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Technical Memorandum

NEW CONCEPTS FOR ELECTRONIC WARFARE

Dr. Allen R. Matthews

Chief Scientist
Naval Air Test Center

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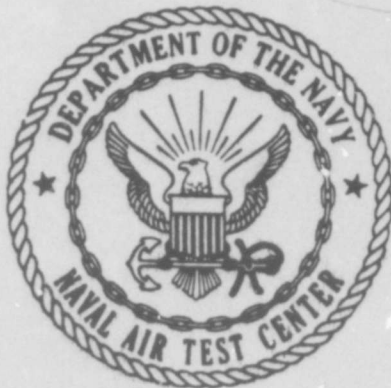
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FOURTH ANNUAL EA-6B ELECTRONIC WARFARE SYMPOSIUM

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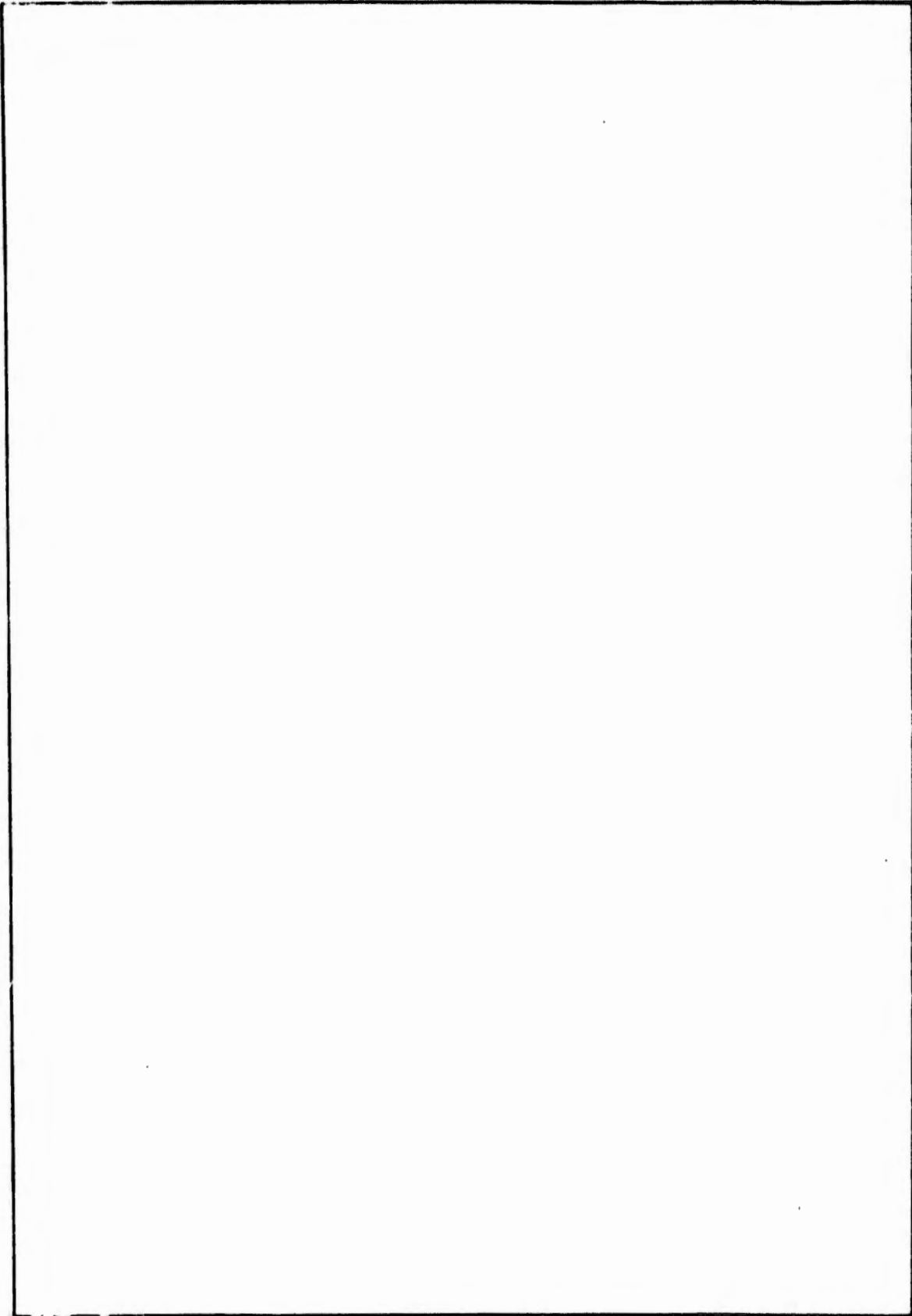
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<p>The classical field of electronic warfare (EW) is conceptually expanded into a broader field of warfare technology and operations defined as electromagnetic defense (EMD). EMD is postulated to fulfill military operational and sociological requirements for nondestructive warfare capabilities that should be further developed by expansion of the unique scope of EW. The current EW field provides a logical base on which to implement the expanded EMD concepts for technology and military operations. A defense concept of applications engineering is presented and related to EMD and nondestructive warfare.</p>		

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PREFACE

This report documents a Keynote Address given by the author at the Fourth Annual EA-6B Electronic Warfare Symposium on 22 July 1975 at the Naval Air Station, Whidbey Island, Oak Harbor, Washington.

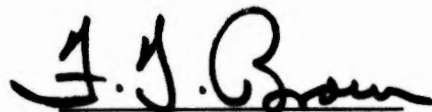
The talk is intended to expand present concepts on the scope of electronic warfare as well as to develop the concepts of nondestructive warfare and defense applications engineering.

It is the author's desire to stimulate creative thinking and appropriate courses of action in three areas:

1. Electromagnetic defense
2. Nondestructive warfare
3. Defense applications engineering

The author's views are not intended to and do not imply or express the concurrence of the U. S. Navy or the Department of Defense.

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F. T. BROWN, RADM, USN
COMMANDER
NAVAL AIR TEST CENTER

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I. INTRODUCTION

After such an Introduction, I hasten to offer the advance comments on my talk. The real purpose of releasing the reviewers' comments is to set up some countermeasures for any additional eggs that members of the audience may be carrying! But remember, the symposium chairman indicated that he didn't want just another technical talk. He wanted something provocative and possibly enlightening.

Well, the reviewers' comments on the Matthews' ethereal concept of warfare were very noteworthy. They are arranged anonymously for obvious reasons:

A key Admiral: "Rather obtuse but OK with me"--Not very enthusiastic.

A key AOC BOD Candidate: "Very interesting"--sounded discouraged.

A bearded friend: "Yes, but how about some of these ideas." They were already incorporated.

A subordinate: "Well yes, but I assured everyone that you have given good papers in the past."

A beloved AOC President: "Matt, why don't you talk about T&E, especially on AWACS or EA-6B." That would really interest those young bucks at Whidbey.

My boss--An Admiral: "Matt, I don't believe in your concepts."

Well, with all this encouragement and considerable upgrading of the paper, I am still going to try to stimulate your imagination and hope that you all will at least be able to say, "He was born too soon."

But remember that within the somewhat esoteric philosophy of this brief, you will find the roots for future electromagnetic warfare. So give close attention; you will inherit the responsibility.

II. THESIS

The purpose of this paper is to stimulate expansion of the conceptual scope of EW by focusing attention on broad problems of warfare that have a potential solution in the principles of electronic warfare.

It is my thesis to emphasize that the EW field is far from being fully developed and will be expanded in both technologies and functions, possibly creating new concepts for warfare. Experts frequently search for solutions to recognized problems and refine solutions to old problems. Unfortunately, solutions are often found too late, such as after the startling facts are brought forth by the enemy or as a routine expansion of technological progress which is unfortunately also well known to the enemy. It is time to reorient EW thinking from "putting out fires" to the long-range objectives of warfare and society.

III. PERSPECTIVE

For 35 years, there has been a major electronic warfare (EW) effort. This effort has been directed primarily towards preventing or degrading the effective use of kill weapons and has been categorized in the classical Joint Chiefs of Staff (JCS) functional definition of EW as shown in Figure 1 which was documented in 1969.⁽¹⁾ Note the unintentional emphasis on the nondestructive warfare capabilities of degrade, retain, and determine.

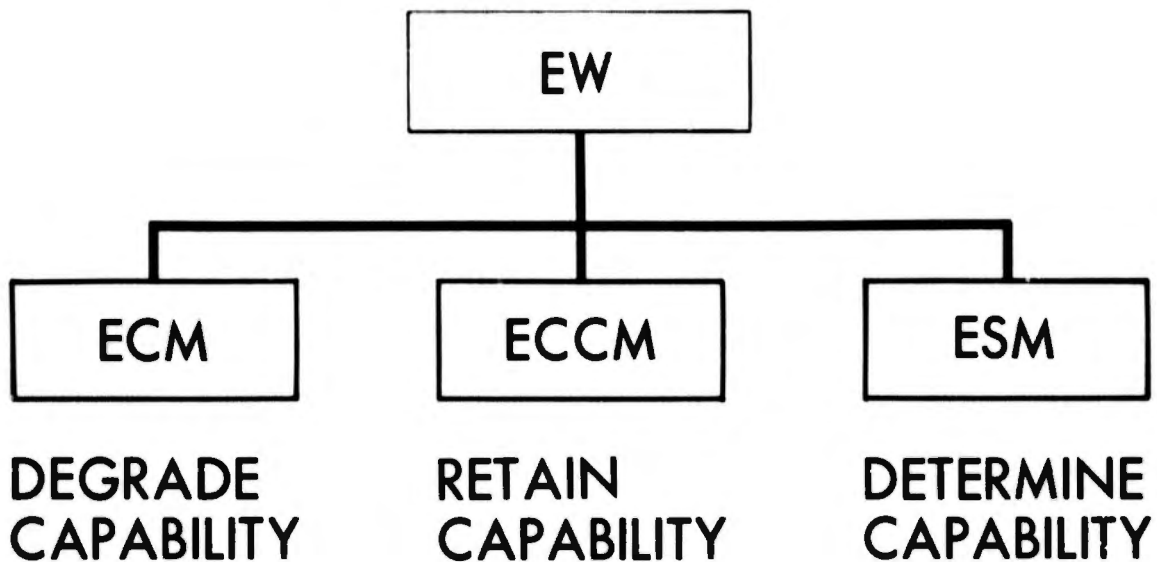


Figure 1

(1) JCS Memorandum of Policy on Electronic Warfare, Number 95, dated 7 March 1969.

The historical perspective of EW is illustrated in Figure 2 and is but a small speck in the art of warfare. The EW field was formally catalogued a mere 6 years before the Navy's Bicentennial Birthday in 1975! Of course, electronics, itself, wasn't even recognized as a unique technology until long after the founding of the former Institute of Radio Engineers (IRE) in 1884 which is 109 years after the Navy's Birthday. EW is a newcomer and didn't evolve until around 1940.

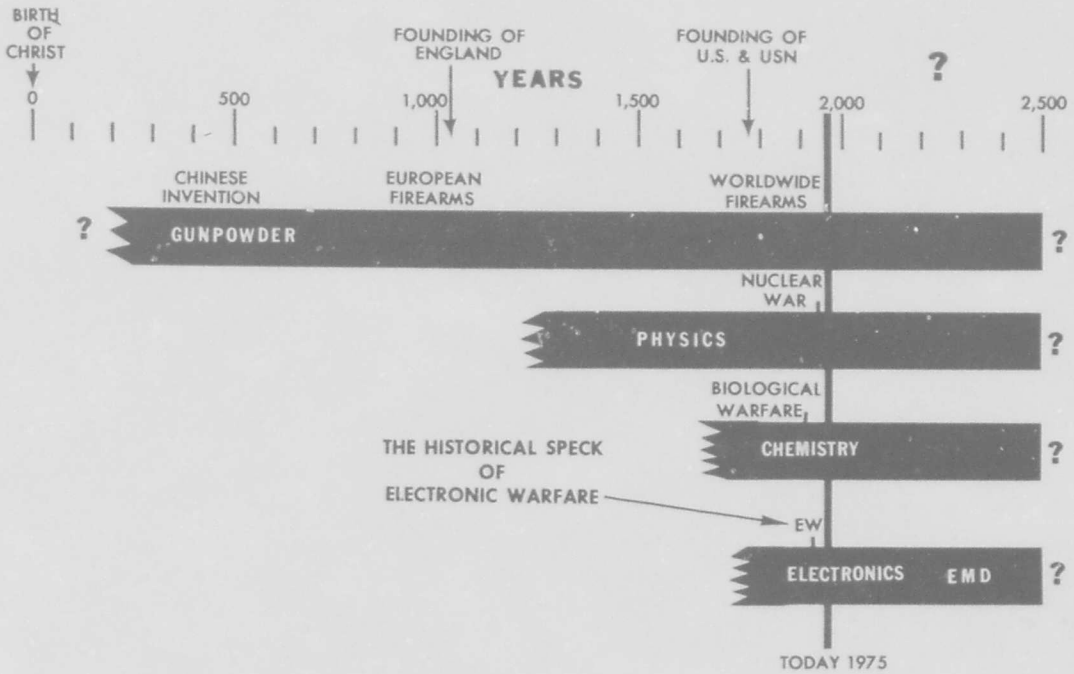


Figure 2

Now consider the art of warfare itself, which is far more than 2,000 years old with hundreds of years elapsed from the invention of gunpowder by the Chinese until its use in firearms by Europeans in the 14th Century, followed by the climactic burst of a nuclear weapon in 1944. In perspective, EW functions and technologies are certainly not as yet of age even in 1975.

IV. DILEMMA OF WARFARE

The history and evolution of warfare reveals a dilemma and demonstrates that new concepts, techniques, and approaches of destructive warfare evolve slowly in theory and even more so in practice. After thousands of years, society may also be evolving a more radical new concept for nondestructive warfare. As history shows, necessity is the mother of invention. The world can no longer tolerate suicidal mass destruction in the classical destructive warfare mode. The first nuclear blast was merely intended to achieve control of the enemy, but may have signaled far more than was realized by initiating a need for a fundamental change to warfare itself from the concept of destructive warfare to nondestructive warfare.

Figure 3 illustrates recent major world events of warfare. The U. S. has not succeeded in a destructive war since World War II, even though low level destruction, commonly referred to as tactical warfare, was employed in Korea and Vietnam. The destructive 6-day Israeli War was temporarily won and then partially negated by negotiations following another destructive war. These negotiations are continuing today with the possibility of negating all of the so-called "gains" achieved during the destructive wars. It is difficult to identify the winner of these destructive wars, and this leads to the unacceptable dilemma that total destruction is necessary but, unfortunately, may involve all contestants.



Figure 3

Modern warfare, illustrated as mutual destruction in Figure 4, is based primarily on destructive capability and is increasingly repugnant to civilized nations their citizens, and their warriors. Indeed, nation-state leaders have attempted to ban chemical (gas and herbicides) warfare, biological (disease) warfare, and nuclear warfare for this very reason. The fundamental reason is not all philanthropic, but is, to a large extent, self-survival as for example from guaranteed mutual destruction with unlimited usage of nuclear weapons. It appears that the history of destructive warfare may have an ending if other less violent techniques could be created to achieve the prime objectives of warfare--to control the enemy and impose your will thereon.

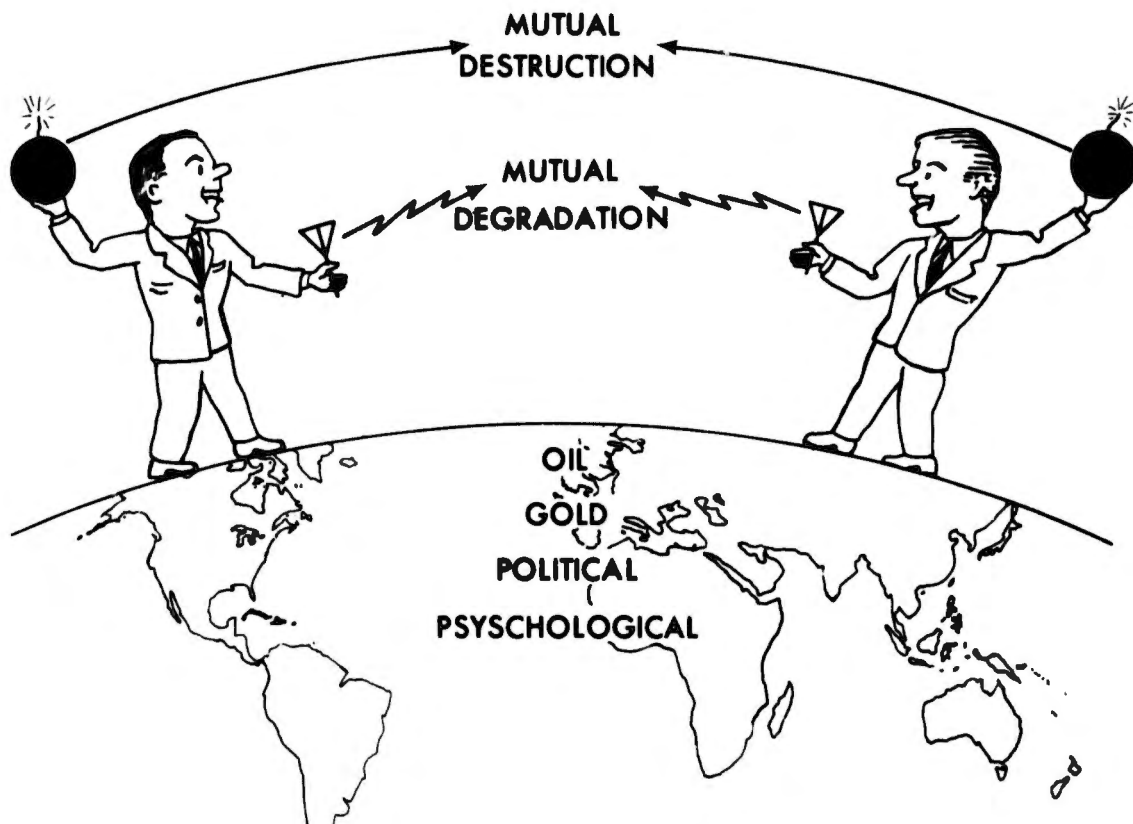


Figure 4

The increasing success of EW, from a tactical problem in World War II to the key to mission success or failure in more recent wars, has demonstrated the general concept and capabilities of basic nondestructive warfare techniques. Although EW capabilities have been in a sense peripheral to destructive warfare, it is postulated that decisive nondestructive warfare capabilities can be achieved within the philosophy and with an expanded scope of EW technology. The mutual degradation shown in Figure 4 is obviously more desirable than mutual destruction.

V. EVOLUTION OF WARFARE TECHNOLOGY

It is appropriate to review the evolution of the technology of warfare which has been rather simple in substance, even if complicated and expensive in warfare equipment, strategy, and personnel. The ingredients and sources of power for warfare are shown in Figure 5. At first, weapons ranging from mechanical devices such as the bow and arrow to chemical devices such as gunpowder provided the clout. This punch was supplemented by delivery systems from horses and elephants to ships, aircraft, missiles, and spacecraft. Simultaneously, a larger destructive capacity was developed from the explosive effects of chemical energy to nuclear energy. Alternatives of gas and biological warfare weapons were developed; however, these weapons were not only tactically unacceptable but offensive in the idea of nonselective mass destruction. What then are the alternatives to achieving superiority? Perhaps mechanical, chemical, biological, nuclear, or electromagnetic devices or techniques could be developed for nondestructive warfare applications and yield superiority.

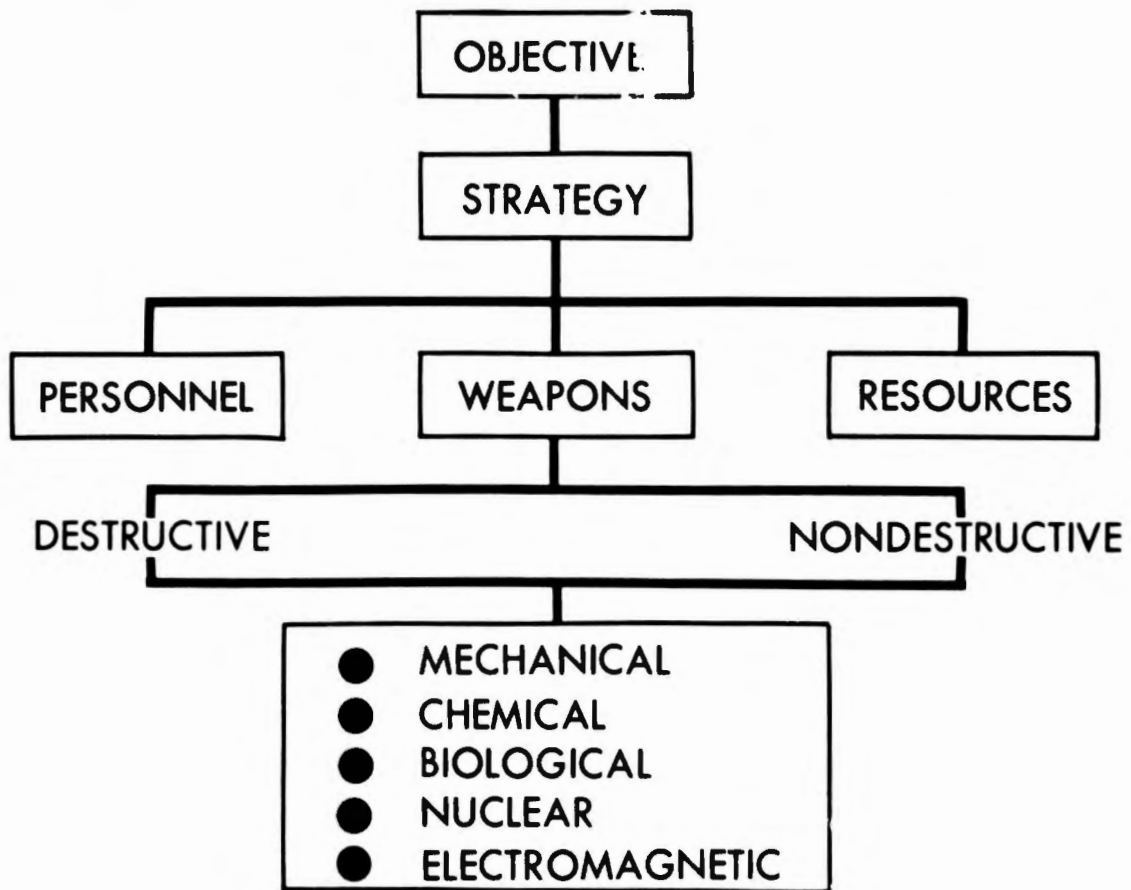


Figure 5

While warfare technology evolved, the new field of electronics provided well known major capabilities for surveillance, reconnaissance, command and control, destructive weapons delivery, support, and others. With these, the currently classic field of electronic warfare was developed around the objectives of confusing and denying the enemy the use of

these new types of equipment while retaining parent operational capability. In effect, EW has provided a means of "defusing" weapons of destruction which is a form of nondestructive warfare. Spectacular exploits in World War II through Vietnam and the Middle East have further confirmed the success of electronic warfare. These accomplishments established the foundation for the future EW role and are the basis for the thesis of nondestructive electromagnetic weapons.

VI. NONDESTRUCTIVE WARFARE

In the broadest sense, nondestructive warfare includes several types such as economic, political, and psychological warfare as well as technological warfare that currently emphasizes destructive capability. Only nondestructive Electromagnetic Defense (EMD) is within the scope of the thesis and no attempt will be made to define subcategories like the degrees of application including specific areas of specialized or limited nondestructive warfare.

Electronics or preferably electromagnetics covers the entire technology of electronic fields and waves involving areas of radio, radar, infrared, optics, ultraviolet, and even aspects of acoustic and gravity devices. Electromagnetic energy can be viewed as analogous to mechanical and chemical energy with an even broader spectrum of warfare applications including nondestructive warfare. Electromagnetic energy is commonly employed for such applications as military support systems including intelligence, communications, navigation, surveillance, command and control, electronic warfare, and others. New nondestructive electromagnetic warfare applications are evident for lasers and EMP. It is these nondestructive warfare applications that offer potential for executing more socially acceptable warfare in the future. These applications may then be the real threat of tomorrow.

It must be understood that destructive warfare is the last resort and probably would be used just as chemical, biological, or nuclear warfare--if there were no alternatives. Therefore, even as ballistic missiles did not replace aircraft weapon systems or the foot soldier, nondestructive weapons will only provide a means of warfare intended to settle disputes without desperation. Unfortunately, some nations may force destructive warfare in the form of classical limited warfare or as unintentional strategic nuclear suicide. This situation necessitates maintenance of the required destructive warfare capability in parallel with new capabilities for nondestructive warfare pending major sociological development of world society. However, Homo sapiens may ultimately not accept destructive warfare on each other.

Specific electromagnetic weapons were explored during World War II when research was directed at the use of high power electromagnetic beams to disrupt the ignition systems of reciprocating engines on aircraft. Since then, electromagnetic lasers and electromagnetic pulse from nuclear bursts have revealed other potentials for disruptive but not necessarily destructive effects.

The increased electromagnetic vulnerability of modern weapon systems necessitates continuous emphasis on new techniques to prevent or degrade the effective use of kill weapons. This objective is achieved by either direct action on the weapon systems after engagement or by early degradation of warfare capabilities that would make a destructive battle and/or an act of war unwise in the eyes of the hostile.

VII. ELECTROMAGNETIC DEFENSE

Therefore, the field of Electronic Warfare may be logically expanded under the name of Electromagnetic Defense (EMD)⁽¹⁾ as shown in Figure 6 to include countermeasures, counter-countermeasures, and support as well as applicable electromagnetic weapons. The latter may be used for either destructive or nondestructive warfare applications since there is potential similarity in the techniques or hardware. The field of Electromagnetic Interference (EMI) or Compatibility (EMC) could then also be incorporated into EMD, whether the EMI was the result of friendly or hostile actions that occurred either accidentally or intentionally. Geographical regions for EMD encompass not only the earth's surface but also the electromagnetic ether of earth and space. In this perspective, the ether is a region of warfare just as are the classical regions of land, sea, air, and space. Is it then possible that nations need an Ether Force as a companion to the current armed forces?

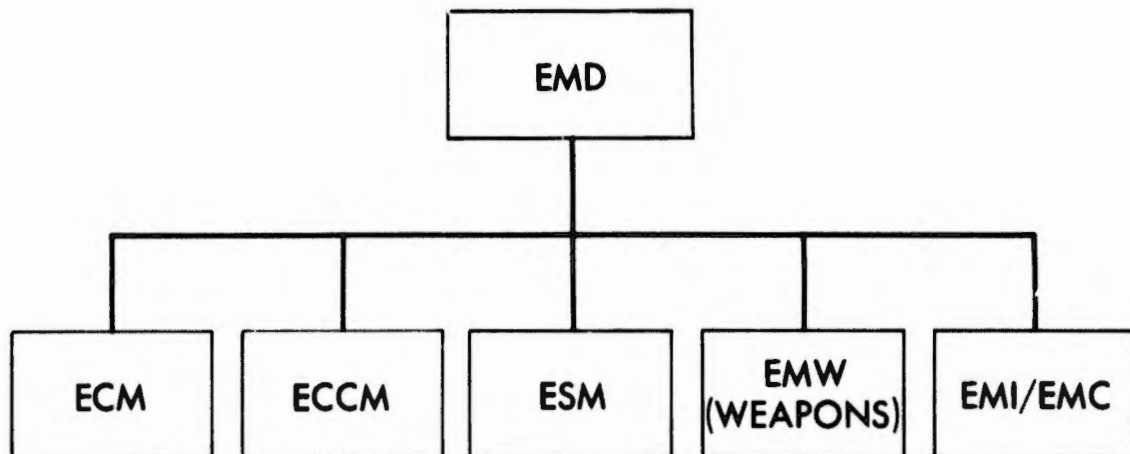


Figure 6

(1) The name EMD was initially proposed in 1969 in a guidance document for the Technical Committee of the 1970 National Association of Old Crows Convention and Symposium.

The functions of ECM, ECCM, and ESM are well understood. The functions of EMI/EMC are similarly well known. But the area of Electromagnetic Weapons (EMW) is only developing and has the potential for the postulated nondestructive weapon warfare.

VIII. NONDESTRUCTIVE WEAPONS

Nondestructive electromagnetic weapons are inherent in the scope of current EW as well as EMD. Specific examples are shown in Figure 7.

- PROPAGATION PATH MODIFICATION
- FALSE AND/OR DEGRADING SIGNALS
- INFORMATION STORAGE AND DISPLAY DUMP
- BIOLOGICAL MODIFICATIONS

Figure 7

Modifications to the electromagnetic propagation path are accomplished by the well known chaff, aerosols, or other techniques involving factors such as major increases in signal attenuation that occurs naturally in the daytime ionospheric "D" layer or as a nuclear weapon effect. A controlled "blackout" could completely but temporarily degrade essential systems such as satellite data links, ground communication, tropospheric communication links, and various radar systems. All of these could deny the use of essential warfare systems such as command and control, reconnaissance, and fire control.

False and degrading signals are generated by classical techniques with new techniques such as nuclear and non-nuclear Electromagnetic Pulse (EMP) offering additional possibilities. These signals may cause equipment malfunction or confusion in information preventing warfare implementation. Laser devices or others yet to be demonstrated offer additional potential.

Information storage and display capacity can be dumped or modified by various intense signals such as EMP. The critical importance of computer capabilities suggests expending extensive efforts to degrade or protect programmed premission data.

Key biological effects can be induced on operator personnel by optical devices and cause hallucinations, spasms, and/or sickness.

It is as impossible to postulate future EMD techniques as it was to forecast nuclear weapons. However, it is essential to be alert to possibilities not only for defense but to take the offense when necessary. It is therefore mandatory to maintain knowledge of hostile capabilities in EMD technology and operations just as has been done in EW. New potential capabilities must be identified to assist those responsible for intelligence and defense. The scope should also include weather, magnetic fields, ozone, and others that disrupt economic, psychological, or military capabilities.

Consider a ballistic missile warfare scenario involving destructive and nondestructive weapons. A hostile ballistic missile is launched and either destroyed enroute or impacts unexpectedly. The defense responds with a nondestructive nuclear blackout weapon that totally immobilizes the hostile's essential damage assessment capability as well as the hostile's command and control system. The defense may now be in the superior position of offering the threat finale which includes the alternatives of annihilation or willing occupancy of the hostile by the defense.

IX. ACTIONS FOR TODAY

Figure 8 lists some actions for today.

- RE-EXAMINE EW SCOPE AND CAPABILITIES
- ASSUME RESPONSIBILITY FOR NONDESTRUCTIVE WARFARE CAPABILITIES
- INCORPORATE EMD CONCEPTS
- IDENTIFY NEW NONDESTRUCTIVE WARFARE TECHNIQUES
- EXPAND EW TECHNOLOGY AND HARDWARE CAPABILITIES
- FURTHER THE QRC CONCEPT TO APPLICATIONS ENGINEERING

Figure 8

The fundamental objectives of EW need to be examined in the light of broader objectives to insure that new capabilities are created and used to advantage. New electromagnetic technologies of magnetohydrodynamics (MHD), light amplification by stimulated emission of radiation (lasers), nuclear "blackout," and others provide capabilities and problems for the classical JCS EW functions. Perhaps the potential capabilities of EMD are far more than we realize when the demands of a future world society for humanitarianism are considered and the evolution of technology is emphasized. Candidate spatial locations of future warfare in the Arctic, subsurface ocean, or space suggest additional possibilities.

It is therefore proposed, in the interest of national security, that the leaders of electronic warfare accept the responsibility for broadening the functional base of EW to include new areas of electromagnetic weapons used for nondestructive purposes. Only a few nondestructive techniques are known but it is anticipated that new electromagnetic techniques can be developed for the incapacitation or protection of equipment, personnel, and the total system. The art of EW must be expanded to include these broader concepts of EMD.

Specialists in electronic warfare are highly qualified in the technology, operations, and testing of new electromagnetic equipment. EW specialists are also necessarily knowledgeable in the broad spectrum of warfare equipment, friendly and hostile capabilities, and possess conceptual expertise. Broad tri-service experience in development, test and evaluation, and operation provides the base for creating the technology of nondestructive electromagnetic weapons. EW specialists may be an even greater key to warfare in the future since they have already demonstrated Quick Reaction Capabilities (QRC) to technology, procurement, and operational employment.

X. APPLICATIONS ENGINEERING

As shown in Figure 9, it is also proposed that new organizational concepts and techniques be considered. These are needed not only to solve current problems, but to lay the basic foundation for developing nondestructive warfare capabilities. The classical EW QRC technique was a good band-aid but today's situation requires a more comprehensive approach in the acquisition process as well as the employment process.

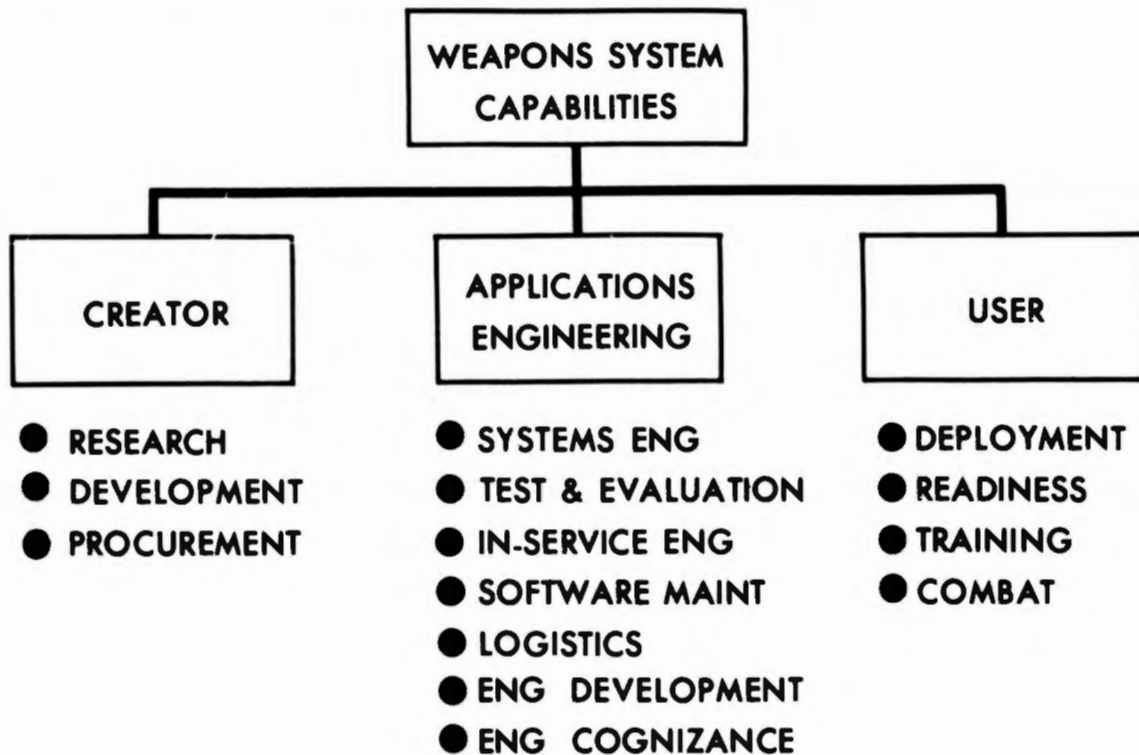


Figure 9

The creation of new weapons, either destructive or nondestructive, would be greatly enhanced by organizational consolidation of the key functions listed under applications engineering in Figure 9. These functions are currently distributed, more or less, on the basis of current capabilities of existing organizations within the creators and users of hardware. These functions of logistics, lead field activity, in-service engineering, software maintenance, engineering development, engineering cognizance, test and evaluation, and others including possibly tactical doctrine have been created or expanded significantly in modern warfare. Consolidation of these functions into a new Applications Engineering organization in parallel with the creator and user commands would not only increase R&D creativity and improve weapon system employment but provide a key organization for evaluating a family of nondestructive weapons. The new warfare modus operandi requires freedom for creativity in the art of warfare. Industry established Applications Engineering organizations over 30 years ago when industrial systems became complex and beyond the capacity for comprehension by individual leaders. Routine industrial hardware competition justified the Applications Engineering approach just as international competition and sociological developments justify a similar approach to the art of warfare.

Consider the complications of designing, developing, testing, and employing complex systems such as the E-2C, AWACS, EA-6B, and WILD WEASEL. Both nuclear weapon and Minuteman projects required completely new organizations within the classical creator and user organizations. The single function of testing requires sophisticated technical personnel and facilities with centralized management. Key new areas of software maintenance are beyond the scope of present R&D or operational organizations and require special concentrations of unique skills. And equally important, there is currently more concentration of talent on eliminating nonacceptable warfare such as biological and nuclear than there is on developing more acceptable nondestructive warfare techniques.

XI. CONCLUSIONS

It is therefore clear that the development of new nondestructive warfare techniques and hardware will also require new concentrations of skills just as the MIT/Harvard Radiation Laboratory complex provided a concentration of skills to develop new concepts of radar and EW during World War II.

This year's symposium theme of "Electronic Warfare Support of Tactical Operations" extends the technology and operations of classical EW while providing a further basis for the thesis of nondestructive warfare. Figure 10 illustrates the functional transition from EW to EMD. Those of you that have been or are involved in programs like the EA-6B, EF-111, WILD WEASEL, and AWACS know the capabilities and problems of acquisition and deployment. These systems were initially created to meet anticipated operational needs for 10 to 20 years in the future. New or modified applications for these systems continually develop. It is equally imperative that we develop the art of warfare to insure the security of the United States against new nondestructive warfare threats.

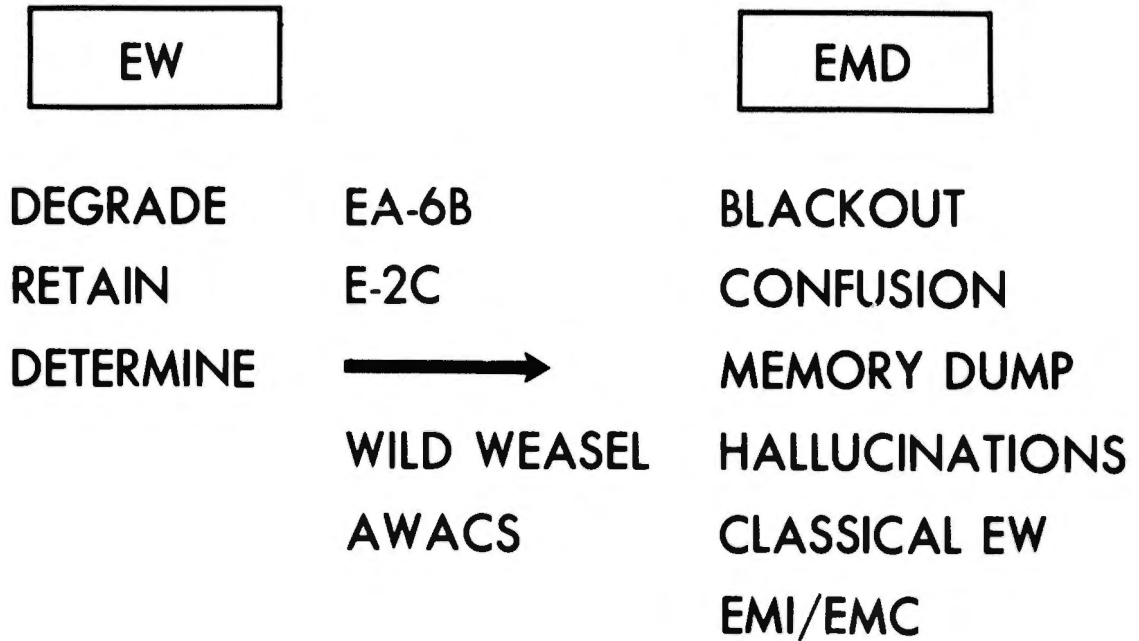


Figure 10

Unless all nations agree to return to the bow and arrow, the EMD field appears to be the key to both destructive and nondestructive superiority of offense and defense for the next 100 years. This superiority is dependent upon an expanded EW technology for which each of you have the responsibility.

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