

## Chapter 1

### CONCEPT FOR ANALYSIS OF WARFARE

1.0 A brief and concise description of the CONCEPT FOR ANALYSIS OF WARFARE will elaborate on the following topics:

- DEFINITION OF "SYSTEM"
- ANALYSIS OF SYSTEM WORTH
- DESCRIPTIVE MODEL OF COMBAT
- INFORMATION-HANDLING FUNCTIONS

The "SYSTEM" can be defined in various ways for various studies. Three alternative definitions used for force-mix studies are shown.

A different and quite comprehensive approach to the evaluation of overall system worth is employed.

This approach is dependent upon a Descriptive Model of Combat, which will be outlined

The most difficult area for analysis is that of the information-handling functions. In this area an approach is developed which models the effect of flexible tactics on the outcome of a conflict.

This introduction to the concept for analysis of warfare is necessarily hypothetical and general. Of course, the devil is in the details which make up the rest of the book.

#### 2.0 Definition of "System"

The System is defined to suit the analysis. The "System" can be a military element or a collection of elements performing some (military) function. By "element" we mean some entity which performs one or more military functions, and which cannot be subdivided without denial of that functional capability. Examples of a military element are: a rifleman, a tank with its crew, a supply point, a truck with driver.

The analysis of element configuration to determine performance characteristics is a LEVEL VI analysis (the levels of analysis will be explained later). We prefer to leave that type of analysis to the design engineers and concentrate on the interactions of elements within a larger system, and the interactions among systems. Of course, the validity of any *quantitative* results is dependent upon the credibility of the inputs as to elemental performance

Combat involves nine military functions. These are defined as:

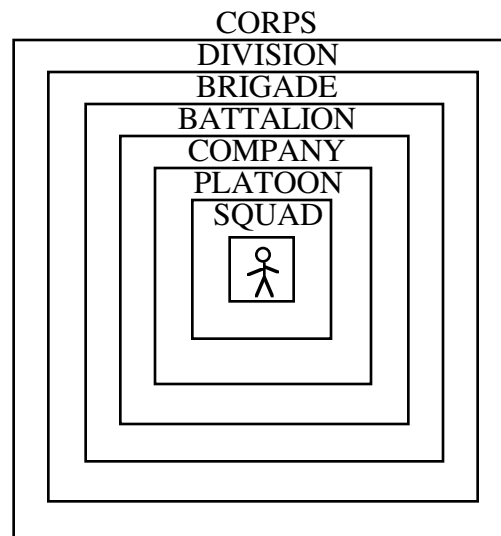
F	FIRE
M	MANEUVER
I	INTELLIGENCE
D	COMMAND
X	SIGNAL
S	SUPPLY
T	TRANSPORTATION
R	MAINTENANCE
E	CONSTRUCTION

When we refer to the *military functions* performed by elements or systems, we mean these. Other functions - for instance administrative services, psychological warfare - will have some bearing on combat outcome; however, we have selected these as the most important for modeling.

Fire and Maneuver are the fundamental expressions of combat power. Command, Intelligence, and Signal are all information-handling functions. The four remaining functions are fundamental logistic support functions. We take some liberties with accustomed terminology; e.g., we regard Medical Services as Maintenance of personnel, and the Replacement Service as Supply of personnel.

The symbols listed are used throughout our symbology to denote these functions.

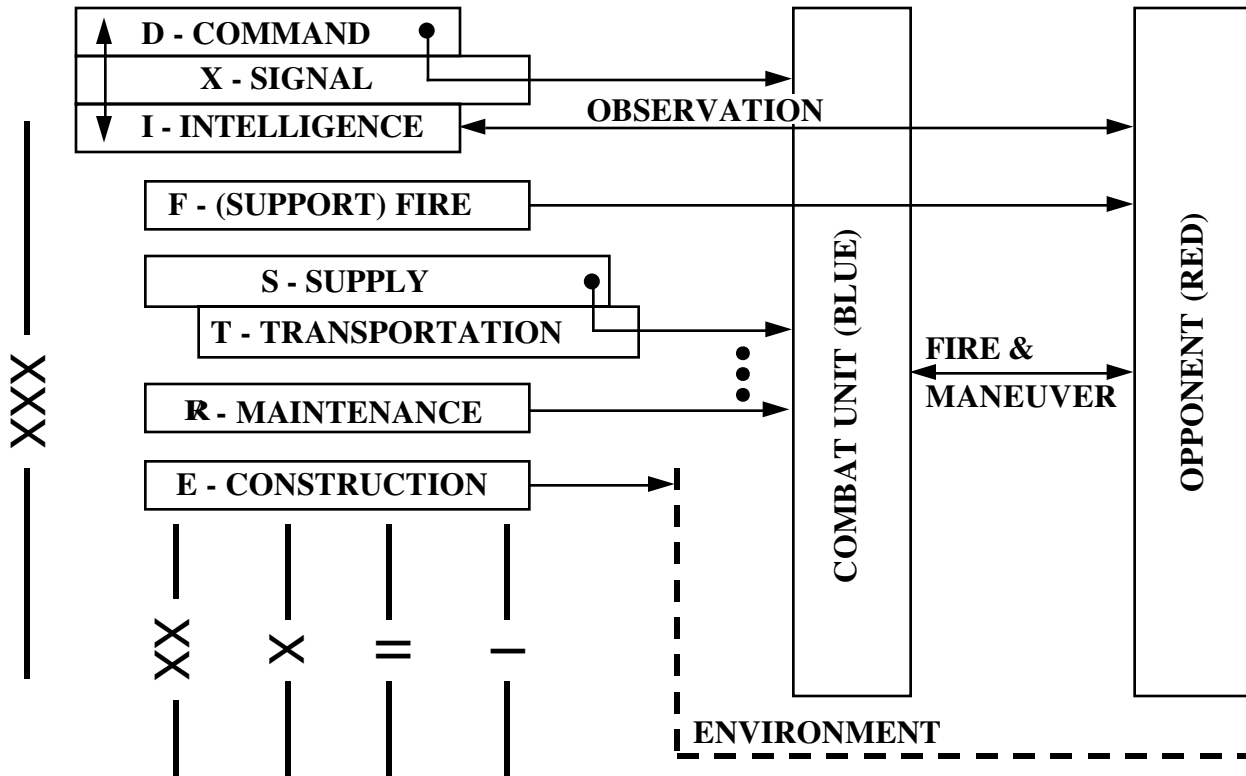
Each combat unit is a system as indicated in Figure 1-1.



*Figure 1-1 - Each Combat Unit Is A System.*

The combat element is a member of a small unit, a squad, which is part of a platoon, which belongs to a company, and so on. Each of these increasingly complex *systems* exist for just one fundamental purpose - to maximize the performance of the combat elements. However, as long as that basic truth is kept in mind, the force design should maximize the performance of the whole force - not of any specialized system or element.

To understand the functioning of units higher than squad or perhaps platoon, it is helpful to look at the *systems* in an alternate way.



*Figure 1-2 - Functional Systems Support Combat Units*

Note that a combat unit is defined as the primary system interacting with the enemy by fire and maneuver. It is supported by functional systems as defined earlier not limited by the next higher unit's capability.

For simplicity only the most fundamental interrelations are pictured. The opposing combat units influence each other by fire and maneuver; the information-handling systems provide directive and intelligence information; the support systems provide supplies and services. Note that the construction system works directly on the environment (terrain), which in turn influences the combat units.

There are of course many other relations, which are recognized but not shown in Figure 1-2. For instance command issues directive information to all other systems as well as the combat unit.

We sometimes, especially for approximate valuing methods, represent each combat element or unit as using a certain share of manpower and other theater resources. This we refer to as a WEAPON CHANNEL as shown in Figure 1-3. It is a concept similar to that of *division slice*. Dedicated

support elements backing up the weapon may have support channels of their own, which is a part of the investment in the weapon channel. The arrows indicate that a weapon channel can be degraded either by attacking the weapon directly or by attacking some element of its support. At this point we have established three *alternative* definitions of what is meant by *system*. The analysis of system worth to the US. Army is now addressed.

The *system* however defined, must operate in a three-part environment (Friendly, Enemy & Natural) as indicated in Figure 1-4. Combat elements or units have a *CAPABILITY* against the enemy, a *VULNERABILITY* to the enemy, and *COMPATIBILITY* with the friendly and natural environments. Non-combat elements or units have *CAPABILITY* to support combat units, *VULNERABILITY* to the enemy, and *COMPATIBILITY* with the friendly and natural environments.

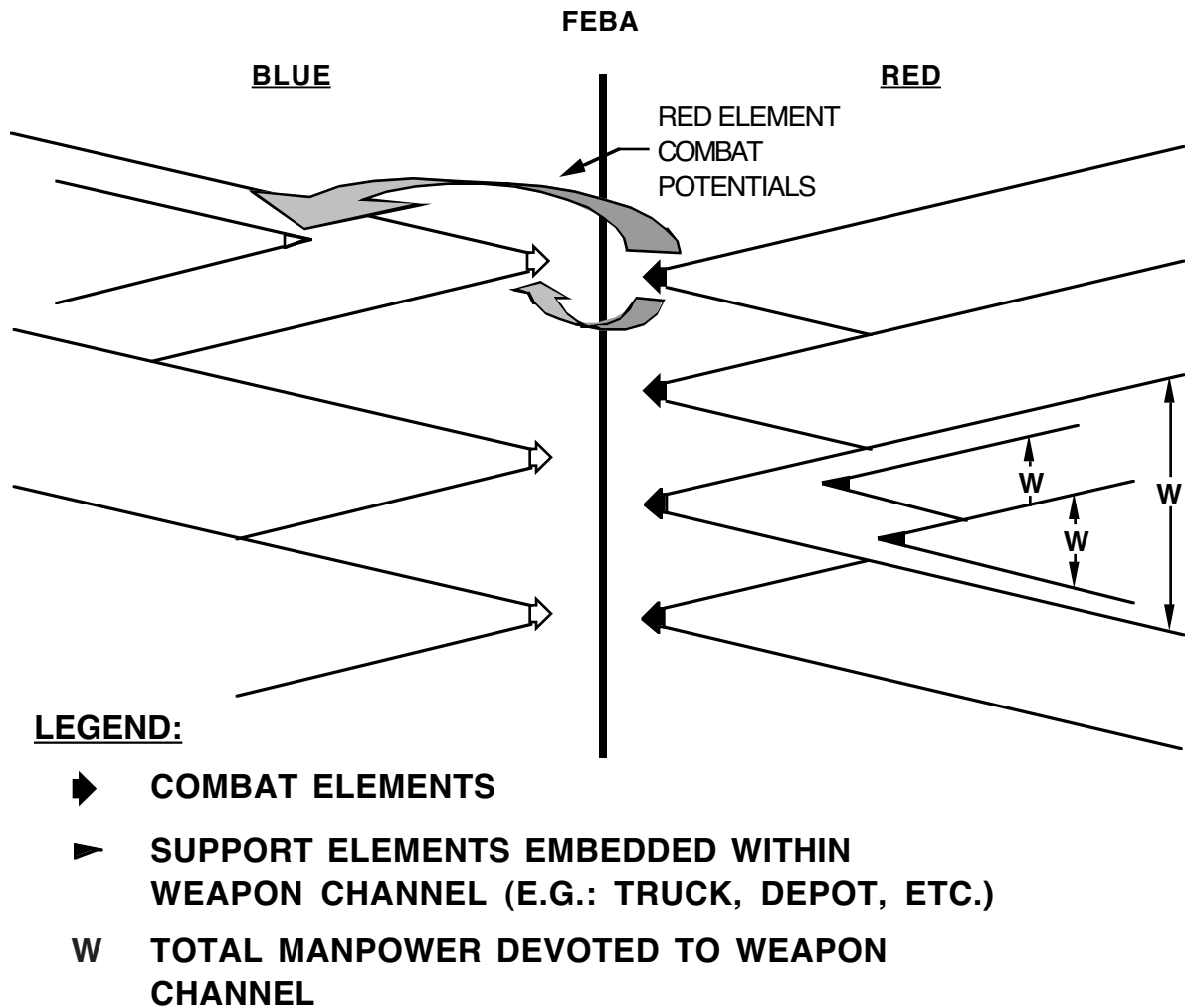


Figure 1-3 - Combat Viewed as Interacting Weapon Channels.

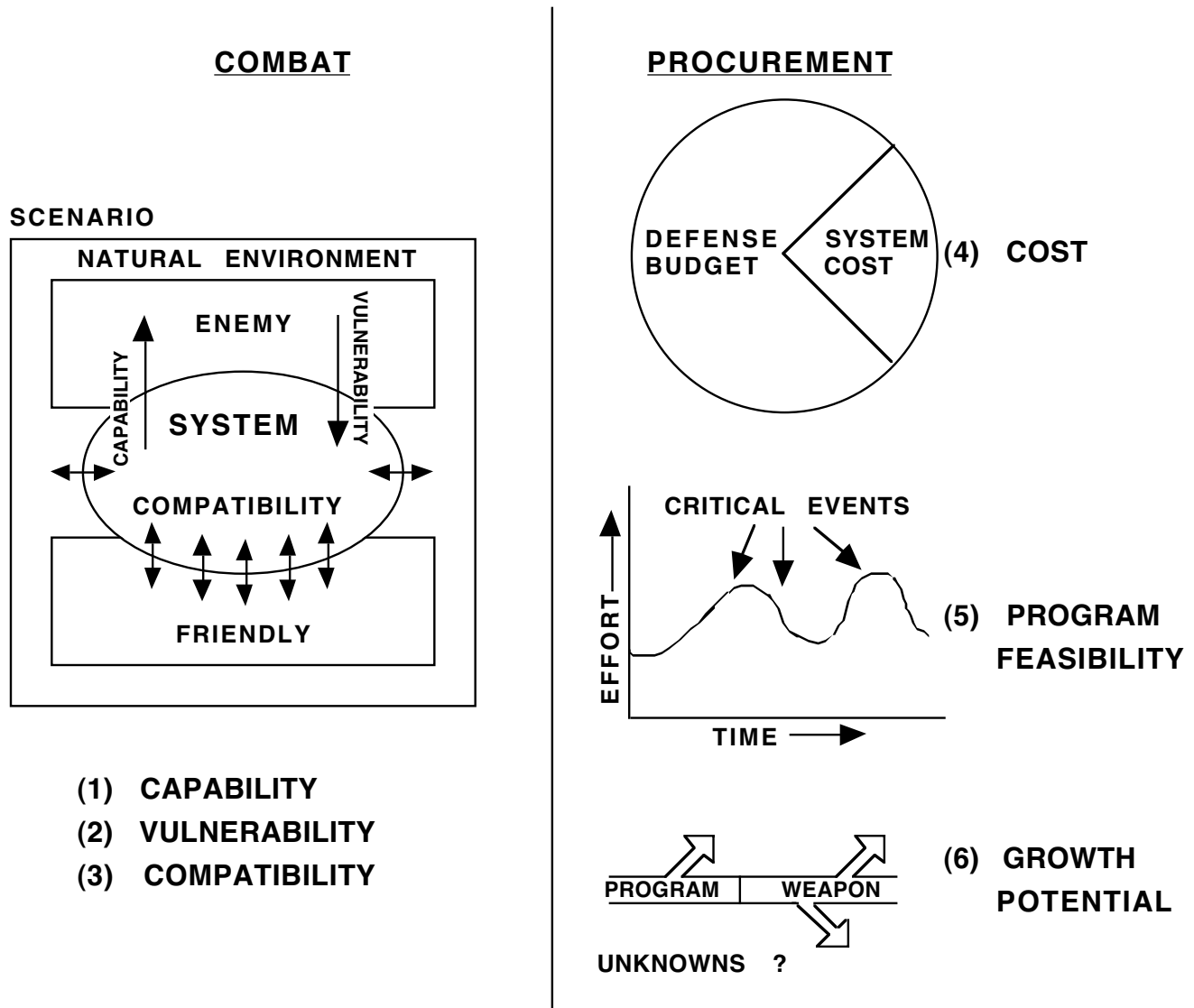


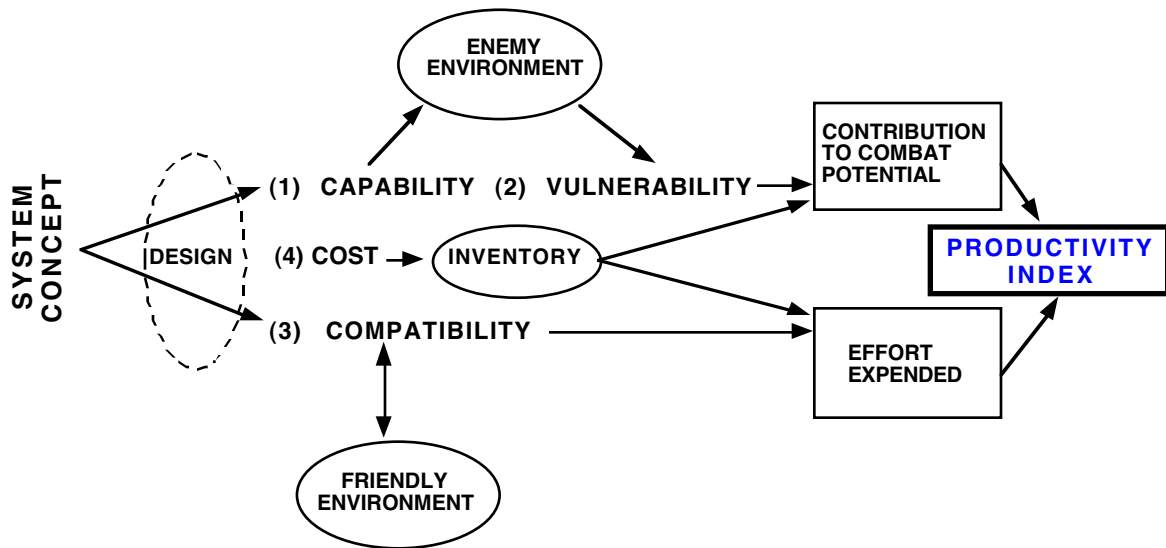
Figure 1-4 - System Decision Criteria.

To do useful analysis the system and its performance and also the total environment with which it must interact must be described . This description of the three-part environment, with dimensions of both space and time, is called a SCENARIO. Systems must be analyzed in those environments in which they are expected to operate; thus proper analysis must include the construction and use of suitable (believable) scenarios.

The three criteria on the left (Capability, Vulnerability and Compatibility) are those which determine combat worth and are of interest to the field commander - they will influence force mix decisions and tactical decisions taken at the point of use. The procurement agency must define and procure

the system years before its use, and must consider, in addition to combat worth, the three criteria shown on the right (Cost, Program Feasibility and Growth Potential). One of the really fundamental problems of analysis is to discover useful methods to combine the different criteria influencing combat decisions and procurement decisions. Of course, *cost effectiveness* has been widely used. However, it is an oversimplification which often leads to suboptimization. The method shown in Figure 1-5 is preferred.

• SOME FACTORS CAN BE QUANTIFIED



• SOME FACTORS ARE QUALITATIVE

- (5) PROGRAM FEASIBILITY
- (6) GROWTH POTENTIAL

*Figure 1-5 - System Evaluation Process*

This sets forth the overall quantitative approach to analyzing the combat worth of a proposed system. It is recommended as a viable alternative to *cost-effectiveness*.

The system concept can be described in terms of configuration, cost, and operating characteristics. The configuration and operating characteristics determine CAPABILITY, VULNERABILITY and COMPATIBILITY which is the load placed on the friendly environment. Cost, combined with budget considerations, establishes the inventory which can be procured. When these factors are quantitatively analyzed within a scenario, the contribution to combat potential (a concept to be

explained later) can be determined as can the effort expended in operation and support of the system. Output contribution divided by input effort results in a PRODUCTIVITY INDEX, which is a valid measure of combat worth.

In addition to combat worth, the developer must consider Program Feasibility and Growth Potential - which are not usefully quantifiable.

We have noted that the concerns of the procurement agency and the combat user may differ. In fact, it is believed that appraisal of any system differs according to each of many points of view. It is the analyst's job to attempt to incorporate all these valid criteria into a single unified appraisal.

<u>LEVEL</u>	<u>TYPE</u>	<u>ACTIVITY</u>	<u>RESPONSIBLE</u>
I	BUDGETARY	STRUCTURE FORCES	NATIONAL GOVERNMENT -DEFENSE DEPARTMENT -
II	STRATEGIC	BALANCE RESOURCES VERSUS THREATS	JOINT CHIEFS OF STAFF
III	STRATEGIC	PLAN USE OF RESOURCES TO ACHIEVE OBJECTIVES	UNIFIED COMMANDER (THEATER)
IV	TACTICAL	IMPLEMENT THEATER STRATEGY	UNIT COMMANDER
V	TACTICAL	UTILIZE CAPABILITY	MILITARY ELEMENT
VI	PROCUREMENT	PRODUCE CAPABILITY	PROCUREMENT AGENCY

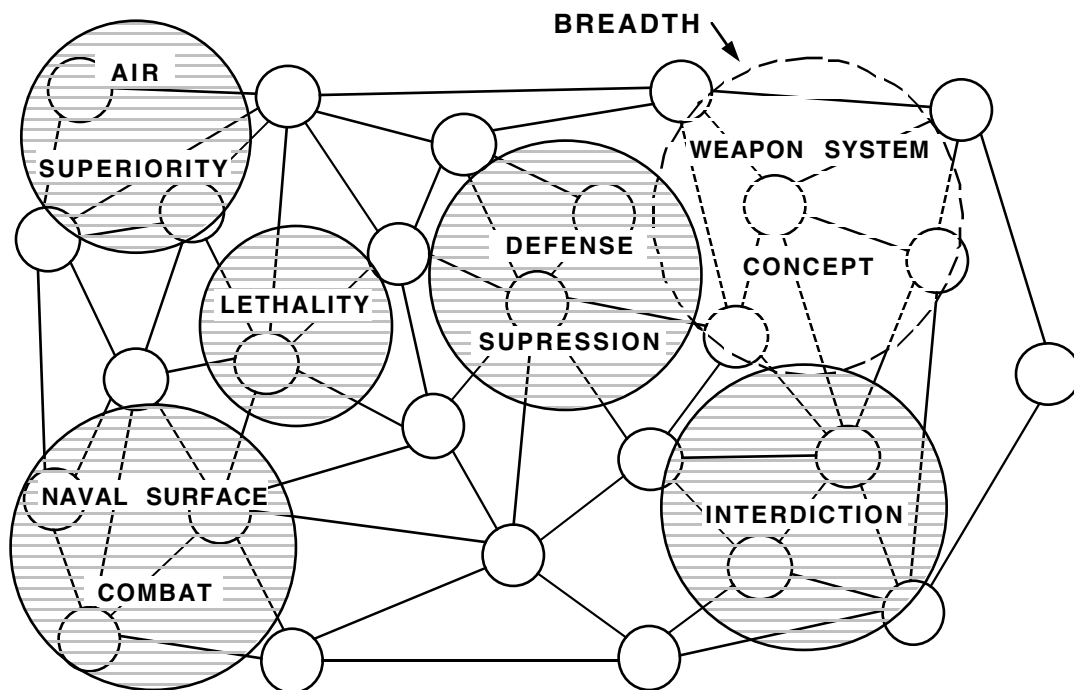
***Figure 1-6 - Model Recognizes Budgetary, Procurement, Strategic and Tactical Considerations.***

Figure 1-6 is a simplified presentation of the various echelons having valid interest in a system acquisition. To unify these various points of view it is necessary to determine a unit of input/output which is meaningful at all levels. Dollars do not qualify (with some difficulty dollars can be used to measure input, but they break down completely as a measure of combat output).

Instead a measure of *man-days* is proposed and used. The principal reasons are as follows:

- 1) Man-days permit us to specifically introduce the vital factor of *time*, and the function of maneuver.
- 2) Man-days permit us to interrelate and compare widely-varying functions, such as close ground combat, tactical air strikes, and rear-area maintenance.
- 3) Man-days do not lead us into some of the *cost effectiveness* paradoxes. For instance the Air Force asks " Is it worth-while to use a multi-million dollar aircraft to attack a \$20,000 truck?" It is indeed, under certain circumstances, but this can be shown only with a man-day measure. Further, inflation affects the dollar values at widely disparate times. Of course, advances in technology can affect man-hours required.

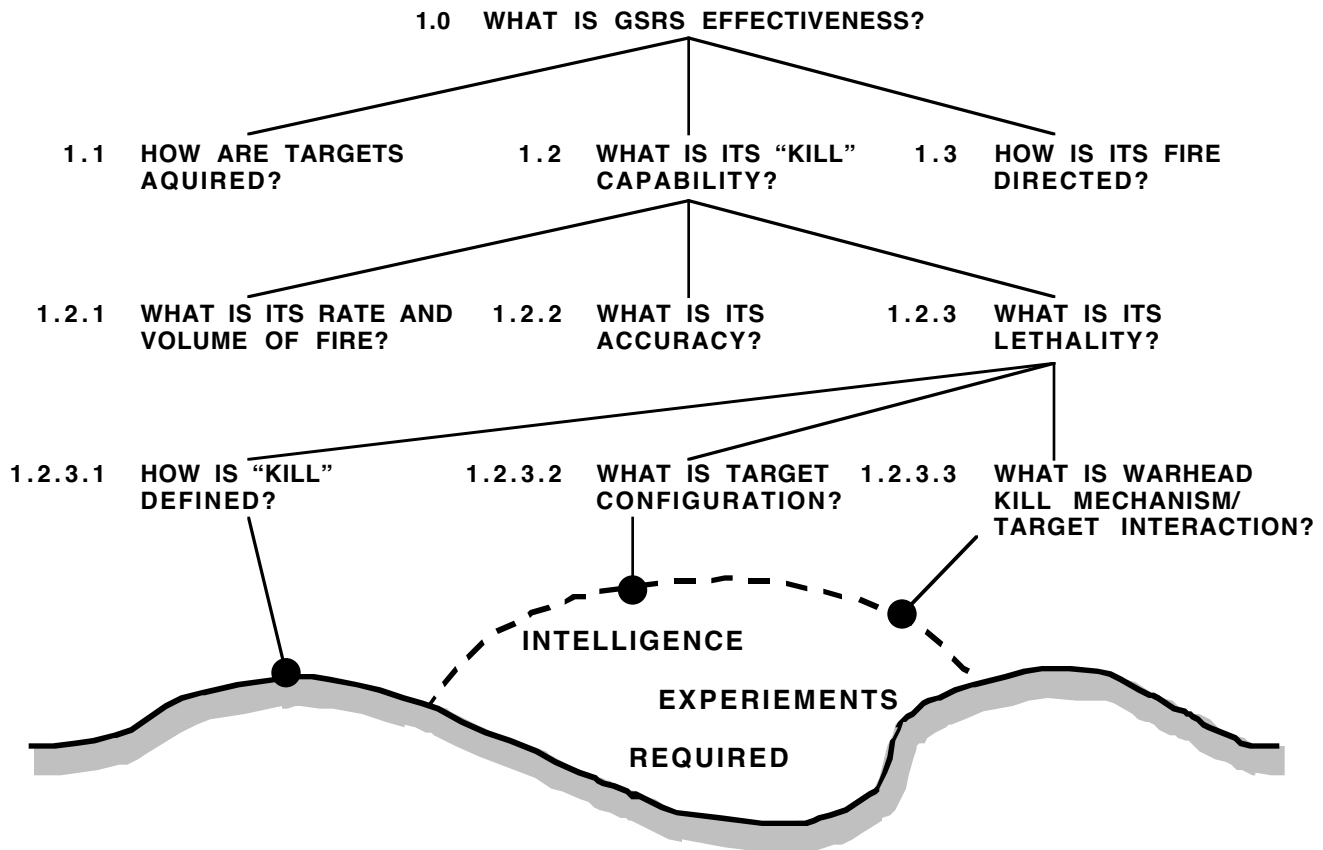
When the task is one of force mix, and involves selection among widely-varying functional systems, it is mandatory that one have a *road-map* of all the system interrelations which influence the outcome of combat. In this way one can integrate the outputs of the various detailed studies which must be performed. Such a road-map is called a DESCRIPTIVE MODEL OF COMBAT. Such a road-map is developed herein and its description is shown after the next figure.



*Figure 1-7 - Analysis of a System Carved from a Descriptive Model of Combat.*

Figure 1-7 is intended to represent the complex interrelations of the numerous differing systems essential to modern warfare. To do meaningful analysis within limits of study effort available, it is necessary to establish the *breadth* of the analysis to be performed - the type systems and interactions to be examined in detail. Relations with systems beyond the breadth of the analysis must be covered by assumption or estimation; these may be more knowledgeable if the adjacent areas have been covered by previous study (overlay with gray shading).

Even with a restricted breadth of analysis, one has problems as to the level of detail to be used in the examination of phenomena.



*Figure 1-8 - Any question tree roots in credible experience data.*

As an example, the effectiveness of a weapon depends upon target acquisition, fire direction, and *kill* capability. Kill capability depends upon rate and volume of fire, accuracy, and lethality. Lethality depends upon the definition of kill, on the target configuration, on the warhead configuration and functioning, and on the kill mechanism interaction with target components.

Studies of a system should be pursued to a *depth* (by which we mean level of detail) at which one can use actual experience data as input. This is not always possible - but where the effort fails the study has defined an area for future experimentation.

Now let us turn to an overview of the Descriptive Model of Combat. This centers around Land Combat, but also treats the contribution of Naval and Air Forces.

This descriptive model establishes the rationale for analysis of the contribution of systems performing each of the nine military functions (mentioned earlier) to the combat potential of a military force. For brevity, the basic concepts underlying the analytic system are described, with some additional detail in the area of the information-handling functions.

The descriptive model is based upon the concept of combat potential - which is the ability to accomplish one's own objectives and defeat those of the enemy. A Combat Potential Ratio Decides Conflict. This ratio is defined as:

$$\frac{\pi_{C,B} \Big]_{t_1}^{t_2}}{\pi_{C,R} \Big]_{t_1}^{t_2}} = ?$$

What this implies is: If either of two opposing commanders (Blue or Red) evaluates the ratio of combat potential for some time into the future as unsatisfactory for accomplishment of his objectives he *gives up*. At a low level "give up" means surrender, retreat or request reinforcements or change of objectives. Any of these alternatives has an impact on the combat potential of the next higher echelon. At theater or national level *give up* probably means to sue for peace, abandoning some or all of the political objectives which led to the combat in the first place

Now, neither commander has any way of knowing the point at which the opponent will give up. Therefore, the objective of any combat commander must be to attain a ratio of combat potential as favorable as possible within assigned resources and in the existing situation. The objective of the force or system designer must be to make the greatest possible contribution to combat potential in possible future conflicts, within budgetary and other constraints.

Combat Potential  $\pi_{C,B} \Big]_{t_1}^{t_2}$  equals the sum of Blue's ability to control terrain  $\sum_{\ell} Q_{\ell} \Delta t_{\ell} \Big]_{t_1}^{t_2}$  and to inflict damage on Red  $\sum_j P_{R_j} \Big]_{t_1}^{t_2} V_{R_j} \Big]_{t_1}^{t_2}$ .

This is the basic formula for computation of combat potential; it includes the functions of maneuver and fire. Some explanation of our notation is in order.

$\pi$  signifies potential,  $\pi_C$  is combat potential,  $\pi_{C,B}$  is combat potential of Blue (our side). All evaluations are made for a specific future time period beginning at  $t_1$ , and ending at  $t_2$ . In the normal planning process, of course, a headquarters might be evaluating the situation and preparing plans for more than one such time interval.

$Q_\ell$  is the tactical value of a specified terrain feature (the  $\ell^{th}$ ) - this is usually a function of time.  $\Delta t_\ell$  is the duration of occupation by Blue of that  $\ell^{th}$  feature during the period  $t_1$  to  $t_2$ .  $V_{R_j}$  is the benefit to Blue of having a specified Red element (the  $j^{th}$ ) out of action at time  $t_2$ ;  $P_{R_j}$  is the overall probability of sufficient damage during the period  $t_1$  to  $t_2$  to put that  $j^{th}$  Red element out of action.

Now, if we study the performance characteristics of the elements involved, it is possible to compute both  $P_{R_j}$ 's and  $\Delta t_\ell$ 's for two opposed courses of action. The  $Q$ 's and  $V$ 's are different, they are *directive* information to the Blue commander, and represent the importance or value to the overall Blue strategy of occupation of features and/or destruction of opposing assets.

Considerable study has been given to these directive variables and their representation of normal decision processes. In order to save time and not lose the main thread of this brief summary, this value discussion is omitted for the present.

Combat potential is changed during the conflict by the performance of both sides. Lanchester first expressed this fact by his equations :

$$\frac{dR}{dt} = -K_1 B$$

$$\frac{dB}{dt} = -K_2 R$$

It has of course been recognized that these equations are too simple - they represent attrition only, and isolated conflict, and non-realistic assumptions on distribution of fire. However, they are a starting point. We suggest an alternate formulation:

$$\Delta_C \pi_{C,R} \Big|_t^{t_2} = -\tau_B \pi_{C,B} \Big|_{t_1}^t (t_1 - t)$$

$$\Delta_C \pi_{C,B} \Big|_t^{t_2} = -\tau_R \pi_{C,R} \Big|_{t_1}^t (t_1 - t)$$

What we mean by this is: at any time ( $t$ ) in the conflict between two combat units, Red's combat potential for the future has been changed by Blue's performance of fire and maneuver to that point (and vice versa of course). Blue's performance has been established by his combat potential, the duration of the time period, and the rate  $\tau$  at which Blue combat potential has been applied or realized.  $\tau$ , which we call *pace*, is strictly a function of Blue information handling and decision making.

The subscript  $C$  on the  $\Delta_C$  implies that this is the change (or increment) in potential produced by the interaction of the combat units in isolation. Of course, we all know that battles are seldom fought in isolation. For useful analysis one must also be able to express the effect on the combat interaction of various external influences. For this purpose, in our methodology we postulate various increments to combat potential, as shown below.

These are the changes to combat potential we attempt to model and eventually to calculate. The following external influences affect Blue Combat Potential:

- $\Delta_C$  ( $\pm$ ) - COMBAT INTERACTION (*INTERNAL*)
- $\Delta_{F,R}$  (-) - RED SUPPORT FIRE
- $\Delta_{B^*}$  ( $\pm$ ) - BLUE REINFORCEMENT (REMOVAL)
- $\Delta_{R,B}$  (+) - BLUE REPAIR (MAINTENANCE)
- $\Delta_{S,B}$  ( $\pm$ ) - BLUE RESUPPLY (EXPENDITURE)
- $\Delta_{E,B}$  (+) - BLUE CONSTRUCTION
- $\Delta_{E,R}$  (-) - RED CONSTRUCTION

The first  $\Delta_C$ , *internal* and previously-listed, results from the *fire* and *maneuver* of the opposing combat units selected for analysis. It can be plus or minus - the situation can improve or worsen - and an event that is plus for Blue is minus for Red, provided their objectives are directly opposing.

Support fire is delivered by higher combat echelons for the purpose of directly influencing the conflict in question. It is always minus, unless Red gunners are very sloppy and destroy their own troops.

By reinforcement we mean the introduction of new elements or units, not simply replacement of those which may have been destroyed. The latter is considered *Resupply*.

Repair restores elements which have been damaged and are therefore non-functional. This is usually battlefield repair, unless evacuation and return are extremely fast.

Resupply can compensate for expenditure, and may even increase potential during the course of the conflict.

Blue construction is intended to help Blue; Red construction (principally obstacles) is intended to hurt Blue. Since the terrain is affected, construction may possibly have opposite effects. With superior tactics, Blue may eventually use the bridge that Red installs.

Note we have not covered transportation. This may contribute directly to  $\pi_C$  by improving mobility of combat elements and therefore the outcome of maneuver. It also contributes to the performance of supply, maintenance, and construction.

Note also that the information-handling function - command, intelligence, and signal are not covered. These contribute through the  $\tau$ -factor brought up in Figure 1-9. In describing the performance of military elements. We use a standard terminology as shown here.

<i>CHARACTERISTICS</i>	MEASURE FACETS OF PERFORMANCE; e.g. RATE OF FIRE, LETHALITY, VEHICLE CAPACITY
<i>CAPABILITY</i>	MEASURES MAXIMUM RATE OF PERFORMANCE IN SOME DEFINED, IDEALIZED SITUATION
<i>POTENTIAL</i>	MEASURES ATTAINABLE PERFORMANCE IN ACTUAL SITUATION IN A SPECIFIED TIME INTERVAL
<i>MEN</i>	$W =$ MANPOWER INVESTMENT
<i>PRODUCTIVITY</i>	$\mu = \frac{\text{CAPABILITY}}{\text{MANPOWER INVESTMENT}}$
<i>EFFICIENCY</i>	$\eta = \frac{\text{POTENTIAL IN } \Delta t}{\text{CAPABILITY} \times \Delta t}$
<i>PACE</i>	$\tau = \frac{\text{PERFORMANCE IN } \Delta t}{\text{POTENTIAL IN } \Delta t}$
<i>PERFORMANCE</i>	$= W \eta \tau$

**Figure 1-9 - Each Function Has Various Measures**

Of course we are most interested in being able to calculate the factors  $\mu$ ,  $\eta$ , and  $\tau$ .

$\mu$  represents the productivity factor - the extent to which equipment multiplies the functional capability of the men assigned. As an example a 2-1/2 ton truck with 1-1/2 ton trailer may be considered to have a one-way lift capability of 500 ton-miles per day, whereas a human porter may have a corresponding capability of 1/2 ton-mile per day. But the truck-driver must be backed up by the equivalent of about 1 man to provide fuel, maintenance, etc.. Thus the productivity factor of the truck would be roughly 500.

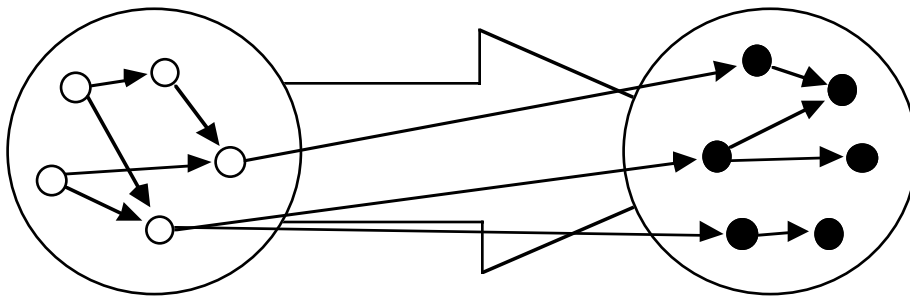
However, the truck is seldom able to use its full capability. The trafficability of available routes may be low, the required lifts may be short, fuel supply may be limited, maintenance requirements may lead to considerable down-time, traffic may slow the achievable speed. All such factors, which are

highly situation-dependent, enter into the efficiency factor,  $\eta$ . One can describe situations in which human bearers have greater transportation potential than an equal number of men operating and supporting trucks.

Included in the factor  $\eta$  must be a translation of the functional potential to combat potential. This takes the form of a *value* of the transportation tasks available in terms of their contribution to the selected Blue course of action.

The factor  $\tau$ , which changes potential to performance, is due to the delays in acquisition of information and formulation and communication of decisions. However, this is not entirely *red tape*. The interplay of the opposing Blue and Red courses of action contribute to the delay. For example, if Red brings the highway under intense fire, Blue logically does not order the trucks to proceed until the source of the fire is neutralized.

Considerable work has been done in identifying and detailing these factors for functional *elements* of various kinds. However, when one tries to do the same for systems which are collections of elements, the problem of *aggregation* is encountered.



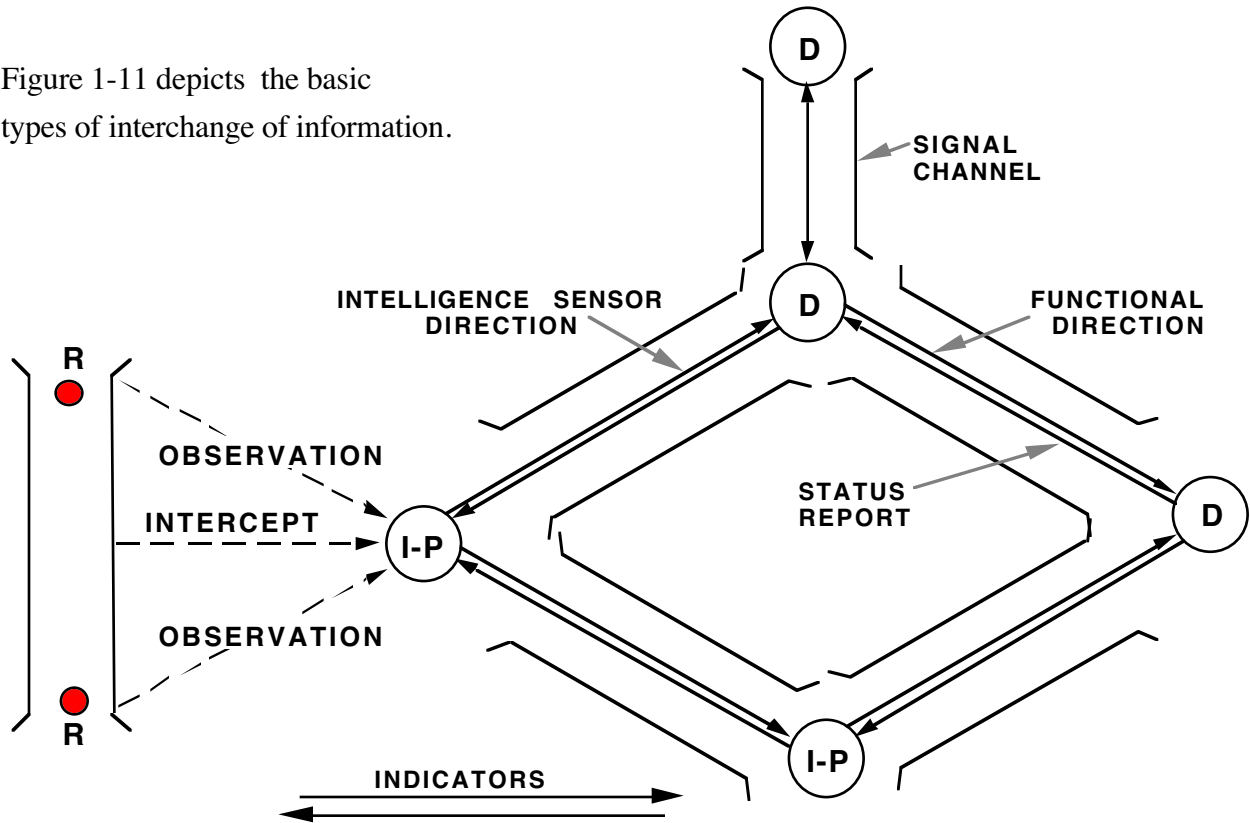
**Figure 1-10 - Aggregation Presents a Problem**

All combat and support interactions are really interactions between elements as indicated by the line arrows. However, if one models strictly on the elemental level, we are severely limited as to the size of the conflict we can analyze. What is needed are concepts which can express the interaction of system with system, as symbolized by the broad arrow.

In some cases, the problem is fairly easily solved; for instance the lift capability of a truck company is simply the sum of the lift capabilities of its elements, and its efficiency may be determined by such factors as percent available, percent fuel available, etc. We have some of these, for instance for aggregated fire.

Now let us turn to a brief description of the approach to the information-handling functions of Command, Intelligence, and Signal. These functions are very probably the most important to the realization of combat potential and the most deserving of careful study. This is also the area in which analysis gets the most complex.

Figure 1-11 depicts the basic types of interchange of information.



*Figure 1-11 - Information Handling Loops*

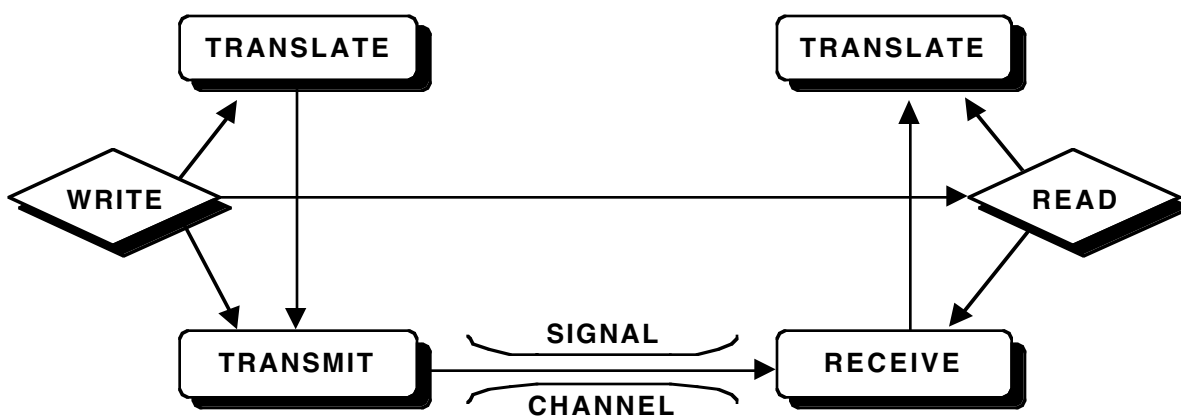
(D) represents a command or decision element; besides the actual commander, we represent each functional element as incorporating a decision element (e.g. the truck driver decides, according to directive information received, what to do with his truck). Each decision element has an associated or incorporated Intelligence-Processing element (I-P). All intentional information flow between elements goes through communication channels. These are not the same as *signal* channels, the relation will be explained later.

Information is obtained from the enemy in two basic ways, by *observation* and by *intercept*. Observation depends on sensors (camera, eyeball, radar); intercept involves tapping some enemy communications channel. Bits of information, which we call *indicators* are combined by the intelligence processors to form items of intelligence, which are passed to the command element.

Note the flow of *sensor direction*, the intelligence processors can be instructed as to the type of information most needed by command.

Between command elements there are two flows of information. *Status reports* are very analogous to intelligence - they cover position and current state of Blue units. Of course, they are voluntarily furnished (or supposed to be); observation and intercept are not involved. Functional direction - orders and requests - is covered later.

Figure 1-12 pictures a communication channel, and the alternate



*Figure 1-12 - A Communication Channel Defined*

methods by which the information may be transferred from a command element which *writes* to another which *reads*, Translation may be required, sometimes as encrypting and decrypting, sometimes into a different language, as for machine processing.

The signal channel is differentiated from the communication channel. *Signal* deals only with the methods to propagate messages other than unaided human voice.

A command element is depicted in Figure 1-13. By an editing process it controls the flow of information out to other command elements and its storage in its own files. This is becoming a major function because of the very large and rapid flows of information in modern warfare.

Its principal processes are a continuous cycle of planning, estimation, and decision. Based on orders received from higher command, and on information presented on a situation map it

postulates courses of action for itself (Blue) and the opponent (Red). It estimates the probable outcome of each opposed pair of courses of action, and decides which Blue course of action is to be adopted.

We model the estimate as being *quantitative*, based on an objective function to be described next, and the decision as being normally the selection of a maximin. It is recognized that selection of other than a maximin may sometimes produce better results, but at greater risk. Such a procedure for Blue depends on some assumption as to what the opponent is likely to do - this is termed *generalship*.

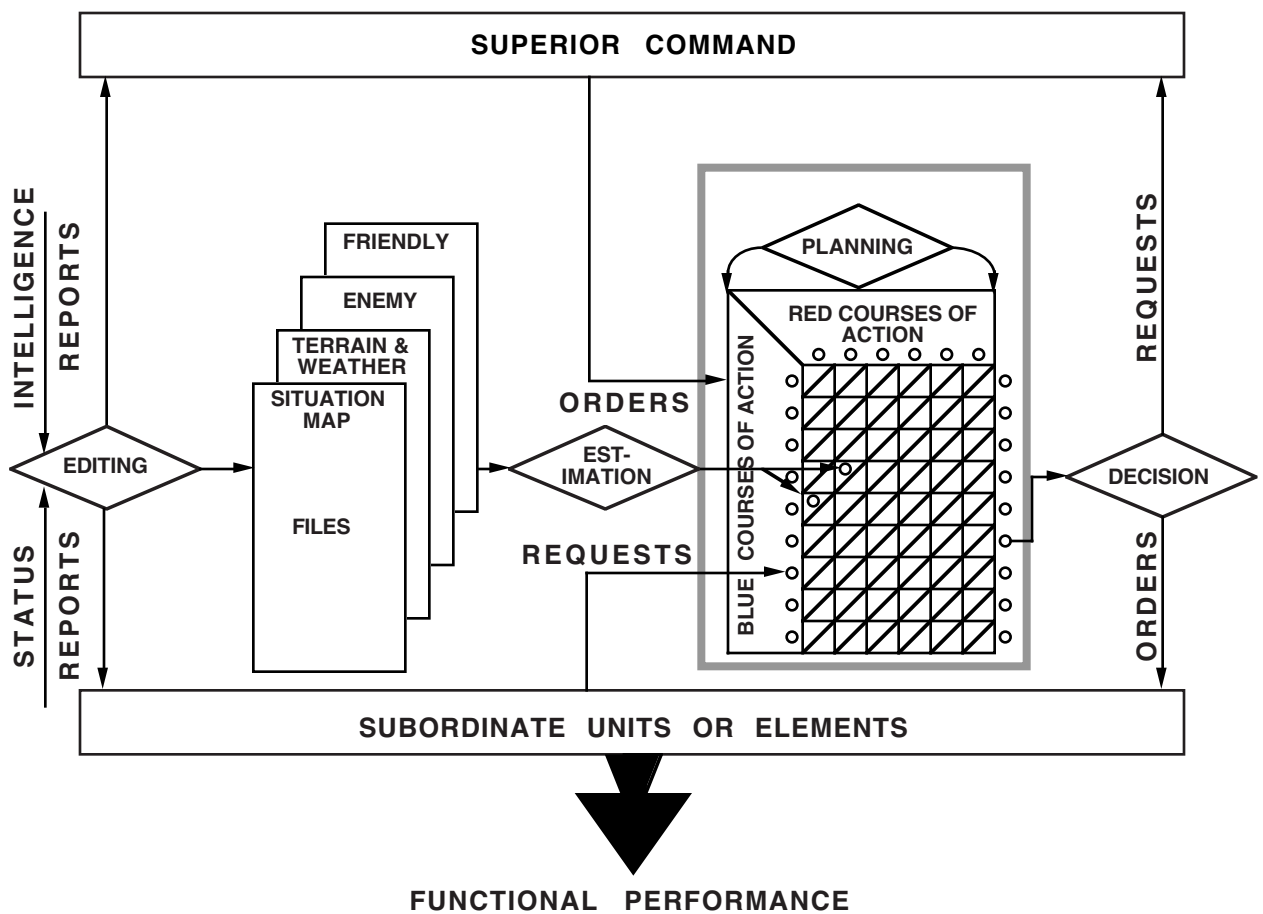


Figure 1-13 - Command Continuously Plans & Triggers Performance

The objective function used by Blue in his estimation of the value of courses of action is that shown here. Blue's Objective Function is:

$$\pi_{C,B}^B - \pi_{C,R}^B$$

or--

$$\sum_{\ell} Q_{\ell}^B \Delta t_{\ell} \Big]_{t_1}^{t_2} + \sum_j P_{R_j} \Big]_{t_1}^{t_2} V_{R_j}^B - \sum_i P_{B_i} \Big]_{t_1}^{t_2} V_{B_i}^B$$

and this guides Blue's decisions. It is actually the difference of combat potentials; we have shown only one  $Q$  term because we assume features successfully occupied by Blue are denied to Red, and vice-versa.

The superscript  $B$  's mean "evaluated to implement Blue higher strategy". For any conflict we isolate, it is likely that values assigned by Blue will differ from values assigned by Red; therefore, objectives are only partially opposed and the "game" is not zero-sum. One side actually has an inferior overall strategy at some level, and this may affect the outcome, even in spite of higher combat potential.

The descriptive model of an intelligence processor (I-P) is shown in Figure 1-14.

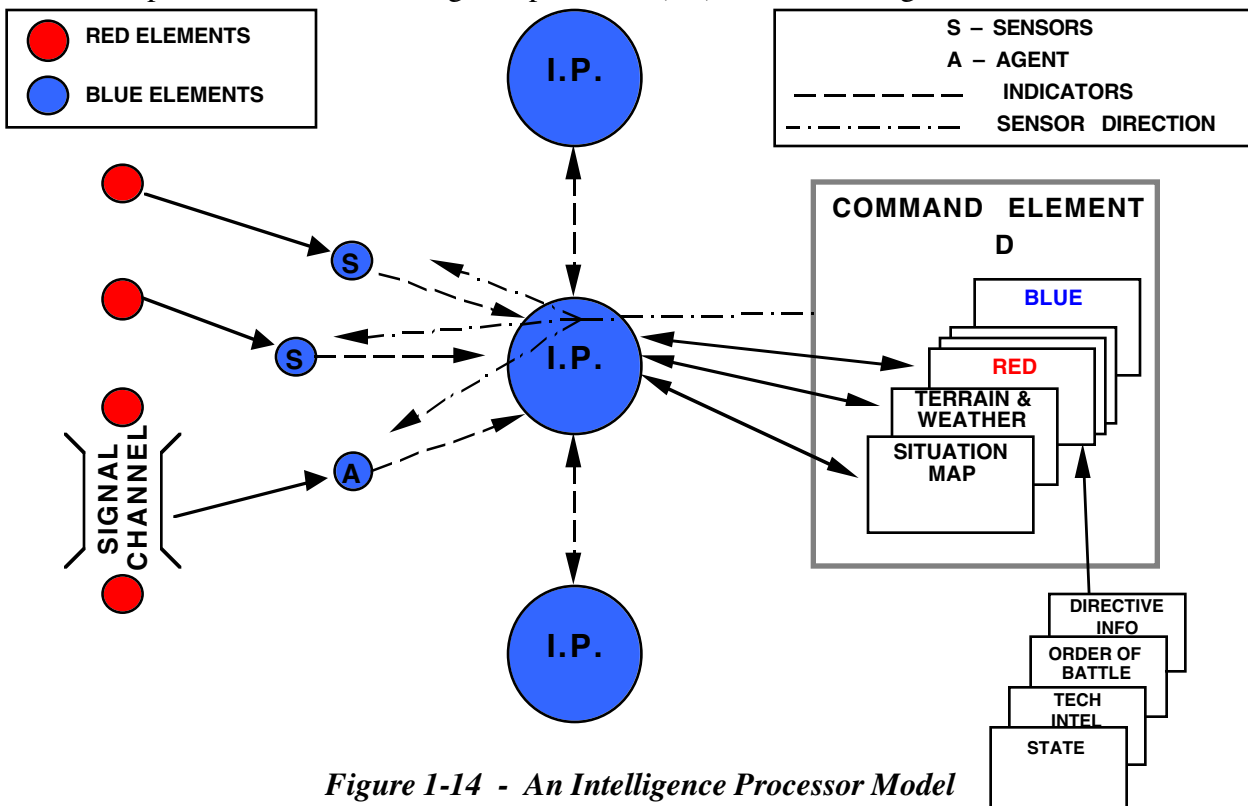


Figure 1-14 - An Intelligence Processor Model

It is responsible for the files on Red and on Terrain and Weather, and responsible for the Red portion of the situation map. It gets *indicators* from sensors, agents, or other intelligence processors, and by internal processes of editing and inference, fills the files. Also, once command has outlined a Blue course of action, it can identify critical voids in the files and use a process of sensor direction to direct the search for necessary information.

Note that the *Red* file is subdivided into four sub-files. Red directive information would be most valuable. It comes primarily by the agent route, though it is sometimes possible to draw valid inferences from Red's observed actions. The Order of Battle file, which identifies the Red units and elements which have been previously associated, is of particular utility in sensor direction. The Technical Intelligence file, which can use a great deal of intelligence collected prior to the conflict, deals with the *capabilities* of the Red elements identified. Information as to the *state* (position, supply, maintenance, etc.) of these elements aids in estimating their current *potentials*.

In summary, the *systems* to be incorporated in a force can be considered as combat systems (either elements or units) supported by functional systems as shown in Figure 1-2. The descriptive model of combat enables us to select a system for quantitative analysis, place it in its total environment and determine its contribution to the combat potential of the force. When this contribution to combat potential is divided by invested manpower, we get a productivity index, which we consider a valid measure of the combat worth of a proposed system.

In closing, the reader is reminded that only a descriptive model of combat has been outlined. To show that this can indeed be transformed into useful computational models, is the subject of subsequent Chapters herein.

As you read on you will become aware of the Unusual or Unique \* Facets of this Tactical War Analytic Approach, which are as follows:

1. From Concept to Deployment of any System, there are SIX LEVELS OF ANALYSIS. -- Department of Defense, Joint Chiefs of Staff, Theater, Engagement, Duel, Procurement.
2. Identifies TEN TACTICAL WAR FUNCTIONS. They are: DIRECT FIRE & MANEUVER, SUPPORT FIRE, INTERDICTION FIRE, STRATEGIC FIRE, AIR DEFENSE, DEFENSE SUPPRESSION, AIR SUPERIORITY, NAVAL SURFACE COMBAT, ANTI-SUBMARINE WARFARE, & INTELLIGENCE.
3. Functional representation of Combat interrelates COMMAND; the Combat Functions of FIRE, MANEUVER, and INTELLIGENCE; and the Support Functions of SUPPLY, TRANSPORTATION, MAINTENANCE, CONSTRUCTION, and SIGNAL.
- 4.\* Developed MILITARY ELEMENT VALUE THEORY which explicitly introduces the Value of Time and Elemental Value contributions to Combat Potential of a force.
- 5.\* Concept of COMBAT POTENTIAL interrelates Maneuver and Fire as decisive functions of Combat and recognizes value of *disruption* and *suppressive*, as well as destructive, fires.
- 6.\* Models COMMAND as a GAME MATRIX enabling the introduction of variable doctrine for both sides seeking to maximize their individual Objective Functions.
- 7.\* Models INFORMATION FLOW of specific Directive Information (Command) and items of Intelligence in a network, making it possible to specify exact information needs, sources of that information, and the effect of errors therein.
8. Provides for Study of HUMAN FACTORS, such as Skill and Motivation.
- 9.\* Recognizes Three Separate Levels of Performance for any Combat System. These are: CAPABILITY as produced, which is modified by the situation to become POTENTIAL, which is then released by Command to become PERFORMANCE.
10. Develops SYSTEM EVALUATION CRITERIA which merges the Combat Potential considerations and those Procurement considerations bearing on Levels I and VI

11. Constructs Sets of Interrelated Analytic Computational Models with defined Interface Variables permitting high-visibility investigation of military problems to the level of detail desired.
12. Develops militarily credible SCENARIOS, balanced within forces and between opposing force designed for use in Force-Balancing as well as for evaluation of systems
13. Simplified TERRAIN Representation by Features, Routes, and Obstacles is tied directly to formulations for Fire, Maneuver, and Combat Potential.

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