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Warfare in the Fourth Dimension-ls the Navy Ready for it?

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Warfare in the Fourth Dimension— Is the Navy Ready for it? How can the Navy Prepare for it?

by

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Most dictionaries define the fourth dimension as time, however, some military writings refer to a fourth dimension of military endeavor beyond the three traditional ones of sea, air and land. That dimension is the electromagnetic spectrum. The two concepts may, at first glance appear to have little in common with each other but, in fact, they are closely related. The battle for the electromagnetic spectrum is, in many respects, a battle for time.

RAdm. Albert A. Gallotta, a recent Director, Electronic Warfare and Cryptology, Office of the Chief of Naval Operations, made the point very clear indeed when he said, "I view all battles as having a time line that can be divided into four phases: 1) the force coordination phase, 2) the surveillance phase, 3) the targeting, weapons direction phase, and 4) the weapon's fusing and impact phase, i.e., the actual engagement. Electronic warfare is paramount in the first three phases." He went on to say that we need to get our operational commanders to spend more time thinking about the first three phases of the battle, rather than spending all of their time thinking about only the last two (targeting and engagement).[1]

The purpose of this paper is to define a need within the Navy for additional thinking about "warfare in the fourth dimension" and to suggest how electronic warfare could be simulated for education and training purposes at the Naval War College to add to the readiness of our Navy. Fleet readiness is the primary mission of the Naval War College and its Center for War Gaming and it must be remembered readiness is a primary requirement for any strategy involving the Navy, no matter what its objective.

The Naval War College is acquiring a new computer-driven war gaming system, the Naval War Gaming System, to assist in maintaining that readiness. The Naval War Gaming System will have the capability to simulate EW and C^3 (command, control and communications) systems; but, as delivered, that capability needs further refinement in order to accurately play EW and C^3 systems. Currently the Naval War College inputs EW into its war games by modifying the probability of kill (pk) in its battle damage assessment calculations. This method, while better than nothing, is insufficient to accurately measure the effectiveness of EW. A major portion of the effectiveness of EW is the time delays that it generates. This is true of both offensive and defensive EW systems. War gaming Battle Damage Assessment is only a

terminal defense versus offensive power calculation rather than an assessment of a system's effectiveness across all four phases of the battle.

Some senior naval officers on both sides already recognize the significance of the battle for the fourth dimension. Both Admiral Gorshkov and Admiral Moorer have indicated they believe that the side which controls the electromagnetic spectrum in the next war will be the winner.[2] However, most less senior officers are not yet aware of the impact that modern electronic warfare technology can and will have on modern warfare.

The Defense Science Board made some comments in its April 1979 Summary Report that go right to the heart of the matter: "A major reason for lack of progress within the US Navy operating forces to date in achieving counter-C^3 capabilities is that relatively few naval officers understand the significance of the change in character of war at sea that current Soviet naval doctrine and electronic warfare capabilities impose. These few who are aware are generally those whose normal duties require exposure to compartmented intelligence. The Navy, as an institution, has not yet recognized this problem. *This, a principal conclusion is that basic change is required in the attitude and emphasis of U.S. naval thought regarding the role of electronic warfare in war.* Some organizational means is required to bring about that change by defining the operational concepts to ensure a whole product—not one that is strong in one aspect and weak in another. Fleet participation in the effort is essential.

"Substantial improvements in force survivability and combat effectiveness can be attained only if the various counter-C^3 measures identified in this report are thoroughly integrated with other operational initiatives . . . . Current arrangements for integration of operational doctrine development with the development of requisite counter-C^3 capabilities are casual and fragmented and so do not achieve the necessary integration."[3]

The Soviets appear to be ahead of us in this regard. It has been clear for some time that they plan to control the electromagnetic environment in war just as they plan to control the other three dimensions.[4] Unclassified writings on the various aspects of a doctrine the Soviets call "radioelectronic combat" (REC) are very clear. Their doctrine integrates all aspects of EW with destructive firepower to neutralize enemy command, control and communications facilities. "Soviet EW specialists, whose skills and equipment currently exceed our own to a significant extent, seek soft kills against a comprehensive spectrum of targets: command/control and communications; radars, fire control systems; infrared and optical seekers; navigation aids; and so on."[5] Their primary mission is to introduce time delays in an opponent's execution of his war plans, be they offensive or defensive plans.[6] This is the essence of the REC doctrine.

The United States is developing a similar doctrine that they call "command, control and communications countermeasures," (C^3CM).[7] The main difference between REC and C^3CM is that the Soviet's doctrine appears to be in place and operational while ours is an embryonic state. To be sure the United States has successfully employed electronic warfare in the past but not in the integrated, coordinated manner in which Soviet writings suggest. The Soviets have obviously devoted a comparatively large share of their resources (time, manpower, money) to this concept. Given the technical capabilities of the US defense industrial base there is no doubt that we have a broad spectrum of very capable EW/C^3CM systems and

can develop more if the resources are provided. But, even as we develop these systems, the question that remains in many people's minds is—How are we going to train our operational commanders in their use?[8] Clearly we have deficiencies in the area of EW/C^3CM training that need to be rectified.

Why study electronic warfare? Electronic warfare is often referred to as the "soft kill" option but in fact is a soft kill only in that it does not do the actual destroying. Successful EW can generate time delays in bringing weapons systems to bear to the point that the weapons systems are useless. This is the focal point of this paper and should be examined in more detail. Each of the three basic elements of EW: Electronic Warfare Support Measures (ESM), Electronic Countermeasures (ECM) and Electronic Counter Countermeasures (ECCM), can be directly related to that statement. Successful ESM can provide warning to allow one time to either move out of harm's way or employ one's hard kill weapons systems against approaching enemy forces. Successful ECM can generate time delays and confusion for the enemy which will allow greater opportunities for maximizing one's own hard kill weapons engagement opportunities. ECCM can cancel or minimize time delays and confusion factors created by an opponents' ECM.

As an example, much has been written about the effect on naval warfare of the small missile that destroyed HMS *Sheffield*. However, very little has been noted in the press on how that Argentine fighter-bomber came to be in position to launch that missile. One account did mention that HMS *Sheffield* had shut down its air search radar to avoid detection from Argentine ESM-equipped aircraft. Additionally, the *Sheffield* appears not to have detected any emissions from the Super Entendard. Thus the aircraft was able to close to within missile-launch range and accomplish its mission. The failure of the *Sheffield*'s ESM gear, be it because of faulty design or equipment failure, provided the *time* needed for the plane to close the ship and launch its missile undetected. If the *Sheffield* had had the opportunity, and it appears that she did not, she could have employed ECM (jamming/chaff), to degrade the Super Entendard's targeting system which would have delayed the launch of the Exocet or at least degraded its probability of success.

There is another possibility beyond those of faulty design or equipment failure and that is that the position of the *Sheffield* had been fixed by Argentine (or Soviet?) SIGINT/ESM and that information was provided to the fighter-bomber either before it took off and/or while it was en route to the *Sheffield*. If this is the case, then the Super Entendard may not have needed to turn on any emitter until it was quite close to the *Sheffield*, thereby decreasing the *time* available to the British to detect and react. One way or the other, it is those kinds of risks we run if we are not "up to speed" on warfare in the fourth dimension.

REC and C^3CM, part and parcel of that warfare, are generally conceded to have four aspects, referred to by the Defense Science Board as the four horsemen of the modern apocalypse. They are: Exploitation, Deception, Denial, and Destruction. EW plays a large role in the first three and provides targeting for the fourth. While "exploitation" and "denial" are fully covered by the tradirional terms, ESM and ECM, respectively, "deception" has many more components than just its EW aspects (which are generally grouped under ECM). However, this paper will address only the EW portions of "deception."

The Soviets are known to have large numbers of devices for the exploitation, deception and denial (jamming) of emissions. Those systems are located on land, in specially configured aircraft and in surface ships (AGIs). They are also reported to have those capabilities in many, if not most, of their surface warships as well as many of their civilian-manned ships (including merchant, fishing and scientific research fleet ships). They may also have some of those capabilities in some or all of their submarines. Additionally, they are reported to have satellites with the capability to exploit emissions.

In all the Soviets pose a very significant threat to our C^3. They can exploit our C^3 for targeting and/or intelligence and they can deceive or deny large portions of it. The above is a thumbnail sketch of the problems we face. The Soviets appear to have both the capability and intent to fully exploit the fourth dimension, be it defined as time or the electromagnetic spectrum.[9]

The US is known to possess similar systems as well, but security constraints preclude an in-depth review of either side's EW capabilities in an unclassified publication such as this. Even if we have the systems we need a coordinated doctrine. One way to develop and test the needed doctrine would be through war gaming. The end result, if fully implemented and supported, would be the capability to develop and evaluate EW doctrine, strategy and tactics. The envisioned system would also provide our operational commanders with an appreciation of their EW assets and capabilities in addition to their liabilities and vulnerabilities, (the understanding of which are, according to RAdm. Gallotta, woefully deficient in today's US fleet).[10]

By preparing our operational commanders for warfare in the fourth dimension via war gaming they will be much better able to survive and win on the modern battlefield. However, at this time, EW is not adequately war gamed anywhere.[11] War gaming of EW requires more sophistication than standard simulation and analytical models which only provide "snap shot" views of iterative processes. An EW war game system would need to be designed as a logic path or a series of logic paths that conceptually mirror real world systems. With this approach, aggregated or fine-grain subroutines can be applied either at the end of logic paths and/or on the objectives of a particular game. The majority of war games at the Naval War College are, historically, "decision-making" games aimed at education and training. The concept outlined in this paper is perfectly consistent with decision-making and tactical/strategic research games such as the Global War Game and NavMat series. An example of the benefits of these kinds of games is the play of the Orange plans prior to WWII which had such a large and direct bearing on our successful prosecution of the war in the Pacific during WWII.

If we are to upgrade our capability to play EW/C^3CM in war games at the Naval War College the first two questions that must be answered are "How?" and "To what extent?" These are questions that, although simple in appearance, require much thought and analysis. As indicated above war games at the Naval War College are designed to give both students and actual naval commanders and staffs tactical/strategic decision-making experiences leading to the development and evaluation of tactical doctrine, thus the "To what extent" part of the question may be the easier question to answer. EW should be included in war gaming to the extent that it contributes to the players' understanding of modern warfare, but not to an extent that prohibits the tactical functioning of the war game scenario. It will be

important to have the right mix of "soft" and "hard" kill in the game because too much "soft" kill could bring the game to a grinding halt without demonstrating anything other than the confusion that is real war even in this electronic age.

The first part of the question, "How do you play EW in war games?" has been the subject of a great deal of discussion. Both the complexity of EW/C^3CM and the high security classification of much of the specifics of EW/C^3CM are problems that must be dealt with. Numerous organizations have undertaken studies on simulation and analysis of EW and C^3 systems for either equipment design analysis or training and tactical decision-making analysis. War gaming at the Naval War College clearly falls into the second category.

Many of the procedures and computer routines that these organizations have created for their studies may very well have direct application to the introduction of a higher level of EW/C^3CM play in naval war gaming.[12] However, several of the studies were concerned with technical (as opposed to procedural) aspects of EW. As such, they are significanrly more detailed than may be required to demonstrate EW/C^3CM at the level of Naval War College usages but, their lessons learned can be incorporated into war gaming at the Naval War College. Other organizations' efforts more closely approach needs of the Naval War College. As an example, while under contract to the Electromagnetic Compatibility Analysis Center, Annapolis, Md., the IIT Research Institute designed, programmed, and installed a system that integrated the dynamic aspects of EW into a computer-assisted war game to analyze the impact of EW on US Army systems, doctrine and tactics. While this system is designed to analyze the performance of tactically deployed Army communications and EW equipment as they would operate in a land engagement, the system does appear to have a core capability which may have applicability in analyzing the impact of EW/C^3CM on US Navy systems, doctrine and tactics. In brief, there are a number of organizations currently doing work that may be applicable to Naval War College needs.

In order to accurately simulate EW/C^3CM play in war gaming it is necessary to fully define both opponents' EW and C^3 capabilities. Those definitions need to include lists of platforms, encompassing ships, planes, submarines, satellites and land sites, with an index of equipment that may be assigned to each platform. Those equipments should include all known C^3 and EW systems such as radars, navigation aids, and communications systems as well as all known or postulated deception, ESM, ECM and ECCM systems. Each of the systems should be described in a separate listing with its capabilities and characteristics such as sensitivity, effective radiated power and frequency range contained in tables that could be modified by a designated war game system operator. These requirements are met in many, but not all, respects by the data base already being prepared for the Naval War Gaming System. That data base will incorporate most of the operational characteristics of nearly all Soviet and US ships, aircraft and submarines.

EW/C^3CM game play requires a routine that will accommodate man-machine-man interface for a two-sided war game. It must give the players the capability to select their options, both active and passive, and then to monitor their selection(s) in terms of status and results. The machine routine should be capable of assessing player against player actions on a real-time basis in order to provide the dynamic capability required for strategic/tactical training as well as analysis and research.

In the final analysis, it is link connectivities that must be modeled in order to successfully describe EW and C^3 system effectiveness. Link connectivity can be best described with an example. A transmitter to receiver is one link (T_1-R_1) a jammer to the same receiver is another link (J_1-R_1). Comparing the two links, the one with the highest signal-to-noise ratio at the receiver (R_1) is the predominant link. When the signal-to-noise ratio of the jammer reaches a certain predetermined value of the signal-to-noise ratio of the transmitter at the receiver, then the jamming is judged to commence being effective. What in effect is happening is that one link connectivity (T_1-R_1) is being overridden by a second link (J_1-R_1). A sliding scale of degradation and effectiveness based on receiver/transmitter/jammer locational geometry, systems' capabilities and environmental factors would need to be used to most accurately portray EW interactions. The same process, matching link connectivity, can be used to judge the effectiveness of jamming systems, intercept systems, DF systems and deception systems. I.e., if the signal to noise ratio of a specific link, be it T_1-R_1, J_1-R_1 or T_{25}-R_1, is beyond a certain, predetermined value, then the link is effective.

Game Play:

The following is a brief description of the procedures envisioned to be required to adequately war game EW/C^3CM. Game play would be initiated by a player (Team A) attempting a specific tactical action, such as the intercept of an air raid or changing the disposition of his fleet. In order for the Naval War Gaming System's computer to understand exactly what is happening the player would need to use a specific key word from a furnished list. The system would then be alerted when the war gamer did some specific action such as hitting the "TRANSMIT" button on the keyboard. (This method of alertment/action initiation presupposes that all orders in the war game are or can be transmitted via CRT I/O devices such as the Interactive Console Station of the Naval War Gaming System.

The use of a key word will allow the action specified to be routed to the computer automatically. The computer must have tables in its memory which would specify which emitters are required and what emitters would be helpful to accomplish the task specified by that key word. Team A has the opportunity of designating whether they were turning on or shutting down any specific emitter that was not on the "NEED TO HAVE" list, be it a piece of communications gear, a radar, a navigation aid, a jammer or a deception device (with a concomitant enhancement or reduction of mission effectiveness). The EMCON (Emission Control) posture of the units will also be considered. The Naval War Gaming System would then search its files to see what systems, active or passive, on Team B's side (the opposition) are within range. This is accomplished by comparing the position of each Team B platform and the range of its systems with the position of Team A's platform and the target emitters. If Team B has an ESM system within range, then notice will be sent to Team B's EW module for evaluation and relay to its command module that a detection had taken place, listing what was detected, e.g., an SPS-48 radar, a TOPSAIL radar, HF TTY, HF link 11, etc. If Team B has a DF system within range then a line-of-bearing is also sent to Team B's EW module for evaluation and relay to its command module. If Team B has a jammer or an applicable deception device within range and Team B has

elected to turn them on, then the effectiveness of Team A's emitter(s) would be judged to be degraded by a factor predicated on a computation of the variables that are dialed into the game (weather, effective radiated power, sensitivity) and that are computed at that time (range, propagation). Team A is then notified that the effectiveness of its specific tactical action had been degraded by jamming or deception, as appropriate; however, teams will have to wait until the "hor wash up" to find out which of their signals had been passively exploited and what the results were. This procedure melds both real war realities (generally, one does not know which of its signals are being exploited) with the proven training/educational technique of immediate feedback.

Imitative deception signals could be simulated just as the signals they are imitating are simulated. Detection and reporting of those signals would flow through the system just as a real signal (which is what happens in the real world).

The procedures described above place specific information requirements on the war gaming system. The interconnectives and capabilities of both sides' EW and C^3 systems would need to be described. Information of the interconnectivities and capabilities of the US Navy is available and must be continuously updated via fleet communications operating instructions and operating orders. Soviet interconnectivities and capabilities need to be developed and maintained from information available at the SECRET level, the classification level of most war games. Our knowledge of Soviet capabilities and interconnectivities is the most sensitive aspect of this whole question, but enough information is available at the SECRET level to realistically simulate Soviet EW and C^3 systems and their functioning. Indeed, to model one side and not the other's EW or C^3 systems would place an unrealistic bias in this entire procedure and skew results to the point that untrue, and possibly unwise, tactical lessons would be inferred, one of the primary problems we are seeking to overcome by introducing more realistic EW/C^3CM play into war games.

The envisioned EW/C^3CM subsystem need not be designed for fine-grain analysis of EW and C^3 systems. To do so would make the system interaction calculations significantly more difficult, requiring much more computer power, and yet not contribute significantly to the fleet operator's understanding of the tactical value and dangers of EW/C^3CM. Required figures of merit for system versus system calculations could be derived from studies done by analytical systems such as the ones at the Applied Physics Laboratory and the Naval Ocean Systems Center as well as the Naval Postgraduate School.[13]

As envisioned by this proposal, and that is what it is at this time, the EW/C^3CM aspect of war gaming could be played either as an end in itself—as an EW/C^3CM war game—or be integrated into regular war games, with only the results impinging on the interaction of the opposing forces. The use of the effective radiated power, sensitivity and frequency range in user-controlled tables would permit the changing of the emphasis of the game in mid-game. Basically, the EW/C^3CM war game subsystem outlined above requires computer resident indices of equipments, cross-referenced to platforms, tables of equipments' characteristics and capabilities, and matrices of systems required and systems "nice to have" for each specific tactical action as well as a matrix of each system's vulnerabilities, expressed as a figure of merit, in order to calculate and express overall system measures of effectiveness.

The above subsystem would be sufficiently granular to provide war game players with immediate feedback as to their EW/C^3CM vulnerabilities and deficiencies as well as their EW/C^3CM assets and capabilities. By using proven figures of merit the results would be scientifically verifiable while demonstrating to the players their need to fully consider the electronic "weapon," the "battle for the fourth dimension," in all tactical decisions. The subsystem could be used to develop and test doctrine and tactics as well as provide training and education.

The choice is clear. The status qno is unsatisfactory and fine-grain analysis is not required to educate and train fleet operators. A system similar to what is ontlined in this paper should be implemented at tbe Naval War College as soon as possible. Clearly more work needs to be done on this concept but this paper is a start from which further definition and refinement can be made. In the end, hopefnlly, the Navy will have a capability to educate and train its commanders to think and fight in terms of the "Fourth Dimension."

Notes

1. Speech by RAdm. A.A. Gallotta, Director, Electronics Warfare and Cryptology, Office of the Chief of Naval Operations, at the Naval War College, 21 May 1982.

2. Robert B. Batburst, *Understanding the Soviet Navy: A Handbook* (Newport, R.I.: Naval War College Press, 1979), p. 127.

3. Defense Science Board, Task Force on Navy Counter C^3(U), (Washington, D.C.: April 1979), p. 19. SECRET

4. M.P. Atrazhev, V.A. Il'uin and N.P. Mar'yin, *Electronic Warfare*—Bor'ba s radioelecktronnynii sredstvami (Moscow: Voyenizdat, 1972), translated by Leo Kanner Associates, Redwood City, Calif., p. 2-7. V. Grankin, *Electronic Warfare*—(Moscow, Voyennyy Vestnik, Nr. 4, April 1977), translated by Translation Division Foreign Technology Division, WP-AFB, Ohio.

5. John M. Collins, *U.S.-Soviet Military Balance 1960-1980* (New York: McGraw-Hill, 1980) p. 233.

6. Walter P. Senio, Systems Research Laboratory, *A Study of Soviet C^3, Electronics Warfare, and SIGINT Terminology* (U), (Washington, D.C.: Defense Intelligence Agency, March 1982), p.I.1. SECRET.

7. US Dept. of Defense, *Command, Control and Communications Countermeasures (C^3CM)*, DODINST 4600.4 (Washington: 1979), p. 1.

8. A.A. Gallotta, "Training-along the Road to Combat Effectiveness," *Journal of Electronic Reference*, September/October 1981, p. 22.

9. For a more complete unclassified description of Soviet REC capabilities see Guy Thomas, "Soviet Radio Electronic Combat and the U.S. Navy," *Naval War College Review*, July-August 1982, p. 16.

10. RAdm. A.A. Gallotta speech.

11. Interview with Dr. Frank Shoup, Deputy Director for Studies and Analysis, Systems Analysis Division, Office of the Chief of Naval Operations, 8 March 1982.

12. Robert Brandenburg of Naval Ocean Science Center, San Diego, Calif., Thomas P. Roina of Boeing Aerospace Company, Seattle, Wash., Charles A. Gettier of Illinois Institute of Technology Research Institute, Annapolis, Md., and Cdr. Gallagher of the Data Link Vulnerability Joint Test Force, Kirtland AFB, NM., have each written papers that have substantial input to the formulization of this study's concepts of how EW/C^3CM could be incorporated into war gaming at the Naval War College.

13. The Applied Physics Laboratory of the Johns Hopkins University concluded a study using their Battle Analyzer war gaming facility to determine the level of antijamming protection a naval task force would require in nine scripted scenario war game events. In order to perform their analysis, the Applied Physics Laboratory (and several other organizations) have created statistical descriptions of HF and UHF propagation (a central necessity for the accurate war gaming of EW and C^3 systems).

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- Courtesy, Admiral Isaac Campbell Kidd, U.S. Navy (retired), who says he first saw it on the wall of Ammiraglio di Squadra Guiseppe Roselli-Lorenzini when the latter was Chief of Staff of the Italian Navy. It has been attributed both to Petronius, a Roman satirist from the first century, A.D. (though the style and subject suggest otherwise), and to an anonymous, but obviously observant, officer on duty in the Pentagon.

Logisticians are a sad, embittered race of men, very much in demand in war, who sink resentfully into obscurity in peace.

They deal only with facts, but must work for men who traffic in theories. They emerge during war because war is very much fact.

They disappear in peace, because in peace, war is mostly theory.

The people who trade in theories and who employ logisticians in war and ignore them in peace are Generals.

Logisticians hate Generals.

Generals are a happily blessed race who radiate confidence and power. They feed only on ambrosia and drink only nectar.

In peace they stride along confidently and can invade a world simply by sweeping their hands grandly over a map, pointing their fingers decisively up terrain corridors, and blocking defiles and obstacles with the sides of their arms.

In war they must stride more slowly, because each General has a logistician riding on his back and he knows that, at any moment, the logistician may lean forward and whisper: "No, you can't do that!"

Generals fear logisticians in war, and in peace, Generals try to forget logisticians.

Romping along beside Generals are Strategists and Tacticians.

Logisticians despise Strategists and Tacticians.

Strategists and Tacticians do not know about logisticians until they grow up to be Generals—which they usually do—although sometimes Generals will discipline errant Strategists and Tacticians by telling them about logisticians.

This sometimes gives Strategists and Tacticians nightmares, but deep down in their heart they do not really believe the stories—especially if the General lets them have an occasional drink of his nectar.

Sometimes a logistician gets to be a General.

In such a case he must associate with Generals whom he hates. He has a retinue of Strategists and Tacticians whom he despises, and on his back is a logistician whom he fears.

That is why logisticians who become Generals are a fearsome and frustrated group who wish they were anywhere else, beat their wives, get ulcers and cannot eat their ambrosia.