistics staff estimate

> provides an accurate and current assessment of the CSS situation, of the organization, its subordinate units, and any attached or supporting elements. The logistics estimate is an analysis of how service support factors can affect mission accomplishment. It contains the G4's conclusions and recommendations about the feasibility of supporting major operational and tactical missions. This estimate includes how the functional areas of supply, transportation, maintenance, facilities, and construction affect various courses of action. [53]

A staff estimate is a process that goes "on continuously to provide important inputs for the MDMP." [54]

Army doctrine does not concisely define the purpose of the staff estimate. Doctrine references the purpose of the staff estimates in different sections of Army manuals, each separate chapter providing the reader with glimpses of this purpose. A more complete and consolidated summary of the purposes of a staff estimate states:

> Mission analysis, facts and assumptions, and the situation analysis (of the area of operations, areas of interest, and enemy, friendly, and support requirements) furnish the structure for the staff estimate. The estimate consists of significant facts, events and conclusions based on analyzed data. It recommends how to best use available resources. Adequate, rapid decision making and planning hinge on good, timely command and staff estimates. They are the basis for forming viable courses of action. Failure to make estimates can lead to errors and omissions when developing, analyzing, and comparing courses of action.[55]

Army doctrine provides a staff estimate format to guide the logistics planner through the staff estimate process. The problem with using the staff estimate framework (appendix A) is the tendency of logistics planners to eliminate the analysis portion of the process and simply fill in the blanks spaces of the formatted estimate. The staff estimate for logistics planners should clearly define the current logistical picture of the unit, provide a complete definition of the logistical problem(s) in accomplishing the mission, and establish a solution set for successful completion of the mission. All of the following steps of the MDMP will be inaccurate or impossible to complete if the logistics staff estimate does not provide these products.

Staff Estimates and Receipt of Mission: Analysis of OPLOGPLN and LEW

Logistics automation provides little assistance to the logistics planner for either completion of the staff estimate format or for presenting the logistics picture. OPLOGPLN and the LEW do not suffice to produce the five paragraph staff estimate format (appendix A). OPLOGPLN does provide sustainment quantities for most supply categories as discussed in previous chapters. These quantities are only sufficient for answering the requirement portion of the analysis of friendly forces. This step also requires the logistics planner to compare the sustainment requirements of the unit to the capabilities, determine if there are any shortfalls, and recommend solutions to satisfy these shortfalls. OPLOGPLN cannot provide these answers except to estimate some division fuel capability. The LEW provides more information for the five paragraph format of the staff estimate. Because it is able to provide transportation requirements, the LEW can compare requirements with capabilities, provide an analysis of the shortfall percentages, and even give a crude estimate of the solution in the form of additional assets needed from higher headquarters to full these shortfalls. Yet neither software system can provide assistance with more than one small section of the five paragraph staff estimate format.

Aside from the staff estimate, the logistics planner must provide the current logistical picture of the unit, establish a complete definition of the logistical problem(s) in accomplishing the mission, and define a solution set for successful completion of the mission. Neither OPLOGPLN nor the LEW can fully assist the logistics planner with this task. OPLOGPLN barely assists in defining the logistical problem by providing the sustainment requirements. The LEW provides a better definition of the logistical problem(s) in accomplishing the mission by comparing the requirements and capabilities of the organization, but still cannot formulate the entire picture. Neither system addresses the most critical problem in logistics the movement and distribution system.

> The heart of any logistics system is the distribution system-the complex of facilities, installations, methods, and procedures designed to receive, store, maintain, issue, and move materiel to using activities and units. Lines of communication connect the critical points of the system. Both logistical and combat operations rely on an effective and efficient distribution system.[56]

Critical issues such as road space, rates of advance, and terrain management issues cannot be addressed with either system. Without such capability, neither OPLOGPLN nor the LEW can define the logistics problems or provide a solution set for successful completion of the mission.

Doctrine defines the first step in the MDMP as the Receipt of Mission. This simple step is defined as the receipt or anticipated receipt of a new mission. The purpose of this step is to initiate the MDMP. The only planning requirements for the logistics planner are to provide the staff estimate and begin to tailor it based on the mission received. The staff estimate should be in existence at the time to the receipt of mission and should provide the initial input into this process. Upon receipt of mission, the logistics planner should immediately begin updating the existing staff estimate based on the mission received from higher headquarters or deduced by the staff. For this step, the utility of OPLOGPLN and the LEW is the same as discussed above for the staff estimate.

Mission analysis: Defining Criteria

The second step in the analytic decision process is to establish decision criteria and goals. Managers must develop specific and measurable objectives.[57] In the analytic decision process, an objective is something "to which an effort is directed, the goal, purpose or criterion a decision maker uses to evaluate alternative courses of actions."[58] This step corresponds directly to the mission analysis step of the MDMP. Mission analysis does not have a concise Army definition, but is rather described as a seventeen step process.[59] A look at the seventeen steps (appendix A) shows the information provided is similar in nature to the second step of the analytic decision process.

The doctrinal purpose of mission analysis is to "allow the commander to begin his battlefield visualization, define the tactical problem, and begin the process of determining feasible solutions." Battlefield visualization is the

> process whereby the commander develops a clear understanding of his current state with relation to the enemy and environment, envisions a desired end state, and then visualized the sequence of activities that will move his force from its current state to the end state. In short, it provides the key to where and how the commander can best lead and motivate soldiers, and see the battlefield, his own forces, the enemy, and the end state.[60]

The staff's role in this is to

> assist the commander with his battlefield visualization by collecting, processing, analyzing, and transforming data into knowledge, allowing the commander to apply his judgement to achieve understanding of the situation in the form of his vision.[61]

Unfortunately, the laundry list of steps associated with mission analysis does not lend itself easily to fulfilling this purpose. The seventeen steps of the formal process should provide situational awareness information, "which creates understanding of the situation as the basis for making a decision. Simply, it is understanding oneself, the enemy, and the terrain or environment." [62] The mission analysis brief presented to the commander will only contain data and not analysis unless the planning staff understands the actual purpose of mission analysis.

Mission analysis: Analysis of OPLOGPLN and the LEW

Even when addressing only at the seventeen step process, OPLOGPLN and the LEW provides only limited assistance to the logistics planner in mission analysis. OPLOGPLN and the LEW can only provide input for three of the seventeen steps. For step four, the review available assets, both systems can provide sustainment requirements. In step five, determining constraints, OPLOGPLN and the LEW can contribute to the determination of shortfall considerations. Using OPLOGPLN, a logistics planner could determine specific ammunition types whose requirements were outside of higher headquarters determined required supply rates (RSRs) or constrained supply rates (CSRs). With the LEW, specific requirements for throughput of certain supplies can be established. These type of analysis would be determined during the staff estimate problem, and if the logistics planner determined that specific supply constraints would adversely impact the mission, they might show up in step six as critical facts or assumption.

The actual purpose of mission analysis should to create a synthesis of the various staff estimates. The battle staff should discuss each staff estimate's definition of the current situation, problem(s) and solutions in relation to the mission given by higher headquarters. The division planners should then use each staff member's analysis to clearly define the problem for the commander, and establish planning factors that define the potential solution sets to the problem. This problem statement and solution set should establish what the division must do to be successful in the given mission by setting a clearly defined endstate, establishing decisive and initial commander's decision points (which determine how the enemy can be defeated), stating staff determined limitations (which usually manifest in a mission analysis briefing as facts, stating constraints (as imposed by higher headquarters.), and establishing criteria (for the analysis of courses of action). The commander communicates these items in his commander's intent.

The first product of mission analysis is an endstate that should be established in the initial commander's intent. The Army defines an endstate at the strategic level and mentions it as an inclusion to the commander's intent in FM 100-5, Operations. The Battle Command Battle Lab at Fort Leavenworth better describes endstate as the

> relationship between the force, the enemy, and the terrain that describes the posture of the unit in relation to future operations, upon completion of the operation.[63]

The logistics planner must be able to take the situation, problem and solution set he defined in the staff estimate and integrate it with other staff estimates to clarify the endstate to the commander. Other than as previously stated in the staff estimate, neither OPLOGPLN nor the LEW can contribute to this process.

The second products of mission analysis are decisive points and initial commander's decision points. Decisive points are "points where an enemy weakness allows maximum combat power to be applied, leading to mission accomplishment." [64] Decision points are locations in time and space where the commander must make a decision.

Logistics planners should compare their staff estimate to the stated mission. This comparison will often produce logistical decisive points and initial commander's decision points. Unfortunately, too many logistics planners tend to simply "record division decision points along the timeline in order to determine what impact various decisions might have on support operations." This in fact, is exactly the opposite of the logistics planner's job."[65] The logistics planner should determine what critical logistics decision(s) will affect the completion of the mission, what input from the logisticians is required for all established commander's decision points, and changes to that concept of support are needed as a result of that decision. Again, other than what they contribute in the staff estimate process, OPLOGPLN and the LEW cannot contribute to the logistics decision point analysis.

The third product of mission analysis is the determination of the limitations and constraints to be imposed on the next step of the MDMP, course of action development. In most analytic decision processes, constraints are defined as

> limitations imposed by nature or by man that do not permit certain actions to be taken. Constraints may mean that certain objectives cannot be achieved. The actions, alternatives, consequences and objectives that are not precluded by the

> constraints are referred to as feasible. In a particular analysis study, some constraints may have to be considered unquestionable, others--from among those imposed by prior decisions--may be removable if the analysis proves a good case for it. [66]

By this definition, analysis "constraints" are actually the facts and assumptions established in mission analysis. The Army definition for a fact is a "statement of known data concerning the situation, including enemy and friendly dispositions, available troops, unit strengths, and material readiness. [67] Army assumptions are defined as "suppositions about the current or future situation that are assumed to be true." [68] From the products of the staff estimate, the logistics planner should determine key deductions and necessary planning considerations. These are synthesized with the key deductions and planning considerations of the other members of the planning staff. The battle staff should translate the compilation of the key deductions and planning considerations into the mission analysis critical facts and assumptions. The commander will use these critical facts and assumptions in his commander's guidance to focus staff activities in course of action development. Like the other products of mission analysis, OPLOGPLN and the LEW cannot provide any input into this process.

The fourth and final product of mission analysis is the determination of the criteria that will be used in course of action analysis. Although doctrine lists establishing criteria as part of the war game process, a correctly completed mission analysis process will create the initial criteria. Evaluation criteria are defined by doctrine as "those factors the staff uses to measure the relative effectiveness and efficiency of one course of action" relative to others. [69] In the analytic decision process, the "ranking produced by using a criterion has to be consistent with the decision maker's objectives and preferences." [70]

This is true also in the MDMP process. Criteria are formulated from the commander's intent and guidance. The logistics planner's input into the commander's criteria in mission analysis is based on the staff synthesis of the individual staff estimate products. OPLOGPLN and the LEW do not provide any new input into this process.

Course of Action Development: Defining Criteria

The third step of the analytic decision process is to formulate a "model or relationship between goals and variables. In other words, develop a representation of the situation-a model." [71] The fourth step is to identify and evaluate alternatives. In the analytic decision process, this step includes generating

> as many solutions to the problem as possible (and usually quickly). Most managers like to have a range or set of options so they can evaluate each option for its merits and drawbacks.[72]

In this case, a combination of both of these steps directly corresponds to the MDMP step of course of action development. The analytic decision process defines course of action development as a means

> available to the decision maker by which the objectives may be attained. A systems analysis usually considers several possible courses of action, which are then referred to as alternatives or as the decision maker's options. [73]

The Army defines course of action development as six step process that "focuses the staff's creativity to produce a comprehensive, flexible plan within the time constraints." [74] A "good" course of action is one that "positions the force for future operation and provides flexibility to meet unforeseen events during execution". [75]

In the analytic decision process, the purpose of course of action development is to produce courses of action that provide a solution to the problem by passing the a feasibility analysis. A feasibility analysis "is that part or aspect of systems analysis that concentrates on finding out whether an intended course of action violates any constraints."[76] In the MDMP, the doctrinal purpose of course of action development is to produce courses of action that are feasible, suitable, acceptable, distinguishable, and complete.

Course of Action Development: Analysis of OPLOGPLN and the LEW

Feasibility is ensuring that the division has the capability to accomplish the mission in terms of available time, space and resources. [77] To ensure that a course of action is feasible, the logistic planners check each course of action to determine if it is possible with respect to all unit movements and maneuver, sustainable, and supportable with respect to the characteristics of the area of operations. The LEW can assist the logistics planner with this aspect of course of action development by determining consumption requirements versus transportation capability. OPLOGPLN cannot assist the logistics planner to the same degree as the LEW, as it has no ability to compare estimated requirements to movement capability.

Suitability is the course of action's ability to accomplish the mission and comply with the commander's guidance. [78] Here logistics planners compare the courses of actions being developed against the key logistics facts and assumptions from mission analysis approved by the commander in his intent and guidance. Logistics planning automation cannot provide any assistance with this area of analysis.

Acceptability means that the advantage gained by executing the course of action justifies the cost in resources. [79] For this, the logistics planner must again refer to the logistics input into the commander's intent and guidance, and again, OPLOGPLN and the LEW cannot provide any additional analysis or assistance.

Distinguishability means that each course of action differs significantly from any others. [80] For logistics planners, this will usually require changes in the priorities of support. Logistics automation cannot provide any assistance in establishing the priorities of support.

Army doctrine never fully defines the term completeness, but as a minimum it should include a complete task organization and a fully developed scheme of maneuver, to include the location of division headquarter elements. Use of a synchronization matrix and a hasty war game during this process can help to ensure completeness of a course of action.

> A synchronization matrix provides a highly visible, clear method for ensuring that planners address all operation systems when they are developing course of action and recording the results of war gaming.[81]

To ensure completeness, the logistics planner must task organize logistics forces, identify a task and purpose for the DISCOM, establish key logistic unit locations, identify critical logistics events in each phase of the operation, establish priorities of support for all logistics categories, establish the logistical impacts in reconnaissance, security, and rear operations, create a timeline for movement of the force, and identify logistics options that may develop during an operation. Unfortunately for the logistic planner, neither OPLOGPLN nor the LEW can provide any assistance with any of these tasks.

Additionally, the role of the logistics planner in course of action development is to ensure that the courses of action developed can succeed.

> Logistics arrangements cannot be so meager that they do not meet the needs of commanders as they execute their operations, nor can they be so excessive that they overwhelm the ability of commanders to move, protect and employ them efficiently. The logistics system must strike a balance of sufficient support to sustain operations throughout the peaks and valleys of their duration without burdening commanders with more support than is necessary to succeed.[82]

Logistics planners must thoroughly integrate the concept of logistical support with their concept of operations during course of action development. "Mobile, responsive capabilities are essential for preparation and execution of tactical logistics", and must be incorporated by the logistics planner during course of action development. [83] Logistics planners must ensure that each course of action has balanced logistics, which mean that it has "enough support to do the mission but not so much that the system is overwhelmed." [84] Here, OPLOGPLN and the LEW can provide some assistance to the logistics planner. Both systems can determine the minimum requirements needed for each unit by phase of a course of action. The logistics planner can use this information to formulate a support concept that is flexible, responsive, and balanced for each course of action developed.

Coarse of Action Analysis (Wargame), Course of Action Comparison and Course of Action Approval: Defining Criteria

The fifth step of the analytic decision process is to select the best alternative. This is the alternative that "best satisfies and is most consistent with the stated goals." [85] In the MDMP, this step is actually listed as three separate tasks: course of action analysis, comparison and approval.

Course of action analysis, usually referred to as the war game, is a disciplined process with set rules and eight steps.[86] The purpose of course of action analysis is to allow the staff to "visualize the flow of a battle" and "focus the staff's attention on each phase of the operation in a logical sequence."[87] It is "designed to stimulate ideas and provide insights that might not otherwise be discovered."[88]

Course of action analysis is perhaps the step most misunderstood by all division planners, to include the logistics planners. It is often viewed as a monumental, time consuming task whose end product will solve all problems with a course of action and answer all questions associated with it. Even doctrine calls course of action analysis the" the most valuable step" that "should be allocated more time than any other step."[89] In reality, this should not be the case. If the MDMP is conducted correctly, and all steps up to course of action analysis completed fully, then course of action analysis should be the shortest and simplest step in the MDMP. The reason that course of action analysis is not simple and is lengthy, time consuming and frustrating, is because most planners do not understand the true products required in the earlier steps of the process. Course of action analysis becomes the step in which all products not completed earlier are in fact, completed.

In the first step, the staff estimate and receipt of mission, the two products not completed are usually the definition of the problem and the options for problem solution sets. At course of action analysis, this lack results in a member of the battle staff announcing that a particular part of a course of action cannot be accomplished because of a problem in that area. For example, the logistics planner may suddenly inform the staff that a particular route cannot support a brigade task force's movement to an objective, or the fires planner may realize that certain artillery units must be repositioned to be within range of a target. These types of issues usually require a course of action to changed in some manner, causing delays, confusion and frustration in the course of action analysis process.

The products not completed from the second step, mission analysis, are usually the formulation of a synthesized definition of the problem and clearly defined planning considerations. During course of action analysis, this deficiency results in planners from two functional areas in conflict. An example of this type of problem is a conflict between the logistics planner and fires artillery planner. The logistics planner defined his problem as congestion on the main supply route, and concluded that the solution was to limit movement on that route to one brigade every six hours. The fires planner defined his problem as positioning his artillery within range of the targets, and planned to move three brigades forward in the first three hours using the main supply route. Obviously, the two solutions are in conflict and a great deal of time is consumed finding a solution that both planners can agree on to solve both problems.

The most common problem not completed from the third step, course of action development, is a planner's sudden realization that the course of action under analysis is not feasible, acceptable, suitable, distinguishable or complete. This usually manifests when a planner realizes that course of action is not possible. In the case of logistics for example the planner realized that the plan is not supportable. This results in the battle staff frantically trying to patch the course of action in an effort to have a viable course of action to present to the commander. Most planners tend to hope that the commander will not pick that particular course of action; that is will become in fact one course of action that is "thrown away."

The true purpose of course of action analysis is to check each course of action is checked against enemy courses of action to validate it and refine it if necessary. Course of action analysis should provide a validated course of action with well developed branches and sequels. Branches are

> contingency plans-operations built into the basic plan-for changing the disposition, orientation, or direction of movement and also for accepting or declining battle. They give commanders flexibility by anticipating enemy reactions that could alter the basic plan.

Sequels are

> subsequent operations based on the possible outcomes of the current operation...executing a sequel will normally mean beginning another phase of the campaign. This is a continuous process during an operation-the commander should never be without option.

Coarse of Action Analysis (Wargame), Course of Action Comparison and Course of Action Approval: Analysis of OPLOGPLN and LEW

The requirement of the logistics planner for course of action analysis is to assist the planning staff in validating the course of action and help to fully develop branches and sequels to that course of action. OPLOGPLN and the LEW will not provide any addition information to validate the course of action, but both can help the planner to develop branches and sequels. OPLOGPLN can assist the logistics planner with branches and sequels to the course of action by computing the daily requirements for each organization. The planner can then compare these requirements to the current situation to help shape supportable branches and sequels, and to create a concept of support for each.

The LEW can also perform the same tasks to develop branches and sequels, with the exception of ammunition consumption quantities. The problem with the logistics planning software in this process is that it is difficult and time consuming to change task organizations within the programs. If task organizations do not change, both programs can provide the same information as in the staff estimate to the logistics planner. If organizations do change, this becomes too time consuming to be done efficiently during course of action analysis. Neither program is better than the other for helping the logistics planner during this phase.

Course of action comparison is a simple and rapid process. Course of action comparison uses the evaluation criteria in developed in mission analysis to highlight the advantages and disadvantages of each course of action. [90] The evaluation criteria are a direct product of the commander's intent and guidance, as discussed in mission analysis. The purpose of course of action comparison is to identify the course of action with the highest probability of success against the enemy that minimizes risk to the division, best positions the division for future operations, provides the most flexibility for the division, and provides the most opportunity for initiative in the brigades. [91] The product of course of action comparison is a decision matrix, another frequently misunderstood and misused tool.

A decision matrix is designed to portray what a course of action does well, what a course of action does not do well, and what the risks associated with each course of action is. It is not designed to establish a "best" overall course of action. The decision matrix should allow the commander to see how each course of action satisfies or takes risk in each category. The role of the logistics planner in this step is to evaluate the advantages and disadvantages of each course of action with respect to logistics. Logistics automation can assist in this process. OPLOGPLN can provide the sustainment requirements for all classes of supply. The logistics planner can use these to determine which course of action uses fewer quantities in each class of supply. The LEW provides better information to the logistics planner, minus ammunition statistics. The LEW can also identify movement requirements. This enables the logistics planner to determine which course of action is more easily supportable.

The next step of the MDMP process is course of action approval. This is the commander's decision, and division planners have no required actions here unless the commander makes changes that require the staff to return to an earlier step in the MDMP. The same adjustments take place in the analytic decision process.

> These steps do not always follow one another without some looping back to an earlier step. Modifying one or more steps before the final results are implemented is not unusual. Still, making good decisions in operations means performing all six steps.[92]

Once the commander has selected a course of action, the staff should have all information necessary to complete the final step of the MDMP, the operational order.

Orders Production: Defining Criteria

The final step of the analytic decision process is to implement the decision. Putting into action the steps of the chosen alternative can be the most difficult phase of decision making, although it should not be.[93] In the analytic decision process, "implementation involves making task assignments and a timetable for their completion."[94] In the MDMP, this means writing the OPORD or OPLAN. If the planners have properly completed the previous steps of the MDMP and have continued to update the staff estimate, the OPORD or OPLAN is already complete. For the logistics planner, a completed staff estimate will provide all of the information for the concept of support, the service support annex and the rear operations annex.

Orders Production: Analysis of OPLOGPLN and LEW

Other than the information provided in the other MDMP phases, logistic planning software does not contribute any additional information production of the OPORD.

Chapter V

Conclusion and Recommendations

Conclusion

Overall, OPLOGPLAN '98 and the LEW '98, do not assist the logistics planner in the creation of division level plans.

OPLOG and the LEW are models that calculate sustainment factors, not decision models. Both software programs are management information systems, designed to manipulate date and provide statistics. They both also have some elements of decision support systems, which provide analysis of information and help logistics planners to manipulate data.

Logistics planners need to accomplish four functions to support division planning. First, they must be able to communicate the logistics situation to all division planners to evaluate the logistics influence on the division plan. Second, logistics planners must ensure the synthesis of logistics into the division plan. Third, logistics planners must be able to overcome the common planning constraints that restrict all planners. Fourth, logistic planners must facilitate the commander's decision making process. Overall, OPLOGPLN and the LEW can not assist the logistics planner with these tasks.

OPLOGPLN and the LEW can provide very limited assistance to the logistics planner in support of the seven step MDMP. Both software programs can provide initial data, but both have critical logistics function shortfalls. OPLOG PLN cannot determine movement requirements, and the LEW cannot compute ammunition requirements, both of which are key logistical factors in any operation. In step one, the staff estimate and receipt of mission, neither OPLOGPLN nor the LEW can provide the current logistical picture of the unit, establish a complete definition of the logistical problem(s) in accomplishing the mission, or define a solution set for successful completion of the mission. In step two, mission analysis, OPLOGPLN and the LEW cannot help the logistics planner to synthesize the logistics staff estimate with the remainder of the division planning staff. This synthesis is necessary in order to set a clearly defined endstate, establish decisive and initial commander's decisions, determine limitations and constraints, and provide criteria for evaluation. In step three, course of action development, OPLOGPLN and the LEW can help the logistics planner to produce courses of action that are feasible, but cannot assist in determining if they are suitable, acceptable, distinguishable, and complete. OPLOGPLN and the LEW do not enable the logistics planner to formulate a support concept that is flexible or responsive, but both can help to ensure that the support concept is balanced for each course of action developed. In step four, course of action analysis, OPLOGPLN and the LEW cannot assist the logistics planner in validating the course of action, but both can help to develop branches and sequels to that course of action. In the fifth MDMP step, course of action comparison, OPLOGPLN and the LEW can help the logistics to evaluate the advantages and disadvantages of each course of action with respect to logistics, to enables the logistics planner to determine which course of action is more easily supportable. In the sixth step, course of action approval, logistics planners have no required actions unless the commander makes changes that require the staff to return to an earlier step in the MDMP. In the seventh and final step, orders production, the logistics planner does not have any new requirements to fulfill, leaving logistic planning software with no requirement to contribute additional information.

Recommendations

While logistics planning software that delineates logistical requirements to the logistics planner are not yet available at the tactical level, logistical automation that can is available at the echelons above.

At the strategic level, the Department of Defense (DOD) has a system called the Logistics Planning and Requirements System (LOGPARS). LOGPARs is "an expert system designed for integrated logistics support (ILS) manager and other project management support personnel who are responsible for acquisition logistics planning and execution."[95] Expert computer systems are "computer programs that mimic human logic and 'solve' problems much as a human would."[96] A Windows based system, LOGPARS has embedded decision logic that allows it to interact with the user, 'tailoring the questions and output text base on a number of different conditions." [97] One of the truly useful features of LOGPARs is that "consistency checks are embedded to warn users of discrepancies in responses in different portions of the plan."[98] This enables the system to inform the user of the impacts to other sections of changes to the current plan, enhancing integration and making it an exceptional planning tool.

At the operational level, corps planners have the advantage of using the knowledge-based logistics planning shell (KBLS). KBLS is an advanced planning tool that "incorporates sophisticated AI-based algorithms to assist the logistician in planning."[99] Produced by the Army Human Engineering Laboratory, the KBLPS is based on the "constraint-directed search technique." [100] In this approach to problem solving, the program is able to

> look for the resources most in demand over time and apply available resources to those bottlenecks. The system then solves problems affecting the next-most-contended-for resources until all problems are solved or all resources committed.[101]

The beauty of this system is that its "algorithms are based on knowledge provided by experts, to include physical and doctrinal constraints."[102] The system is specifically designed to formulate a complete plan, then allow the logistician to examine the plan in detail. The program will "identify the area of the plan by commodity and time frame where there are problems that may require intervention or risk taking." [103] The KBLS has planned upgrades that will allow planners to manage terrain, evaluate and select supply routes, change support relationships and produce documents to include paragraph four of the OPORD and the service support annex. [104]

The abilities of these higher level systems demonstrate the need for such software at the division level. The use of "artificial intelligence (AI) techniques can provide logistics planners with decision aids that have not been available previously. [105] Planners will be able to "perform tasks that now must be done slowly and manually." [106]

> Given the complexities and demands of the logistics planning environment, the use of AI techniques offers logisticians the potential of greatly increasing their effectiveness and responsiveness. [107]

Division level planners meet all of the criteria for establishing a division level AI assisted planning system.[108] In the absence of division level AI assisted planning software however, one recommendation to better incorporate the data provided by OPLOGPN and the LEW is to utilize a system called a Logistics Planning Matrix

(Appendix B). The logistics planning matrix helps the logistics planner convert data into battlefield visualization.

> Raw data must be quickly and efficiently refined into a form conducive tactical planning. This can be accomplished by using a logistics synchronization matrix that projects requirements 72 to 96 hours into the future...the timeline at the top and event or resource designations at the left provide an effective method for analyzing tactical operations in terms of time, space and availability of resources. The matrix is specifically designed to cover four crucial areas-concept of operations, force protection and intelligence, other areas of direct logistics support, and, finally, operation decision points.[109]

The matrix links the phases of a logistics plan in a military operation with the logistics functions and planning functions from Army doctrine. It forces the

> planner to consider the effect of planning factors on each function at each stage of the plan. The considerations and principles prompt the questions of feasibility, acceptability, and suitability that must be asked after the plan is put together.[110]

This technique can help the logistics planner to conceptualize the support concept in the planner's terms of time, space and combat power. This relates directly back to staff estimate process, and allows logistical planners to communicate efficiently with the combat force planners. Simply speaking, the use of the logistics planning matrix will allow the logistics planner to integrate the output of OPLOGPLN and the LEW into a usable format for mission analysis.

Appendix A

Steps of the Military Decision Making Process[111]

Staff Estimate

1. Mission
2. Situation and Considerations
   a. Characteristics of area of operations
      (1) Weather
      (2) Terrain
      (3) Facts
   b. Enemy forces
   c. Friendly forces
      (1) Friendly courses of action
      (2) Current status of resources within the staff area of responsibility
      (3) Current status of other resources that affect the staff area of responsibility
      (4) Comparison of requirements versus capabilities and recommended solutions
      (5) Key considerations (evaluation criteria) for course of action supportability
   d. Assumptions
3. Analysis
4. Comparison

5. Recommendation and Conclusions

Receipt of Mission

Mission Analysis

1. Analyze the higher headquarters' order.
2. Conduct the initial intelligence preparation of the battlefield.
3. Determine the specified, implied and essential tasks.
4. Review available assets.
5. Determine constraints.
6. Identify critical facts and assumptions.
7. Conduct risk assessment.
8. Determine initial commander's critical information requirements.
9. Determine the initial reconnaissance annex.
10. Plan use of available time.
11. Write the restated mission.
12. Conduct a mission analysis briefing.
13. Approve the restated mission.
14. Develop the initial commander's intent.
15. Issue the commander's guidance.
16. Issue a warning order.
17. Review facts and assumptions.

Course of Action Development

1. Analyze relative combat power.
2. Generate options.
3. Array initial forces.
4. Develop the scheme of maneuver.
5. Assign headquarters.
6. Prepare course of action statements and sketches.

Course of Action Analysis

1. Gather the tools.
2. List all friendly forces.
3. List assumptions.
4. List known critical events and decision points.
5. Determine evaluation criteria.
6. Select the war game method.
7. Select a method to record and display results.
8. War game the battle and assess the results.

Course of Action Comparison

Course of Action Approval

Orders Preparation

Appendix B

Logistics Planning Matrix[112]

Factors

Functions

Stages

Appendix C

Classes of Supply[113]

Class I	Food
Class II	General Supplies: Clothing, Individual Equipment, Tents
Class III	Petroleum
Class IV	Construction and barrier material
Class V	Ammunition
Class VI	Personal Demand items
Class VII	Major assemblies, to include items such as vehicles
Class VIII	Medical supplies
Class IX	Repair parts
Class X	Agriculture and non military material

Endnotes.

[1] Joseph M. Heiser, Jr., "*The Logistics Environment in Vietnam*," United States Army Logistics, 1775-1992, ed. Charles R. Shrader (Washington D.C.: Center of Military History United States Army, 1997), 673.
[2] Ibid., 670. A Forward Support Activity was a provisional unit that was created adhoc from a parent logistical command and temporarily deployed in the vicinity of a supported tactical unit's operating base, providing only direct supply, maintenance and service support for a specific operation. The Logistical Support Activity was similar in many respects to the current Area Support Group and, although a provisional activity, occupied a fixed base camp and existed for a much longer period.
[3] Joseph M. Heiser, Jr., "*The Logistics Environment in Vietnam*," United States Army Logistics, 1775-1992, ed. Charles R. Shrader (Washington D.C.: Center of Military History United States Army, 1997), 671-673.
[4] Headquarters Department of the Army, *Staff Officers' Field Manual Organizational, Technical, and Logistical Data Planning Factors*, vol. 2, Preface , vii.
[5] Ibid., vii.
[6] Major John M. Friedson, *Supply Usage Requirements Estimator (SURE) Version 2.0*, (Fort Leavenworth, KS: School of Advanced Military Studies, United States Army Command and General Staff College, 1994.), 1.
[7] Ibid., 2.
[8] Force Development Division, *OPLOGPLN '98, Version 2.01, Read First*, (Director of Combat Developments, Combat Service Support, Fort Lee, Virginia, 1998), 1.
[9] Headquarters Department of the Army, Field Manual 100-5 *Operations*, (Washington, DC: HQDA, 14 June 1993) 12-1.
[10] Principia Cybernetica Web, *Systems Analysis*, http://pespmc1.vub.ac.be/ASC/SYSTEM_ANALY.html
[11] Ibid.
[12] Jay Heizer and Barry Render, *Production and Operations Management-Strategic and Tactical Decisions*, 4th ed., (New Jersey: Prentice Hall, 1996), 54-55.
[13] Ibid., 54-55.
[14] Ibid., 55.
[15] Principia Cybernetica Web, *Decision Theory*, http://pespmc1.vub.ac.be/ASC/DECISI_THEOR.html
[16] Jay Heizer and Barry Render, *Production and Operations Management-Strategic and Tactical Decisions*, 4th ed., (New Jersey: Prentice Hall, 1996), 56. Decision tables are charts that help define alternatives. For any alternative and a particular state of nature, there is a consequence or outcome.
[17] Ibid., 60. A decision tree is a graphic display of the decision process that indicates decision alternatives, states of nature, and their respective probabilities, and payoffs for each combination of alternative and state of nature. Decision trees are most useful for problems that include sequential decisions and states of nature.
[18] Ibid., 780. PERT follow six basic steps: Define the project and all of its significant activities or tasks, develop the relationships among the activities. Decide which activities must precede and which must follow others, draw the network connecting all of the activities, compute the longest time path through the network (the critical path) and use the network to help plan, schedule, monitor and control the project.
[19] Ibid., 706.
[20] Ibid., 335.
[21] Ibid., 335.
[22] B. Don Sullivan, "Knowledge-Based Logistics Planning, *Army Logistician*, (Nov-Dec 1991) 16.
[23] Colonel Dwight E. Phillips, "Matrix for Logistics Planning," *Army Logistician*, (Feb-Mar 1993) 15.
[24] Ibid., 15.
[25] Philip A. Girmus, "Logistics Training" *Army Logistician*, (Mar-Apr 1997) 42.

[26] Major Kenneth W. Carroll, "Logistics Decisionmaking Model," *Army Logistician*, (Jan-Feb 1996) 8.
[27] Ibid., 8.
[28] Ibid., 10.
[29] Professor James A. Huston as quoted by Philip A. Girmus, "Logistics Training" *Army Logistician*, (Mar-Apr 1997) 42.
[30] B. Don Sullivan, "Knowledge-Based Logistics Planning, *Army Logistician*, (Nov-Dec 1991) 16.
[31] B. Don Sullivan, "Knowledge-Based Logistics Planning, *Army Logistician*, (Nov-Dec 1991) 16.
[32] Ibid., 16.
[33] Ibid., 16.
[34] Ibid., 16.
[35] Principia Cybernetica Web, *Systems Analysis*, http://pespmc1.vub.ac.be/ASC/SYSTEM_ANALY.html
[36] *Field Manual 101-5 Staff Organization and Operations*, HQDA, 1997, 5-1.
[37] Field Manual 100-5, *Operations*, HQDA, 1993, 2-14.
[38] Jay Heizer and Barry Render, *Production and Operations Management-Strategic and Tactical Decisions*, 4th ed., (New Jersey: Prentice Hall, 1996), 55.
[39] Ibid., 55.
[40] Principia Cybernetica Web, *Decision Theory*, http://pespmc1.vub.ac.be/ASC/DECISI_THEOR.html
[41] Jay Heizer and Barry Render, *Production and Operations Management-Strategic and Tactical Decisions*, 4th ed., (New Jersey: Prentice Hall, 1996), 55.
[42] Ibid., 55.
[43] Philip A. Girmus, "Logistics Training" *Army Logistician*, (Mar-Apr 1997) 42.
[44] *Field Manual 100-5, Operations*, HQDA, 1993, 6-5.
[45] B. Don Sullivan, "Knowledge-Based Logistics Planning, *Army Logistician*, (Nov-Dec 1991) 16.
[46] Principia Cybernetica Web, *Systems Analysis*, http://pespmc1.vub.ac.be/ASC/SYSTEM_ANALY.html
[47] Ibid.
[48] Jay Heizer and Barry Render, *Production and Operations Management-Strategic and Tactical Decisions*, 4th ed., (New Jersey: Prentice Hall, 1996), 53-54.
[49] Ibid., 53.
[50] *Field Manual 101-5, Staff Organization and Operations*, HQDA., 1997, 5-1.
[51] Jay Heizer and Barry Render, *Production and Operations Management-Strategic and Tactical Decisions*, 4th ed., (New Jersey: Prentice Hall, 1996), 53-54.
[52] Kathryn B. Laskey, "Bayesian Decision Theory and Machine Learning" (Lecture, George Mason University, 1995), http://ite.gmu.edu/`klaskey/machine/tsld001.htm.
[53] *Field Manual 101-5 Staff Organization and Operations*, HQDA, 1997, C-2.
[54] Ibid., 5-3.
[55] Norman M. Wade, *The Battle Staff SMARTbook,* (Lakeland: The Lighting Press, 1999), 1-4.
[56] Headquarters Department of the Army, Field Manual 100-5 *Operations*, (Washington, DC: HQDA, 14 June 1993) 12-7.
[57] Jay Heizer and Barry Render, *Production and Operations Management-Strategic and Tactical Decisions*, 4th ed., (New Jersey: Prentice Hall, 1996), 53-54.
[58] Principia Cybernetica Web, *Systems Analysis*, http://pespmc1.vub.ac.be/ASC/SYSTEM_ANALY.html
[59] *Field Manual 101-5 Staff Organization and Operations*, HQDA, 1997, 5-5.
[60] *Field Manual 101-5 Staff Organization and Operations*, HQDA, 1997, 1-3.
[61] *Field Manual 101-5 Staff Organization and Operations*, HQDA, 1997, 1-3.
[62] *Field Manual 101-5 Staff Organization and Operations*, HQDA, 1997, 1-3.
[63] Norman M. Wade, *The Battle Staff SMARTbook,* (Lakeland: The Lighting Press, 1999), 1-25.
[64] *Field Manual 101-5 Staff Organization and Operations*, HQDA, 1997, 5-10.
[65] Major Kenneth W. Carroll, "Logistics Decisionmaking Model," *Army Logistician*, (Jan-Feb 1996) 11.

[66] Principia Cybernetica Web, *Systems Analysis*, http://pespmc1.vub.ac.be/ASC/SYSTEM_ANALY.html
[67] *Field Manual 101-5 Staff Organization and Operations*, HQDA, 1997, 5-7.
[68] Ibid., 5-7.
[69] Ibid., 5-18.
[70] Principia Cybernetica Web, *Decision Theory*, http://pespmc1.vub.ac.be/ASC/DECISI_THEOR.html
[71] Jay Heizer and Barry Render, *Production and Operations Management-Strategic and Tactical Decisions*, 4th ed., (New Jersey: Prentice Hall, 1996), 53-54.
[72] Ibid., 53-54.
[73] Principia Cybernetica Web, *Systems Analysis*, http://pespmc1.vub.ac.be/ASC/SYSTEM_ANALY.html
[74] *Field Manual 101-5 Staff Organization and Operations*, HQDA, 1997, 5-11.
[75] Ibid., 5-11.
[76] Principia Cybernetica Web, *Systems Analysis*, http://pespmc1.vub.ac.be/ASC/SYSTEM_ANALY.html
[77] *Field Manual 101-5 Staff Organization and Operations*, HQDA, 1997, 5-11.
[78] Ibid., 5-11.
[79] Ibid., 5-11.
[80] Ibid., 5-11.
[81] Ibid., H-9.
[82] Headquarters Department of the Army, Field Manual 100-5 *Operations*, (Washington, DC: HQDA, 14 June 1993) 12-2.
[83] Ibid.,12-3.
[84] Ibid.,12-5.
[85] Jay Heizer and Barry Render, *Production and Operations Management-Strategic and Tactical Decisions*, 4th ed., (New Jersey: Prentice Hall, 1996), 53-54.
[86] *Field Manual 101-5 Staff Organization and Operations*, HQDA, 1997, 5-16.
[87] Ibid., 5-16.
[88] Ibid., 5-16.
[89] Ibid., 5-16.
[90] Ibid., 5-24.
[91] Ibid., 5-24.
[92] Jay Heizer and Barry Render, *Production and Operations Management-Strategic and Tactical Decisions*, 4th ed., (New Jersey: Prentice Hall, 1996), 53-54.
[93] Ibid., 53-54.
[94] Ibid.,53-54.
[95] Gary L. McPherson, "LOGPARS '97," *Army Logistician*, (Mar-Apr 1998) 36.
[96] Jay Heizer and Barry Render, *Production and Operations Management*, (Upper Saddle River, NJ: 1996) 868.
[97] Gary L. McPherson, "LOGPARS '97," *Army Logistician*, (Mar-Apr 1998) 36.
[98] Ibid., 37.
[99] B. Don Sullivan, "Knowledge-Based Logistics Planning, *Army Logistician*, (Nov-Dec 1991) 17.
[100] Ibid., 17.
[101] Ibid., 17.
[102] Ibid., 17.
[103] Ibid., 17.
[104] Ibid., 18-19.
[105] Ibid., 16.
[106] Ibid., 16.
[107] Ibid., 16.
[108] Ibid., 17. Planning problems are normally of immense size. AI techniques can help the planner reason about the multitude of factors that affect a plan over an extended period and develop and evaluate the alternative logistics support concepts.

1. There is a premium on timeliness. The tools available from AI technology help to speed problem-solving by focusing on feasible solutions. This "directed-search" approach will enable logisticians to process information and identify solutions much faster, and more effectively, than is currently possible.
2. Decision-making and problem-solving are based, in part, on heuristics, or "rules of thumb," derived from the experience of the planner. AI techniques permit the planner to incorporate into the system judgements gained from experience, the commander's guidance, doctrinal preferences, and other knowledge bases that will affect problem-solving. The result is a knowledge-based planning system that can use the incorporated expertise, as weighted by the planner, to reason about problems.
3. Resources are constrained and decisions must be made about how best to allocate them. AI-bases decision aids, when guided by heuristics, priorities, and data on resource constraints and preferences, help to solve resource problems the same way a human expert would. But the decision aids are much faster than a human and provide a broader view of the effects of how resources are allocated.
4. Human experts are scarce and subject to loss. Since logistics planning is frequently affected by the reassignment or loss in battle of key personnel, an AI-based system can "standardize" the methods and reasoning of the expert by incorporating them into a knowledge base.

[109] Major Kenneth W. Carroll, "Logistics Decisionmaking Model," *Army Logistician*, (Jan-Feb 1996) 10.

[110] Colonel Dwight E. Phillips, "Matrix for Logistics Planning," *Army Logistician*, (Feb-Mar 1993) 17.

[111] Colonel Dwight E. Phillips, "Matrix for Logistics Planning," *Army Logistician*, (Feb-Mar 1993) 17.

[112] Ibid.,17.

[113] Norman M. Wade, *The Operations and Training SMARTbook,* (Lakeland: The Lighting Press, 1999), 222.

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