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MOVEMENT OF AGGREGATED UNITS

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1.0 Three distinct types of movement should be recognized:

1) Administrative March
2) Tactical March
3) Combat Movement

2.0 ADMINISTRATIVE MARCH

Administrative March is always by road, with speed established by the class of road and the speed of the slowest vehicle (whichever is less). Administrative march is used in areas, or at times, of relative safety from ground or air attack, or possibly, as a "calculated risk", when time pressure is great. Battalion or lower units should be presented as one Serial using one route. A unit not totally motorized is normally made so by attachment of transport; otherwise one must provide for two or more lifts (two lifts take three times as long as one lift, because the vehicles must dead-head back). The interval between vehicles in meters is assumed as 1.5 times the speed in KPH. This interval times the number of vehicles establishes the column length. Column length together with speed establishes time length. (Actually there might be five-minute intervals between company march units; it is suggested that this be disregarded for simplicity.)

The time taken for an administrative movement is the single-vehicle time (distance/speed) plus twice the time-length of the column, which must deploy into a column and then close at the end of the march.

3.0 TACTICAL MARCH

Tactical March may be by road or cross-country. It is used to lower vulnerability to air attack or ground fire, and also to bring units to contact in a formation more manageable than a single long column. It should be assumed that units not in contact proceed by tactical march, unless road space is inadequate and time pressures rule out cross-country movement.

In Tactical march, the intervals between vehicles are 100 meters. Battalions should be considered to move, if on roads, in up to three columns (provided that many routes forward are available). This reduces the length and time length of the moving unit. When moving cross-country the unit is assumed to fill a rectangular space of total area equal to the number of vehicles multiplied by 10,000 square meters.

A tactical march by road is subject to the same time calculations as an administrative march by road - i.e., single-vehicle time plus twice the column length. For a tactical march cross-country the unit starts and ends in a deployed formation.

4.0 COMBAT MOVEMENT

In Combat Movement, the unit may change size or shape and it may move in toto in any direction. It should be considered as occupying a rectangle, and three movements should be recognized:
1) Increase (decrease) in length, 2) Increase (decrease) in breadth, and 3) Movement of center of gravity. Any two or all three may occur simultaneously.

"Length" and "Breadth" are interpreted as dimensions containing 100% of the units. This may produce a zone of overlap occupied jointly by two or more units, friendly or opposed.

The maneuver elements in contact move whenever the local situation and their Directive Variables dictate, usually in short dashes by small numbers at any one time. On some occasions the length is increased because an element moves further forward than any other has been. None of these moves much affect the center of gravity.

Non-maneuver elements (Support Fire, Logistic, Command, Intelligence, Signal) and reserves move less frequently, in larger numbers, and in larger increments of distance. Such a move (usually by logistic elements) may decrease the length of the unit. These moves have more influence on the motion of the center of gravity.

The speed of the center of gravity is uniform when in march formation, but widely varying for combat movement. The movement of the front is very much stop-and-go. We may define a FEBA[1], and its movement rate also will be erratic.

The movement rate of the unit is erratic because the elements proceed in a stop-and-go fashion when under fire or the threat of fire. By discussing the behavior of the elements we may be able to draw some conclusions as to the movement of the unit.

The element makes all decisions on the basis of its assigned directive information: $\{....,Q_\ell(t),....\}$, V_{B_i}, $\{....,V_{R_j},....\}$, $V_{S_{(V)}}$[2]. It may have a set of Q's increasing in value along some route to a final objective. It will move from point ℓ to $\ell+1$ if the Objective Function is positive; it will stay put or retreat if the Objective Function is negative. It may stop also if V_{R_j} is high and an attractive target is offered. (The balance between Q and V_{R_j} determines the degree to which resistance is bypassed.)

When an element stops because its Objective Function value for further advance is negative, it does not start again until there is a change in the situation or a change in its orders (Directive Variables).

An adequate change in situation would result from a reduction in the opposing fire threat along the intended route. This could occur if there is a change in the opponent's positioning, or if enemy casualties are caused either by the element, or by friendly supporting fires. The casualties could occur in the absence of further orders, or as a result of a request for support.

A change in orders without a change in situation would require the element to take a risk higher than that previously established as acceptable. ("Damn the torpedoes, full speed ahead.") It is questionable that this is a common occurrence, because of "human factors". The implication of such a change would be that the element is being sacrificed.[3]

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1 Forward Edge of Battle Area. e.g., as a line perpendicular to the direction of motion, which has equal and minimum numbers of elements on the "wrong side". That is, as many Blue elements are in Red territory as Red in Blue.

2 $V_{S_{(V)}}$ denotes the Value of Category V (ammunition) Supply.

3 It should be noted that a simultaneous move by several friendly elements may reduce the risk to each to acceptable levels. Each element can recognize that the enemy threat to him is diluted by the availability of other equally - or more -- attractive targets.

The more common response to a hold-up would be Support Fire to reduce the fire risk, or maneuver by other elements to drive off the opponent(s).

5.0 It is conjectured that combat movement rates will vary as shown in Figure 1.

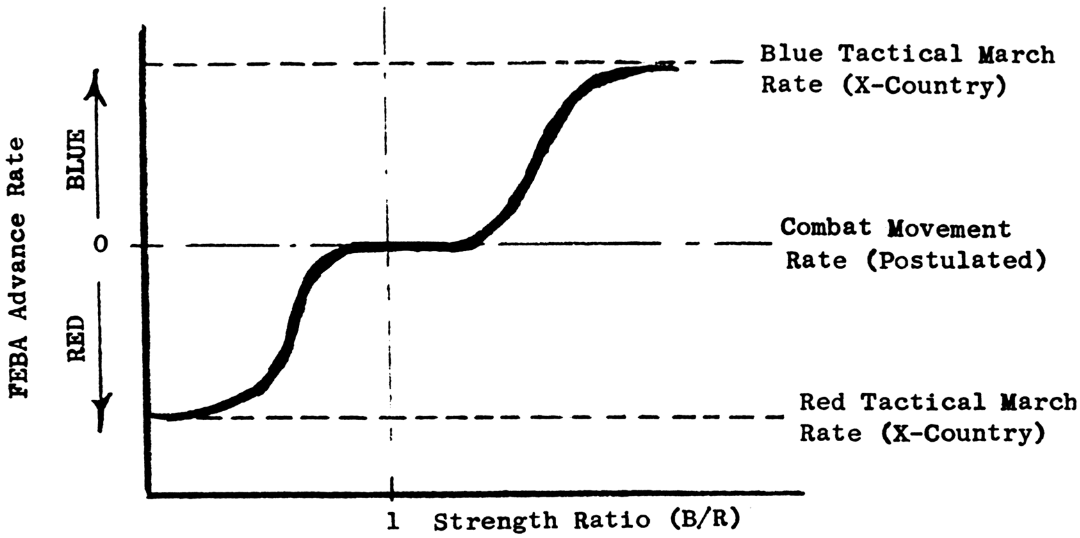


Figure 1 - Combat Movement Rate (Postulated)

Neither side can move faster than its cross-country tactical march rate unless it decides that the low level of opposition justifies a tactical or administrative road march. If the two sides are equal in "strength"[4], neither can sustain an advance - the movement should be zero. It may be briefly other than zero[5], but the advancing side will suffer enough casualties to be brought to a halt. As the strength ratio moves significantly away from 1 (unity), the stronger side can move faster - up to the tactical march rate limit.

6.0 The "strength" referred to is not simply a ratio of manpower - it is affected by the detailed composition of the force, the individual capabilities of the elements, the terrain, human factors, and the quality of command, intelligence, and communication. If one can deduce the ways in which these factors affect "strength" (to be designated Combat Potential), one can use Figure 1 as a curve for umpiring.

[4] To be discussed in detail below.

[5] See discussion of Directive Variables below.

7.0 Prior to discussing these factors, let us consider the way in which Directive Variables may affect movement and casualty rates. By definition, an element in motion is more vulnerable and less fire-capable than one at rest at a feature. When two opposing elements are both in motion, both casualty rates will be down. If we have two collections of like elements, both in motion, that which is moving fastest is in motion most often, therefore its casualty rate is higher. This is considered basically true, whether both are advancing, or one is advancing and the other retreating. A well-conducted delaying action can make the enemy pay heavily in casualties for ground gained, whereas a retreat or rout causes the defending side to lose heavily.

A commander, by assigning high values of Q/V_{B_i} can force some advance against equal or superior enemy forces. However the price paid in casualties will worsen the strength ratio still further, and eventually the movement stops or reverses because of attrition.

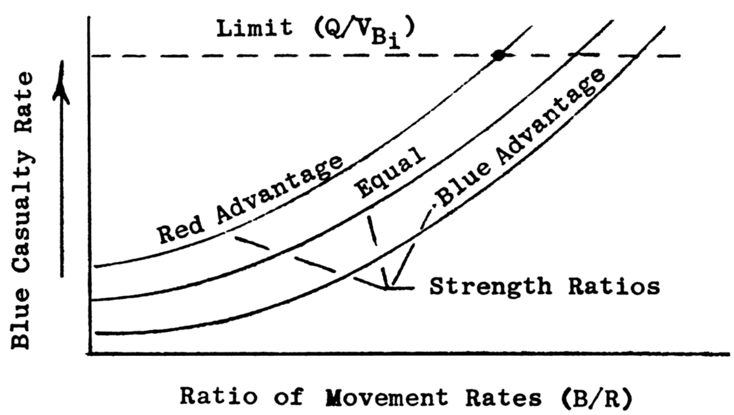


Figure 2

The average Q/V_{B_i} is a factor similar to one that has been called "resolve" by some modelers.

If the density of elements on terrain[6] is low enough, the advancing elements may have choices between a move and an attempt to eliminate an enemy element. The ratio Q/V_{R_j} in Blue's directive information will determine the extent to which resistance is by-passed.[7]

6 See discussion in Para. 10.0 below.

7 The elements are here pictured as accepting the Directive Variable values completely and acting according to an Objective Function value calculated therefrom - they are said to have perfect motivation. If they do not, and substitute their own preferred values the result is unpredictable.

8.0 The movement rate of the front of the unit, or of the FEBA, depends on the movement rate of the maneuver elements. Their movement rate depends somewhat on their speed while actually moving but usually far more on the frequency and duration of the stops. The movement rate of individuals, and therefore of the FEBA, increases if speed is increased, if stops become less frequent, and if stops are of shorter duration.

9.0 Suppose we let α denote the ratio in a certain sector of the number of Blue maneuver elements to the number of Red maneuver elements. On the average each Blue element is faced by $1/\alpha$ Red elements. As α decreases it is increasingly likely that any Blue element will be faced with opposition sufficient to prevent its further movement. The frequency of Blue stops goes up - the Blue movement rate goes down.

The direct opposition to movement of Blue maneuver elements is largely provided by the Red maneuver elements employing direct fire. The Red support-fire elements, which are generally indirect-fire and require appreciable reaction times, have difficulty engaging a moving target.[8] It is reasonable to assume that the indirect-fire threat is negligible to decisions regarding forward movement. Heavy indirect fire can of course make an area untenable - one which must be passed through rapidly or abandoned.

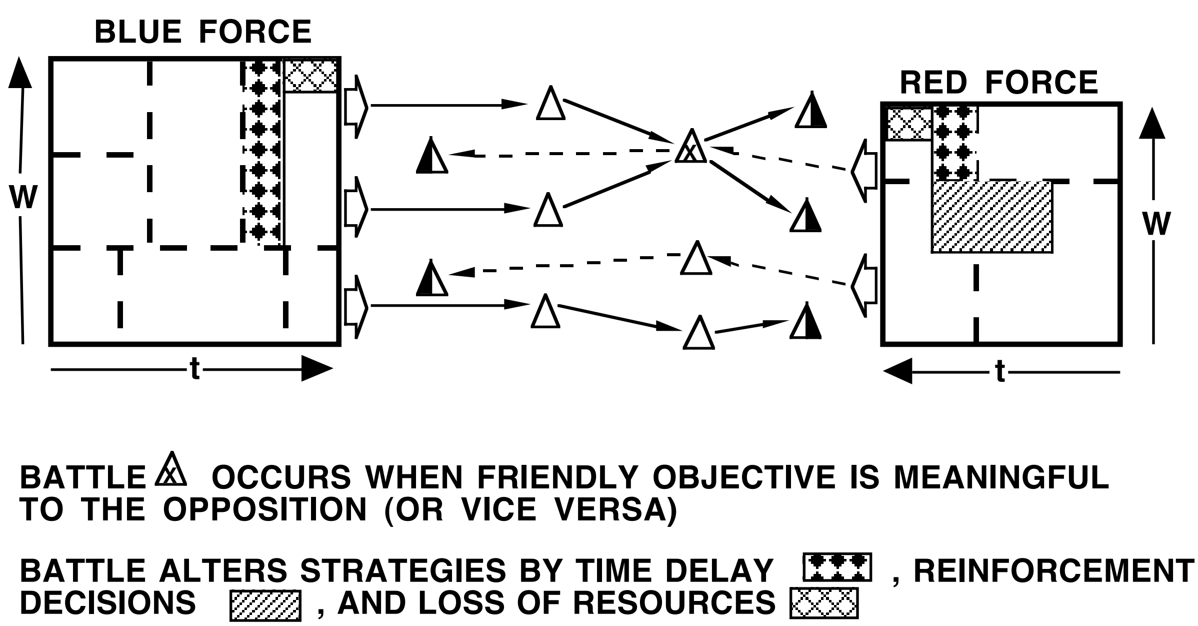


Figure 3. Nature Of Blue Advance

8 Its direct-fire capability can be an advantage to a helicopter or aircraft, provided it is properly munitioned and not constrained by heavy surface-to-air defense.

In advancing, each Blue element is expected to move along some rout connecting a series of terrain features. At each feature the element has the option of remaining, and perhaps engaging in a fire-fight, or of continuing to the next. It will remain unless the choice of becoming a casualty on the next leg $\left(p_{B_i}\right)$ is less than Q/V_{B_i}.

$$p_{B_i} = 1 - \exp\left[\int_{\Delta t_M} \Phi_{B_i} dt\right]$$

$$\Phi_{B_i} = \sum_j \Phi_{B_i,R_j}$$

$$\Phi_{B_i,R_j} = r_{F,R_j} \ln\left(1 - p_{B_i,R_j}\right)$$

The number of Red maneuver elements which can bring effective fire to bear on a route-segment is a strong determinant of p_{B_i}. Simultaneous advances by Blue elements may dilute the risk, since a Red element can generally engage only one at a time. However, unless they are equally "valuable" (threatening to Red course of action) Red will concentrate on that one presenting the greatest product of value and p_{B_i}. That one may well estimate the advance to be unprofitable.

Perhaps a more usual tactic will be for some set of Blue elements to advance while another "covers by fire". The fire is calculated to "suppress" - to impose enough risk on each R_j to prevent or degrade its fire.

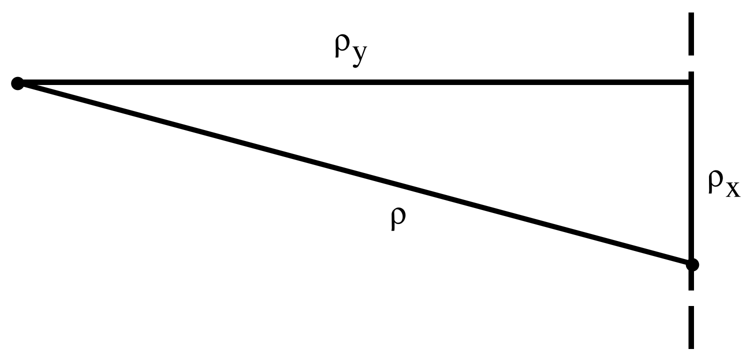
To decrease α would be to increase the number of Red maneuver elements. If they are employed on the same frontage and Blue attacks on that frontage, this has the effect of an increase in density, which is discussed in the next paragraph.

10.0 Let us consider the "density" of the maneuver elements on either side (not including reserves) as the number per unit length of the front on which the engagement takes place. Let us assume that Blue is advancing and Red is holding ground and consider the effects of increasing density.

If Blue elements are well-trained or battle-experienced they will maintain a suitable degree of dispersion both while moving and while at rest. This is a measure of self-preservation, because two or more elements form an attractive target for such weapons as machine-guns or grenades. In actuality, men in battle do tend to bunch up - this is a case where "human factors" overcome rational decision by the individuals concerned.

Increased Blue density may make it necessary to advance in "waves" to avoid undesirable concentrations, probably increasing the waiting time between waves. This is judged to be a minor effect, applicable only at very high densities.

The major effect of increase density is believed to be its effect on Φ_{B_i}, the risk to B_i along a certain route. This is the sum over j of Φ_{B_i,R_j} which is a function of the range between R_j and each point on the proposed route.



Sketch A.

The range can be considered as composed from ρ_x along the defensive front, and ρ_y perpendicular . Increased density of Red reduces ρ_x for some elements, with calculable results for Φ_{B_i} .

11.0 It may be noted at this point that the Fire capability of the maneuver elements affects the opposing movement in rather obvious ways.

Φ_{B_i,R_j} depends on rate of fire, accuracy as a function of range, and lethality of the weapon employed. If any of these are improved, the probability that Blue elements will be halted goes up, and the movement rate goes down.

12.0 The type of maneuver element has an effect on the movement rate - consider the characteristics of a tank as opposed to those of a rifleman.

The speed of movement of the element has probably the least effect. For short distances a rifleman can move about as fast cross-country as can a tank - though he will have to rest frequently. If the movement is against very light opposition the tank's speed may make substantial differences.

The major difference, however, is that the tank has a high degree of integral protection while the rifleman does not. A tank is truly vulnerable only to specialized anti-tank weapons; thus it can keep moving until these are encountered. it then may seek hull-down shelter to engage in a fire-fight. However, while at rest it may be subject to attack by infantrymen with shoulder-fired AT weapons, Molotov cocktails, etc. It can also be attacked by artillery if it stays long. Suitable features for tank occupation are less common than for riflemen. For all these reasons tanks will move a greater proportion of the time than will riflemen. If a tank attack is successful it will advance rapidly; if it meets heavy opposition it retreats as rapidly, and probably seeks another route.

The strength of a tank-infantry combination is that the infantry can help protect the tanks when at rest; while the tanks can lead, carry, or cover the advancing infantry.

13.0 Terrain affects the rate of advance by three characteristics:

1) Trafficability, 2) Cover, and 3) Concealment.[9]

The Trafficability of a route establishes the fraction of maximum speed which can be achieved in traversing that route. Thus high trafficability means that any given route can be traversed in less time, and therefore at less risk. High trafficability increases combat movement rates by increasing speed of motion and by reducing the frequency of stops.

Cover reduces the vulnerability of an element, "features" are features because they have available cover. If cover is plentiful features are close together and connecting routes are short. Elements are less likely to be stopped by the lack of a safe route, and the movement rate will go up.

Concealment affects the movement rate by its effect, through the Intelligence function, on the decision process. If an element cannot see the opponent(s) it must make assumptions as to their

[9] Note that cover implies some degree of concealment, the reverse is not necessarily true.

presence and position. If these assumptions are optimistically wrong, casualty rates will go up. If they are pessimistically wrong, the movement rate will slow down because elements will stop when there is no need.

14.0 The above effects on combat movement rate have dealt with the speed while moving and the frequency of stops. The length of stops also affects the movement rate very significantly.

When an element stops as a result of a rational decision, it will proceed again only if given reason to change that decision. This reason can be either a change of orders or a change in situation. The change in situation may develop from previous orders, may be a result of enemy action, or may result from a request by the element and resulting support fire.

Either the change in orders or the support fire brings in a reaction time Δt_r between the element's request and the desired event. Δt_r is composed of Intelligence delays, Signal delays, and Command delays. Obviously, shortening Δt_r will improve the movement rate.