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Occasionally, a hardware development springs upon us with extraordinary and lasting impact on the way we conduct war. Some examples include the longbow, gunpowder, the machine gun, armored vehicles and nuclear energy. In some cases, such as the machine gun, the impact is so immense that an overwhelming offensive or defensive advantage is created until the next "miracle weapon" is developed in response (armored vehicles, for example, to counter the machine gun). In the most extreme of cases, an entirely new category of warfare must be defined to accommodate the magnitude of change wrought by a given development, such as the air and undersea warfare of this century, and a revalidation of all existing tactical and strategic postulates is required.

Stealth warfare is a development which promises to be as revolutionary as the machine gun or the armored vehicle. In this type of warfare, all "observables" of a combat platform have been reduced dramatically. These observables consist of emitted or reflected energy which can be detected by senses or sensors. This method of human conflict has had an extraordinarily long gestation period. Whereas some would identify the submarine as the original stealth warfare platform, a credible case could be built that would identify the primitive ambusher as the original progenitor of the new nuclear attack submarine and the B2 bomber.

In any case, judging by the efforts of special groups within all of the armed services, stealth warfare, at least as a concept, has arrived. With the possible exception of submariners, however, it is not entirely apparent that those warriors who stand most to benefit from these latest products of high tech understand fully the great tactical and operational changes that are required if their potential is to be realized. For in many cases, the lessons of modern

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warfare are exactly in opposition to some operational truths of stealth warfare.

Several years ago, speaking in support of the Seawolf-class submarine, Admiral Bruce DeMars described the primary characteristics of a modern SSN as stealth, mobility, firepower and endurance. Though at first he identified all of these as equally important, soon he defined stealth as being "more equal" than the others. He said that all of the others must exist and be exploitable within an inviolate envelope of absolute stealth. This conveys properly the image of a weak-link philosophy, and is essential to understanding how stealth technologies must be applied for maximum benefit. The overriding need to protect the platform's stealth results in some dramatic changes across a broad spectrum of operational areas. Some of these areas will be discussed below, using the modern submarine as the premier example of an operational stealth warfare platform.

Coordination of Forces

Submariners like to say that if you're not outnumbered, you've been sent to the wrong place. This seems to be a refutation of the traditional military maxim of concentration of force. The term *force*, however, can be thought of as a resultant of many factors, or as the total area under a very complex curve. Since the ability granted by true stealth to engage at the time and at the place of choice is so potent, then the unavoidable degradation of stealth caused by the need to coordinate with friendly forces in one's immediate vicinity argues strongly against the presence of such friendly forces. The same principle is embodied in the submariner's response to the question "How do you avoid Blue on Blue encounters?" which is "Easy—everyone in my area is Red!" Identification Friend or Foe (IFF) procedures become simple when a commanding officer can regard classification as a contact as tantamount to classification as a target.

Post-Attack Withdrawal

Datum was a term long used by antisubmarine forces to describe that point (or more generally that area) within which, at a certain point in time, overwhelming evidence existed that a submarine was present. Typically, a datum of about 3 square nautical miles was centered upon a merchant ship at the instant a torpedo detonated against her hull—proof that some 3 or so minutes prior to that, a submarine had been within about a mile of that point. Since the submarine's commander fully realized these thought processes and since a hostile response to his actions would not surprise him, it was reasonable for him to leave at some optimum speed which accounted for the tradeoff between the rate at which datum was expanding (as a function of speed and time squared) and his submarine's energy budget of speed versus battery capacity (propulsion power varying as the cube of the ship's speed). In those times the tactics of convoy protection were based on the premise that the submarine would establish datum with the first attack, and a high enough percentage of the resultant datum prosecutions would be converted into submarine kills to make the tactics worthwhile. It was not so much antisubmarine warfare as it was counter-submarine warfare. Convoys worked because the destruction of the first of many available targets served as a bell ringer for a local concentration of ASW forces in a datum of very constrained size and rate of expansion.

Although nuclear submarines need not consider the stored energy budget as a tradeoff, there is a scenario-specific optimum speed which will maximize the submarine's escape probability by a tradeoff between datum expansion rate and radiated noise. The weighing by a submariner of the multiple factors involved in this nonlinear set of equations is based on experiential intnition (a mystic force not to be trifled with). Since the time factor of air warfare is many orders of magnitude shorter than that of submarine warfare, it borders on inconceivable that operators of airborne stealth platforms after they have attacked and so revealed their presence could even begin to weigh the odds in their favor without a comprehensive near real-time "if-but-maybe" level of artificial intelligence. It is a reasonable assumption, however, that aerospace "pilot's associate" technologies will soon be available to help a stealth aircrew bound some of the uncertainties and sort out options and alternatives.

Weapon Characteristics

Since all principal traits of a successful stealth platform have first to protect that platform's stealth, there is no benefit to be gained by building an aircraft with an extremely small radar cross section if the external bomb load hung on it has a much greater radar cross section. This explains the cool reception that many submariners give to missions in heavily defended waters which require the release of air-breathing weapons whose visual, infrared and radar signatures mark the immediate presence of the slow and shallow submarine. In stark contrast, the detonation of a modern submarine-launched torpedo yields only the conclusion that 20-30 minutes ago a submarine was within about 300 square miles of that event, and that the present circle of containment could be more than 6 times that value, expanding at a rate (itself expanding) of almost 500 square miles an hour. To calibrate one's perceptions in this matter, the state of Rhode Island has an area of about 1,000 square miles. It is true that pursuing helicopters and aircraft can travel faster than the submarine leaving the scene, but this advantage is of marginal value when the pilot is unsure of the direction in which he should fly.

Organic Armament

Since stealth is the principal means of a stealthy system's defense, the ratio of its offensive to defensive ordnance and other capabilities is extraordinarily high.

There might easily be over 50 tons of torpedoes aboard a modern nuclear attack submarine, but only a few hundred pounds of off-hull defensive countermeasures. A carrier battle group cannot match such a ratio, since non-stealth warfare systems must invest a high percentage of their payload into defensive systems if they are to be used in an offensive manner.

It is not only manned systems that potentially benefit from stealth. The mine, ashore or afloat, is a classic example of a stealth weapon, and now Tacit Rainbow, an autonomous and loitering airborne antiradiation vehicle, is alleged to have brought the smart mine airborne. Truly mobile sea mines cannot be far behind: weapons that would cruise a specified area with on-board logic fed by passive sensors to detect and classify potential targets before turning into lethal machines. In fact, it is open to debate whether this would best be called a mine or a torpedo fired at very long ranges at targets that have not yet been detected. Submariners would much prefer the latter definition, since they don't like mining missions but might be enthusiastic about launching a few dozen such "torpedoes" into their assigned operating area, and then returning for their medals and another weapons loadout. Since many threats to a patrolling submarine (e.g., dispersed minefields) are a direct function of total time on-station, this concept offers a way to operate during that phase of hostilities in which targets are scarce and long periods in-area between targets is to be expected. In a sense, it serves to convert what would be a platform-intensive campaign to one which is weapon-intensive.

Command, Control and Communications

We read a lot about the need for, and impact of, command, control, communications and intelligence (C-cubed-I) systems, with the strong implication that the total "goodness" of a system has a mathematical relationship to the product of those four values. The perception is that warfare systems are on the verge of being controlled, in real time, by a higher and distant authority who has instant access to whatever intelligence might be appropriate. In this context, the "C" of communications is viewed as having positive "goodness" as are the two "Cs" of command and control. There is no doubt that command and control are essential, regardless of the type of platform. But those who have had experience in employing stealth warfare platforms (again, primarily submariners) have a different view of the "goodness" of communications, particularly those which require (or, higher authorities believe require) a response from the stealth platform. Submariners would rather establish the required level of command and control by careful advance planning and pre-positioned contingency instructions. They view communications as evil, sometimes necessary but usually mission-degrading due to its adverse impact on the cardinal virtue of stealth. In a mathematical sense then, the "goodness" algorithm for a stealthy system more properly becomes C-squared-I divided by C. Those who boast of "covert" communication schemes should remember that if a system is truly covert, even its intended receiver will not detect it. There are systems with varying degrees of what is called "low probability of intercept," and these do have a place in stealth warfare. But the great advantages of "zero probability of intercept" systems should be kept in mind. These involve no release of energy to the environment by the stealth warfare platform.

Sensor Technology

Concern about probabilities of intercept applies even more to sensors than to communications systems. Stealth warfare platforms should not release any energy that could be exploited by others. Instead, they should exploit the energy their targets release. This is an easy concept for submariners to embrace, accustomed as they are to "bearings only" fire control methods, but it is a difficult concept for the emergent community of aviation-based stealth warriors, who have viewed their navigation, search and fire control radars as being nearly indispensable. However, with the multiplicity of energy sources from their targets ashore or their non-stealthy airborne targets, and with the very high relative speeds and resultant high bearing rates involved, it would appear that a combat system could be installed on a stealth aircraft which would employ some analogue to the submariners' Target Motion Analysis algorithms. This system would exploit passive inputs from ESM, RFDF, IR, low light level optical or other such sensors, and should easily be able to maintain that degree of dynamic situational awareness about locations of targets necessary to execute survivably a broad set of missions.

Warfare systems ashore can also benefit from stealth techniques and concepts, but they too will have to adapt to a new form of command and control, perhaps not unlike that familiar to submariners, whose receipt of an order is generally "rogered" by the effects of order execution. Perhaps one of the greatest potential benefits for land warfare units will be the neutralization of many of their opponent's "smart weapon" sensors by the elimination of cooperative "signatures" for whatever terminal guidance system makes the weapon so smart.

Limited Intensity Conflict

Though counterintuitive to non-stealth warriors, stealth technology promises to be highly valuable in Third World warfare. If stealth's primary benefit is platform survivability, and if the most important variable for the United States in small wars is the avoidance of death or injury to our forces, then stealth weapon systems provide a means to inflict selective, measured and telling damage to an adversary with very low risk of political fallout from casualties taken in return. Stealth warfare, therefore, might be most important for its potential use in regional conflicts or counterterrorist punitive strikes. In fact, a more general observation, justified when evaluating the "Pax Americana" of the last 45 years, is that application of its advantage in high tech has given the United States the greatest return in Third World warfare.

Stealth warfare is here to stay. Among other matters, we need to study different command and control concepts, the likelihood of more solitary or autonomous operations, the techniques of combat in a stealth vs. stealth scenario, stealth in space, and the nature of weapons that will function effectively against stealthy targets. Indeed, with properly managed development, stealth warfare systems promise to be the greatest single example of benefits to be gained from prudent application of the "Competitive Strategy."

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