1. Report Security Classification: UNCLASSIFIED			
2. Security Classification Authority:			
3. Declassification/Downgrading Schedule:			
4. Distribution/Availability of Report: DISTRIBUTION STATEMENT A: APPROVED FOR PUBLIC RELEASE; DISTRIBUTION IS UNLIMITED.			
5. Name of Performing Organization: JOINT MILITARY OPERATIONS DEPARTMENT			
6. Office Symbol: C	**7. Address**: NAVAL WAR COLLEGE 686 CUSHING ROAD NEWPORT, RI 02841-1207		
8. Title (Include Security Classification):			
9. Personal Authors: Major Randy L. Kaufman, USAF			
10.Type of Report: FINAL	**11. Date of Report**: 3 Feb 03		
12.Page Count: 27 **12A Paper Advisor (if any):LtCol Joseph Dill, USAF**			
13.Supplementary Notation: A paper submitted to the Faculty of the NWC in partial satisfaction of the requirements of the JMO Department. The contents of this paper reflect my own personal views and are not necessarily endorsed by the NWC or the Department of the Navy.			
14. Ten key words that relate to your paper: Precision, Near-Precision, Principles of War, Operational Art, Desert Storm, Allied Force, Enduring Freedom, Iraq, Kosovo, Afghanistan			

15.Abstract:

The current proclivity to use PGMs and near PGMs restricts the inherent flexibility and versatility of airpower and reduces the effectiveness of the Joint Force Commander(JFC) to fight and win the war in today's rapidly moving battlespace. PGMs, and their counterpart, near PGMs (consisting primarily of GPS-guided munitions) do not currently possess the capability to meet the needs of the ground forces in a timely manner. Additionally, these types of weapons also demonstrate a lack of ability, in adverse weather conditions, to destroy mobile or emerging targets in the same timely manner.

This over-reliance demonstrates a breach with four of the principles of the principles of war: mass, economy of force, surprise, and simplicity. It also undermines one of the key tenants of airpower, flexibility and versatility, by failing to capitalize on the unique supporting attributes of both guided and unguided munitions. The effective employment of airpower requires a keen understanding of the strengths and limitations of all three weapon types: precision, near precision, and unguided. It is only thru the effective use of a combination of these weapons that the JFC will be afforded the options that are critical in the increasingly dynamic battlespace experienced today and expected in the future.

16.Distribution / Availability of Abstract:	**Unclassified** X	**Same As Rpt**	**DTIC Users**
17.Abstract Security Classification: UNCLASSIFIED			
18.Name of Responsible Individual: CHAIRMAN, JOINT MILITARY OPERATIONS DEPARTMENT			
19.Telephone: 841-3556		**20.Office Symbol:** C	

NAVAL WAR COLLEGE
Newport, R.I.

Precision Guided Weapons:
Panacea or Pitfall for the Joint Task Force Commander?

By

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A paper submitted to the Faculty of the Naval War College in partial satisfaction of the requirements of the Department of Joint Military Operations.

The contents of this paper reflect my own personal views and are not necessarily endorsed by the Naval War College, the Department of the Navy, or the U.S. Air Force.

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Contents

Abstract

The current proclivity to use PGMs and near-PGMs restricts the inherent flexibility and versatility of airpower and reduces the effectiveness of the Joint Force Commander (JFC) to fight and win the war in today's rapidly moving battlespace. PGMs, and their counterpart, near-PGMs (consisting primarily of GPS-guided munitions) do not currently possess the capability to meet the needs of ground forces in a timely manner. Additionally, these types of weapons also demonstrate a lack of ability, in adverse weather conditions, to destroy mobile or emerging targets in the same timely manner.

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Introduction

After Operation Anaconda in Afghanistan, Major General Franklin Hagenbeck, U.S. Army, criticized the ability of the United States Air Force (USAF) to deliver timely support to U.S. forces on the ground. General Hagenbeck said it took hours for the Air Force to deliver close air support (CAS) primarily because of the reliance on the use of precision guided munitions (PGMs).[1] Obviously, when supporting ground forces, the preponderant airpower effort should be directed to meeting the needs of these forces. PGMs, and their counterpart, near-PGMs (consisting primarily of GPS-guided munitions) do not currently possess the capability to meet this requirement in a timely manner. Additionally, these types of weapons also lack the ability in adverse weather conditions to destroy mobile or emerging targets in the same timely manner.

The current proclivity to use PGMs and near-PGMs restricts the inherent flexibility of airpower and reduces the effectiveness of the Joint Force Commander (JFC) to fight and win the war in today's rapidly moving battlespace. This over-reliance demonstrates a breach with four of the principles of war: mass, economy of force, surprise, and simplicity. It also undermines one of the key tenants of airpower, flexibility and versatility, by failing to capitalize on the unique and supporting attributes of both guided and unguided munitions.

Precision engagement is the emerging joint operational concept published in *Joint Vision 2010* and *Joint Vision 2020*.[2] Precision engagement provides the JFC and the Joint Force Air Component Commander (JFACC) with the ability to "precisely" attack fixed targets while reducing the potential for undesired collateral effects. However, the key word is "fixed". In the increasing complex battlespace environment encountered

today, and anticipated in the future, the ability to attack and destroy moving and emerging targets in the support of ground forces is significantly jeopardized by the current reliance on guided munitions.

Utilizing the unique attributes of airpower is critical to the success of the JFC to manage the dynamic battlespace environment of the future. Applying the principles of war to the employment of airpower will prove to support the reliance on a mix of weapons, both guided and unguided, in order to take advantage of the inherent strengths of airpower, flexibility and versatility. This requires a keen understanding of the limitations and advantages of each weapon type. It points to stepping back to a "mix" of weapon types and not the sole reliance on "guided" munitions, thus increasing the flexibility of airpower and its ability to provide the JFC options in the operational art of war.

Evolution of Precision Guided Munitions

While the advent of PGMs seems to have come to fruition in the last twenty years, precision engagement has been the cornerstone of airpower since its inception in World War I. Precision engagement was conceptualized during the Air Corps Tactical School (ACTS) in the early 1930's. [3] Throughout its evolution, the single greatest factor restricting the advancement of precision has been technology. As technology increased, the capability to deliver munitions that are more precise has naturally followed suit.

During World War II, greater precision was attempted by better identifying the target and compensating for the speed and altitude of the delivery platform with the then highly classified "Norden" bombsight. This leap in technology gave Eighth Air Force bombers the capability to conduct what was then known as daylight precision strikes

against Germany. Unfortunately, this "precision" required favorable weather conditions as the bombardier needed positive visual target identification. This "weather" limitation would continue to hamper the advancement of weapon precision for the next 50 years. World War II also saw the first achievement in optically guided and heat seeking munitions. However, these advancements came about near the end of hostilities. With the new focus on the strategic employment of atomic weapons, precision accuracy was pushed to the sideline, effectively stagnating American precision research and development for the next twenty years.

The Vietnam War brought about dramatic increases in precision as technology finally evolved to meet the military requirement of one bomb, one target. Most notable was the improvement to weapon guidance capabilities. New techniques, utilizing moveable tail fins, allowed weapons to correct for in-flight targeting and release errors, thus generating incredible increases in precision. These advancements allowed the Air Force and the Navy to introduce effective television, infrared, and laser guided munitions to airpower employment in Vietnam. [4] The evolution of precision had now progressed from not only more accurately identifying the target, but also to more effectively guiding the weapon to the target, setting the stage for future precision operations.

Operation Desert Storm
(The Gulf War)

Operation Desert Storm was a sustained 43-day combined-joint air operation conducted by the United States and its Allies that saw the first true precision capability in modern warfare. During Operation Desert Storm, approximately 227,000 deep attack

weapons were used. Of these 92 % were unguided and 8 % were guided. About half (4 %) of the guided weapons used were laser-guided bombs (LGBs).[5]

Precision munitions allowed Allied forces the capability to attack numerous high priority targets simultaneously since fewer munitions were required to achieve the desired damage effects, thus capitalizing on the principles of mass and economy of force. In some cases, the USAF F-117 was able to achieve the same result with one precision-guided munition as a 1,000-plane raid in World War II accomplished with 9,000 unguided bombs, or 177 unguided bombs accomplished in Vietnam, and without the associated collateral damage.[6] This incredible leap in precision was achieved primarily through the use of LGBs and their ability to accurately identify and guide the munition to the target. However, unguided weapons were not without their own successes and proved very adept against Iraqi fielded forces. In some cases entire Iraqi regiments surrendered primarily because of the threat of massive attacks by U.S. B-52's, demonstrating the continued applicability of unguided munitions.[7]

The unique blend of both guided and unguided munitions offered the JFC, General Norman Schwarzkopf, a wide variety of options, increasing his operational flexibility. Initially, LGBs were reserved for high value fixed targets, but they were later used against mobile targets that had become stuck in a fixed location, further increasing the probability of destruction. However, because of the concerns generated from the lack of capability of LGBs in inclement weather conditions, the Department of Defense (DOD) organized a project to develop near-precision, or accurate, weapons for use in all-weather operations. This led to the advent of near-precision GPS-guided weapons, such as the Joint Direct Attack Munition (JDAM).

Operation Allied Force
(OAF)

OAF saw the "most precise and lowest collateral damage air operation ever conducted – with no U.S. or Allied combat fatalities in 78 days of around-the-clock operations and over 38,000 combat sorties against very active Yugoslav integrated air defenses."[8] During this operation, North Atlantic Treaty Organization (NATO) forces conducted over 23,300 strike missions against various targets. Of these, approximately 7,600 were fixed targets and just over 3,400 were flex (or unplanned) targets. Air operations utilized the full spectrum of airpower capability, from unguided 500-pound bombs to sophisticated long-range cruise missiles.[9]

Drawing on the lessons learned in Desert Storm, precision engagement proved to be the cornerstone of OAF, and further promoted the reliance on guided munitions, with the majority of guided weapons consisting of LGBs.[10] Over the 57 days of actual air strikes, emphasis was placed on munitions that either increased the probability of kill against a given target or that significantly improved survivability of weapon platform and crew. [11] OAF also saw the first use of new all-weather, near-precision weapons, such as JDAM, with the U.S. dropping 656 of these weapons from B-2 bombers.[12]

Incredibly, coalition aircraft achieved these successes even when confronted by serious adverse weather factors, primarily through the use of GPS-guided munitions. During OAF clouds covering more than 50% of the sky impeded operations 70% of the time. This allowed "unrestricted" air strikes on only 24 of 78 days.[13] While this operation seemed to prove the feasibility of all-weather precision engagement and its ability to reduce collateral damage effects, it highlighted the requirement to use a mix of weapon platforms and capabilities. In one instance, aircraft employing guided JDAM

munitions targeted the Obrva Airfield in Northern Yugoslavia, delivering "precise" weapons that successfully denied enemy air operations for 24 hours. Nevertheless, the limited numbers of weapon craters only restricted operations until these craters were filled (Figure 1). Later, when it was decided that continued denial was required, other aircraft dropped over 120 unguided weapons against the same airfield effectively denying its use for the remainder of the conflict (Figure 2).[14] This effectively demonstrated the advantages of unguided weapons and their employment against area targets.

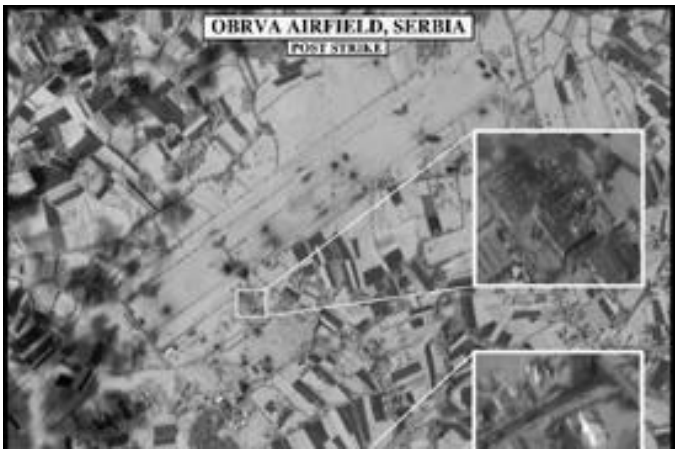

Figure 1. Obrva Airfield, Yugoslavia. Notice the precise craters along the taxiways and runways.

Figure 2. Obrva Airfield, Yugoslavia. Notice the large amount of damage covering both the taxiway and runway and the previous "precision" craters that are filled in.

In the final days of OAF when the weather had improved, the availability of a complete mix of weapons maximized the flexibility of strike options available to the JFACC.[15] Yet, even with the advent of all-weather GPS-munitions, targeting results were not as great as desired. The *Joint Statement on the Kosovo After Action Report Review* stated, "As expected, attacks on mobile targets … and concerns for limiting collateral damage also constrained us in some circumstances from attacks on possible ground forces."[16] The fragility of the NATO alliance, and the Yugoslavian understanding of this vulnerability, forced the dependence on guided weapons, ultimately reducing the options available to the JFC in many instances.

Operation Enduring Freedom (OEF)

Operation Enduring Freedom (OEF) saw the culmination on the reliance of guided munitions. OEF was "a new operational style, one that was revealed in Desert Storm and Allied Force in 1999 but brought to a higher level in the skies over Afghanistan."[17] The lessons learned in Operation Desert Storm and OAF concerning precision engagement were incorporated into OEF, furthering the proclivity and reliance on guided munitions. During the first two months of OEF, more than 72% of the munitions delivered by the USAF were precision guided. When Navy assets were added in the mix, the total U.S. munitions expended against Afghanistan targets exceeded 12,000, of which 60% (7,200) were PGMs.[18] The percentage of LGBs was approximately 20% compared with 40% near-precision, or accurate, weapons.[19]

The reliance on guided munitions such as JDAM was so great during OEF that production had to be increased to meet the pace of expenditure. According to Pentagon

officials, at "the pace of JDAM usage during the early weeks of the conflict, stocks would have run out in midwinter if no adjustment had been made."[20]

Analysis

As can be seen from the past three major conflicts preceding this analysis, the reliance on guided munitions has continued to grow with each successive conflict conducted by the United States. Their use rose from 10% in Operation Desert Storm, to 35% in OAF, and finally 60% in OEF. Guided weapons are force multipliers that support the JFC in a decisive manner by providing a precision capability that was only dreamt of 30 years ago. This precision strike ability allows the JFC to surgically attack high priority fixed targets, especially in heavily defended areas, or collaterally intensive environments, all this with a significantly reduced number of platforms and weapons. As cited in the *Gulf War Air Power Survey*, during the Gulf War one precision guided munition achieved the same level of damage as 9,000 bombs in World War II, and 177 bombs in Vietnam. However, while guided munitions demonstrate inherent advantages, they possess significant restrictions.

LGBs are severely hampered by target obscuration effects and may not always be a viable option in adverse weather conditions, resulting in the regression to near-precision munitions such as JDAM or even unguided "dumb" bombs. During the Gulf War, smoke from burning Kuwaiti oil wells severely hampered target identification and limited the LGB capabilities of coalition aircraft. In the postwar analysis the DOD determined that the lack of a credible all-weather precision strike needed to be corrected, resulting in the development of near-precision GPS-guided munitions, such as the JDAM.

This new capability was quickly called upon during OAF, when the incredible poor weather restricted the use of LGBs and demonstrated the all-weather capabilities of GPS-guided munitions. However, while GPS-guided munitions solved the all-weather precision strike problem, they presented a new problem to the JFC, with the requirement to acquire accurate mensurated target coordinates.[21] This necessity increased the amount of time required to obtain and calculate the desired mean point of impact (DMPI) and lengthened the sensor-to-shooter targeting cycle, providing the JFC a poor attack capability against mobile, emerging, or time critical targets.

The increased sensor to shooter cycle identifies a problem in the support of ground forces when the predominant number of targets are mobile, or emerging, and need to be destroyed quickly. According to LtCol Christopher F. Bentley, the Army Deputy Fire Support Coordinator during Operation Anaconda, "Although PGMs give the U.S. military an unparalleled ability to strike any point on the earth precisely, the time required to mensurate a target's coordinates and determine the DMPI to ensure the PGMs can hit the target is generally a luxury troops in contact don't have."[22] Adding to this problem is the continuing trend toward a greater standoff capability and the associated increased time of flight (TOF) of current weapons.[23] GPS-guided munitions do not currently possess the capability to predict future target location, thus allowing freedom from attack for mobile targets in adverse weather conditions. "Once released from the aircraft, current autonomous weapons have no capability to detect, reduce, or minimize any targeting or intelligence errors."[24] Against "fixed" targets this inability disappears, and demonstrates the advantages and disadvantages of GPS-guided munitions.

Inherent in the success of any military operation is an understanding of the enemy, both in the scope of his objectives and his operations. "Know the enemy and know yourself; in a hundred battles you will never be defeated."[25] Unfortunately for the United States, our current enemies seem to understand our strengths (precision engagement), and as such, do not project themselves in the classic battlespace environment. According to LtCol Bentley, "In Afghanistan…we face an opponent who chooses, in most cases, not to line up against our strengths."[26] The enemies we currently face, and expect to confront in the future, are adept and intelligent, and have taken advantage of a critical vulnerability with their understanding of our reliance on guided munitions and our aversion to civilian casualties. As a result, they routinely hide, camouflage, relocate, or place their high value assets amongst civilians to reduce the operational effectiveness of our guided and unguided munitions. During Operation Desert Storm, Saddam Hussein placed civilians near known high priority targets, and during OAF, Yugoslavian forces placed themselves in and amongst civilian refugees, effectively denying our use of unguided munitions.

Additionally, our enemies also understand the criticality of the GPS signal to the effectiveness of GPS weapons and may exploit this vulnerability with GPS jammers, thus denying our ability to use these weapons to their fullest advantage. During a 1997 Russian Air Show, a $4,000 jamming transmitter was on display with claims from the manufacturer that the device could foil the ability of GPS receivers to provide correct geographical coordinates to the weapons.[27] Recently, officials at the Pentagon expressed concern that Iraq may have acquired up to 400 GPS jammers from a Russian company.[28]

This could prove to be a significant factor in a future war against Iraq, or in other theaters, if the current trend towards GPS-guided munitions continues to hold true.

As stated earlier, the reliance on guided munitions presents several problems, some of which have been documented in the past. On 2 July 1996, the General Accounting Office (GAO) published an evaluation of the Gulf War and cited numerous deficiencies in the air operations and the over reliance on precision guided munitions, "…the services' increasing reliance on guided munitions to conduct asymmetrical warfare may not be appropriate."[29]

These limitations place the JFC and the JFACC in a quandary. Do they continue to rely on the prescribed effectiveness of precise munitions as the solution to all targeting problems or do they rely on less accurate, albeit more flexible alternatives, such as unguided weapons to meet their objectives? As stated earlier, the answer should be, "it depends". In a permissive battlespace, reliance on less precise weapons that can deliver ordnance on target in a matter of minutes, with reasonable accuracy, may be the preferable option. All this is predicated on the assumption that precision accuracy is not a requirement. Sometimes, munitions delivered in the general area will provide the desired effect.

In a rapidly moving battlespace, or when employed against mobile or emerging targets, precision or accurate weapons lack the flexibility and rapidity to destroy these forces, thus degrading the JFCs ability to utilize the concepts of operational art and the principles of war to their fullest advantage. Unguided munitions may provide a bridge to this gap until technology achieves the ability to support an all-weather precision strike against mobile and emerging targets.

Principles of War

> The principles of war guide war fighting at the strategic, operation, and tactical levels. They are the enduring bedrock of US military doctrine.
>
> -Joint Pub 3-0

Mass

"The purpose of mass is to concentrate the effects of combat power at the most advantageous place and time to achieve decisive results."[30] Guided munitions provide mass in the sense that a reduced number of platforms can strike the same number of targets simultaneously. However, unguided weapons supply another aspect of mass with their almost unlimited availability. According to a 1998 General Accounting Office (GAO) study, 1,300,000 deep attack munitions existed in the DOD inventory, of which 170,000 were guided, with additional plans to acquire or convert an additional 158,800 guided weapons, leaving almost one million unguided munitions.[31]

If guided munitions are used against all targets, including those that can be destroyed by unguided munitions, the JFC has effectively thrown away some of his ability to "mass" power. In both OAF, and OEF, the U.S. came very close to exhausting its supply of GPS-guided munitions early in the conflict. This would have necessitated the use of unguided weapons for all target types, reducing the options available to the operational commander. The judicious employment of unguided munitions against appropriate targets might thus free a greater number of guided munitions for use later in the conflict. Once again, this depends. During OAF the necessity for reducing unwanted collateral damage, the incredible poor weather conditions encountered, and the fragility of the coalition alliance degraded the ability of NATO forces to use unguided munitions, since their use may have broken the coalition, depriving the NATO of its ultimate victory.

Economy of Force

"The purpose of economy of force is to allocate the minimum essential combat power to secondary efforts…It is the measured allocation of available combat assets."[32] Guided and unguided munitions provide a two-fold and complimentary solution to this principle. The ability to precisely strike numerous targets with a single platform reduces the number of assets required, and thus puts less friendly forces in harms way, as was seen in Operation Desert Storm with one F-117 destroying multiple high value targets. However, the employment of guided munitions is time intensive and requires a significant greater amount of planning and effort, as highlighted by LtCol Bentley in his analysis of airpower support during Operation Anaconda. Most airborne platforms do not currently possess an internal guided self-targeting capability, thus requiring external platforms to provide the necessary targeting information, either through laser designation of the target, or by providing mensurated coordinates in the case of GPS-guided munitions. This denies the JFC critical assets that may be needed elsewhere and thus further reduces the economy of force seemingly implied with the use of guided munitions.

Unguided munitions possess the capability to accurately, although not precisely, acquire their own target and thus relieve the JFC of the task of allocating assets to support the bombing mission. Consequently, unguided munitions may prove to be of great value in the support of ground forces, or against emerging or time critical targets, although more platforms and sorties may be required to achieve the same level of damage or destruction. Unguided weapons possess a vital capability when operational fires need to

be conducted rapidly in a given general area, increasing the flexibility available to the operational commander.

Surprise

"The purpose of surprise is to strike at a time or place or in a manner for which the enemy is unprepared."[33] Both guided and unguided munitions provide the ability to support the JFC in this endeavor, increasing the potential for surprise with their ability to strike high priority heavily defended targets or large area targets quickly. Guided munitions accomplish this through the use of precision engagement. A stealth aircraft, armed with guided munitions, provides an unparalleled element of surprise, as seen in the Gulf War with the predominant number of stealth platforms employed. The enemy can't see the platform and thus can't react to its effects. However, as seen in every conflict faced by the United States in the past twenty years, our enemies understand this capability and routinely use camouflage, movement, and deception to degrade this capability. Unguided munitions, in a permissive battlespace, without the restriction of collateral damage, provide the JFC the ability to deliver massive amounts of power over large areas. A high altitude bomber delivering massive numbers of unguided munitions can easily be seen utilizing the principle of surprise if the enemy has no idea where, or when the bombs will strike. This concept was demonstrated during the Gulf War when USAF B-52's significantly reduced the Iraqi Army by causing numerous soldiers to surrender under fear of massive attack.[34]

Simplicity

"The purpose of simplicity is to prepare clear, uncomplicated plans and concise orders to ensure thorough understanding…When other factors are equal the simplest plan

is preferable."[35] However, this capability is an oxymoron, identified by the disparity between guided and unguided munitions. Guided munitions are normally, fire and forget, but they require a substantial amount of support to deliver munitions on target, either through the requirement to designate the target, or calculate mensurated coordinates, essential for the effective employment of these weapons. Unguided munitions eliminate these requirements, and thus are less intensive to deliver. However, the employment of unguided munitions is an art. It requires the operator to use the inherent aircraft systems to find, identify, and locate the target. In a sense, guided munitions are simpler to release, but unguided munitions are easier to deliver. Each weapon type possesses their own intrinsic value and it is critical that the operational commander understand these inherent capabilities.

Recommendations

Precision vs. Flexibility

Mass, economy of force, surprise, and simplicity are four principles of war that support airpowers greatest strengths, flexibility and versatility. Airpower possesses the ability to attack strategic, operational, and tactical objectives with precision, near-precision, and unguided capabilities. As such, airpower provides the JFC with a plethora of options, increasing the flexibility to react to changes in the dynamic battlespace found today and expected in the future. Relying completely on the use of guided munitions effectively robs the JFC of this critical strength. "Precision-guided munitions (PGMs) are not 'silver bullets' for every target engagement. The array of armament packages in any ATO (Air Tasking Order) should be structured to respond rapidly to any situation."[36]

Ensuring that a flexible array of weapon systems and munitions are available is essential to the successful application of airpower, especially in support of operational

objectives, but also in the support of ground forces and the destruction or denial of emerging or time critical targets. While this concept is not new, and has been proven throughout history, it seems to have been forgotten in the mad dash to embrace precision engagement and its theoretical reduction in collateral damage. Unfortunately, precision does not always equate to justice. Just because the use of precision weapons may reduce collateral damage it does not necessarily transmit to a reduced loss of life. "Most recently, U.N. studies of the impact against Iraq suggest that a half a million infants died between 1991 and 1998 as a result of the continuing U.N. embargo."[37] When this staggering number is compared with the 2,300 civilians that Iraq claims were killed during the six-week air campaign in 1991, its seems obvious that the public revulsion to collateral damage is misplaced. Defeating the enemy and forcing him to acquiesce to your political and military objectives is the cornerstone of military engagement and should never be forgotten.

Obviously, the JFC and his airpower expert, the JFACC, need to be cognizant of the inherent strengths of precision, near-precision, and unguided weapons. These various munitions possess attributes that are mutually supportive and not necessarily mutually restrictive. The effective use of all three capabilities increases the operational flexibility available to the JFC and provides the necessary options to meet his objectives. "The requirement to maintain a mix of weapon capabilities and platforms was highlighted by OEF. In the final stages of the campaign when the weather had improved and the air defense systems had been degraded, the availability of a complete mix of weapons maximized the flexibility of strike options against the remaining priority targets. Because pilots could now employ direct attack weapons at less risk, less costly legacy weapons

were, in many cases, as effective (and sometimes more) as more costly preferred weapons against such targets as fielded forces, large military storage complexes and airfields."[38]

When beginning an operation against an enemy, a reliance on both long and short range precision munitions to place operational fires where desired and thus provide freedom of maneuver are definitely warranted. However, once air superiority or air supremacy has been achieved, the focus of the operational commander should be on placing the most effective platform and munition against the intended target. While precision and near-precision munitions provide distinct capabilities, they are not the sole avenue to success. In many cases, unguided munitions provide the same effects in a more timely manner and with greater economy than guided weapons.

Conclusions

The last three major conflicts involving airpower demonstrate an increasing reliance on the use of guided weapons at the expense of operational flexibility. While guided weapons possess distinct and devastating capabilities they are severely limited by weather and in their employment against mobile or time critical targets. The most effective use of airpower requires adhering to the principles of war. Mass, economy of force, surprise, and simplicity support the operational flexibility and versatility of airpower and increase the JFCs potential for success. The current over-reliance on the use of guided weapons denies the JFC of vital options by reducing the operational flexibility of airpower and its ability to meet the requirements in the current and future dynamic battlespace.

The future employment of airpower should seize upon the unique capabilities inherent in all three types of weapons currently available in the vast United States military arsenal. Precision, near-precision, and unguided weapons possess mutually supporting attributes with their ability to strike targets at all three levels of war. In any conflict, initial air operations may require a larger number of guided munitions to deny or destroy critical precision targets and thus ensure freedom of maneuver. Nevertheless, once air superiority or supremacy is achieved, the judicious use of all three types of weapons needs to be analyzed and incorporated into the operational plan. Although unguided munitions are less accurate, they may be delivered in larger numbers and prove superior to guided weapons in the timely support of ground forces or in the destruction of enemy fielded forces. Additionally, unguided weapons currently demonstrate advantages in adverse weather conditions against mobile or emerging targets. The effective use of all three types of weapons will prove to support the JFC by providing the necessary flexibility required in the dynamic battlespace of the future. "A balanced application of direct attack, standoff, and GPS-guided munitions will be the backbone of future operations."[39]

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Endnotes

[1] Sean D. Naylor, "Officers: Air Force Policy Left Ground Troops High and Dry," Army Times," (30 September, 2002): 10. In current military definitions, munitions are categorized into two main types, guided and unguided. However, with the advent of the increasing number of guided weapons available in the U.S. arsenal, two additional classifications have come to be added, precision and near-precision. If a weapon has a circular error probable (CEP) of three meters or less it is considered "precise". If the CEP is greater than three meters but less than 13 meters, it is considered a "near-precision", or "accurate" weapon. Finally, if the CEP of the munition falls outside 13 meters it is considered an "unguided" munition.

[2] U.S. Joint Chiefs of Staff, Joint Vision 2010, (Washington, DC: 1996).

[3] Donald I. Blackwelder, "The Long Road to Desert Storm and Beyond: The Development of Precision Guided Bombs", School of Advanced Airpower Studies, (June, 1993), ix.

[4] Ibid, 13.

[5] Department of Defense. Report to Congressional Committees, "WEAPONS ACQUISITONS: GUIDED WEAPON PLANS NEED TO BE REASSESSED,", GAO/NSIAD-99-32, (Washington DC: 9 December 1998) 12. <http://fas.org/man/gao.nsiad-99-032.htm> [27 December 2002].

[6] Thomas A. Keaney and Eliot A. Cohen. Gulf War Air Power Survey (GWAPS). Vol. 4, Weapons, Tactics and Training and Space Operations (Washington DC: Government Printing Office, 1993), 87. LtCol David A. Deptula further expands this analysis in his article "Firing for Effect: Change in the Nature of Warfare, Defense Education Foundation, Defense and Airpower Studies, Arlington, VA, 24 August 1995, note 22.

[7] Keaney and Cohen, 266.

[8] Department of Defense, Report to Congress, "Kosovo/Operation ALLIED FORCE, After Action Report (Washington, DC: 31 January 2000), xvii. <http://www.defenselink.mil/pubs/kaar02072000.pdf> [24 January 2003].

[9] Ibid, 87.

[10] Ibid, 79.

[11] Ibid, 88.

[12] Ibid, 97.

[13] Ibid, 60.

[14] United States Air Force Weapons School, "CAOC Operations During Operation Allied Force," briefing slides (Ellsworth AFB, SD,: USAF B-1 Weapons School, Air Combat Command [ACC], 1999).

[15] Department of Defense, Kosovo/Operation ALLIED FORCE, After Action Report, 90.

[16] U.S. Joint Chiefs of Staff, "Joint Statement on the Kosovo After Action Review," (Washington, DC: 14 October, 1999), 14.

[17] Rebecca Grant, "The War Nobody Expected", Air Force Magazine (April 2002): 1. <https:www.afa.org/magazine/April2002/0402airwar.html> [30 December 2002].

[18] John A. Tirpak, "Enduring Freedom," Air Force Magazine, (February 2000): 3-4. <http:www.afa.org/magazine/Feb2002/0202airwar_print.html> [30 December 2002]. In this instance the author adds both "precision" and "near-precision" munitions into the category of PGMs in conflict with the military definition.

[19] Carl Conetta, "Operation Enduring Freedom: Why a Higher Rate of Civilian Bombing Casualties", Project on Defense Alternatives Briefing Report, #11, (18 January 2000), 4.

[20] Tirpak, "Enduring Freedom", 5.

[21]Mensurated coordinates are those that provide highly precise latitude, longitude, and elevation information and cannot normally be accomplished by aircraft in a timely manner.

[22] LtCol Christopher F. Bentley, "Afghanistan: Joint and Coalition Fire Support in Operation Anaconda," Field Artillery Magazine," (September-October 2002): 13.

[23] According the USAF Weapons School time of flight (TOF) is defined as the amount of time from weapon release to impact or detonation. The TOF of current weapons is over 30 seconds from medium altitude, and even greater when delivered from higher altitudes. When confronting a mobile target this delay from release to impact is critical. A target moving at 15 miles per hour will displace itself approximately ¼ mile in the time the munition is released and reaches its desired impact point. Unless the delivery platform is capable of guiding the weapon to the "new" aim point, the munition will miss the target by ¼ mile, substantially outside the lethal effects of even a 2,000 pound munition.

[24] Keith J. Kosan, "United States Air Force Precision Engagement Against Mobile Targets: Is Man In or Out", School of Advanced Airpower Studies, (November 2001), 17.

[25] Samuel B. Griffith, Sun Tzu - The Art of War (New York: Oxford University Press 1963), *84*.

[26] Bentley, 11.

[27] Michael R. McPherson, "GPS and the Joint Force Commander: Critical Asset, Critical Vulnerability", Naval War College (18 May, 2001), 9.

[28] Brett Baier and Molly Henenberg, "Iraq May Have Devices to Throw Off U.S. Smart Bombs," Fox News Channel, (11 January 2003). <http:www.foxnews.com> [24 January 2002].

[29] Department of Defense. Report to Congressional Requesters, "OPERATION DESERT STORM – Evaluation of the Air War,"GAO/PEMD-96-10, (Washington DC: July 1996), 12.

[30] U.S. Joint Chiefs of Staff, Doctrine for Joint Operations, Joint Publication 3-0 (Washington, DC: 1 February, 1995), *A-1*.

[31]Department of Defense, WEAPONS ACQUISITONS: GUIDED WEAPON PLANS NEED TO BE REASSESSED, 16-18.

[32] U.S. Joint Chiefs of Staff, Doctrine for Joint Operations, *A-1*.

[33] Ibid, *A-1*.

[34] Keaney and Cohen, 266.

[35] U.S. Joint Chiefs of Staff, Doctrine for Joint Operations, *A-1*.

[36] Bentley, 13.

[37] Phillip S. Meilinger, "A Matter of Precision", Foreign Policy Magazine, (March-April 2001): 2.

[38] Department of Defense, Kosovo/Operation ALLIED FORCE, After Action Report , *90*.

[39] Ibid, 90.