Future Combat Assessment

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Chapter 1

Introduction

> *In essence, Air Power is targeting, targeting is intelligence, and intelligence is analyzing the effects of air operations.* [1]
>
> Colonel Phillip S. Meilinger

For many familiar with air power, combat assessment is perhaps the least visible and least understood component of the six step targeting process used by airmen to plan and execute air operations designed to meet the objectives of a joint force commander. Yet the development and fielding of new generations of weapons combined with increasing expectations to minimize collateral damage is dramatically altering our ability to measure and assess the effects of these weapons. The purpose of this paper is to answer two questions, (1) How will future weapons impact combat assessment? and (2) How will success be measured?

Chapter 2 will provide a sufficiently detailed background of current combat assessment doctrine and capability to understand how combat assessment fits into the targeting cycle and the air tasking order cycle used by air operations centers to plan and execute air operations. Chapter 2 will also introduce intelligence, surveillance, and reconnaissance operations used to collect the information required for combat assessment. Chapter 3 will survey current trends in new weapons and identify the challenges the capabilities of these new weapons will pose to combat assessment.

Chapter 4 will build upon the information provided in chapters 2 and 3 and provide specific recommendations regarding where specific areas of technology and change to current doctrine can improve combat assessment to keep pace with future weapons. Finally, Chapter 5 will summarize recommendations and provide conclusions.

Notes

[1] Phillip S Meilinger, "10 Propositions Regarding Airpower." Air Force History and Museums Program, 1995. P20.

Chapter 2

Combat Assessment

Assessing the results or effects of operations is as important as determining objectives.[2]

Joint Publication 2-01.1

Combat Assessment Doctrine

Operation Desert Storm proved to be a watershed event for combat assessment and resulted in development of comprehensive doctrine for this discipline. The purpose of this section is not to review historical problems with combat assessment but to summarize and evaluate existing combat assessment doctrine.[3] Joint Publication 3.0, *Doctrine for Joint Operations*, points out the increasing complexity of modern warfare and its effects required evolutionary improvements transitioning traditional bomb damage assessment to what we know today as combat assessment. Joint Publication 3.0 goes on to describe the following key attributes of combat assessment.

- Combat assessment is the determination of the overall effectiveness of force employment during military operations.
- At the Joint Force Commander Level, the combat assessment effort should be a joint program . . . designed to determine if the required effects on the adversary envisioned in the campaign plan are being achieved by the joint force components.
- The intent is to analyze with sound military judgment what is known about damage inflicted on the enemy . . .
- Combat assessment is done at all levels in the joint force. Normally, the joint force J-3 will be responsible for coordinating combat assessment, assisted by the joint force J-2.

- Combat assessment is composed of three major components, (a) battle damage assessment, (b) munitions effects assessment, and (c) reattack recommendations.[4]

Joint doctrine also clearly identifies combat assessment as a part of the targeting process. A conceptual model used to describe the process of selecting targets for attack which have the greatest likelihood of accomplishing the joint force commander's warfighting objectives is known as the joint targeting cycle. This cycle is a continuous process, which consist of six phases:

- Objectives and guidance
- Target development
- Weaponeering
- Force application
- Execution planning/force execution
- Combat assessment

As the final phase of the targeting cycle, combat assessment "closes the loop" and feeds the other five elements in the cycle. Combat assessment today consists of three sub-elements, battle damage assessment, munitions effectiveness assessment, and reattack recommendation. These key elements are defined in Joint Pub 2-01.1 as follows.

> **Battle Damage Assessment**. Battle damage assessment is the timely and accurate estimate of damage resulting from the application of damage resulting from the application of military force, either lethal or non-lethal, against a predetermined objective. Battle damage assessment is primarily an intelligence responsibility and evaluates whether operational or tactical objectives were met by force employment. Battle damage assessment objectives are accomplished by conducting three types of assessments, (a) physical damage, (b) functional damage, and (c) target system.

- Physical damage assessment is an estimate of physical damage to a target based upon observed or interpreted damage. This assessment is made on any and all sources of information.
- Functional damage assessment estimates the remaining functional or operational capability of a targeted facility or object. Again using any and all sources of information, this assessment includes an estimate of the recuperation or replacement time required for the target to resume normal operations.

- Target system assessment is an estimate of overall impact of force employment against an entire adversary target system. These assessments are the result of fusing all physical and functional damage assessments within a target system.

Munitions Effects Assessment. Munitions effects assessment is conducted concurrently and interactively with battle damage assessment using the same sources of information and is primarily the responsibility of operations. Munitions effects assessment is focused on the effectiveness of the specific munition used to attack a target as well as the tactics used to employ the weapon. The purpose is to systematically and continuously evaluate the best combination of delivery platform, weapon, and tactics used to attack and neutralize specific target types.

Reattack Recommendations. Reattack recommendation necessarily follows battle damage assessment and munitions effects assessment to fix problems identified during the course of these assessments.[5]

Joint doctrine also recognizes and introduces a relatively recent addition to the combat assessment process known as Mission Assessment. Mission assessment addresses the effectiveness of the overall operation in light of command objectives and missions. Importantly, mission assessment recognizes cumulative damage to targets is not necessarily representative of the total effectiveness achieved by proper targeting. Mission assessment estimates the total impact on adversary warfighting and war sustaining capabilities in specific mission areas. Mission assessment provides the decisionmaking authority with a broad perspective regarding the comprehensive impact of operations against the enemy.[6]

The remainder of this section builds on the above definitions of combat assessment to provide a deeper understanding of the combat assessment process as it exists today. This understanding will serve as the foundation for addressing the first question posed in this paper; "how will future weapons affect combat assessment?" To begin, some observations must be made on the adequacy and completeness of joint combat assessment doctrine. First, targeting doctrine correctly identifies the most critical ingredient for effective combat assessment as a comprehensive understanding of the Joint Force Commander's warfighting objectives and how they relate to target sets.[7] Underlying this critical ingredient, of course, is the core assumption of understanding the capabilities and extent of the target system(s) to be targeted. Combat assessment is a comparative and continuous process of first measuring and estimating damage to individual targets and then evaluating the effect of damage on the capability of the target system. Second, joint doctrine emphasizes combat assessment is a distributed process where all combatant commands, joint force functional components, and members of the Intelligence Community[8] contribute to the process. Joint doctrine not only identifies the participants in the combat assessment process but also identifies responsibilities and functions for these participants.[9] It is important to note while the combat assessment process is distributed, the final assessment is centralized and ultimately the responsibility of the joint force commander. Third, Joint targeting doctrine provides comprehensive procedures for accomplishing the battle damage assessment subset of combat assessment. The comprehensiveness of this doctrine extends to providing physical damage definitions for specific military targets to providing specific worksheets and reporting formats for conducting and reporting battle damage assessment.[10] Finally, joint targeting doctrine acknowledges the importance of beginning to plan combat assessment prior to mission application and force execution. Assessing the results or effects of operations is as important as determining the objectives. Combat assessment must be a proactive process and as targeteers identify and develop targets they must answer five questions in order to accomplish combat assessment.

- What information is required?
- Who requires the information?
- When or how rapidly do intelligence and operations personnel require the information to make an assessment or decision?
- Where is the information required and where will it be processed and assessed?
- From which sources will information be available in the required time frame?

No longer can combat assessment occur as a reactive process consisting of planning collection and evaluating post-strike imagery.[11] Combat assessment must become integral to the campaign plan itself with specific attention given to how required information will be obtained within the timeframe it is needed. If it is important to the commander's intent to strike a target it is equally important to know, in a timely manner, what damage has been inflicted on the target.

Air Force doctrine for intelligence participation in targeting is found in Air Force Pamphlet 14-210. This pamphlet is comprehensive and congruent with the joint targeting doctrine described above. Both joint and Air Force combat assessment doctrine appear to provide an adequate foundation for this important function. However, increasingly, a distinction must be made between fixed target systems and mobile (or re-locatable) time critical target systems when discussing the phases of the targeting process to include combat assessment. For time critical and or mobile targets, the time available to acquire, target, and attack may be very brief. Thus an accelerated targeting cycle must be used. Under these circumstances, the first five elements of the targeting cycle (objectives & guidance, target development, weaponeering, and execution planning/force execution) must occur simultaneously or on a compressed time line.[12] If available intelligence, surveillance, and reconnaissance are able to accurately find, identify, and fix critical mobile targets then battle damage assessment and subsequent mission analysis should be straightforward.

Fixed target systems on the other hand are ideal cases for the deliberate planning described in targeting doctrine. Joint Publication 3-56.1, *Command and Control for Joint Air Operations*, defines a deliberate planning cycle for the development of the air tasking order. The ultimate purpose of the air tasking order is to attack and destroy targets (or be prepared to do so) to accomplish the joint force commander's objectives. Not surprisingly, the six phases of the air tasking order cycle closely parallel the targeting cycle and are defined as follows. (See Figure 1)

- Joint Force Commander/Component Coordination (Result: JFC guidance)
- Target Development (Result: Joint Integrated Prioritized Target List)
- Weaponeering/Allocation (Result: Master Air Attack Plan)
- Joint Air Tasking Order Development (Result: Joint Air Tasking Order & Special Instructions)
- Force Execution (Result: Air Tasking Order is "flown" to achieve "effects")
- Combat Assessment (Result: Feedback to continue cycle as needed)

Joint doctrine prescribes a 72 hour period to plan and execute each air tasking order cycle. The first 48 hours of each cycle are dedicated to centralized deliberate planning by the Air Operations Center, dissemination of the air tasking order, and decentralized unit mission planning to "fly" the air tasking order. The following 24 hour period is reserved for actual execution of the air tasking order. There are usually three joint air tasking order's being worked at any given time, (1) the air tasking order in execution today, (2) the air tasking order in final production for tomorrow, and (3) the air tasking order in planning for the day after tomorrow.[13] As discussed above, joint and Air Force doctrine adequately describe the process necessary to conduct combat assessment in a deliberate planning environment.

Intelligence, Surveillance, and Reconnaissance Support to Combat Assessment

In what very well may be an overstatement of the obvious, combat assessment is critically dependent on the timely collection of information and this information is provided by intelligence, surveillance, and reconnaissance systems. A substantial weakness in doctrine today affecting combat assessment is the management of intelligence, surveillance, and reconnaissance operations. Joint Publication 3-56.1 indicates the joint air operation center must be responsive to changes during the execution of the air tasking order and provides three primary reasons why this is necessary. First, in-flight reports and initial battle damage assessment may provide information leading to redirection of joint air capabilities. Second, the dynamics of the battlefield may require the joint force commander or joint force air component commander to change execution of the air tasking order. Finally, the joint force commander or joint force air component commander may retarget joint air missions to respond to moving targets or changing priorities.[14] These three items indicate the need for intelligence, surveillance, and reconnaissance capabilities responsive to a dynamic, time critical environment to conduct all phases of the air tasking order cycle including combat assessment.

Joint publication 3-55, *Doctrine for Reconnaissance, Surveillance, and Target Acquisition Support for Joint Operations (RSTA),* identifies the responsibilities of intelligence, surveillance, and reconnaissance capabilities to the targeting process and specifically to battle damage assessment. However, the process described for planning, tasking, coordinating, and executing intelligence, surveillance, and reconnaissance operations is a deliberate process. The time critical management or re-tasking of intelligence, surveillance, and reconnaissance capabilities is not discussed in doctrine publications. Joint publication 3-55 was last published in 1993 and joint tactics, techniques, and procedures for intelligence, surveillance, and reconnaissance operations have not been identified.[15]

Air Force Doctrine Document 2-5.2, *Intelligence, Surveillance, and Reconnaissance Operations,* published in 1999, identifies intelligence, surveillance, and reconnaissance principles important to operating in a dynamic, time critical environment as well as supporting combat assessment. These principles include the *integration* of surveillance and reconnaissance operations to meet the *timeliness* and *accuracy* requirements of aerospace power. Also important is the principle of *fusion* in which intelligence, surveillance, and reconnaissance-derived information from many sources is combined, evaluated, and analyzed to produce *accurate* intelligence. A major benefit of *fusion* is helping to overcome the inherent limitations of collection systems that inhibit the ability of a single source to provide adequate information for decision making.[16] However, the intelligence, surveillance, and reconnaissance process described in AFDD 2-5.2 is largely a deliberative process similar to that described in Joint Pub 3-55. This disconnect between the deliberative (and somewhat time consuming) intelligence, surveillance, and reconnaissance process describing how to satisfy information requirements and the need to integrate intelligence, surveillance, and reconnaissance operations to improve timeliness and accuracy are the result of theater command relationships.

Tasking and control of intelligence, surveillance, and reconnaissance assets is a function of the command relationship over collection management authority. When intelligence, surveillance, and reconnaissance capabilities are provided to regional

Commander's in Chief (CINC) to achieve theater and national objectives, the CINC receives operational control of the asset. The CINC normally delegates operational control to the component responsible for operating the capability. Collection management authority for the intelligence, surveillance, and reconnaissance asset may be retained by national authorities or, upon request, collection management authority may be delegated to the CINC. Based on guidance and direction from the CINC, the CINC's staff develops an overall collection strategy and posture for execution of the intelligence, surveillance, and reconnaissance mission. The Air Force views the air operations center, especially when the commander of Air Force forces is designated as the joint force air component commander, as the best location to integrate the warfighter's theaterwide intelligence, surveillance, and reconnaissance capabilities.[17] Since this Air Force position is not agreed to in joint doctrine, the development of tactics, techniques, and procedures to integrate the operation if intelligence, surveillance, and reconnaissance assets will likely not occur until a joint position is agreed to on this issue.

Today, the operation of intelligence, surveillance, and reconnaissance assets like the U-2, Joint STARS, RC-135 RIVET JOINT, the Predator Unmanned Air Vehicle, national reconnaissance systems, and the intelligence, surveillance, and reconnaissance systems operated by the US Army and US Navy are not integrated. The collection requirements are managed in a coordinated "stovepipe" manner using the process described in Joint Pub 3-55 and AFDD 2-5.2. It is also important to note the information collected by these intelligence, surveillance, and reconnaissance platforms is fused in a predominately manual fashion that is extremely complex and manpower intensive to accomplish in a timely manner. Operating intelligence, surveillance, and reconnaissance systems in this manner makes it very difficult to reliably find, fix, track, and target time critical mobile target systems. It also follows that without optimum find, fix, track, and target, you cannot engage or assess the damage to these target systems in an optimal fashion either.[18] In the future, for air power to remain responsive in meeting the needs of joint force commanders, it is absolutely essential the above shortfalls be addressed and a good place to start is in developing adequate doctrine. Joint and service doctrine must allow the adaptive and flexible employment of intelligence, surveillance, and reconnaissance capabilities if we have any hope of meeting the stringent and increasingly time critical requirements demanded by future combat assessment and precluded today by the above shortfalls.

Notes

[2] Joint Publication 2-01.1, *Joint Tactics, Techniques, and Procedures for Intelligence Support to Targeting,* (Washington: Joint Chiefs of Staff), Chapter VI.

[3] For an excellent discussion of Combat Assessment issues from Operation Dessert Storm, see: Robert E. Suminsby Jr., Maj, USAF, "Battle Damage Assessment: A Progress Report," Newport, R.I., 13 Feb 1995.

[4] Joint Publication 3-0, *Doctrine for Joint Operations* (Washington: Joint Chiefs of Staff, 1 Feb 95), IV-16, IV-17, and GL-4.

[5] Joint Publication 2-01.1, *Joint Tactics, Techniques, and Procedures for Intelligence Support to Targeting* (Washington: Joint Chiefs of Staff), Chapter VII.

[6] Ibid, Chapter VII.

[7] Ibid, Chapter 1.

[8] For example, Defense Intelligence Agency, Central Intelligence Agency, National Security Agency, National Imagery and Mapping Agency.

[9] Joint Publication 2-01.1, *Joint Tactics, Techniques, and Procedures for Intelligence Support to Targeting* (Washington: Joint Chiefs of Staff), Chapter VII, and Appendix C.

[10] Ibid, Annex A, Annex B, Annex C.

[11] Ibid, Chapter VI.

[12] Ibid, Chapter I.

[13] Joint Publication 3-56.1, *Command and Control for Joint Air Operations,* (Washington: Joint Chiefs of Staff, 14 Nov 94), Chapter IV.

[14] Ibid, Chapter IV, Pg IV-11.

[15] Joint Publication 3-55, *Doctrine for Reconnaissance, Surveillance, and Target Acquisition Support for Joint Operations,* (Washington: Joint Chiefs of Staff, 14 Apr 93).

[16] Air Force Doctrine Document 2-5.2, *Intelligence, Surveillance, and Reconnaissance Operations,* (HQ Air Force Doctrine Center, 21 Apr 99), Pg 9-11.

Notes

[17] Ibid, Chapter Four, Pg 49-52.

[18] Telephone Interview with Col Herbert Kemp, HQ USAF/XOR, 30 Nov 99 and with Col Mark Chapin, 497IG/CC, 3 Dec 99.

Chapter 3

Combat Assessment and Emerging Weapons

> *Precision Engagement . . . Mass no longer means many hundreds of aircraft attacking a single target . . . It is the effect rather than forces applied, that is the defining factor.*[19]
>
> AFDD 1 Air Force Basic Doctrine

Continuing advances in the capability of U.S. weapons and adversary countermeasures to U.S. high technology weapons have posed increasing challenges to combat assessment. For example, the evolution of precision weapons since WWII dramatically increased the number of targets aerospace forces can attack in a given period of time. The B-17 used in WWII dropped bombs with a precision of 3,300 feet circular error probable.[20] Destruction of a target required 1,500 B-17 sorties delivering a total of 9,000 bombs (each bomb weighing 250 pounds). The Vietnam era F-4 could deliver gravity weapons within 400 feet. During the Vietnam conflict, the destruction of one target required 30 F-4 sorties delivering 176 bombs (each bomb weighing 500 pounds). Prior to the end of the Vietnam conflict, precision guided weapons had been introduced in combat. During Desert Storm, one F-117 sortie delivered two precision guided 2,000 pound bombs and destroyed two targets. Desert Storm era precision weapons could be delivered day or night with 10 feet accuracy but not in all weather conditions. More recently, during operation Allied Force, the B-2 saw its first combat where it employed the new Joint Direct Attack Munition. The Joint Direct Attack Munition is the first of a new generation of near-precision weapons (20 foot accuracy) guided to intended targets using a combination of global positioning system and inertial navigation system (GPS/INS) inputs to guide weapons to targets. One B-2 sortie delivered 16 Joint Direct Attack Munition 2,000 pound bombs destroying 16 separate targets.[21] Once released from the weapon platform, GPS/INS weapons, like the Joint Direct Attack Munition, are autonomous. There is no need to center the aim point in a cross-hair using conventional, infrared video, or designate the aim point with a laser. This autonomous delivery capability allows the weapon to be delivered day or night and in *any* weather conditions. The impact to combat assessment of this continuing evolution in precision weapons is significant.

The most obvious impact of precision weapons on combat assessment is the increase in sheer numbers of targets that can be attacked. In addition to the large volume of targets, precision weapons can be delivered reliably around-the-clock and in virtually any weather conditions. Remembering the critical importance of timely and accurate information regarding target damage for good battle damage assessment, the evolution of precision weapons has placed increasing demands on the quantity, quality, and timeliness of information provided by intelligence, surveillance, and reconnaissance capabilities. The collection of "cockpit video" by the strike aircraft somewhat alleviated the demand placed on intelligence, surveillance, and reconnaissance capabilities by providing generally good answers to three questions important to the battle damage assessment process; (1) Did the bomb hit its desired impact point? (2) Did the bomb detonate high order? (3) Did the bomb fuze function as intended? However, the increasing numbers of drop-and-forget munitions like the Joint Direct Attack Munition drive an expanded need to collect information providing the raw data needed to answer the above questions.[22] The capability to continuously attack large numbers of targets around-the-clock also provided the ability to simultaneously attack a number of target systems (for example: POL, command & control, electrical power, transportation, fielded forces, etc.), not just a larger number of similar targets. Many believe the high tempo of such around-the-clock air attack operations along with the ability to sustain such operations for long periods of time create strategic military effects beyond the sum of the damage done to individual targets. Parallel warfare or the ability to attack multiple target systems simultaneously increases the complexity of the combat assessment process and explains the evolution of combat assessment to now include mission assessment.[23]

Two broad adversary countermeasures to the evolution of precision weapons as well as the continued effective enemy use of camouflage, concealment, and deception further broaden the challenge of combat assessment. The first countermeasure widely employed by potential adversaries is to harden or deeply bury fixed targets. This trend perhaps first became prominent during the Gulf War where precision munitions were used to attack aircraft in hardened aircraft shelters. The weapon would penetrate the shelter and detonate on the inside but would not destroy the shelter. Post-strike imagery of the shelter would show the hole in the shelter where the weapon entered and *may* contain evidence that the weapon fused properly and detonated (for example debris or blast mark near a shelter opening). In this case, video collected by the strike aircraft during the attack can clearly indicate if the weapon fused and detonated as intended. This combined with a priori knowledge the shelter was occupied would result in excellent and, equally important, timely battle damage assessment. Since Desert Storm, we increasingly face hardened structures buried ever deeper underground. The U.S. technology response for attacking such targets is with improved penetration weapons capability coupled to advanced smart fuses. Smart fuses utilize sensitive accelerometers and fast microprocessors allowing measurement, in real-time, of the amount of earth overburden penetrated and the number of voids and floors penetrated once inside a buried and hardened structure. Assuming the precise intelligence needed to target such a weapon is available, the target's destruction, as intended, must still be verified. The difficulty of conducting battle damage assessment with such weapons begins with the fact they will leave little if any external damage.

The second adversary countermeasure to the evolution of precision weapons is the use of mobile systems capable of relocating frequently enough to frustrate efforts to find, fix, track, and target. By disrupting the deliberate planning cycle used by the air operations center for targeting, the deliberate planning for the collection of timely information needed for accurate battle damage assessment, munitions effects assessment and subsequent mission analysis is also disrupted. Today, when mobile targets are found, the aircraft directed to attack may return with cockpit video of the weapon employment along with observations by the aircrew providing important and timely information regarding damage inflicted on the target. This information supports initial battle damage assessment and necessary information for any future collection supporting combat assessment. As capability to find, fix, and track mobile targets improves, our ability to employ deliver-and-forget weapons like Navy Tactical Tomahawk and Joint Direct Attack Munition, utilizing rapid re-targeting and better precision, will likely provide improved ability to attack mobile targets. As these improvements occur, cockpit video will diminish as a source for battle damage assessment, requiring advances in near-real-time management of intelligence, surveillance, and reconnaissance systems. The intelligence, surveillance, and reconnaissance capability must first find mobile targets and then collect necessary data for battle damage assessment all without the benefit of traditional deliberate collection requirements management and related mission planning.

Completing the discussion of adversary countermeasures, is the effective enemy use of camouflage, concealment, and deception. This countermeasure is as old as the very art of warfare and remains potently effective today. The U.S. remains susceptible to assessing damage that does not exist when adversaries create false signatures showing our high technology sensors what is expected. In addition, targets remain hidden from the capabilities of current sensors, and inexpensive decoys are used to attract the employment of expensive precision weapons.

Two trends will add to the demands under which weapons will be employed further increasing the challenges faced in conducting battle damage assessment. The first trend is the ever-growing concern over collateral damage. US forces will be asked to attack targets with just enough force to achieve the desired affect but simultaneously minimize even enemy collateral damage. For example, the Air Force today has an active program to develop miniaturized munitions likely to produce weapons in the 250 and 100 pound class. The second but related trend is the need to hold at risk targets representing weapons of mass destruction. Such targets will comprise chemical, biological, or nuclear materials and they must be attacked in a manner ensuring complete destruction or neutralization yet releasing no material able to cause collateral harm. Carefully managing the consequences of attacking targets by only applying sufficient force to neutralize while simultaneously minimizing collateral damage will pose obvious difficulties to battle damage assessment and munitions effects assessment subsets of combat assessment.

Longer-term developments in weapons may further exacerbate damage assessment of targets and target systems. An example that quickly comes to mind is a directed energy weapon based on high power microwaves or high energy LASERs. Such devices can disrupt or permanently damage electronic devices and sensors critical to operational functions of most weapons and command & control systems. The challenge posed by such weapons to combat assessment is the damage will occur inside enemy systems where it is not visible. The development of microwave weapons, for example, will compel establishing new methods for assuring the operational community that the use of these weapons has successfully accomplished the desired mission effects.[24]

One final issue regarding the relationship between future combat assessment and emerging weapons is directly related to cost. First, existing and future precision weapons will be relatively expensive to procure. Second, now that the United States Air Force is again an expeditionary force and not a forward deployed force, the logistics cost of moving munitions from storage locations to wherever they may be needed for employment operations must increasingly be considered. The up front assumption is the acquisition community has made the most efficient use of taxpayer dollars to procure these munitions. It is also reasonable to assume that modern "smart" munitions are worth the increased cost over "dumb" munitions when one considers the dramatic improvements in military effectiveness and reduced collateral damage. However, U.S. practice has been to frequently revisited targets, employing multiple precision weapons, to ensure a target is neutralized. In many cases the decision to re-strike a target is driven by inconclusive battle damage assessment or damage assessment that is not timely enough given the importance of ensuring certain targets are neutralized. Given the associated dollar costs and opportunity costs of procuring and moving precision weapons where needed for employment, cost seems yet another substantial reason to ensure the robust viability of future combat assessment.

Notes

[19] Air Force Doctrine Document 1, *Air Force Basic Doctrine,* (HQ Air Force Doctrine Center, September 1997, Pg. 30.

[20] A weapon system capable of 3,300 foot CEP indicates that half of all weapons employed by the platform under similar conditions will impact within a circle of 3,300 foot diameter,

[21] Chuck Link, Maj Gen, USAF (Ret), *Thoughts on Aerospace Power & Conflict,* (A Presentation for the Air War College, 16 Nov 99).

[22] Air Force Pamphlet 14-210, *USAF Intelligence Targeting Guide,* (Washington: HQ USAF/XOI, 1 Feb 98), Chapter 9.

[23] For additional discussion of parallel warfare see David A. Deptula, *Firing for Effect: Change in the nature of Warfare,* Air Force Association, Aerospace Education Foundation, Defense and Airpower Series, 24 Aug 95, and John A Warden III, *The Enemy as a System,* Airpower Journal, Spring 1995, 41-50.

[24] Eileen M. Walling, Colonel, USAF, "High Power Microwaves: Strategic and Operational Implications for Warfare," Occasional Paper No. 11, Center for Strategy and Technology, Air War College, Maxwell AFB AL, February 2000.

Chapter 4

Combat Assessment, Evolving Technology, and Doctrinal Change

Using the previous discussion on combat assessment doctrine and trends in emerging weapons as background, the purpose of this chapter is to identify and discuss some specific areas where improvements in doctrine and technology will allow combat assessment to remain effective and responsive to needs of the combat commander.

Combat Assessment Database

Combat assessment doctrine describes a continuous process occurring at all levels of conflict, tactical, operational, and strategic, providing information for decisions at all levels. During Operation Allied Force, for example, elements of combat assessment were conducted by the following units at widely separated locations:

- Units conducting air strikes such as the 31st Fighter Wing, Aviano Air Base, Italy
- The 32 Air Intelligence Squadron, Ramstein Air Base, Germany
- Joint Task Force Noble Anvil, Naples Italy
- Combined Air Operations Center, Vicenza, Italy
- The EUCOM Joint Analysis Center, Molesworth Air Base, United Kingdom
- The Defense Intelligence Agency (DIA), Washington D.C.

Because combat assessment occurs at all levels, it has become a distributed process critically dependent on the sharing and integration of information produced at each node in the architecture. Personnel responsible for combat assessment at the Combined Air Operations Center found it necessary to devise a database to organize, track, and de-conflict battle damage assessment inputs from all participants in the battle damage assessment process. This database proved indispensable to development of reliable mission assessments necessary for proper functioning of the targeting cycle and the air tasking order process.[25] The development of an integrated database to support combat assessment has been proposed by at least one other author, and now actual experience during Operation Allied Force validates the importance of this concept.[26] The detailed architecture of such a battle damage assessment database and a secure communications architecture allowing instant access for updates by all nodes in a distributed combat assessment network should be incorporated into joint and Air Force targeting doctrine.

Training and Education

The effective accomplishment of all aspects of combat assessment will require both training and education. Accomplishment of battle damage assessment and munitions effects assessment will draw heavily and primarily on training programs designed to develop and sustain requisite skills in the right numbers of people to identify and evaluate damage to individual targets and target systems. Following training, these skills should be regularly exercised and evaluated to maintain a sufficient state of readiness in the event such crisis or wartime skills are needed. On the other hand, higher-level combat assessment skills like mission assessment require analysis along with exercise of sound military judgment. Individuals with the developed powers of reasoning and critical thinking cannot come from training alone and must be established either through actual experience or through vicarious experience in education and study. Since actual experience in combat assessment during military conflict or war is not a dependable alternative for personnel development in the art of combat assessment, the only suitable substitute is to rely on robust education and study programs. This is analogous to the use of education programs like the Air Force School of Advanced Aerospace Studies (SAAS) or the Army School of Advanced Military Studies (SAMS) to develop military strategists. The Air Force should evaluate the use of education programs like SAAS or the postgraduate intelligence program offered by Defense Intelligence Agency's Joint Military Intelligence College to develop individuals able to analyze, with sound military judgment, what is known about damage inflicted on the enemy. Ultimately, the application of this knowledge must be applied toward achieving the Joint Force Commander's military objectives.

Specialized Data Collection for Battle Damage Assessment

The continued evolution in capability of air delivered weapons combined with unique restrictive demands like collateral damage and consequence management will demand early planning, perhaps even during the weapon development and acquisition, to ensure effective battle damage assessment once the weapon is fielded and employed.[27] One clear example of this is the problem of damage assessment for weapons of mass destruction targets housed in hardened deeply buried structures. As discussed in the previous chapter, attacking such a target with a penetrating weapon and smart fuze will leave little damage to assess visually. A multifaceted approach is under consideration for damage assessment. One aspect of the approach is development of predictive damage impacts using carefully controlled experiments. The result is a computer model useful for evaluating and predicting damage to targets where less is known about the internal structure. The model can be used to select the optimum weapon, fuze setting, and weapon aim point but is also designed for damage assessment when combined with observations of the specific weapon and target interaction. These observations could include telemetry information from the actual weapon fuze providing exact details on how the weapon penetrated the target and detonated. Observations may also come from dedicated battle damage assessment sensors designed specifically to collect information before, during, and after the weapon strikes the target. Such sensors may be airborne on the aircraft delivering the weapon, tethered to the weapon itself, or on an unmanned aerial vehicle. Alternate possibilities include disposable, air delivered unattended ground sensors emplaced prior to weapon employment. The predictive damage model when combined with specific information from dedicated sensors will provide target damage assessment to include collateral damage and consequence analysis.[28]

Weapons of mass destruction targets certainly offer a specialized case for battle damage assessment. However, similar planning can occur to accomplish battle damage assessment for deliver-and-forget precision weapons capable of delivery against targets around the clock under any weather conditions. As these weapons proliferate a carefully constructed plan specifying what information must be collected, how this information will be collected given pressure to improve timeliness of collection planning cycles, and how this information will be processed and integrated to support battle damage assessment, munitions effects assessment, mission analysis, and ultimately combat assessment must be developed.

Broaden Information Use for Battle Damage Assessment

Combat assessment today is focused on traditional imagery as the primary and almost sole source of information.[29] If combat assessment is to keep pace with weapon technologies and the pace of modern warfare, sources of information used for battle damage assessment must expand. Traditional imagery of a destroyed target still offers the best resolution of damage to an individual target and offers the advantage of being easy to understand by anyone, even those not trained in photo interpretation or battle damage assessment. However, unlike modern precision weapons, traditional imagery cannot be collected at night or during adverse weather conditions. Alternative sources of imagery like synthetic aperture radar and infrared have been available for many years and can be collected at night and in adverse weather. While the resolution of synthetic aperture radar and infrared imagery has improved dramatically since introduction, the resolution of these imagery variants is not as good as traditional imagery. On the other hand, non-traditional imagery sources are sufficient for many battle damage assessment applications and should be considered for greater application to combat assessment to improve the timeliness of the process.

Non-imagery sources could also enjoy wider application in combat assessment. A good example would be more creative use of electronic intelligence. If the target in question is an operating radio or television transmission tower and electronic emissions cease at the precise moment an employed weapon detonates, it is extremely likely the target was neutralized. Electronic intelligence information alone could satisfy all preliminary battle damage assessment requirements for such a target allowing a lower priority to be assigned to subsequent imagery collection to evaluate precise damage and estimating time for enemy repairs to put the transmitting tower back in service.

New collection technologies such as multi-spectral and hyper-spectral imagery also offer great potential to improve combat assessment. Traditional, synthetic aperture radar and infrared imagery rely on the collection of either reflected or emitted energy in relatively narrow regions of the electromagnetic spectrum. Multi-spectral imagery and hyper-spectral imagery simultaneously collect information across a relatively broad portion of the electromagnetic spectrum. The portion of the spectrum used for multi-spectral imagery and hyper-spectral imagery collection is divided into equidistant wavelength slices with the number of slices defining the image as multi-spectral or hyper-spectral. Each pixel element of a spectral image simultaneously contains information on the intensity of energy collected for each wavelength slice across the portion of the electromagnetic spectrum covered by the sensor.[30]

The fielding of spectral sensors will allow intelligence specialists to take advantage of phenomenology. For the purpose of this paper, phenomenology refers to events of interest producing a unique and repeatable signature when viewed by spectral sensors. This potential of spectral sensors if applied to battle damage assessment may allow the development of unique and repeatable signatures indicating a particular target has been neutralized or destroyed. In operation, spectral sensors may observe a weapon employment against a specified target producing the desired signature indicating success and conversely, the lack of a signature would indicate an unsuccessful attack. Today, spectral sensors are years away from operational capabilities. While offering great potential, obstacles must be overcome. Primary obstacles result from the large volume of data collected by spectral systems. This large amount of data makes it difficult to identify unique and repeatable signatures for specific events of interest under a wide range of collection conditions (day, night, rain, fog, snow, etc.). Also, once a unique signature is developed, the computer processing power and techniques may not yet exist to identify a specified event or target in tactically relevant timeframes. However, as these obstacles are overcome, planning for how to use such capability in applications like combat assessment should begin now.

Many obstacles to using alternative information sources to traditional imagery are institutional in nature. While traditional imagery will always retain a primary role in combat assessment, alternative existing and future sources of information can serve as increasingly important sources. The use of exercises and warfighting experiments can be useful in demonstrating the utility of these sources to the combat assessment process while at the same time establishing institutional confidence.

Integrated Management of Intelligence, Surveillance and Reconnaissance

As discussed earlier, the operation today of intelligence, surveillance, and reconnaissance assets is not integrated. Additionally, intelligence, surveillance, and reconnaissance collection requirements are managed in a coordinated but "stovepipe" manner. The increasing importance of Information Superiority places heavy demands on intelligence, surveillance, and reconnaissance capabilities as they must provide strategic and operational decision makers with threat information vital to development and implementation of strategic plans that must be executed with a military force of optimum size and composition. Intelligence, surveillance, and reconnaissance systems must also provide critical inputs to targeting, provide situational awareness and threat warning to operating forces, information to support combat assessment, and increasingly locate mobile targets. Collection capabilities must be sufficiently robust and balanced to meet all the information needs identified above including when the consumer needs it. Increasingly, we must understand accurate, timely information on the effects created by the employment of air power is equally important to understanding enemy capabilities and intentions. Intelligence, surveillance, and reconnaissance collection management is optimized today for a deliberate planning process while providing a limited, perhaps slowly improving ability, to react dynamically to changing collection requirements within the operational "stovepipe" existing for each intelligence, surveillance, and reconnaissance collection platform. However, expanded adversary use of mobile systems increasingly demands time critical flexibility while employing intelligence, surveillance, and reconnaissance systems supporting tactical and operational consumers. Improved procedures must be developed to dynamically manage the integrated collection of information by intelligence, surveillance, and reconnaissance systems in near real-time to realize the full potential of existing and future capabilities. Every intelligence, surveillance, and reconnaissance system has strengths and weaknesses and it is possible to compensate for weaknesses of one system by capitalizing on the strengths of other systems. For example, the moving target indicator capability provided by Joint STARS and some U-2 aircraft is strong in the area of searching broad areas to identify moving vehicles but weak in the area of positive identification of the type or purpose of the moving vehicle. Medium to high-resolution imagery on the other hand is very poor at searching broad areas for targets in the absence of external indicators as to potential search locations. A strength of imagery systems is to discriminate and identify vehicles once located. Integrated management of intelligence, surveillance, and reconnaissance systems will produce a total capability greater than the sum of the parts by dynamic management of total system sensor strengths while simultaneously minimizing individual weaknesses.

Improving the dynamic management of intelligence, surveillance, and reconnaissance systems to optimize collection strengths and minimize weaknesses will require three actions. First, dynamic management of intelligence, surveillance, and reconnaissance systems must be incorporated and agreed to in joint doctrine beginning with the revision of Joint Pub 3-55, *Doctrine for Reconnaissance, Surveillance, and Target Acquisition Support for Joint Operations.* Joint Pub 3-55 was last published in April 1993. Second, joint tactics, techniques, and procedures for dynamic, integrated management of intelligence, surveillance, and reconnaissance capabilities must be developed and refined. The development of joint tactics, techniques, and procedures for intelligence, surveillance, and reconnaissance management can perhaps best be accomplished using joint warfighting experiments. This will be difficult to accomplish since virtually all intelligence, surveillance, and reconnaissance platforms are high-demand, low-density (HDLD) systems. The operational tasking and deployment of these systems remains sufficiently high even during peacetime such that ensuring the participation of a critical mass of intelligence, surveillance, and reconnaissance platforms in a warfighting experiment would likely require Joint Chiefs of Staff prioritization. The third and final action required to improve the dynamic management of intelligence, surveillance, and reconnaissance systems is the automated integration and fusion of data collected by intelligence, surveillance, and reconnaissance sensors. This will be discussed in the next section. The integrated management of intelligence, surveillance, and reconnaissance systems will benefit all consumers including those responsible for combat assessment by improving the timeliness of products and by improving the quality of products due to synchronized collection management.

Integration and Fusion of Intelligence, Surveillance, and Reconnaissance Data

The integration and fusion of data collected by intelligence, surveillance, and reconnaissance systems today is a manual, time intensive process. Automating and improving the timeliness of correlating intelligence, surveillance, and reconnaissance data would facilitate rapid cross-platform cueing allowing different sensors, with differing strengths and weaknesses, to sense the same target synergistically improving such elements of information as positive identification and precise location. Complimentary capabilities currently in development to process intelligence, surveillance, and reconnaissance data streams include automated target recognition.[31] The primary benefit to combat assessment of automating the integration and fusion of intelligence, surveillance, and reconnaissance data would be the efficient collection of data to assess damage to mobile targets once these targets are located and attacked.

Notes

[25] Telephone interview with Col Mark Chapin, 497IG/CC, 3 Dec 99. Col Chapin also served on the CAOC C-2 staff during Operation Allied Force.

[26] Robert E. Suminsby, Maj, USAF, *Battle Damage Assessment: A Progress Report,* Newport, R.I., 13 Feb 95, Pg 13.

[27] Ibid, Pg 13.

[28] Barbara Starr, *USA studies weapons in battle against bunkers,* Jane's Defence Weekly, 25 Nov 95, Pg 6.

[29] Telephone interview with Col Herbert Kemp, HQ USAF/XOIR, 30 Nov 99.

Notes

[30] Barry Karch, Air Force Research Laboratory Briefing on Hyper-spectral Imaging provided to Air War College Students, Wright-Patterson AFB, OH 29 Sep 99.

[31] Mark Chapin, Col, USAF, *Real-Time, Automated Time-Critical Targeting,* (A power point briefing presentation, 3 Dec 99)

Chapter 5

Conclusions and Recommendations

How will future weapons impact combat assessment?

Improvements in weapons allow virtually any target to be attacked with precision, day or night, and in any weather. This provides modern airpower the ability to continuously destroy or neutralize targets at an increasingly rapid pace. In addition to attacking large numbers of targets, multiple target systems can be attacked simultaneously or nearly simultaneously. The ability to continuously attack large numbers of targets increases the workload and places a premium on timeliness for battle damage assessment, munitions effects assessment, and reattack recommendations. The ability to attack multiple target systems simultaneously increases the complexity of mission assessment.

Improved precision and high technology fuzes for weapons are allowing development of smaller weapons and weapons capable of attacking hardened, deeply buried targets. Such technology allows targets to be destroyed yet minimize collateral damage; this technology also produces less visible damage to measure and evaluate for battle damage assessment and munitions effects assessment. Some future weapons like high power microwave or lasers may destroy or neutralize a target and cause *no* visible damage. These advances in weapons will require serious planning, perhaps as early as during the development and acquisition of the weapon, to determine how to assess target damage when the weapon is employed (what data must be collected when; how will the data be evaluated?). Some weapons may require dedicated battle damage assessment systems while others will require near-real-time integrated collection and exploitation of information from existing intelligence, surveillance, and reconnaissance systems.

The proliferation of deliver-and-forget weapons using GPS guidance technology will preclude collection of data (cockpit video for example) to support battle damage assessment or munitions effects assessment by the platform delivering the weapon. This will place increased demands on intelligence, surveillance, and reconnaissance systems.

How will success be measured?

The critical issue here is the ability to collect the right information, in a timely manner, needed to support battle damage assessment and munitions effects assessment. The capability of emerging and future weapons to destroy or neutralize targets could easily outstrip the ability to collect the information needed to evaluate the actual damage to the target. Careful planning and experimentation should occur in this area to ensure this is not the case. In addition to improving the ability to collect the right information needed for future combat assessment, doctrine governing the employment of intelligence, surveillance, and reconnaissance systems must also be improved. Existing doctrine in this area is inadequate. To support future combat assessment, doctrine must provide the flexibility to dynamically task and employ these systems in an integrated and timely fashion. If the right information can be collected to support the assessment process, current combat assessment doctrine is adequate to meet the challenges posed by emerging weapons.

Conclusions

The analysis and discussion in this paper lead to three conclusions. First, current joint and Air Force combat assessment doctrine is adequate. Second, joint and service training programs will remain important to combat assessment readiness for skills supporting battle damage assessment and munitions effects assessment. Education programs will be critical to combat assessment readiness by providing individuals with developed powers of reasoning and critical thinking necessary to accomplish mission assessment. Finally, combat assessment is critically dependent on timely collection of information provided by intelligence, surveillance, and reconnaissance systems. The integrated management of intelligence, surveillance, and reconnaissance systems during collection operations as well as improved methods to automate the correlation and fusion of data and information derived from intelligence, surveillance, and reconnaissance systems would dramatically improve combat assessment.

Recommendations

Four recommendations with the potential to improve future combat assessment can be distilled from the information presented in this paper. First, combat assessment has become a distributed process conducted by geographically separated cells of people. Joint and service doctrine should be revised to incorporate the use of a database to organize, track, and de-conflict battle damage assessment and munitions effects assessment inputs from *all* participants. Implementation of such a database should include a communications architecture allowing instant access to all participants.

Second, joint and service doctrine should be revised to provide for dynamic management of intelligence, surveillance, and reconnaissance systems. Air operations will increasingly occur in time critical environments that cannot be effectively supported by the existing deliberate process used to manage collection requirements.

Third, aggressive steps should be taken to develop and implement automated capabilities to correlate and fuse data collected by intelligence, surveillance, and reconnaissance systems. Such capability should provide the dynamic ability for cross-platform cueing of sensors. These actions will not only improve timeliness of the targeting cycle but also optimize the employment and synergy of sensor capabilities.

Fourth and final, personnel responsible for combat assessment should conduct experiments and develop processes able to broaden the use of non-traditional imagery contributing information to combat assessment. Traditional imagery is predominately a daylight, clear weather sensor capability yet modern weapon systems can attack targets 24 hours a day in virtually any weather conditions. We must resolve this disconnect.

In closing, the reality that parallel warfare, the capabilities of current and emerging "smart" weapons, adversary countermeasures to airpower, and the fast pace of modern air operations are collectively establishing an environment that will outstrip our ability to assess the effects of a modern air campaign must be widely acknowledged and addressed within the Department of Defense. To effectively employ modern airpower in accomplishing the objectives of the joint force commander the U.S. *must* possess the ability to accurately assess the effects created in a timely manner. Put another way, the maximum value from the hard work and investments required to establish the capabilities and potential of modern airpower cannot be achieved without the commensurate capability to assess the effects created when airpower is employed.