TACWAR # 246
11 July 77

THE VALUE OF INTERDICTION

HCBrown

1. PURPOSE

"Interdiction" has come to be a rather ambiguous word; it has been used to describe attacks on every class of target situated at some appreciable distance beyond the line of contact of the opposed combat units. Rather than debating definitions, this paper attempts to classify the kinds of target thus situated geographically and to discuss the value of attacks on each class.

2. THE COMBAT UNIT

Combat units at any echelon from platoon to field army can be viewed as having the generalized structure shown in Figure 1. Each contains a number of subordinate combat units (of similar structure), usually from two to five. If the major unit is committed, some of the subordinate units are committed and usually some are in reserve. Each unit has certain elements or units which handle information - Intelligence, Orders, Reports. These elements can be classified as Intelligence, Command, and Signal and they net together the major unit, its subordinates, its superiors, and usually its neighbors. Each unit also has elements or units concerned with logistic-support - Supply, Maintenance, Transportation, and Construction - for its subordinates. These can be pictured as a branching pipe-line extending from the rear through the unit area and down to each subordinate.

Usually every unit from company up has some assigned or attached capability for Air Defense. These may operate autonomously or they may be linked in to some area-wide control. Any unit from platoon up has assigned ground fire support elements, it may also have some temporarily attached or placed in direct support.

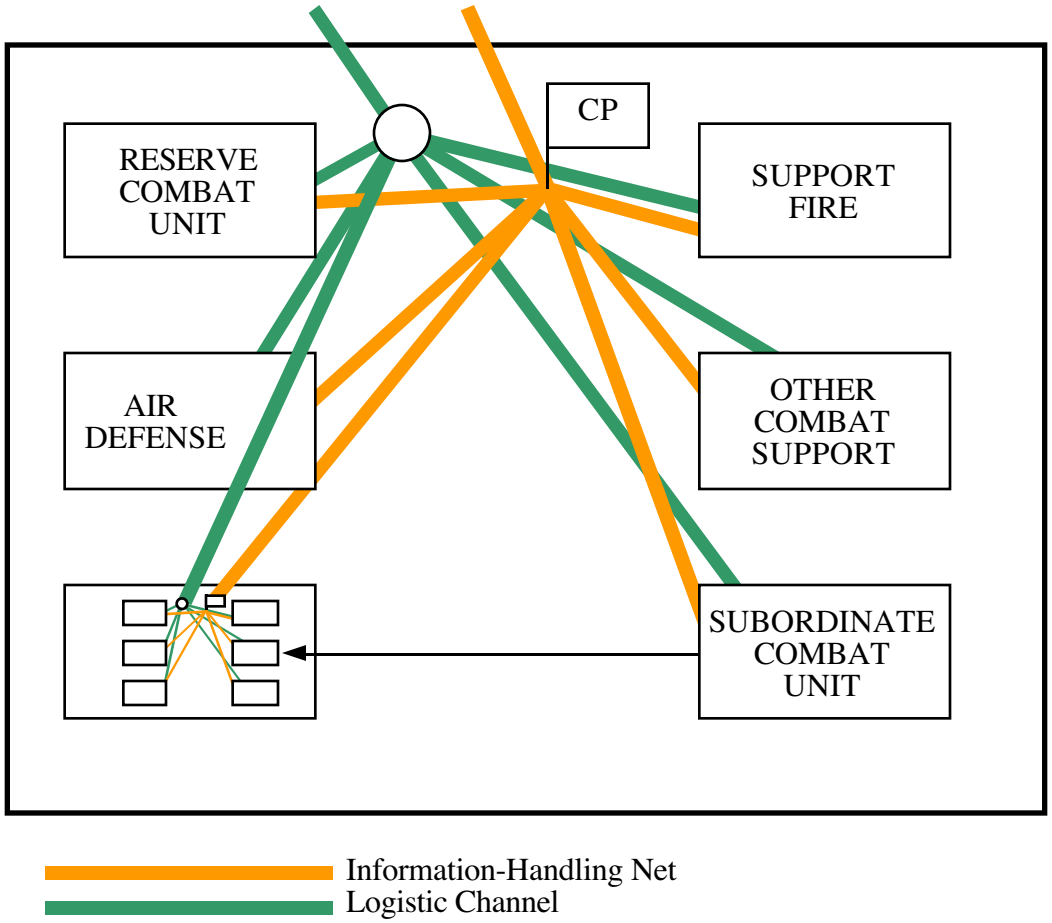


Figure 1 - The Ground Combat Unit

Lastly, higher echelon units such as brigade or division have other types of combat support elements - combat engineers, chemical troops, military police, psychological warfare, and perhaps others.

3. TYPES OF FIRE

Fire need not always be directed against the elements or units themselves; it may be directed against natural or man-made terrain features as well. However, the purpose is to interfere in some fashion with the functioning of the elements. For the purpose of discussion, let us label the various types of fire as follows:

- Against committed combat units - Support Fire (for delivered ordnance, close air support)

- Against reserve combat units - Interdiction of Reserves
- Against Air Defense - Defense Suppression
- Against the Logistic pipe-line - Interdiction of logistics.
- Against Fire Support - Counter battery Fire
- Against the Information Net - Counter-information Fire.
- Against other Combat Support - Special-purpose Fire

4. VALUATION OF TARGETS

At present we are completely unable to assign any relative value to Counter-Information Fire. Research aimed at developing such a capability will be a part of the CASM (Close Air Support Missile) effort.

The valuation of Defense Suppression should be in the context of the concurrent air war. This subject is not treated herein, but has been treated in ARM (Anti-Radiation Missile) Study[1].

Special-purpose fire could cover a number of varying "spot" situations. As an example, during the defense of a major river-line, it is obviously very desirable to diminish the enemy's tactical bridging capability by destroying bridge equipment and attacking combat engineer units. Examples such as this could be made specific and quantitative in suitable scenarios. They are not discussed further in this paper, which will concentrate on the relative value of Support Fire, Counter battery, Interdiction of Logistics, and Interdiction of Reserves.

5. THE VALUE OF SUPPORT FIRE

It seems self-evident that the value of delivery of fire against any target should be measured in terms of its effect on the ultimate outcome of the conflict then in progress. The difficulty is, of course, that there is no general agreement on how the outcome of land combat is to be measured, and no experimental or historical substantiation of any theories on how the outcome is affected by a host of factors which may be used to describe the capabilities of the opposing sides.

---

[1] Chapter 8.5, The Anatomy of Combat

We start by assuming that the outcome of land combat must be measured by some combination of casualties and movement of the opposed combat units. We also assume that these results are determined by the ratio of some measure of the fighting strength of the opposed committed units.

Before discussing measures of fighting strength, it must be admitted that no one has ever been able to confirm the above assumptions by evidence drawn from history or practical experience. Typically, the plotted results are too scattered to give credibility to any theoretical curve of combat outcome as a function of fighting strength. This may be at least partly because the historical record does not furnish sufficient suitably parallel examples at a level of detail permitting some quantification of the many relevant factors. In addition, no suitable technique has been devised for assessing the effect of opposing decisions and of morale and human performance. The first of these factors will be investigated in the CASM effort.

Frederick Lanchester, the first man to apply mathematics to combat, measured fighting strength by numbers of combatant elements and an average capability of each element for attrition of the opponent. This general approach has been elaborated over the years into several different sets of "fire power" scores. These all have well-documented deficiencies, and are generally not well-received; but they are still the only well-developed method of quantifying fighting strength.

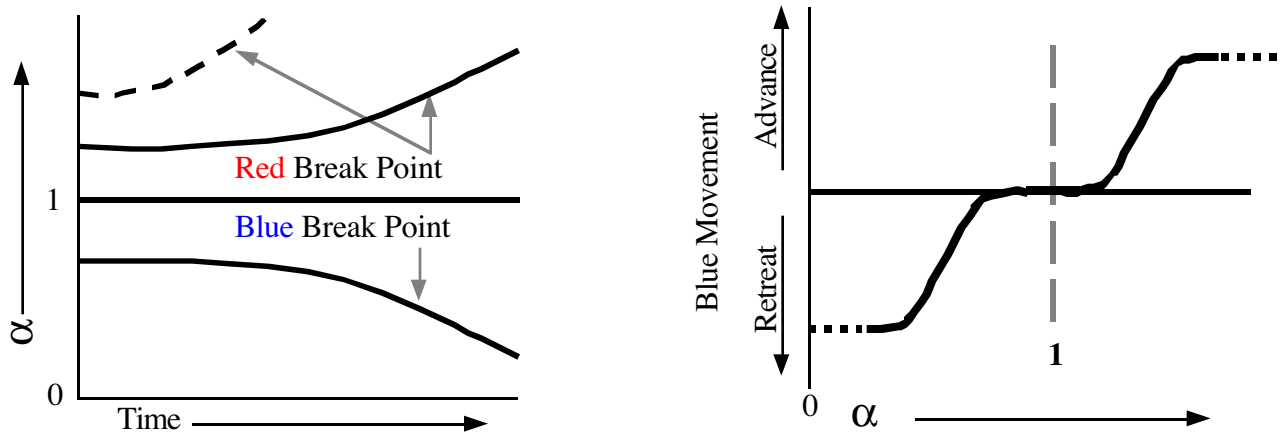
We have been in the process of developing a measure called Combat Potential, which will introduce maneuver and varying tactics as well as sheer fire power. In addition we expect to have discussions soon with members of USAF/S&A who are developing a concept of combat "momentum".

For the time being ratios of fighting strength must be expressed in some version of fire-power scores modified by considerations drawn from either combat potential or the momentum concept. In addition, because we have no basis for quantitatively expressing movement as a function of the ratio of fighting strength; we must simply assume that a favorable ratio leads to eventual victory and that it tends to get increasingly favorable unless some outside factor intervenes in the conflict.

Support fire allocated to a committed unit should be considered as a direct addition to its fighting strength during the period of allocation.

These concepts are illustrated by Figure 2. In these diagrams, α is used to represent a ratio of Blue fighting strength, however measured, to Red fighting strength. If a Blue combat unit starts with α greater than 1, and the ratio is not altered by some outside factor, the α advantage will grow continuously greater. Eventually a "break-point" is reached at which Red finds further

combat hopeless and alters his behavior (retreat, surrender, etc.). This case is shown by the upper solid curve in Figure 2 a). If α is originally less than 1 it gets progressively less eventually coming to a Blue break point (lower solid curve).



a) Variation of α with Time

b) Movement as a function of α

Figure 2 - Combat Results

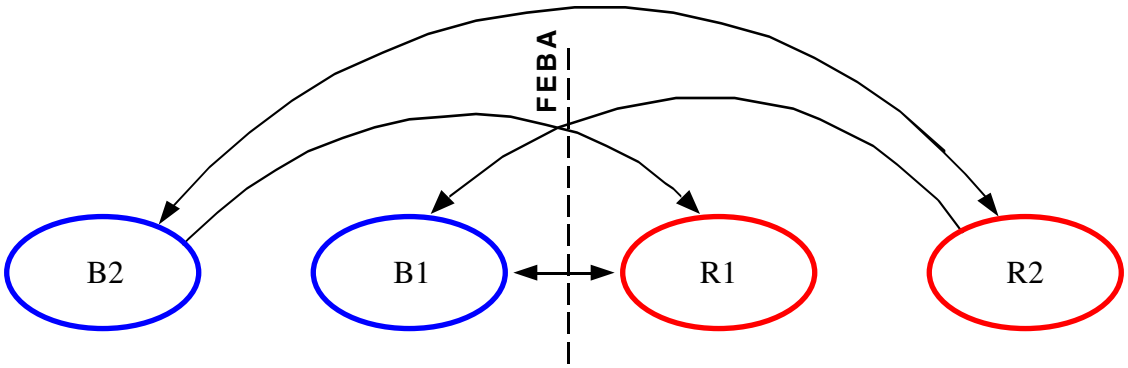
If Blue devotes some of his available fire support to direct support of the committed unit, α starts at a higher value and the break-point is achieved sooner (dotted line in Figure 2 a)).

The movement of the FEBA (assuming both sides are trying to advance) is pictured as in Figure 2 b). When α is near 1, neither side can sustain an advance. As it departs considerably from 1 the movement rate increases, eventually going asymptotic to an unopposed rate of cross-country movement for the type unit being discussed.

6. THE VALUE OF COUNTER BATTERY FIRE

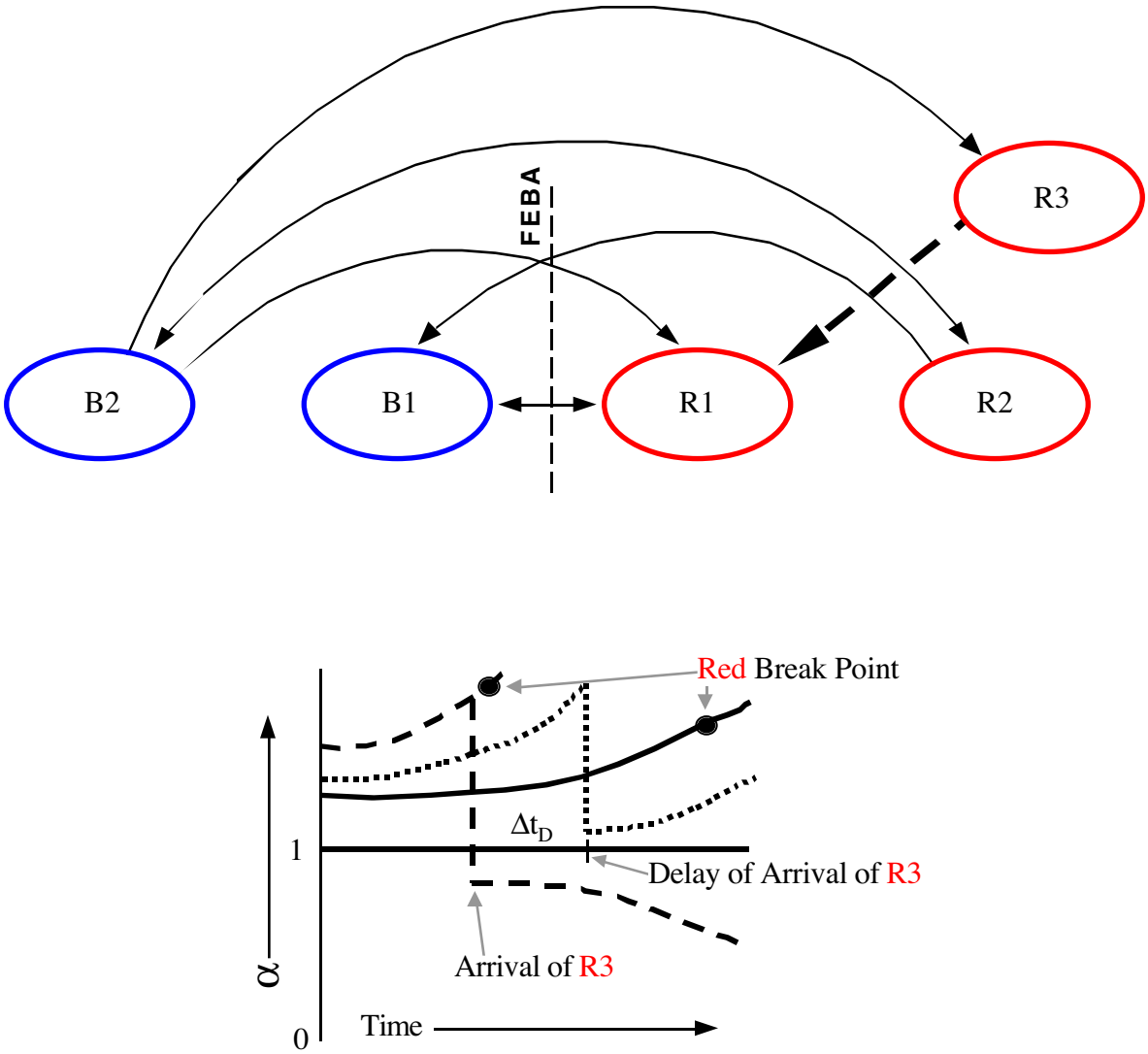
The counterbattery problem can be pictured as in Figure 3 a). B_1 and R_1 are opposed committed combat units which are capable of both fire and maneuver, but do not have the capability of delivering fire against R_2 and B_2 respectively. B_2 and R_2 are support fire units which can deliver fire against each other or against the opposing combat unit. The question is asked: "In what proportion should B_2 distribute it fire between R_1 and R_2 ?"

Let $k_{B_{11}}$ represent the rate at which fire from $B1$ can reduce the fire-power of $R1$, with corresponding explanations for $k_{B_{21}}$, $k_{B_{22}}$, $k_{R_{11}}$, $k_{R_{21}}$ and $k_{R_{22}}$. Let γ be the proportion of the fire of $B2$ directed against $R1$, and δ be the proportion of fire of $R2$ directed against $B1$.



a) Counterbattery Fire

Figure 3 - Fire Modes



b) Interdiction of Reserves

Figure 3 - Fire Modes

The interchange of fire and its results can be described by this set of equations:

$$\frac{dB_1}{dt} = -k_{R_{11}} R_1 - \delta k_{R_{21}} R_2$$

$$\frac{dB_2}{dt} = -(1-\delta)^{k_{R22} R_2}$$

$$\frac{dR_1}{dt} = -k_{B_{11}} B_1 - \gamma k_{B_{21}} B_2$$

$$\frac{dR_2}{dt} = -(1-\gamma)^{k_{B22} B_2}$$

Presumably Blue's objective is to maximize $\alpha \left(= \frac{B_1}{R_1}\right)$ and Red's objective is to minimize α. Given all the k's and the initial strengths of $B1$, $R1$, $B2$, and $R2$, the above equations can be solved for optimum values of γ and δ. (They can also be solved for other objectives such as maximizing or minimizing $\frac{B_1 + B_2}{R_1 + R_2}$.)

One might also extend the above simplified problem to a more realistic situation in which each side has several classes of support fire with differing range capabilities. This would lead to a larger set of differential equations, which would still be solvable on the computer.

A better approach might be to resurrect the Capability Model (CAPMOD). This is designed to calculate the results of various fire capabilities against specified target sets. It will calculate the optimum γ's and δ's by its built-in fire direction algorithm. It does require considerable input effort on target sets and weapon capabilities.

The problem solution discussed this far is realistic for a situation in which the combat units are not moving. This sort of counterbattery action is typical during the period just before an attack. After the attack begins, both sides tend to concentrate their fire support to facilitate the advance of their

own troops and impede that of the enemy. This is because fire support units cannot engage combat units at short range. If the opponent's advance succeeds, they must either retire or be overrun.

If it is desired to study this more dynamic counterbattery problem, we would have to modify the combat element values in CAPMOD to reflect their maneuver potential. This could be done using the principles of Combat Potential.

7. THE VALUE OF INTERDICTION OF RESERVES

The upper diagram of Figure 3 b) illustrates the generalized situation for interdiction of reserves. A reserve unit R_3 is also attackable by B_2. It is incapable of delivering fire against either B_1 or B_2, but may be moved forward to reinforce R_1.

In the lower diagram the solid line represents the progress of the battle if B_1 faces R_1 and R_2. If Blue uses his B_2 resources in a combination of support fire and counterbattery the progress might be as shown by the upper dashed line, with the Red break-point arriving earlier. However, R_3 may move in and actually reverse the course of the battle, as shown by the lower branch of the dashed line.

If Blue uses part of B_2 to attack R_3, the battle may progress according to the dotted line. Provided that R_3 is delayed by at least Δt_D, R_1 may break and retreat before its arrival. It should be noted that the prime objective here is <u>delay</u>. Unless delay is achieved, destruction of assets in R_1 is to be preferred to equal destruction in R_3.

As in the case of counterbattery fire, these concepts can be illustrated by supplying specific details in the generalized discussion above, or by an application of CAPMOD. Our valuing system used in CAPMOD takes account of the forward movement potential of reserve units.

8. THE VALUE OF INTERDICTION OF LOGISTICS

Interdiction of logistics is of value only when two conditions are met:

a) The opponent's logistic capability is limited in some fashion - shortage of routes, vehicles, or supplies

b) Friendly tactical expenditure of enemy supplies; i.e., he cannot simply refrain from using ammunition until supplies are adequate.

The first condition seems unlikely to be satisfied in a European conflict - the USSR can stockpile supplies sufficient for months, the road and rail networks in Germany are highly developed, and there is no known shortage of trucks or rolling stock.

Satisfaction of the second condition is also dubious. If the Russians have the initiative they will be able to control the pace of combat and overcome any temporary logistic shortage by modification of tactics.

The chief problem in analyzing the value of Interdiction of Logistics is that we have no credible curves as to how combat capability varies as a function of available supplies. Investigation of this question is scheduled for CASM.

We do have some algorithms for expressing the value of logistic targets for use in CAPMOD. They can be used if desired, but the results will be hard to defend.

9. SUMMARY

The methods described above can be used to show that Interdiction of Reserves, Counterbattery, and even Interdiction of Logistics are sometimes worthwhile - dependent on the situation and the timing of attacks. They will not show that attacks on "second-echelon units" are generally preferable to direct support operations.