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Electronics Warfare Concept

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The complexities of electronic warfare often discourage the amateur from attempting to understand the basic concepts involved. These concepts have retained their validity over the broad sweep of history, but the techniques for achieving them have changed dramatically in recent years. If the commanding officer achieves an understanding of these concepts and a knowledge of the capabilities of the equipment in his command, he will be able to manage his units effectively without detailed technical training.

ELECTRONICS WARFARE CONCEPT

An article prepared

by

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Most readers may have some trouble in following terms specialized to electronics. Does hearing the words "white noise swept frequency jamming" turn you on? If you are comfortable with that phrase, you probably also like to discuss fast time constants or the ratio of information band width to spectrum band width. Most likely, however, none of these words mean much to you for, as every trade does, there is a jargon used by the professionals of EW. This jargon need not turn off your own signal processor called commonsense for the basic ideas are really quite simple. This discussion should first touch the underlying concept for electronic warfare and then try to relate it to some operational parameters.

Let me start by asserting that concepts are not new—only techniques. Over two thousand years ago, Alexander the Great maintained campfires as an indicator of a fixed force while he actually maneuvered troops to new positions. A century ago it was logs painted black arranged in typical artillery array—called Quaker guns since they couldn't hurt anyone—that provided the balloon-borne observers of the Northern armies a false impression of Lee's strength. Today we use electronics for the same general function as the campfires and logs of yesteryear—to manipulate the information-gathering and transfer process. Information and the manner of its use affects actions. Thus, the information gathering and processing system is the target for electronic warfare which uses some new techniques for an ancient task.

Modern military actions are frequently dependent on a variety of technological wonders: for example, the airplanes of today that carry a man faster than artillery shells that once were the superlative of conversation with the phrase, "faster than a bullet." Similarly, the basic human senses of eyes, ears, and memory have been remarkably extended in time and distance. The ability to talk and hear is limited by nature to short distances. Now, men, miles apart, can converse with ease through the magic of modern communications. The exact same technology that permits the conversation also grants to the adversary the opportunity to eavesdrop or the ability to disrupt. The extension of the eyes which we call radar, penetrating night and fog, is essential to our civil and military aviation. Technology is even handled here too, for radars can be jammed or can furnish to an adversary data on one's own forces. The list can go on through sonars and a variety of other devices. Looked at individually, the list is bewildering in its complexity, with all of them candidates for electronic warfare. To treat them individually is nearly impossible. Order and simplicity must be introduced to cope with planning needs.

The proposal that I make is to think of electronic warfare as an element of a learning process. When one first learns to read, one needs good lighting, quiet, and supporting help by a teacher. Progress at first is slow, then accelerates, and finally is followed by a final level of skill. If we quantify the skill as words per minute with retention of meaning, a growth pattern of skill as a function of time will result.[1] The result can be visualized as shown on figure 1.

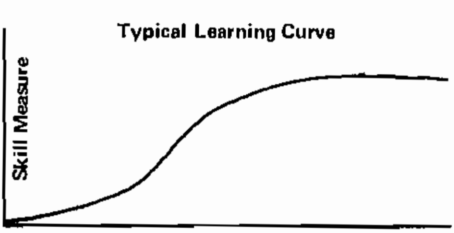

Figure 1

Complex skills such as operating a typewriter can be shown by laboratory tests to follow somewhat the shape of figure 1. Most readers can visualize that more complicated group tasks such as those involved in the tasks performed by combat information center's control of a fighter plane to intercept an enemy plane follows a similar pattern. First attempts of a crew newly assembled are best described as chaotic. Gradually things improve until a smoothly functioning team will emerge with crisp voice procedures and predictable results. Additional practice may yield very little improvement, and a plateau of ability is reached. The fighter direction process, if not exactly identical to figure 1, does have the general characteristic of that curve.[2]

Other examples of complex team skills characteristically used in military tasks can be easily cited. In antisubmarine warfare we might quantify the skill measure in another way such as the probability of detection of a submarine which tries to penetrate the screen.

Let us now consider what the impact of electronic warfare on these complex team skills might be. First of all, return to the example of reading skill. Once reasonable proficiency is reached in reading ability, we can complicate the problem of reading by a variety of disruptive techniques. The lighting can be varied or troublesome noises can mar the quiet. At first, such effects are disastrous to the reader. Gradually, however, the reader will regain much of his ability to read despite these upsets unless catastrophic conditions obtain. The general characteristics of the disruption and recovery are shown on figure 2.

In the military problem the change from a "clear environment" to an "electronic warfare environment" is a somewhat similar change to that from reading in the quiet of the library to reading in the noise of a subway. The first reaction of the naive radar operator faced with unexpected jamming may be to send for the electronic technician to repair the equipment failure. On the

LEARNING PROCESS DISRUPTED

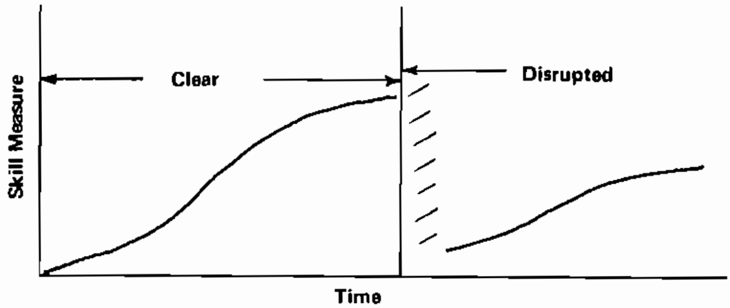

Figure 2

figure 2 curve with the hatched area, the team skill level will now drop to zero. At a somewhat later time, the combat information center may transfer fighter control to another center with a less favorable control so that the overall performance recovers somewhat. Gradually, a combination of new tactics, procedures, and perhaps even modified equipment permits a return to a new level of skill. This may be greatly improved over the initial disaster level, but may not achieve again the original skill level.

For those who are oriented toward other military tasks than fighter direction, you might consider other cases. Consider the example of the destroyer skipper of World War II who gleefully expended depth charges on the false contact created by a pillenwerfer. The overall kill capability based on a complex team skill of sonar operators, ship handlers, and ordnance personnel had dropped from one level measured by one kill per 10 attacks to nearly zero. This useless skill level may have lasted for hours or days. Eventually, however, with the help of postbattle analysis, shared experience with other crews, specialized training, the performance recovered. Eventually, the seasoned crew could again achieve their mission but at a level which would not have fully recovered without the development of new weapons and equipment.

There are crucial factors that the operational planner should understand from these simple examples. First of all, the team performance depended upon quality of information and speed of its transfer and could therefore be disrupted by an electronic warfare technique. Secondly, the introduction of electronic warfare may have a profound initial effect. The final observation, however, is that this impact rarely is permanent by itself. The introduction of electronic warfare should thus be considered as merely the start of a new learning cycle. The military commander must use this window of opportunity to accomplish his objective which is usually the equivalent of the academic technique of flunking the student. The commander really should terminate the learning process using another tool of his trade.

In the previous discussion, it was assumed that all the recovery phase flows smoothly as continuous improvement. As the history of warfare clearly shows, however, humans are prone to error. The example of German search receivers for U-boat protection is a near classic. The search radars on Allied airplanes were partly defeated by use of the R600 or "Metox" which detected the British Mk II radar before the radar could detect a submarine.[3] When the shift took place to the new wave length of S-band provided by the Mk III, in early 1943, the Germans initially experimented with infrared detectors and followed tactics which from their viewpoint were disastrous. A far more realistic process that accompanies use of electronic warfare is to increase the opportunities for blunders. The learning process will become more like figure 3. In the case of World War II, recovery was too slow and late to modify the battle results.

It is impossible to introduce into the planning process an estimate of the adversary's blunder rate. One can test a plan, however, to see if it contains the flexibility needed to capitalize upon mistakes when they take place. Every case will no doubt be different, but a simple mental question—What happens if he makes a mistake?—should be on every planner's check list. Since a characteristic of electronic warfare is to increase the opportunity for mistakes, the question is relevant whenever electronic warfare is part of the plan.

DISRUPTED LEARNING WITH ERROR

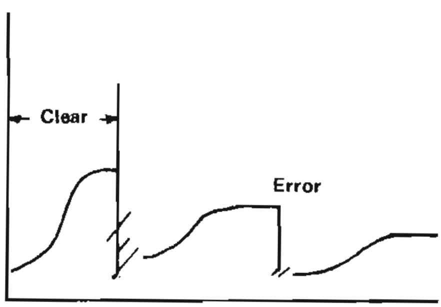

Figure 3

Perhaps no other aspect of electronic warfare planning is as faulty as the belief that EW is a separate entity. Pious hopes that THEY know what all the words mean is grossly inadequate. The slang expression that "the best jammer is a 1000-lb. bomb" is pithy and full of folk wisdom. Military planners know that interdiction of supplies by itself is useless. All that interdiction of material can do is create tactical control of logistics long enough to permit successful battle action. For some reason, the minute jammers, signal to noise ratio, or any other similar term arises. Many planners seem to retreat from a realistic application of combined consideration of the EW effects and what tactical actions can take place during the time of those effects. Interdiction of the flow of information can rarely by itself win any battles. Just as a planner considers trade-offs of use of air power for interdiction versus close air support, similar trade-offs apply to electronic warfare. The learning process which is disrupted by EW can be terminated by other means. A planner should force himself to invent an alternate procedure so that he can then apply the usual tests of feasibility and desirability.

There is no intention to convince the reader that figures 2 and 3 are precise statements of real life. These figures do, however, show what are the essential facts needed for a plan which includes EW. First of all, the enemy's skill level needs to be high enough so that it is worthwhile to change. Your first task is to estimate present capability. If your professional help with the double-talk jargon promises to destroy this capa-

BIOGRAPHIC SUMMARY

Professor James C. Aller has extensive experience in electronics, computers, and operations analysis. After graduating from Annapolis in 1942, he completed 20 years in the naval service, obtaining in the process a master's degree from Harvard in 1949. Professor Aller then served for 4 years with the Operations Evaluation Group, after which he took academic leave to obtain a doctorate from The George Washington University. The author of a variety of technical papers and publications, Professor Aller presently holds the Chair of Physical Sciences at the Naval War College.

bility, you have two more tasks which can be phrased as questions. How long will this reduced capability last? Equally important, what is the estimated recovery rate? The essence of your operational problem is to win before recovery takes place. Your planning problem is to fit the other elements of your tactical plan together so that the expected result is in your favor.

FOOTNOTES

1. Bernard Berelson and Gary A. Steiner, *Human Behavior* (New York: Harcourt, 1966).
2. Richard C. Atkinson, et al, *An Introduction to Mathematical Learning Theory* (New York: Wiley, 1966).
3. Philip M. Morse and George E. Kimball, *Methods of Operations Research*, OEG Report No. 54 (n.p., 1946).

The unresting progress of mankind causes continual change in the weapons; and with that must come a continual change in the manner of fighting.

Mahan, 1840-1914