A Decision for Strategic Effects:

A conceptual approach to effects based targeting

Maj Thomas Tighe
Lt Col Raymond Hill
Lt Col Greg McIntyre

Introduction

Strategic effects are an accepted, expected, recognizable, yet often hard to quantify capability of aerospace power. Classic airpower theorists suggested hitting enemy population or industry centers to achieve disproportionately favorable results from aerial bombardment. Contemporary theorists, such as Warden, suggest leadership or infrastructure targets are the key targets to hit and yield strategic effects and strategic paralysis. Unfortunately, the proper target set seems scenario dependent. The targets hit in Desert Storm seemed to yield strategic effects while similar targets hit in Kosovo did not yield the same effect. The allure of strategic effects is their economic efficiencies in war. Strategic effects promise to save money, national resources, political expenditures, and most importantly the lives of our citizens in uniform. The challenge is understanding these effects and then conducting successful strategic attacks?

Historically, studies of strategic effects try to link target destruction to some specific indirect result, such as the collapse of the enemy's warfighting effort. The problem is these indirect results are not historically consistent and therefore are extremely difficult to predict. Attempts to apply science and mathematical modeling to the study of strategic effects has been frustrating. Thus, doctrinal philosophy remains the primary medium for understanding strategic effects with some of the central theories emanating from the venerable military teachings of Clausewitz. Unfortunately, there is no clear link between the doctrinal ideas and the physical world results.

This article proposes a framework that may be useful in analyzing an enemy and identifying opportunities for strategic attack. This approach is broad enough to capture doctrine, simple enough to apply in practice, and structured enough to attempt to model mathematically. The framework is a logical extension of Boyd's Observe-Orient-Decide-Act (OODA) loop decision cycle theory. The OODA loop was developed to describe a tactical situation and has been extrapolated to explain overarching command and control systems. The proposed approach uses the OODA to describe war as a chain of discrete, but dependent and irreversible decisions that take place throughout the enemy system. Impacting the processes that make these decisions becomes the focus for creating the desired effects.

Conceptual Framework

The key to a strategic attack is to attack strategy. In general terms, a strategy is a plan or collection of plans that are developed to respond to various forecasts of the future. This simple definition is the conceptual foundation for this paper. It should be pointed out that this definition does not limit strategy to a grand or national level. Strategic effects are usually thought of as war-winning, although these same effects occur at operational and tactical levels which can be thought of as campaign- or battle-winning as demonstrated later. A strategic effect occurs if and

only if an action disrupts an adversary's strategy. This implies the adversary must have a discernable strategy for us to purposefully conduct successful strategic attacks. While we do not expect perfect knowledge of the enemy's plan, if the enemy is doing something undesirable enough to warrant our military intervention, we should have a reasonable idea of their course of action. The goal of a strategic attack would be to get them to abandon their undesirable course of action for one more favorable to us.

With a solid strategy, one must simply observe the events that are occurring, pick the (preconceived and rehearsed) plan that is most appropriate for those events, and put the plan into action. The decision to be made is a quick, simple, "Do I put the plan into action?" instead of, "What can we do?" Events often unfold to put one in an unanticipated situation. If the situation is drastically different than anticipated, a new plan must be built from scratch or pieced together from scraps of old plans. Here the decision-maker may be confused, surprised, or in disbelief of the unanticipated events. Developing a new plan from the ground up is often time consuming and difficult to do under pressure. If the situation is rapidly developing and moving away from the anticipated conditions, subsequent "new" plans may be invalid or obsolete before they can be implemented. This can leave the decision-maker with a feeling of futility and hopelessness. If you know your adversary's plans, including their assumptions about the environments to which the plans are to be applied and the resources required to carry out the plans, you can purposefully attack his strategy. This is done by shifting the environment to one that he did not anticipate. Either the collection of plans becomes irrelevant to the current situation or the applicable plans become invalid because resources required for execution are unavailable. These two cases have been described as tactical surprise (unanticipated situation) or logistical surprise (insufficient resources to effectively execute a valid plan). Eliminating the resources he needs to execute his plans (forcing a logistical surprise) is a classic interdiction style of strategic attack.

There are three apparent avenues that have produced strategic effects. The first and probably most prevalent is dumb luck. An action on our part is misinterpreted by the enemy who then makes an inappropriate decision based on misunderstanding the environment. Hitler's shifting his attacks from the RAF to London after the Allied bombing of Berlin just days short of crushing the RAF is one example. The second is the brute force method typically associated with nuclear weapons or popular uprisings. Here the physical and political environment changes so quickly that it is unlikely any amount of planning could be sufficient. The third avenue is gaining a true understanding of the enemy's strategy and exploiting it. This is "military art," and is the direction this article takes as it fills in the proposed framework.

The first section of this article is background information on OODA theory. The second section describes targeting to exploit OODA advantages. The third section ties the decision cycle theory to our doctrinal expectations of strategic effects and sets groundwork for expanding the theory to all levels of conflict. The fourth and final section discusses some possible implications of a decision cycle approach to targeting.

OODA Background

In Joint Publication 3-13.1 [1], the OODA loop is recognized as a model of a decision cycle that is applicable to all C2 systems – friendly or adversary. There are several other recognized

decision process models, but the functional elements of these models are the same. These models include Lawson's C2 process model [2] (sense-process-compare-decide-act), the monitor-assess-plan-execute model, the see-decide-act model, the input-process-output model, and the find-fix track-target-execute model. The OODA loop is also analogous to the Shewhart cycle and Ishikawa circle, which are general-purpose process improvement cycles taught as techniques in the Quality Air Force initiative [3]. The point to be noted here is that the decision process is not just applicable to C2 or military/combat decisions, but also to business, political, and social decisions. Any entity that makes systematic decisions has a OODA cycle.

OODA Loop Basics

The OODA loop model, represented graphically as a circular connection of the four phases of the decision cycle, is depicted in Figure 1. These phases or nodes are described in detail below.

OBSERVATION. This process is gathering information pertinent to the decision at hand. Information may be collected from internal or external sources. Internal sources of information can be thought of as a feedback loop. External sources of information usually come from a sensor or other information source outside the decision-making entity.

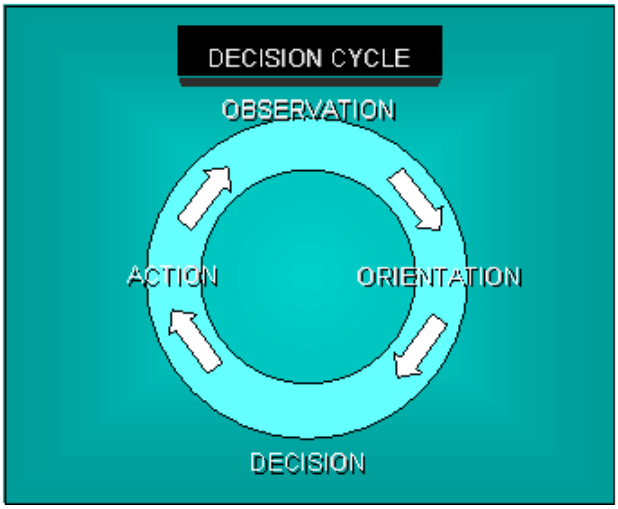

Figure 1. OODA loop as shown in JP3-13.1

ORIENTATION. Boyd [4] emphasized that most of the cognitive effort in an OODA happens during the orient phase. Orienting consists of two sub-processes: destruction and creation. Destruction involves breaking the situation into small component pieces that can be more easily understood. A decision making entity will try to destruct or decompose a problem until the component problems are close to situations for which the decision maker has a plan. Familiarity with these sub-problems is gained through education, training, experience and instructions. This familiarization can be thought of as compiling a set of doctrine based contingency plans. The decision-maker simply matches the current situation to one he has experienced, thought about, or been instructed on, and applies the plan to the sub-problem. These component problems are matched to their respective contingency component plans, which are then combined (created) into an overall plan of action. If there are no feasible plans to choose from, the decision cycle

will return to or remain in "orient" for further decomposition. If no plan can be developed that offers a reasonable chance of success, the decision cycle may grind to a halt. "Out of airspeed and ideas," the decision-maker may concede defeat or "lock up" in a desperate orient (destruction) phase spiral that results in complete internal distraction or paralysis. DECISION. If the decision maker can only construct one feasible plan, the decision is simply whether or not to execute. If there is more than one overall plan (or combination of component contingency plans), one must be chosen as a course of action. The decision often involves weighing the risk or cost of a plan to its potential benefit. One illustration of this is NATO's attack strategy in Operation Allied Force which initially minimized risk, but was relaxed as the cost of failure became higher.

A single superior choice usually results in a quick, confident decision. The decision may take longer if there are many good feasible plans from which to choose. Similarly, if there are many poor choices, the decision may take longer as the emphasis shifts from choosing the plan with the highest probability of success to choosing the plan with the lowest risk of failure. A decision can also be made for the status quo. Here the current plan is periodically reevaluated during execution and allowed to continue.

ACTION. This node represents executing the chosen course of action or plan. The action may be a physical attack or movement, the issuance of an order, or a focus of effort on the sensors for a better observation in the next cycle.

A common misconception of the OODA loop shown in Figure 1 is that the OODA decision cycle processes a single series of sequential events. Instead JP 3-1.3 describes the OODA process as continuous; meaning an entity simultaneously has multiple concurrent OODA processes with all phases underway at all times.

The OODA Cable

The OODA Cable is another approach to viewing the OODA loop. Envision the "OODA cable" as four separate pieces of cable spliced together at the OODA phases or nodes to form a loop as depicted in Figure 2. Decisions flow through this cable like charges of electrical current with many in the cable at one time. The piece of cable going into the observe node is the thickest (most strands) with some loose or frayed ends on the end away from the observe node.

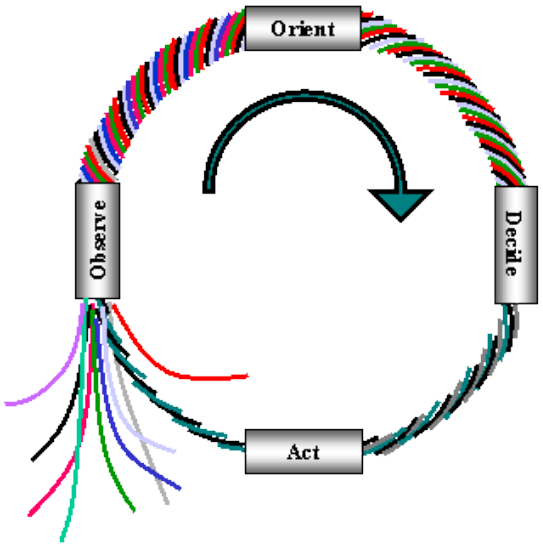

Figure 2. The OODA cable

Each strand represents a data delivery device or sensor available to the entity. The frayed ends represent sources of external information while the unbroken strands are internal feedback. Not all incoming information is relevant to the decision at hand, nor can all the information be processed, thus at the observe node the cable is spliced into a thinner cable with a strand representing all relevant inputs. The cable thickness of this section represents the information capacity of the decision-making entity. Information overload occurs when more information is presented to the entity than it can include in the decision process. At the orient node all the strands of information are spliced into a thinner (fewer strands) cable with a strand for each plausible course of action. The number of strands in this section of the cable represents the number of options of the entity can evaluate before a decision must be reached. This section of cable is spliced into a smaller section at the decide node. The strands leaving the decide node represent the actions the individual has decided to take. This cable is spliced into a smaller cable at the act node where there is a strand for each action the entity can do simultaneously. These "act" strands lead directly into the observe node as feedback from the action taken and is processed with new external information from the loose or frayed strands. In short, the OODA cable represents the inherent need to filter and consolidate information through the decision cycle with thicker cables representing an increased ability to carry information.

Systems of OODA Loops

OODA loops often combine to form multidimensional, complex systems of decision making. In these systems some OODA loops depend upon others for input or actual functions of their decision processes. There are two typical forms of dependent OODA systems; concentric and hierarchical.

Concentric Systems. In a concentric system, the function of each node of an OODA is performed by a separate subordinate OODA. The system can be decomposed into components that resemble the original system. This can be seen when staffs or groups of people execute large decision processes. Often these staffs are subdivided and specialized by their function to the decision

process, but each component has an OODA of its own. For example, an ATO cell gets the status, location and other pertinent information from an intelligence group (observe), attack options from targeteers that are matched with the work of an apportionment group (orient) to build possible strike packages. The target sets are finalized (decide) by an executive or staff and the ATO is published (act). The intel group primarily responsible for observation has an independent OODA loop where the action is reporting the observation to the ATO cell. On that intel group is a photo reconnaissance officer who has an independent decision process where the action is to report to the intel group if the bridge in the imagery is still functional. This shows how smaller OODA loops can be woven together into a larger one and that a complex decision process may have many layers of decision processes. Figure 3 illustrates a decision making system consisting of distinct but interconnected OODA loops.

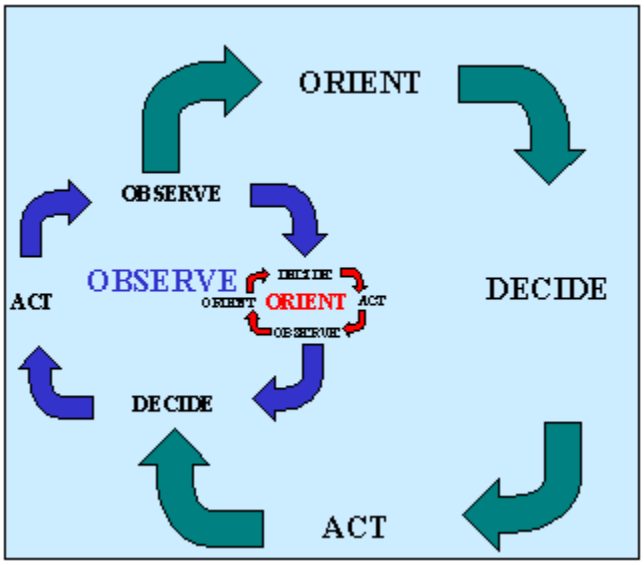

Figure 3 Concentric dependent OODAs

Hierarchical Systems. Another common arrangement is when the OODA loops form a hierarchically interconnected system as depicted in Figure 4. OODA loops at one level in this system may depend upon OODA loops at the same or other levels for information (observations), instructions (orientation), or to carry out decisions (actions) [5]. OODA loops in a system can also be laterally dependent on adjacent "peer" loops. OODA loop cycles at any level may differ in length from those at other levels. For example, a commander issues orders in the act phase. These orders feed into the orient interaction phase of the subordinate. The outcome of the actions of the subordinate affect the commander’s observe phase.

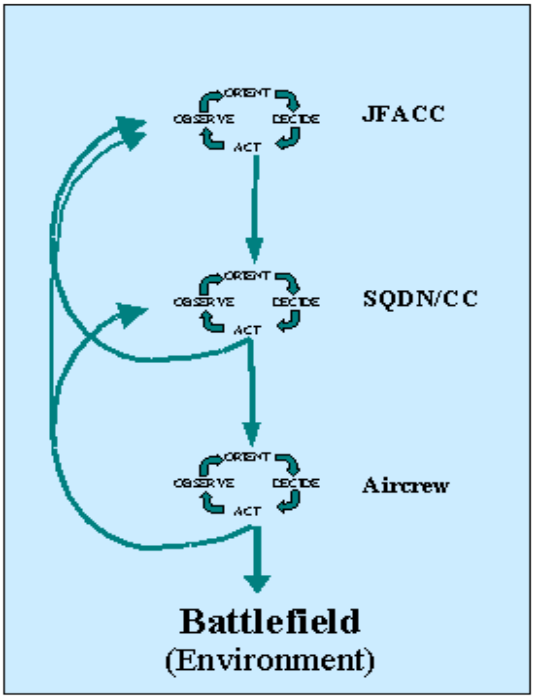

Figure 4. Typical Hierarchical OODA

Composite OODA Webs. From a decision making, or OODA perspective, envision the enemy system as a web of dependent OODA links with irregular but successively smaller links towards the bottom (see figure 5). Each link is an OODA cable. The links of OODA cable are not uniform. Some links have many other links dependent on or connected to them. Others are dangling relatively free from adjacent links. The cables at the top are typically longer and thicker as commanders with their staffs are able to process a lot of information, but have relatively long decision cycles (a day or two). These larger links are often concentric systems themselves and have subordinate hierarchical links attached to them. Subsequent rows in the web are shorter, thinner cables fastened at the orient node to the commander's act node. The bottom row in the web is made of short, thin cables representing the individual combatant. These individuals have only a small amount of information to process, but need a decision every few seconds. If a bottom link is broken, the web is tattered and less effective. If an upper link is broken, the web may falter leaving the enemy exposed. If enough links are broken, the web becomes ineffective. These conceptual constructs allow for an unlimited number of OODA combinations and corresponding interdependencies. To target an OODA web one must first build a model or estimate of its functional characteristics. This OODA web model is the framework needed to begin a deliberate (strategic) effect-based campaign. Once the web structure is identified, decision based target selection is possible.

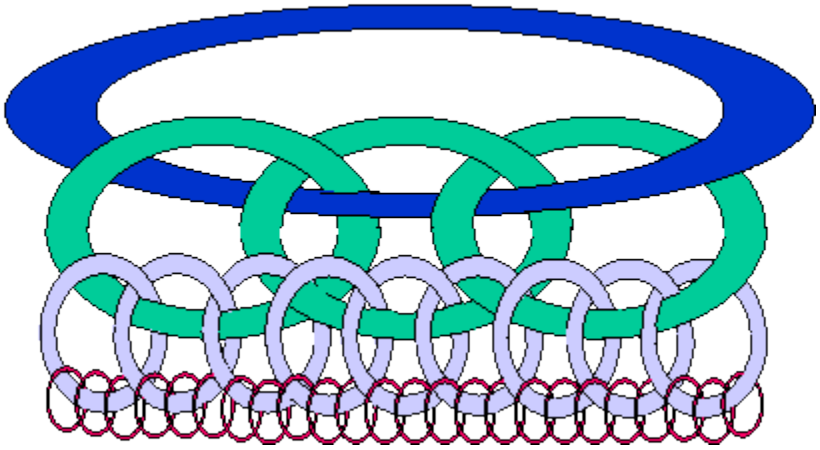

Figure 5. OODA web

Targeting the OODA Loop

Before looking for actual target sets, the goal of the strike needs to be defined. This is true for the doctrinal discussion as well as the physical application. The doctrinal concerns will be addressed first by defining the goals of targeting decision cycles.

What is an OODA Advantage?

There are two ways to improve your decision process and defeat your opponent through their OODA loop. The first way is to have quantitatively faster decision cycles since this will allow you to make the first move and make the opponent reactionary. The second is to make qualitatively better, more appropriate decisions than the opponent. Better decisions can lead to more preferable outcomes than quick but poor (hasty) decisions. Since the decision cycle is a process, it makes sense to try to systematically make both quantitative and qualitative improvements.

Faster OODA. Boyd suggests "turning inside" the enemy decision process, or beating the enemy by having a faster OODA loop than the enemy's. Warden's theory is similar [7], although he advocates making the enemy's OODA loop larger and slower by adding physical friction and fog through the destruction of key centers of gravity (COGs), where Warden's COGs can be thought of as things needed to make plans work. This speed advantage can be seen initially in the OODA loop directly targeted. Since the C2 challenge in any web is to coordinate the dependent OODA loops so they can feed each other without delaying the subsequent decisions, a single slowed decision can gum up the timing of the rest of the system. "Though time frames vary at each echelon of command – according to the mission and battlefield perspective – decision cycles must be sufficiently synchronized to exploit both sequential and cumulative opportunity" [6]. Therefore, a single OODA delay can cause a ripple effect through the web that inhibits synchronization and reduces the ability for the entire system to take advantage of opportunities.

Achieving a faster decision process often results in a two way effect. The first effect is offensive in nature. You can implement your plan first and initiate the change in the current environment

before your opponent acts. If your plan requires the enemy's participation (i.e., he needs to be at a certain location) then initiating the action allows you to attain the necessary conditions prior to executing your plan. This amounts to a first strike advantage in which you kill the opponent before he can shoot at you. This usually makes the opponent defensive and reactive, putting the principle of offense on your side. While this can impact any node, it is easiest to see the effect on the enemy's ability to execute his existing plan. This would be an attack on act even though it will effect the rest of the OODA from this point forward. A good example is taking a "sniper" shot with AAA against an unsuspecting aircraft. The AAA piece can take its time and calculate the precise lead point it needs to hit the aircraft. It fires the shot and the unknowing aircraft flies into the path of the bullet. The second effect of a faster decision cycle is defensive. The entity with the OODA advantage is able to move out of harm's way or otherwise prepare itself to mute the effect of the opponent's offensive efforts. In other words, you can become a non-cooperative target by not complying with the attacking opponents' expectations (or the status quo) since you've completed one course of action (his previous expectation) and moved on to the next, which he may not have accounted for in his plan. This targets the orient phase since his plan must be continuously updated or redeveloped to match your new position. Defensive evasive maneuvers by an aircraft against anti-aircraft artillery where the aircraft must simply move out of the ballistic path of the bullet to defeat the shot is an excellent example of this. The combination of a (more effective) first strike offense and a reduction in vulnerability can produce a surprising advantage. In Clausewitzian terms, this adds moral (mental) fog to the enemy's situation by degrading his observe/orient functions and adds friction by degrading his decide/act functions.

Better OODA. Achieving a qualitatively better decision than the opponent is the other way to achieve decision cycle supremacy. Assuming we are not trying to make bad decisions, how can we qualitatively improve our decisions? The actual level of quality of decision is a relative, not absolute, measurement. We can improve the difference in quality of decisions in both directions by making our decisions better and theirs worse. However, a better decision isn't just a more creative thought process (genius). Education and training is the most common way we improve our OODA process. By practicing in an exercise , we get experience with the kinds of information we need in a situation. We also build experience as to which actions work under what circumstances. This is especially important for those whose combat function is specifically to make decisions, like battlestaffs and air operations center (AOC) teams. Experience here can give the future decision maker greater breadth of choices and a measure of confidence in what will be successful. Improved information operations and intelligence, surveillance, and reconnaissance (ISR) can also give a decisive qualitative advantage. These quantities can improve OODA quality since the trained decision maker can see more options, gather only the information pertinent to the decision, and have the confidence to finalize his best option. This can be described as better synthesis or fusion of the information (all improvements to orient). At the same time we can degrade the opponents OODA through security (observe), deception (observe or orient), or taking uncharacteristic or unexpected action known as surprise (orient). While it is advisable to systematically work to improve our decision processes and degrade those of our opponents, it is risky to rely solely on a qualitative OODA advantage.

What to Attack in the OODA Loop

Since the OODA loop is only a model for the decision cycle, it is not something that can be seized physically. However, many decisions are reliant on physical objects. By attacking these objects we might be able to degrade the decision cycle and achieve an OODA advantage.

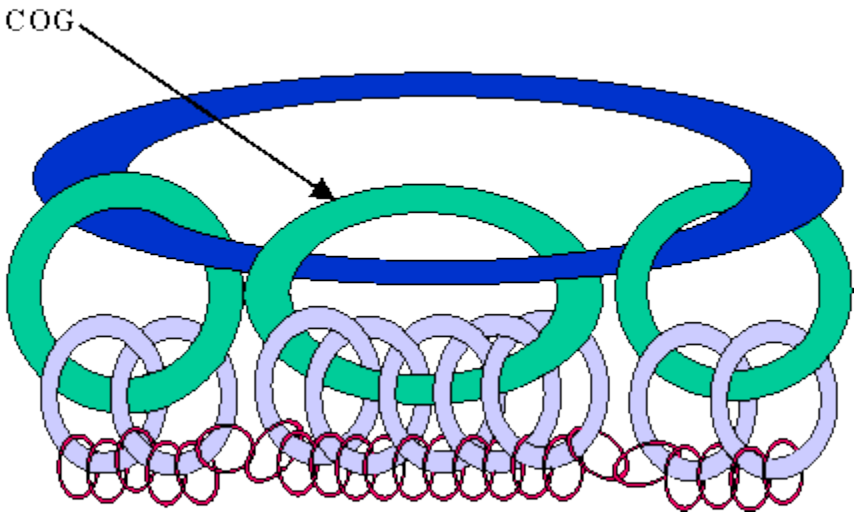

Figure 6. OODA web with identifiable COGs.

What is a decision cycle center of gravity (COG) and how can it be recognized? There are two ways to view COGs in the context of an OODA system. The first type of COG is a decision cycle that has many other dependent decisions (see Figure 6). Disrupting that key OODA will impact all the dependent decisions. Slowing or stopping that key OODA could render incapable all OODAs beneath it hierarchically. The second embodiment of a COG is a physical object upon which several OODAs, or their supported plans, rely. The plans that are woven into strategy all include assumptions about the environment, resources available, and other physical objects that may be used by one side or the other in the conflict. (see Figure 7). Destroying such a key object will invalidate a plan or its assumptions and can disrupt many different OODAs involved with the plan. This will quite possibly disrupt OODAs from different webs, sending ripples throughout the entire enemy system.

When deciding on a plan of attack, the enemy's OODA structure should be carefully examined or estimated. There will more than likely be several overlapping OODAs trying to bring plans to bear on multiple issues. Military, political, and social OODAs will all be active. Individuals may be participants in more than one OODA web. Striking a target can produce different effects within the various OODA webs under different circumstances. The specific OODA to be attacked must be identified and analyzed because the most effective target set should vary with the phase of the decision cycle under attack.

Observation is a continuous function. Even if the enemy has no current plan in action, they will be in observe. In military OODA webs, for example, initial strikes on integrated air defense system (IADS) components, communications centers, and ISR assets can impair the enemy’s ability to observe the "true" situation. Maneuver can then further complicate his problem by moving the truth away from "its last known trajectory" and having him commit observation

resources to ineffective areas, further concealing our actions. This means he must spend more time to get the same quality of information about his situation. The OODA is either lengthened due to more intense information collection, or degraded by an incomplete understanding of the actual conditions (poor SA).

An attack on orient will try to deny the enemy the use of their plans. Decisions in orientation can be attacked by creating an unanticipated environment. This can be achieved by removing resources needed to execute the plan prior to the decision, or by

changing the environment away from the assumptions faster than the adversary can formulate/modify the plan. This requires a rapid (relative to the OODA length) change in the environment: a surprise or shock. The component plans that are attacked and invalidated must be stripped off, a new, more suitable plan woven on, and the entire strategy revalidated. This shoring-up of the embryonic strategy adds time or length to the OODA process, or forces an incomplete strategy to be pushed into execution. Orient can be attacked by interdiction if key plan components are eliminated prior to a decision for the plan. A strike against C3 facilities is often aimed at the orient nodes of hierarchical subordinate OODAs.

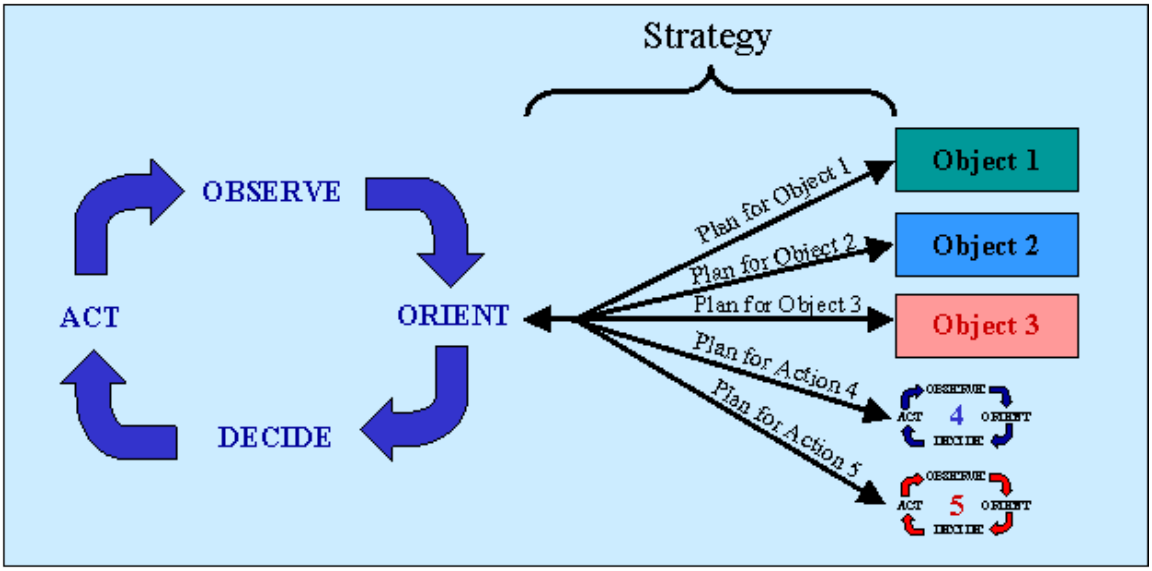

Figure 7. Strategy links OODAs to traditional physical targets.

The purpose of an attack on decide is to change the cost or risk-to-benefit ratio associated with a "feasible" plan. If all feasible plans (forwarded from ORIENT), including the plan to do nothing, have an unacceptable cost or risk for the perceived benefit, the OODA process will stall. For example, the cost associated with a decision to execute a viable plan for foreign humanitarian assistance may change if the operation is opposed by the target nation, economic partners, the UN, or a large rival military power. Deterrence is an example of a traditional attack on the decide phase. Deterrence attacks the decision phase by keeping the cost of a war above the potential political gains and is perhaps the greatest example of a strategic effect.

If the plan has been put into execution, the act phase must be targeted in order to keep the plan from succeeding. This is often a classic force-on-force battle in which our plan is to defeat them at the point of attack, such as a halt phase. Interdiction can also work against act by denying resources critical to a plan that has already been decided upon.

Since there are often many overlapping decision processes in the military-political arena during the complex event of war, it is possible to attack more than one OODA web at a time by striking a single target. Also, because an OODA is a continuous process, it is possible to attack the same OODA at more than one node at a time. These are two ways a parallel attack can be made against a OODA system. An OODA attacked at more than one node is more likely to break or collapse. This collapse can ripple through a web to many other dependent OODAs or through overlapping webs. The greater number of OODAs that are degraded and the more significant the degradation, the better the opportunity to dominate the overall military/political/social decision space.

The Time Sensitive Nature of OODA Targets

A strategic target set is perishable. The list of strategic targets in an "off the shelf" O-plan is very possibly not in tune with the enemy's current plan. An object or decision cycle can be a COG one instant, and not the next, as the plan, which is dependent on that COG, gets executed. The enemy may not need the bridge to execute this strategy. If he does, he may only need it for the first week of the war. He may make a reactive change in his plan, a mid-course correction, which now requires the bridge only in the third week of the war. Those items are only strategic targets while they are needed to execute his plan. Hitting the bridge after it has served its only (strategic) purpose is a waste of a good bomb. Hitting the bridge well before it is needed gives the enemy time to make repairs or develop a suitable substitute plan.

A classic example of a time sensitive OODA target is the US nuclear Single Integrated Operations Plan (SIOP) C3 system. The SIOP is a complete enough plan that once the execution order is given, all forces have enough information to complete their mission autonomously. If the C3 system is taken out as a preemptive strike, the SIOP forces may stay on alert for the rest of their (very short) lives. However, the SIOP is not effected if the entire C3 system is knocked out just after the SIOP execution order has been received by the combat crews. In fact, lack of C3 is a condition anticipated and somewhat expected during SIOP mission execution. The time sensitive nature of OODA targets means only continued persistent attacks on timely targets may prevent a good workable plan from ever being pieced together. This is because the component contingency plans become infeasible or inappropriate for the changing environment and the projected course of action is overcome by events.

Multiple Levels of Attack

In a traditional, symmetric confrontation, OODA loops compete directly with OODAs of about equivalent position in the adversary's web. This conflict occurs simultaneously at all levels with soldiers against soldiers, aircrews against SAM crews, brigade commanders against brigade commanders, and CINCs against CINCs. It is possible, however, to target a specific OODA or level of OODAs indirectly by influencing the OODAs above or below the target (see Figure 8).

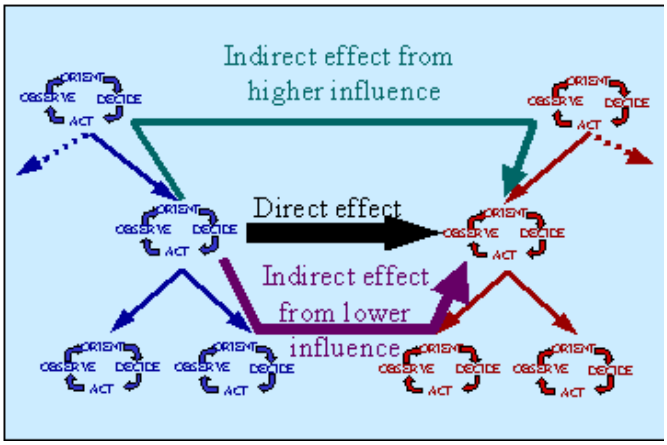

Figure 8. Multiple levels of attack

If the decision being targeted is the decision by an air component commander to use CBUs, a direct attack would be to take out the command and control structure needed to issue the order for CBUs in the ATO. An example of indirect influence from above is political pressure from the CINC to issue rules of engagement (ROEs) that limit the use of CBUs. Indirect influence from below can be exemplified by an attack on an ammunition depot or airfield, preventing CBUs from being loaded onto aircraft.

Since a plan is often executed at a low level in the web, it has a "decision path" from the upper level OODAs to the point of execution. That decision can be attacked at any point in the decision path (web structure) prior to the completion of the plan's execution. Here the decision path must be traced to see which OODAs can still influence the plan and which ones are no longer pertinent targets. Those OODAs with the ability to influence the plan should be the only ones considered for targeting.

Exploitation of OODA Loops for Strategic Effect

The Air Force Doctrine Center has recommended the elements of Clausewitz's trinity as a starting point for any effort to explain strategic effects [8]. The elements of Clausewitz's trinity [9] are chance, violence, and reason. Clausewitz's gives the military, the population, and the government of a nation as an example of the three elements. This specific example describes three distinct OODA webs that exist at the national level. This example has become a popular modern surrogate for the original trinity. The decision cycle theory will first be applied the to the trinity example at the national level, then in a more liberal analogy to the original trinity elements.

The Modern Clausewitzian Trinity

The original element of chance is mapped to the modern element of the military. This is because the initiation of an act of war usually depends upon an existing chance or opportunity to succeed through military action. Attacking Clausewitz's "chance" in this example is striking the enemy nation's ability to wage an effective war by nullifying its military force, preparations or strategy.

The military OODA web is often the most structured and disciplined of the national decision process systems. A typical military OODA web has strong vertical and lateral linkages because these systems tend to be centralized in control and decentralized in execution. The dependencies or relationships within the web are formally defined and these links are often exercised. Because of the well-defined responsibilities for the decision process component execution within a military OODA web, it may be attacked effectively at any level with some repercussions expected above and below the actual decision cycle targeted. It is potentially the most stable (fewest COGs) of the national webs. It is also the most targeted web since it brings force to bear and offers the most legitimate military targets.

Chance can be attacked by either foiling an enemy's military plans or directly diminishing its forces' abilities. The former approach requires us to change the environment from that which his plan anticipated, reducing his opportunity to employ the plan. The latter requires strike or interdiction missions designed to reduce the resources needed to execute his plan. Either way leaves the enemy less likely to find an opportunity for successful military action.

Clausewitz assigns violence to the population in the national system model. This is because the citizens of a nation must have passion, either for the cause or against the enemy. Through this passion, the population will support the prosecution of war and accept the risk of potential hardships. The OODA web structure of a nation's population base will be referred to as the social web. This web is typically not well structured with a majority of the linkages being lateral instead of vertical. This web is often decentralized in control and in execution. The lateral links in the social web are built from personal, cultural, religious, nationalistic and economic interests. This type of web be may better visualized as a bunch of disjointed, low-level, OODA clumps, which lie on the floor instead of the well structured curtain of OODAs typical of a military system. The "clumps on the floor" represent small groups of family, friends, or colleagues that are nearly independent in action from other similar groups. The lack of vertical structure or extensive lateral structure in a social OODA make it an especially difficult target because there are rarely any OODAs that have even indirect dependencies with the rest of the social system (COGs). Occasionally a strong personality can bring vertical order and structure to the social web, although the web typically remains shallow. Examples of such strong personalities include Winston Churchill and Adolph Hitler (political leaders), the Pope and the Ayatollah (religious leaders), Martin Luther King, Jr. and Lech Walesa (social leaders), and even Rush Limbaugh and Oprah Winfrey (celebrities). These organizing personalities can be COGs. Some issues or causes can also bring organization to a social web. One such cause is a common hatred, or violent disposition, toward an enemy. Attacks on the social OODA will typically try to erode and further fragment the shallow social OODA web. While the social web may not directly impact the war fight, the other national OODAs rely on the same individual decision-makers which have been degraded or distracted by the erosion or fragmentation of their clump of the social web. A successful attack here needs to be very broad-based so as to impact a large number of OODA clumps. These broad based attacks on a "social" or civilian target are not only difficult to effectively execute, they have the potential to break the link to "military necessity" and infringe on the Law of Armed Conflict. This kind of social attack can easily produce a common hatred of an enemy where an attack designed to have the exact opposite effect can result in a unification of social structure. Typically subtler, less lethal forms of attack like economic sanctions or propaganda have been used more successfully against the social OODA.

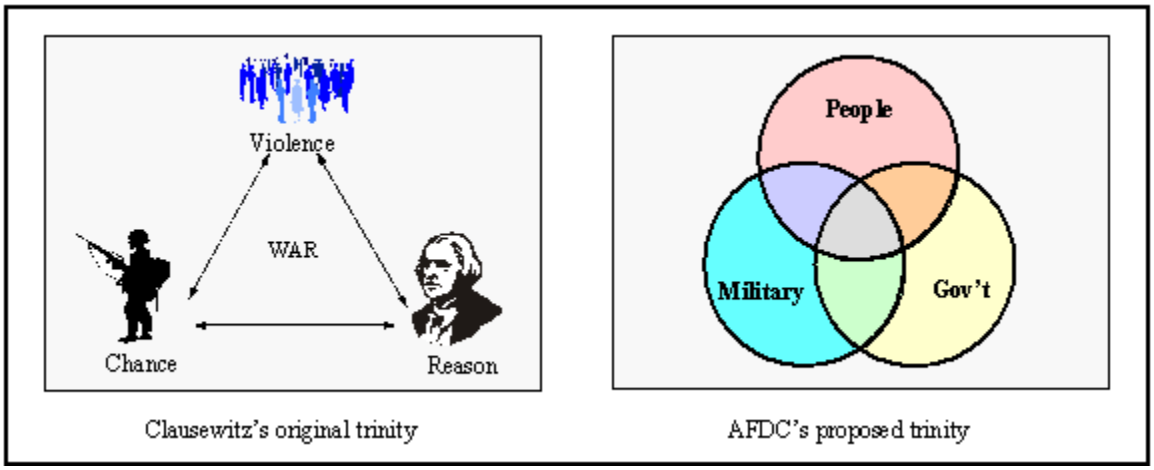

Figure 9. The Clausewitz trinity compared to the AFDC's interpretation

Clausewitz's element of reason corresponds with the government in the modern, national-level trinity. The government must weigh the risks, benefits and consequences of the act of war for the nation. For this reason, the government is the embodiment of the political OODA web. Political systems are typically centralized in command and execution and tend to be structured concentrically with some strong vertical hierarchical linkages. The government system is vulnerable to espionage, information warfare, and traitors, as these will erode the support structure needed to formulate and evaluate viable plans in the concentric system. An attack on government can target the highest level as in a physical or political assassination. Here, the expectation is that the political plans will collapse with the loss of the key decision-maker. This is a cut in an upper level of a hierarchical OODA structure.

One classically anticipated signal that a strategic effect has been achieved is a cascading failure of the enemy's system. The cascade effect from strategic attack may be either bottom up like pulling the chair out from under a system, or top down like a snow avalanche where small individual decisions influence adjacent decisions (OODAs) by proximity. A highly successful attack on the government web would be expected to give the former results. An attack on the social web would be likely to produce the latter. An attack on the fielded military is less likely to have cascading effects, but the effect would be dependent upon the component of the web attacked.

While the OODA theory fits well into the Military/Population/Government interpretation of Clausewitz's trinity, the original trinity holds more insights and applications for the OODA model. The trinity the Air Force Doctrine Center's proposes for the study of strategic effects [8] is compared to Clausewitz's trinity in Figure 9. This shows the specific national level example of the trinity cannot be used as a replacement for the general concept.

Original Trinity Concepts

In the national system described above each of the three trinity elements represented a distinct OODA web performing unique OODA functions concentrically in the national decision process for the prosecution of war. This structure was very appropriate for the national decision responsibilities in Clausewitz's time. In our modern open society with a democratic government "of the people", an all volunteer force of citizen soldiers, and an informationally liberated population, those roles are a lot less rigid and distinct. The individual citizens, whose decision cycles constitute the elemental building blocks of the OODA webs, are often simultaneously active in more than one web. The original trinity concepts describe the processes required in these elemental decision cycles, and to every level of decision making in the system, to initiate and sustain an effort of war. We will now revisit these original trinity concepts and discuss their characterization of wartime decision processes at all levels.

In Clausewitz's original trinity, the element of chance attempts to quantify the ability to take advantage of military opportunities. It can be thought of as initiative. Taking the initiative will alter the environment, hopefully to one for which the enemy has not planned. Besides the immediate effect of changing the environment to nullify enemy plans, a strike can force the enemy into an intensified effort to generate new, more applicable plans. The focus on rebuilding strategy after an initial strike can also put the enemy on the defensive and blind them to immediate tactical opportunities, further impairing their ability to capitalize on a chance. Chance is quite possibly correlated to the relative speed of an OODA in that those that bring a plan to bear first have a better probability of finding and exploiting other opportunities.

In the national example from Clausewitz's time, the military was the only group that realistically was in a position to find and exploit opportunities against the enemy. Today, opportunities for initiative happen frequently at every level and in every aspect of the national system. Forming international political alliances, increasing industrial production, and growing 'victory gardens' are all examples of chances to gain an advantage over the enemy. But these chances must be seen (observed) by someone in a position to take action before they can be exploited.

Violence is the perspective from which events are seen. This perspective is based on the cultural biases of the observer. Violence frames an event in context of the conflict for decision-making entities. Violence orients observations toward a decision. A decision-maker with violence will tend to attribute negative events to the enemy, strengthening its resolve against that enemy. A decision-maker with less violence may search for other alternative causes to the event before blaming the enemy. If a reasonable alternative can be found, the less violent decision-maker may not be motivated to support war. Violence may be seen as a strength or durability factor for a plan, with high violence being more likely to make greater sacrifices, to tolerate higher shock, and to work to find creative alternative plans to achieve the goal. Violence shapes the interpretation of events, or observations, to support a decision for war.

Targeting Clausewitz's "violence" is targeting the individual's will to fight. Neither Germany's bombing of London nor Britain's bombing of Germany changed either nation's attitude or will to fight in WWII. In fact public resolve against the aggressor likely increased in each instance. On the other hand, swarms of Iraqi infantry surrendered to unarmed corespondents near the end of Desert Storm. This inability to get consistent effects makes violence or national will much more difficult to target. National will is a group behavior that emerges from the individuals that make

up the nation. To attack this web, the predominantly lower level (individual) social OODAs must be changed so the same individual is less effective in the political, military, or other social decision processes in which he is involved.

Reason is the element that keeps the war from escalating to the horrific level of 'total war'. The government takes this function at the national level because it usually makes the decision as to whether or not the country should attack, or conversely, should surrender. The government is also the body that will face any political repercussions for war crimes.

Reason is applied at every level in the enemy system on decisions concerning the conflict. Individual soldiers must decide whether or not to shoot enemy combatants and enemy non-combatants. The nation must decide whether or not to support military conscription and how young those conscripts may be. Reason impacts the decide phase of decision cycles at every level. Reason, as a trinity element, is a realization of the costs or risks associated with the plan weighed against the potential benefits. Reason can be thought of as a measure of the appropriateness or quality of the decision.

An attack on reason is designed to demonstrate the full or increasing price a decision-maker will have to pay. Consider the El Dorado Canyon Raid in 1986 that targeted Libyan leader Kadafi. The attack demonstrated that the US was indeed willing to prosecute a war that would be costly to Libya and Kadafi. This attack was outside the bounds of Kadafi's expectations. It raised the perceived cost of the Libyan course of action and apparently impacted Kadafi's decision to pursue his policies.

If chance is what must be observed, violence is how observations must be oriented, and reason is why the decision is made, then Clausewitz's trinity can be viewed as factors that directly describe the first three nodes of a OODA cycle concerned with the act of war. Clausewitz tells us these three elements are essential for waging war. Through his trinity, Clausewitz defines the decision cycle qualities required to support war. This interpretation maps the three elements of the trinity to the three initial phases of any decision process, instead of to the components of the national system. All three trinity elements must be present in decision processes at every level in each of the webs to have a national or strategic level decision system capable of initiating and sustaining war. Furthermore, all three original elements may be found in any decision-making subset of the original national system, all the way down to the individual combatant or citizen concept. This is a significant indicator of the appropriateness for mathematically modeling the enemy decision system with chaos theory or other "new science" methods. Figure 10 describes this alternative interpretation of the Clausewitz trinity. This interpretation will serve as a theoretical basis for targeting the OODA loop to achieve strategic effects.

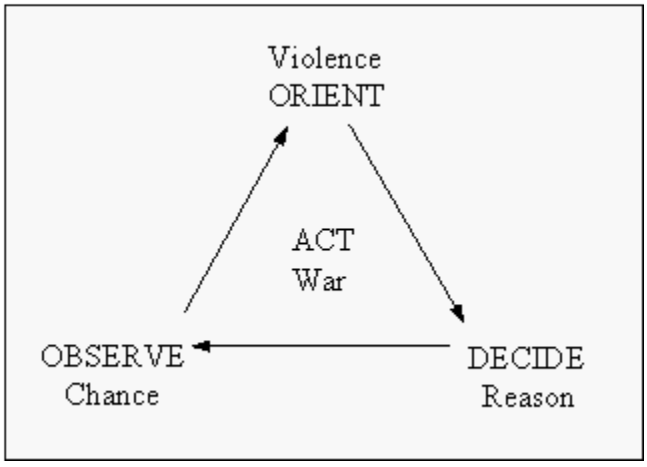

Figure 10. The Clausewitz trinity from the OODA perspective

Strategic Attack in terms of OODA

A successful strategic attack will drive a wedge between the decision-maker and a plan he wants to execute. This wedge can be driven into any point in the OODA loop before the decision is fully executed. A single wedge can often be overcome by selecting an adjacent plan or by removing the wedge. This is why Warden [10] advocates parallel attack. Hit the system at all levels simultaneously and continuously and drive as many wedges into the critical OODAs as possible. Persistent, parallel attacks can isolate the decision-maker from all feasible plans and could even leave him paralyzed with indecision or stalled in disbelief that all of his plans are invalid. This is shock and awe and causes a complete break in the OODA loop. A break, or even a significant stretch (lengthening), of a key OODA or several lesser OODAs can collapse the web. In this way, OODA theory is unique in that the intended target of the attack is a specific decision cycle, not the physical object destroyed by munitions.

Robert Pape [11], a contrarian to Warden, uses historical examples to refute the effectiveness of strategic bombing. For instance, the U.S. strategic bombing campaign in Europe during WWII did not sufficiently disrupt Germany's industrial capacity. The sequential (versus parallel) bombing campaign allowed Germany to reorganize, regroup and rebuild between attacks. In short, Germany worked around the wedges, developing or implementing alternate plans and repairing their key OODAs and web. Parallel attack as seen in DESERT STORM can drive many wedges into a strategy, which will stress the enemy system so it has neither the time nor the ability to recover before further attacks can break key OODA links and collapse the web. Nuclear attack would (and did) halt the OODA process (cut the cables) on most levels simultaneously, giving a parallel attack with just one weapon. This explains why Pape does not try to denounce strategic effects of nuclear weapons.

Most historic attempts to predict targets that will produce strategic effects have started with target sets. These approaches are predominantly one-dimensional, seeking a single type of target to attack. These types of targets may indeed work if the enemy cooperates and does not change strategy. General rules or principles about strategic bombing can not, however, then be drawn from these isolated target-class based successes. Trying to predict strategic effects based only on

target sets without studying how those targets will impact the OODA decision webs is like trying to predict rush hour traffic flow patterns by studying only automobiles. The real answer lies in the thousands of dependent decisions made by the individuals relying on the "targets," not the target objects, themselves.

The point is that the target in effects based targeting should be the enemy's decision process. Disrupting an enemy's OODA web requires striking the proper OODAs (COGs). Identifying OODA processes that are vulnerable COGs can be a difficult task. A link of any size that has a large number of dependent, attached links is a center of gravity. A physical object (bridge) that is required to carry out the most plausible plans is a means to get at the COG, since its destruction will drive a wedge into the OODA. This viewpoint differs from most convention where the bridge would be seen as the COG. The bridge or other physical object could be the COG if many OODAs and the plans they support depend on that object. Here again a single strike can influence many decision cycles, possibly in more than one web, keeping in mind the mission target (bridge) is not the strategic target (decision process).

Resources and capabilities available, cultural predisposition, and tactical opportunity for successful gain, all shape the decision. As the nature of the required decisions change, so do the nature of strategic targets. Hence the metamorphosis of "ideal strategic target sets" from Douhet (citizens) to WWII (industrial web) to Desert Storm and Kosovo (Warden's five rings).

Turning inside your own OODA

Pre-announcing the target set works against OODA exploitation. Pre-announcing a target set, as was occasionally done in operation ALLIED FORCE, can limit collateral and hence political damage while demonstrating a supreme control of the battlespace (I'm telling you what I'm going to do because you can't do anything to stop me.) However, it also allows the enemy to prepare for the attack. This gives the opponent an OODA advantage. He not only has an opportunity to move any tactically significant, mobile resources away from the attack, but he has time to develop a plan (orient) to work around the forecast loss of the target. It also allows the threshold of coercive "pain" to creep upward (decide) before the hurt is applied. Declaring a target set off-limits has a similar effect for the exact opposite reasons. The enemy knows he can rely on those non-target objects and can formulate plans that depend heavily on them. These plans will tend to be more reliable and stable as the environment changes.

Graduated response works against OODA exploitation. The decide phase is essentially a risk analysis of potential cost vs. potential gain. If the enemy has determined a cost he is willing to pay for his political gain, and that cost is not quickly exceeded, then that "threshold of pain" may creep up. For example, if they had a threshold or breakpoint of 1000 casualties and were expecting 800 dead but only lost 100 soldiers, that 100 may seem relatively insignificant. This may then lead to that threshold staying at or near 1000 casualties from the remaining force or a total of 1100 for the breakpoint. An initial result below expectation (800 dead) can be unifying, " They aren't as good as we expected. We have a much better chance of succeeding than I thought." A result well below expectation can lead to martyrdom of the casualties (a unifying cause in the social OODA) and an increase in the value of the political objective, "Now I want to punish you as well as get my original goals." In ALLIED FORCE the large deployment of air

forces was intended as a show of force, but the small number of initial attacks were trivial compared to expectations based on the first week of DESERT STORM and the political saber rattling immediately prior to initiating the strikes.

OODA Exploitation and Implications for Airpower

This OODA-based theory leads to the conclusion that the current planning process does not expressly allow (strategic) effects-based targeting. This is because too much attention is focused on the hardware and physical destruction of things. While the estimate of the enemy plan is usually considered in target selection, it is generally not targeted directly. The ability to correctly interpret enemy plans from actions and intuitively shift the campaign to defeat that plan may be the basis of "military genius," as described by Clausewitz. The targeting process elements need to directly consider what the enemy (at any level) needs to execute his current plan and his likely alternative plans. This means motives, cultural influences, ambitions, and other typically non-military considerations must be brought into the military targeting system.

Implications for Theater Planning

Historically, commanding generals have been the primary participants that were responsible for anticipating the enemy's plan. For OODA exploitation to be successful, a large part of the force will have to be a part of that effort. This is consistent with the US trend to emphasize C4ISR (remember that C2 -command and control-is the process and the remaining C2 -communications and computers- and ISR are tools for that process) and information warfare (our observe). A rapid strike capability is required to be able to take advantage of our gains in observe and hit time sensitive OODA targets. This means better mobility (lighter deployment footprint) and more agile combat support to allow our forces to get into the fight and sustain the effort on our terms (control the environment to meet our planned requirements). Bigger OODAs are easier to target. It is easier to run a campaign (ATO) against an industrial system than an individual. Most importantly we need to exercise our OODAs. Train the groups responsible for decisions as teams and treat these "decision crews" similar to "aircrews."

Targeting the OODA will require a better understanding of the enemy's plan. While we may never expect perfect knowledge of the enemy system, an adversary’s national strategy should be dissected to the best of our ability into component military, political, and social plans. The interactions in each OODA web must be understood before decision cycle-based COGs can be determined. These interactions and interdependencies make each national system and its three component OODA webs unique. The plans must then be examined to determine which support the objectionable course of action. Military targets can then be selected to impact the decisions to execute/continue those plans, based on the current OODA phase. A typical target selection process using OODA theory should proceed something like:

1. Identify enemy's potential courses of action to be influenced
2. Identify OODA loops that support those courses of action
3. Identify the appropriate nodes of key decision cycles based on the phase of the plan
4. Identify physical targets that impact those nodes

OODA theory also has important implications for national defense as we try to secure our borders from terrorism, information warfare, and other asymmetric tactics available to our potential adversaries.

Implications for Combat Modeling

Current computer modeling techniques cannot account for, let alone demonstrate or predict strategic effects. This is due to the fact that most models do not account for reactive decision making or learning. This takes qualitative decision making out of the simulation. Most models also adjudicate combat effects across a fixed time period. This eliminates the possibility of showing the effect of a quantitative OODA advantage. Without implicitly modeling the decision process, factors such as training, leadership, C4ISR, and combat support are left as unquatifyable "tuning knobs" used to tweak the outputs to historically or hypothetically explainable results. OODA theory, while still in infancy, offers an approach to explain the impact of these "soft" factors on combat capability. Modeling combat via OODA theory will require a fundamental change in current model architecture. A campaign level simulation that accounts for decision processes will not be a trivial undertaking.

The decision cycle system is probably best described mathematically with chaotic or complex system architecture. One of the necessary conditions for mathematical complexity is decomposability, in which an object can be described by pieces that all resemble the original object. The trinity-based OODA construct allows a national OODA web to be decomposed to the elemental decision-makers that resemble the national web. One very promising approach for modeling the entire OODA web is with autonomous agents in a complex adaptive system. Another approach is to model independent decision process with many unique neural network models connected into a web with a macro neural network. This approach is very reasonable but even more technically challenging. These two approaches can be combined using agents "deciding inside a neural network web or with a complex adaptive web with agents using a neural decision process. These emerging techniques are the logical paths to pursue in order to describe effects based warfare from decision cycle theory.

Another hurdle will be putting the decision process model into combat or combat simulations. Dr. Alfred Branstein of the Marine Corps Combat Development Command (MCCDC) is working on a technique to have a campaign level combat (adjudication) model query a complex adaptive model for alternative courses of action to be played out in the campaign. This effort, Project Gauss, is a logical first step in trying to model aggregated combatants as decision makers and this approach seems very promising.

Developing such an decision based model will not only require a major paradigm shift, but also push our technical capability. Although this is not an easy road, developing an OODA based model will open the door for modeling, simulating and analyzing the revolution in military affairs.

Conclusions

Strategic attack is an attack on strategy. The OODA web model of decision-making systems allows us to look at strategy in a general framework instead of through the specifics of any single plan. By targeting the decision process, we gain and maintain an OODA advantage. The advantage can transform into an OODA dominance if that becomes an objective. OODA dominance allows us to keep the environment consistent with the requirements for our strategy and creates a less favorable environment for the enemy.

Airpower is the force of choice for OODA exploitation. "Because of its speed, range, flexibility, and ability to maneuver as required to locate and precisely attack targets while neutralizing or avoiding threats, aerospace power is uniquely suited to conducting rapid, parallel attacks against the enemy" [12]. These characteristics of airpower allow simultaneous and continuous attacks on an enemy OODA system, preventing recovery. "A key difference between aerospace power and surface warfare is that aerospace forces can often strike directly at key target sets that have strategic results, without having to go through the process of drawn-out attrition at the tactical level of war" [13]. With airpower, all four nodes of the decision process can be attacked at once. This was the case in Desert Storm and is fundamental to Warden's theory and current Air Force doctrine.

The change required to move towards OODA dominance is evolutionary, not revolutionary. This will only require a shift in how we do business, not a restructuring. This shift is consistent with current USAF efforts. Trends toward information warfare (IW), improved battlefield awareness (AWACS, JSTARS, Predator and other UAVs), expeditionary forces, global attack, space based systems, and emphasis on the AOC as a weapon are all examples of how the USAF is converging toward improved OODA processes.

The shift towards exploiting decision cycles in combat means a shift away from the traditional focus on static target sets. It requires that "soft factors" including political and social considerations must be added to combat decisions. There is an uncomfortable first step, but to achieve the full effects of airpower anticipated by our doctrinal fathers, OODA dominance needs to be a conscious effort instead of a welcome coincidence.

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Appendix A. Specific Examples comparing typical Warden target sets to OODA target sets

Striking C2. This is an attack on decide. A C2 attack is crippling if the system is based on centralized execution or at a strategic crossroads or otherwise requires a decision to proceed. The effect of a strike here can be nullified by thorough planning (SIOP) and a solid understanding by the lower decision makers (combatants) of the plan. This understanding can by doctrinal or specific "commander's intent"

Striking System Essentials. This could be an attack on orient, decide, or act. If the indigenous resources attacked are required for future operations or plans, the orient phase is being attacked. If the attacks are meant to raise the price or pain level some portion of the enemy system must endure, you are targeting the decide phase (classic coercion). If the attack is on resources required to complete a plan currently being executed, then the act phase is the target.

Striking Infrastructure An infrastructure attack can impact any phase of the targeted OODA, depending on how the infrastructure is needed in execution of the plan. The communications

infrastructure could effect the ability (of the key decision-makers) to observe. The orient phase is attacked if unexecuted contingency plans are nullified or made inappropriate. The decide phase is impacted if the target significantly raises the overall cost or increases the risk of failure of the current plan. If execution of the current plan is dependent upon the targets, the attack impacts the act phase.

Striking the General Population. This is almost always a strike on the decide node. The idea here is to raise the cost of the war above the value of the expected benefit. The OODA loop under attack can be the national leadership OODA, but is more likely to be the thousands or millions of individual citizen's personal OODA loops: the national will. This is an appropriate place to discuss the OODA effect of a limited, phased, or escalating campaign. At the beginning of the conflict each individual makes a personal estimate of the benefit of the political objective and the cost he is willing to pay for that objective. The acceptable cost may be a $0.10 per gallon increase in gasoline or it may be a 50% attrition rate (half of his family). He also makes an initial estimate of the enemy's expected damage on an attack (I think they will kill 20% of my family and friends per night for a week, and that price is acceptable for the national cause). If the initial attack is less damaging or costly than expected then the individual may become numbly comfortable at the new level of pain and raise his tolerance. " That wasn't so bad, they only killed 10% of my family and friends. Now, I can still tolerate a 50% casualty rate from here" (cumulative 55% casualty rate). On the other hand, if the initial attack exceeds the initial max acceptable cost, the individual's will may be broken. ("Wow, they killed 40% of my family and friends in one night, We'll never survive. The political objective just isn't worth that.") In this type of effort it is imperative that maximum effort is applied to exceed the acceptable cost before that cost threshold shifts upward.

Striking the Fielded Military. This is initially an attack on the act node. The plan cannot be carried out because there just aren't enough surviving resources to do it. All other nodes are subsequently effected since observation usually depends to some degree on the fielded units, orientation breaks down because the resources may now be inadequate for other contingency plans, and the cost of the operation has increased.
