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THE ANALYSIS OF BATTLE AS A PROCESS

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1. A system analyst should evidently be concerned with the analysis of systems. Webster's Collegiate Dictionary defines "system" as "an assembly of objects united by some form of regular action or interdependence." The "regular action" seems to imply that a typical system is dynamic, and certainly those of greatest interest to an analyst are dynamic -- are engaged in some process. A process is defined (same reference) as "any phenomenon which shows a continuous change in time; a series of actions or operations definitely conducing to an end."

2. To construct a useful analysis we must first select the system -- the collection of objects whose interdependence is to be examined, and then bound the process. The complex interdependence of real-life objects is such that it is almost impossible to isolate a closed system; the best that can be done is to isolate some set of objects having a strong interdependence. When this is done it remains necessary to consider also the influence of the environmental objects not included in the defined system -- on the operation of the system. The analysis should make it possible to express the terminal state of the system as an outcome of the initial state of the system and its environment and the intervening events.

3. Although modern computer capabilities make it possible to process large amounts of information in very brief periods of time, it is usually desirable to restrict an analysis in such a way that its procedures can be comprehended and its outputs usefully interpreted. The limitations on an analysis can be established in three ways:

a) The BREADTH of an analysis is measured by the number of different types of objects included. The numbers within each type are of secondary importance, though they should not be needlessly proliferated. The number of types determines the number of different interactions to be define, and that number tends to be N !

b) The DEPTH of the analysis is measured by the number of types of "events" defined. (See Paragraph 5)

c) The SCOPE of analysis is determined by the space-time volume included.

4. Tactical warfare is a process, a series of interactions among a large and diverse system of objects operating in a complex environment. It must be analyzed for two reasons:

a) The estimation process by which a commander selects a course of action is in fact a systems analysis. Limited application of system analysis techniques, always subject to human judgment override, can be of assistance in information processing for command purposes.

b) Analysis of weapons and other military systems which ignores or over-simplifies their total operational context can easily lead to very erroneous conclusions. An approach to analysis from the angle of the commander attempting to solve a combat problem does provide a total operational context.

5. To restrict an analysis of tactical warfare we start by defining its SCOPE -- the volume of space-time within which the process will be examined. Since it is fairly obvious that the entire war cannot be profitably examined without some prior consideration of smaller constituent phenomena, we shall have to hack out a piece which we call a "battle". A battle is going on, in our terminology, if the selected volume contains opposing Fire elements (see below) and at least one side has been issued currently effective combat orders (values of directive variables, see below).

The system thus isolated will, of course, have an environment, adjacent areas of space in which other battles are often going on, and precedent and subsequent events outside the selected time range. In limiting the scope of the analysis we have now created the requirement for expressing the interrelation of adjacent battles -- a two-way flow of information, resources, and functional performance.

The environment can be classified into natural environment -- terrain and weather -- and various sets of objects (systems). Always existent are the opposing military force, "friendly" (uniformly

designated hereafter as Blue) and "enemy" (Red). In addition, for specialized analyses, such as guerrilla warfare, one may consider other classes, e.g., population forces.

The set of objects involved in tactical warfare is extremely varied; in fact, considering the diversity of human response, it is probably the case that no two are exactly alike. To make any useful analysis it is necessary to select a limited number of types (establishing the BREADTH of the analysis) and to express their capabilities for interaction in terms of some uniform performance variables. It is also to be recognized that capability varies in time (because of events like resupply, maintenance, etc.) according to current values of state variables. To make it possible to tie the analysis to the real world it is desirable that these performance and state variables be defined in such a way that input values can be derived by experiment.

This tie-in to experimental values can probably be achieved at the level of what we designate as military elements. An element is a military asset which cannot be subdivided without losing the capability for performance of its function -- one of the nine military functions enumerated below. It is recognized that all of these elements are in fact systems consisting of interacting components; at a lower level (DEPTH) of analysis (see discussion of events, below) the performance and state variables can be explained in terms of component interaction and relation to the environment.

Analysis at the level of elements must be limited to rather low-level military operations in order to establish a BREADTH of analysis producing understandable results. To progress to higher-level operations it is necessary to define military units -- sets of elements. Definition of the performance and state variables of units requires aggregation from the corresponding variables for elements.

The defined military elements interact by performance of nine selected military function -- Command, Fire, Maneuver, Intelligence, Supply, Transportation, Maintenance, Construction, and Signal. In addition, the hostile interaction of units is expressed in terms of a composite function termed Combat. Each performance of a function results in an Event which may alter the state of one or more elements. Certain processes involving only one element are necessary preludes to the performance of the functions -- for instance, before orders are issued a Command element must have completed processes of Planning and Estimation. Stages in these processes which mark different levels of readiness for the performance of function (Potential) may be defined as another type of event. The number of types and outcomes of event establishes the detail with which processes are modeled and the DEPTH of the total analysis.

The events take place in space and time, and each event is regarded as leading to other events. To express this relationship analytically we must define interface variables, at least one for each function. An interface variable is an expression of the output of the functional performance of one element or unit (e.g., a quantity of supply transferred) which enters into determination of the changed potential of the element or unit acted upon.

The interface variables are regarded as confined to relationships within the defined system. Similar relations may be modeled across the system-environment boundary, but in such case we consider the vehicle of effect in the system to be an environmental variable. Typically environmental variables will represent the aggregated effect of larger systems than that one being analyzed, and cannot be expressed in the same terms as interface variables.

Because of the inclusion in the battle of human intelligence, events must be regarded as falling into two general classes -- Probability-dependent and Logic-dependent. Certain of the events, once triggered, have an outcome determined by physical processes. If they could be modeled with infinitely detailed input, the outcome would actually be deterministic, but since we are normally modeling on some aggregated level, we must treat the uncertainty of outcome probabilistically. The other class of events occurs as the result of some human decision based on some process of thinking. To model the processes of thought we must fall back on some body of rules for thinking which we term "logic", while recognizing that some decisions taken under uncertainty must be intuitive rather than logical.

To handle decisions and orders we use another class of variables -- directive variables. These are used in processes of estimation and decision and communicated in the resulting orders.

6. To summarize, in order to analyze the process of battle even at a low level, we must define in each case:

Space-time volume to be analyzed

Types and numbers of elements or units

Events considered

Performance variables

State variables

Interface variables

Environmental variables

Directive variables

In order to progress to higher-echelon analyses we must discover useful methods of aggregating the above. In making such aggregations we must endeavor to define a connection back to empirically-determinable input.

Appendix A