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REPLACING THE A-10

LT COL ROBERT S. HINDS

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REPLACING THE A-10

by

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Lieutenant Colonel, USAF

A DEFENSE ANALYTICAL STUDY SUBMITTED TO THE FACULTY
IN
FULFILLMENT OF THE CURRICULUM
REQUIREMENT

Advisor: Colonel Melvin L. "Smokey" Greene Jr.

MAXWELL AIR FORCE BASE, ALABAMA

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EXECUTIVE SUMMARY

TITLE: Replacing the A-10

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A historical review of the development of the close air support (CAS) mission introduces a discussion about which aircraft should be chosen to replace the A-10 as the CAS aircraft for the 1990's. The discussion covers the debate over the advisability of continued performance of the mission and the debate over transfer of the mission to the Army. The need for an improved CAS aircraft is established by defining the more dangerous battlefield environment of the 1990's in which it must operate. After examining the criteria by which a new CAS aircraft should be judged, the author suggests the appropriate aircraft to choose and makes other recommendations concerning the selection process.



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BIOGRAPHICAL SKETCH

Lieutenant Colonel Robert S. Hinds (M.S., Central Michigan University) has spent much of his 21 year Air Force career supporting ground troops as a close air support pilot. Immediately following his graduation from pilot training in 1969, he was assigned to fly the F-100 in Southeast Asia. While there he flew 252 close air support sorties. Colonel Hinds is a 1978 graduate of the F-5 Fighter Weapons Instructor Course, where he continued to acquire extensive knowledge about close air support, as well as counter air operations. His knowledge of other countries and other possible battlegrounds has been expanded by his assignments in Kenya and central Europe. As an A-10 squadron commander in Europe, Colonel Hinds saw and studied, first-hand, the problems facing today's close air support pilots. Colonel Hinds is a graduate of the Air War College class of 1989.

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CHAPTER I

INTRODUCTION

In 1970 the United States Air Force (USAF) asked the commercial aircraft industry to design a special aircraft. For the first time in its history, the USAF asked for an aircraft to be built exclusively for employment in the close air support (CAS) role(21:26). Until then USAF policy had been to procure aircraft that could be used in a variety of tactical missions(28:1).

This policy, which was certainly based on cost effectiveness, tended to make our tactical aircraft "adequate" across the full spectrum of tactical operations, but not especially good at any one of them. The F-4 "Phantom" of Vietnam fame, is a good example of this. Although originally designed as a U.S. Navy fleet defense interceptor, it eventually saw action in the Navy, USAF and U.S. Marine Corps in four different tactical roles(28:2). It performed valiantly in all, but, no one could claim that the F-4 was the best possible aircraft in any single role. Nor was it supposed to be. It was designed to do an admirable job against a variety of targets.

Southeast Asian experience, with multi-role aircraft in the CAS environment, led the USAF to recognize several future aircraft design necessities. The need for high sortie generation rates meant that the aircraft must be

simple and reliable. The need to destroy large numbers of targets with relatively limited assets meant that it must be able to accurately deliver a large diversified payload. The need to be responsive and persistent meant that it must be short-field capable, survivable, and able to stay airborne for a long time. In short, it had to be able to deal with the threat for which it was designed. After a prolonged debate and competitive comparison of all the designs submitted, the A-10 "Thunderbolt II" was selected as the USAF's first dedicated CAS aircraft(1:90).

The A-10 was chosen to meet the Warsaw Pact threat of 1970's. That threat was personified in overwhelming Pact superiority in numbers of main battle tanks and armored personnel carriers. It was postulated that these massed armor units would lead the Soviet assault to overwhelm North Atlantic Treaty Organization(NATO) defenders(21:28). The threat was compounded by overwhelming numbers of Warsaw Pact air defense units. Increasingly sophisticated anti-aircraft guns and ground-to-air missiles, in enormous numbers, will accompany the attacking columns. Finally, the normally adverse European weather conditions offer a tremendous threat to any defending NATO CAS pilot(1:91). In simplified form, this was the environment in which the A-10 was designed to fight.

The A-10 is a flying platform for the world's most lethal armor killer. Its internally mounted 30mm Gatling gun

is an awesome weapon. The fact that the "Warthog" can also carry up to 16,000 pounds of various conventional weapons makes the A-10 a very formidable foe(18:74). The aircraft is slow, but purposefully so. It was designed to fly slow at extremely low altitude (100 feet or lower), to avoid low cloud ceilings and enemy air defenses. It was made extremely maneuverable so it could stay close to its target, allowing easier target acquisition and timely reattacks when appropriate(1:91). This maneuverability, plus "hardened" critical systems, allowed it to become the most survivable aircraft in the USAF inventory(18:74). Every nut and bolt in the A-10 was designed and built to meet and defeat the close air support challenge of the 1970's.

Unfortunately, the 1970's has come and gone. The CAS role of the 1990's is different from that of the 1970's. The threats have changed and the U.S. Army requirements have changed. To meet these changes, the USAF is trying to decide on a replacement CAS aircraft for the A-10. This paper will look at the issues involved and the choices proposed and make recommendations as to what the final choice or choices should be. To begin, we will examine close air support and try to understand its importance and meaning.

CHAPTER II
CLOSE AIR SUPPORT (CAS)

What is it?

Close air support is the title of one of the missions performed by the Tactical Air Force(TAF). In general terms, it is a mission we have been doing, to some extent, for over 60 years. Although other names have been used to describe it, and other missions were once included in its overall category, air support of ground troops has been around since the First World War. It has gradually evolved with each armed conflict into a very specific mission. Experience in World War II, the Korean conflict, and the Vietnam war all provided refinements to the scope and definition of CAS (19:92). Our experiences in Vietnam gave particular meaning to its modern definition(9:253). But, the development and operational deployment of the first USAF aircraft developed solely to accomplish the CAS role (the A-10) has provided the modern day definition of the term and the mission(4:33).

As defined in AFM 1-1:

Close air support objectives are to support surface operations by attacking hostile targets in close proximity to friendly surface forces. Close air support can support offensive, counter-offensive, and defensive surface force operations with preplanned or immediate attacks. All preplanned and immediate close air support missions require detailed coordination and integration with the fire and maneuver plans of friendly surface forces. Close air support missions require access to the battlefield, timely intelligence information, and accurate weapons delivery.

Close air support enhances surface force operations by providing the capability to deliver a wide range of weapons and massed fire power at decisive points. Close air support can surprise the enemy, create opportunities for the maneuver or advance of friendly forces through shock actions and concentrated attacks, protect the flanks of friendly forces, blunt enemy offenses and protect the rear of surface forces during retrograde maneuvers(2:3-4).

TACM 2-1 expands this definition more by declaring that the purpose of CAS is to:

- Blunt an enemy attack on friendly positions.
- Help ground forces obtain and maintain the offensive.
- Provide cover for friendly movements(29:4-37).

The operative idea in both statements is that CAS is a mission accomplished to support friendly ground forces who are in actual combat with enemy ground forces. Although CAS is an obviously dangerous mission, the USAF has agreed to perform the role regardless of the risk or threat (29:4-46).

Pro and Con.

From a variety of standpoints, CAS has become an extremely controversial subject. Opponents and proponents alike can easily be found to argue their views on: the applicability of CAS in today's battlefield; the suitability of fixed-wing versus rotary-wing assets; or the ability of the Army to provide its own CAS. This paper cannot prove or disprove either side of these issues, but, a brief comment or two is probably appropriate to place these issues in their proper perspective.

Those arguing that there is no place for CAS on the modern battlefield, do so out of respect and appreciation for the changing nature of the battlefield environment and the ever expanding threats within that environment(26:92). This topic will be dealt with more fully in the next chapter, but a brief comment now is appropriate. There is no doubt that the enemy is improving his ability to defend himself against aerial attack. Tremendous threat improvements have been made and will continue to be made in maneuverability, warhead lethality, guidance accuracy, radar jam-resistance, missile envelope expansion, multi-target engagement potential, and low altitude capability(19:94). In short, the modern battlefield has become a very dangerous place for the CAS aircraft(23:46). But, just because the environment is risky is not sufficient reason to discontinue performing the mission.

By every method of counting and assessing relative conventional strength, the Warsaw Pact outnumbered NATO by an overwhelming margin. This advantage is especially evident in armored vehicles such as main battle tanks and personnel carriers. Even if the popular view is true, which says that NATO may be outnumbered, but possesses a qualitative advantage in weaponry, it would not help. A massive, all-out Warsaw Pact attack would overwhelm NATO ground forces in short order. The only chance NATO has is for tactical air power, in the CAS and interdiction roles, to stop or

slow the attack, to allow our ground forces to regroup and be reinforced(18:74)(1:110)(10:62). In simple terms, CAS will definitely remain applicable as a USAF mission well into the 21st century because we have no alternative(20:73). As long as we have ground troops who need support, we airmen will have CAS as a mission.

Other arguments, on this subject are rather simplistic and, frankly, immaterial to the realistic assessment of CAS. For instance the arguments concerning the appropriateness of fixed-wing verses rotary-wing aircraft have strength on both sides. Clearly fixed-wing aircraft are hampered by poor weather and lack of maneuvering room to a greater degree than rotary-winged aircraft. Further, if the rotary-winged aircraft are based close to the action, they are probably more responsive to ground force needs(5:62). But on the other side, only fixed-winged aircraft can repeatedly mass the amount of ordnance needed, over the required distances, in a timely and supportable manner (19:94). None of these arguments really makes any difference because there simply is not enough of either fixed-wing or rotary-wing aircraft to alone do the CAS mission(4:34).

Just as with the applicability question, we do not have the option to choose one or the other. With the overwhelming, Warsaw Pact numbers advantage, we will need a mixture of fixed-wing and rotary-wing aircraft to do the job (24:68).

The argument concerning the Army providing its own CAS is equally irrelevant. The question comes down to, should we transfer all fixed-wing CAS assets to the Army? Notice the question is not "can we" transfer, but "should we" transfer? The reason for doing this, presumably, would be to develop a similar relationship between ground and air units as that enjoyed within the Marine Corps(20:73). But, the Air Force and the Army have already developed their own close relationship, through years of practice and cooperation (4:33). Although inter-service rivalry did once interfere with the cooperation required for real teamwork, that is no longer a factor. The Commander of the Tactical Air Command (TAC) states that:

The Army has been delighted with our close air support. Army people who have been in battle will tell you what a great thing it has been. The senior leadership of the Army solidly supports the idea of the Air Force doing close air support(7:50).

There appears to be no good reason to make such a drastic change.

"Could" the Army become the only CAS provider?

Clearly it could , but at tremendous expense.

Administrative, training, and logistical support changes would be extremely costly for everyone concerned. Further, agreements between the Army and the Air Force have clearly delineated CAS roles and missions for each service(19:96).

Both are satisfied with the joint direction in which this mission is headed. Besides, there are more problems which are much more relevant.

Why Do We Do CAS?

With all the arguments, both pro and con, why do we still plan on doing CAS? With the dangerous and risky battlefield of today, why should we still intentionally plan on flying CAS missions? Some would state that the Air Force does CAS because, in 1946, on the formation of a separate service, General Spaatz promised General Eisenhower that the Air Force would always support the Army(25:45). Others might say that we do CAS because joint Air Force and Army exercises have honed us into an effective fighting team(7:54). Still others would say that recent official agreements between the Army and Air Force have delineated roles and missions guaranteeing that the Air Force will continue doing CAS(19:96). All of these, while quite true, completely miss the point concerning CAS.

In my view we do CAS for one very simple reason. There is no realistic, viable option available, which would let us avoid it. With the status of forces as it is today, and will be for the foreseeable future, there is no choice! The USAF will continue doing CAS, regardless of the risk, well into the 21st century, because there is simply no other option open to us. Even so, our chances for success will be improved if we understand what the mission is that CAS pilots

will be required to fly. This information will also help decision makers to decide what the next CAS aircraft should be able to do.

CHAPTER III

THE MISSION

The Old Battlefield

As has been mentioned previously, the A-10 was designed to be compatible with a certain type of battlefield, with a certain type of threat array. The A-10 was built with a Vietnam era battlefield in mind(19:92). It was constructed from the ground up to meet a certain set of battlefield criteria. Everything from weapons load, to flight characteristics, to communications/navigation equipment, and offensive/defensive capabilities were all tuned and honed to address a certain need(1:90).

Since Warsaw Pact armor is one of the main NATO threats, the A-10 was designed to be an armor killer(18:73). Its internally mounted 30mm Gatling gun was, and still is, a most formidable weapon in dealing with large numbers of armored targets. Other weapons, such as air-to-ground guided missiles and armor piercing cluster bombs, further enhanced the A-10's ability to destroy armor(18:74).

Flight characteristics were also replanned to optimize A-10 capabilities. It was designed to fly at slow speeds for long periods of time to allow it lengthy loiter time in the target area. This slow speed, plus its maneuverability and the capability to fly at low altitudes, allowed it to find targets and stay with them long enough, through

repeated attacks if necessary, to kill them(1:90). Structurally, the A-10 was built with redundant critical aircraft systems and has been armor plated to protect the pilot. It has been equipped with radar warning and electronic countermeasures gear which, along with its nimble maneuverability, helped to make the A-10 one of the most survivable aircraft ever assembled(18:74).

But, survivability seems to be a very relative term. The A-10 was designed to fight and survive in the battlefield of the 1970's. A battlefield defined by relatively linear and consistent lines of battle. Where, generally speaking, all the "good guys" were on one side of the line and all the "bad guys" were on the other. The A-10 was designed to fly and fight on the "good guy" side of the front, with only limited incursions, for short distances, into enemy territory. Further, since the A-10 has only limited night and poor weather capability, the battle was expected to be fought in daylight and during relatively good weather (22:1192).

This was the expected battlefield of the 1970's. And, while there will probably be opportunities around the world to still find this battlefield, at least the expected European battlefield of the 1990's has changed dramatically. Along with it, the U.S. Army requirements for fighting on this battlefield have also evolved into something quite different.

The New Battlefield

What will the new battlefield of the 1990's be like? Who defines that battlefield? How do we plan ahead to meet the new criteria? Part of the answers to these questions comes from the enemy. To a great degree, the battlefield environment of the 1990's will be determined by the fielding of enemy threats and the employment of those threats according to his doctrine and strategy. The Warsaw Pact is employing greatly improved air defense missiles, anti-aircraft artillery, small arms, and detection devices. Not only are the numbers of these weapons increasing, but also their quality and mobility have improved tremendously. These systems have longer ranges and better low altitude capability than those of the past. They are also much more difficult to defeat through deception or electronic countermeasures. Technology and sophistication have elevated the problem of survivability in the modern battlefield to a much higher level of uncertainty(19:94).

But the enemy forms only part of the definition of the battlefield of the 1990's. The other part comes from our own U.S. Army. At least for the USAF, the U.S. Army determines what the battlefield environment will be like. Historically this is true because of an agreement struck in 1946 between Generals Eisenhower and Spaatz upon the formation of the new, separate Air Force. General Spaatz agreed that, even though a separate service had been created,

the Air Force would continue to support the army(25:45). For over forty years now, that "gentlemen's agreement" has been upheld. Every mission that the tactical air force accomplishes, from air superiority to close air support, supports Army operations. A close relationship has been maintained which permits the Army to determine its own doctrine and strategy, while at the same time, determining what effect it wants the Air Force to have on the enemy. The Air Force then determines the appropriate air power application which will achieve the Army objective(27:13). This close relationship has allowed the Army to do its business and the Air Force to do its business without interference from the other(7:53).

The Army's doctrine for the 1990's is called the AirLand Battle. There are many aspects of this doctrine. It was developed after careful study of the Soviet Union's developing doctrine and strategy. Part of this new doctrine defines the battlefield of the 1990's(27:53).

The January 1989 issue of Armed Forces Journal International does an excellent job of briefly describing the battlefield expected by the AirLand Battle doctrine and definitized in Army Field Manual 100-5:

Given the mobile nature of modern armies, particularly those equipped with large numbers of troop-carrying assault helicopters, Army and Air Force planners envision the battlefield of the 1990's as a fluid, nonlinear forward line of troops with the major combatants ebbing and flowing with the battle. Air Force commanders believe this geographical mixing of forces will require U.S. aircraft to penetrate hostile

airspace to perform both close air support and battlefield air interdiction missions. In addition, they will have to perform these missions continuously-day and night, and in adverse weather.

Not only will tactical support aircraft have to spend an increasing amount of time in hostile airspace, they also will be faced with an increasingly broad array of dangerous threats, from small arms to improved surface-to-air weapons to opposing fighters with all-aspect, look-down/shoot-down capabilities. This is where differing CAS aircraft philosophies emerge(24:70).

This brief overview is enough to highlight some major differences between the old and new battlefields.

The new battlefield will be one of high technology. The new threats will make it an extremely lethal place. But, in addition to that aspect, technology makes the battlefield one that is much larger in depth and breadth. More than ever before, armies will now be able to move more quickly and see more deeply into the enemy rear(3:6-1). To avoid being overwhelmed, our Army has determined that it must be able to strike 100-200 kilometers behind enemy lines(3:5-1)(32:29). It needs to be able to do this day or night and in all weather conditions. This is a stark contrast to the old battlefield for which the A-10 was designed.

Notice too that the new battlefield will be an ever changing, dynamic one that has no real fixed boundaries. Peaks and valleys of influence will ebb and flow throughout the entire battle. This means that instead of staying behind friendly lines, CAS aircraft will regularly have to fly over enemy territory to reach close air support targets. Flying over enemy territory may in fact mean that CAS aircraft will

be regularly tasked to perform battlefield air interdiction (BAI) missions(24:70).

Air interdiction is one of those missions defined in AFM 1-1 as an official Air Force mission. BAI is a form of air interdiction, both are defined as follows:

Air interdiction objectives are to delay, disrupt, divert or destroy an enemy's military potential before it can be brought to bear effectively against friendly forces. These combat operations are performed at such distances from friendly surface forces that detailed integration of specific actions with the fire and movement of friendly forces is normally not required. Air interdiction attacks are usually executed against enemy surface forces, movement networks (including lines of communication), command, control, and communications networks, and combat supplies. Interdiction of the enemy can delay the arrival or buildup of forces and supplies, disrupt the enemy's scheme of operation and control of forces, divert valuable enemy resources to other uses, and destroy forces and supplies.

.... Air interdiction attacks against targets which are in a position to have a near term effect on friendly land forces are referred to as battlefield air interdiction....(30:3-3).

Close air support missions target enemy troops in actual combat with friendly forces. BAI targets are those, excluding troops-in-contact, which are close enough to the battle zone to be a factor in the near future. The possible inclusion of the BAI mission to the regularly assigned tasks of the CAS forces is a source of much disagreement among those planning the new CAS aircraft(24:70).

With this view of the battlefield of the 1990's, it is clear that this new anticipated environment is quite different than the battlefield of the 1970's. Based on this new battlefield environment, the Air Force has determined

that the A-10 must be replaced. It follows then that the new battlefield environment requires careful study to determine what characteristics the CAS aircraft for the 1990's must have.

CHAPTER IV

CAS AIRCRAFT CRITERIA

In April 1985 the US Army and Air Force signed the Air Force and Army Memorandum of Agreement (MOA) on Follow-On Close Air Support (19:94). This MOA more or less formalized the handshake agreement made in 1946 between Generals Eisenhower and Spaatz. As has already been discussed, this handshake arrangement guaranteed continuing Air Force support for the Army. For years Air Force and Army leaders have been denying that a controversy, concerning CAS, existed. Air Force leaders, such as the Commander of Tactical Air Command, have said very plainly, in speeches and in text, that support of the Army is one of the tactical Air Force's primary missions (25:45)(24:70). Regardless, suspicions and accusations that the Air Force regards close air support of the Army as a mission of minor importance have still existed(7:50). This MOA would seemingly go a long way toward proving these rumors groundless.

The MOA also continues a relationship which was established many years ago. This concept allows the Army to estimate what the future battlefield environment will be like and to determine the desired effect it would like the Air Force to have on that environment. The Air Force then determines the equipment, weapons, and tactics it needs to produce the desired effects(19:96)(27:13). Granted there are

critics of both the Army and the Air Force who say that the Army has incorrectly assessed the characteristics of the future battlefield, and that the Air Force is not using the correct criteria in determining its future CAS aircraft (7:53). But, for the most part, these dissenters are people whose credentials and motives are suspect (19:53). The important point is that the qualified expert in ground warfare, the US Army, has determined its requirements. Plus, the qualified expert in aerial warfare, the US Air Force, is working to determine its solutions for responding to those requirements. There is no controversy between the two services over who will provide close air support. Both are in complete agreement over the separation of missions and in the continuing established relationships between the two. (19:96). The only thing that remains is to overcome the outside interference and complete the task of deciding what aircraft will best perform the required mission.

The Air Force has decided on a rather detailed set of criteria with which to measure its proposed candidates. The criteria were not analytically determined. Rather they are based on the Army's assessment of the future battlefield. Validity of the criteria will therefore depend on the accuracy of the battlefield assessment.

USAF CRITERIA

The Air Force has determined that it will investigate candidates for the A-10 replacement based on the criteria of

responsiveness, flexibility, survivability, lethality, and target identification/acquisition(27:13).

Responsiveness.

CAS aircraft must be responsive. History has proven that CAS aircraft are not suited for every type target. However, when the target is in fact a bonafide CAS engagement, there are never enough aircraft available (19:96) When CAS targets are available, CAS aircraft assets must be massed and continuously on target to provide assistance. When numerous CAS targets are active, success or failure will hinge on the Air Force's ability to generate high sortie rates(27:13). In addition, concentrated time on target means that CAS aircraft are going to be damaged or lost frequently(20:74). All of this means that for a CAS aircraft to be effective it must be simple to operate, maintain, and repair. It must be available to get to the battle in a timely manner over and over again each day (27:14). This criterion would appear to heavily favor the simple, cheap, unsophisticated aircraft candidates, which could be purchased in large numbers, and would be relatively easy to operate, maintain and repair(20:74). There is no controversy over this requirement, CAS aircraft must be reliable and maintainable in order to be responsive. However, there are numerous arguments over the trade-off between responsiveness and the need for higher sophistication.

Flexibility.

In this regard, flexibility is another term for "multi-role" capability. This criterion fuels the age old argument between those who say that the "do one thing great" design of an aircraft, like the A-10, is far better than " the "do many things adequately" design of the F-4, and those who hold the opposite view. Many studies have been accomplished on this issue, none have been conclusive (28:120). Both sides have valid points to make for their side(7:53).

Flexibility also means being able to do the mission in any weather conditions, both day and night. As good as the A-10 is at performing the CAS mission, it does not possess this capability. Any realistic candidate must be able to fulfill this component of flexibility, even though in doing so the sophisticated avionics required will no doubt somewhat compromise the criterion of responsiveness.

Even though there is at least some value in much of the criticism offered, there is really only one argument that is of any importance at this point. The US Army and Air Force have agreed on the battlefield environment of the 1990's. They have also agreed that there is still a requirement to do CAS and that the new CAS aircraft must also perform the BAI mission as well(19:94). And it must be able to do both in all weather conditions in daylight or darkness(27:14). All other arguments are pointless.

Survivability.

Survivability is probably the most critical of all the criteria. The search for a new CAS aircraft is based almost entirely on the Air Force's lack of confidence that the A-10 can survive in the battlefield environment of the 1990's(7:52). New Warsaw Pact defensive weapons and detection devices, plus the perceived requirements to fly deeper into enemy territory at night and in poor weather conditions, make survivability all important. The Air Force measures survivability in several ways, including speed, maneuverability, electronic countermeasures, force packaging, and hit tolerance(26:92).

To a large extent, speed and maneuverability go together to determine an aircraft's hit avoidance capability. The Commander of Tactical Air Command believes that speed is the most critical factor of survivability. He concludes that a fast aircraft significantly complicates an enemy pursuer's aiming and tracking problem (26:94). Many disagree with him, stating that, with today's technology, speed alone is not that difficult a problem to overcome. Further, high speed creates other problems for the CAS pilot that will be discussed later (13:116). However, no one can argue that high speed will decrease an aircraft's time in enemy territory and also will reduce the enemy's

available detection time. And, when combined with maneuverability, certainly does help an aircraft to avoid getting hit (26:94).

Maneuverability can be simply defined as an aircraft's ability to make hard turns. This is probably too simple a definition to adequately describe a capability that is absolutely critical to the survival of the CAS aircraft. The ability to make quick, and more importantly, unpredictable turns will be a critical factor in allowing the pilot to maneuver his aircraft in such a way as to avoid being hit. Maneuverability, in combination with high speed, compounds the enemy's problems immeasurably(26:94).

In addition, survivability is increased through an adequate array of electronic countermeasures. Improved threat technology makes state-of-the-art defenses against new and more numerous radar and infrared detectors necessities. As the modern battlefield becomes more lethal, our ability to fight and survive within the ever expanding electromagnetic combat arena will be a prime decider on who wins or loses the battle(26:94).

The U.S. Air Force considers force packaging, a somewhat controversial factor, to be necessary for survival. This belief is not held by our NATO allies. They feel that, during the chaos of battle, disrupted communications and logistics support will quickly prevent any consistent

success at force packaging. They also feel that the concentration of enemy defenses will also make the concept impractical. The U.S. Air Force disagrees especially when talking about targets deep in the enemy's rear area(26:94).

When attacking deep targets, CAS aircraft will hopefully be escorted by F-15's to defend against enemy fighters; F-4G's to suppress enemy defenses; and EF-111's to jam enemy radars. This "package" will use teamwork to penetrate enemy defenses and reach the assigned targets. For this "package" to be effective, all the components must be compatible in speed and maneuverability or run the risk of being left behind or endangering the entire force(26:94).

Finally, throughout the history of CAS aircraft, one of the consistent facts that has held true from World War II through Vietnam is that CAS aircraft are going to sustain battle damage(20:74). There is no reason to expect that this will change in future wars. The nature of the mission is that CAS is performed where fighting takes place. Therefore, for the new CAS aircraft to be survivable, it must be able to tolerate battle damage and keep on flying.

Engineering and material advancements such as: self-sealing hydraulic and fuel systems; redundant flight control and electrical systems; new alloys; honeycomb structures; graphite composites; and the wide use of computers have tremendously increased the durability of the modern fighter aircraft(27:14). Continued advances along these lines, plus

greater attempts to protect critical aircraft systems, to include the pilot, must also be made(26:97). Of course hit tolerance and durability must be achieved without hampering the performance of the aircraft.

Target Identification/Target Acquisition.

The perfect CAS aircraft is absolutely worthless unless it allows the pilot to identify the target area and then allows him to acquire a specific target. The A-10 does this by being able to loiter in the area for long periods of time. It then attacks and reattacks a target until it is destroyed(21:31). Since the predicted new battlefield will not allow the luxury of long loiter times in the target area or multiple reattacks, new developing technology must be used to assure first pass target identification and acquisition(27:15).

New, expensive equipment will be needed to offset the planned reduced target area time. New radar, intelligence, and reconnaissance systems will be needed to give real time information on target locations(27:16). Further, new on-board high technology equipment for solving poor weather, day/night, and hidden target problems are necessities. And, computers which permit first pass target destruction through exotic but reliable weapons release systems are required to insure mission effectiveness(27:17).

This is one area where high speed may be considered detrimental to the accomplishment of the mission. The faster

the speed the less time there is available, and, thus, the more difficult the target identification and acquisition problems(19:116).

Lethality.

The new CAS aircraft must be lethal. It must possess the weapons capable of destroying armored and hardened targets. The A-10 does this through stand-off weapons such as the AGM-65 "Maverick" missile and its magnificent GAU-8 30mm Gatling gun. History has proven, repeatedly, that the most effective weapons for mobile, hard targets are "point and shoot" weapons such as those described for the A-10 (20:74). The new CAS aircraft may even use combinations of advanced technology in the areas of low-observables ("stealth") and advanced stand-off munitions to become dangerously lethal in all circumstances(13:117).

Other Criteria

The above are the advertised U.S. Air Force criteria for the new CAS aircraft. However, there are a few others that are also worth mentioning.

Cost.

Unfortunately, the most important consideration for Air Force planners, as they decide on the next CAS aircraft, is probably not going to come from the list of criteria which I've already discussed. In today's austere, military, budget environment the most important criterion to consider is probably going to be cost. Survivability, responsiveness,

lethality, and the others are all critical. But, I believe, when it is time to make the final decisions, the deciding factor won't be how capable the aircraft is, but rather, it will be how much capability can we afford! Therefore, since we don't have an unlimited supply of money with which to construct the ideal aircraft, the choice is probably going to be a compromise that allows us to buy the best aircraft possible for the money available.

Timeliness.

Another unspecified but important criteria is timeliness. Since we are trying to find the appropriate CAS aircraft for the battlefield of the 1990's, it's important that we acquire the aircraft quickly so that it isn't obsolete before it becomes operational. Time just isn't available to research and test every conceivable possibility before choosing. The 1990's are almost at hand, therefore, the aircraft for the 1990's must be available quickly. The time factor will probably rule out several options, which I'll discuss in the next chapter.

Miscellaneous.

Finally, there are several other issues that should also be considered. One is the issue of single-engine aircraft verses dual-engine aircraft. Is the simplicity of a single engine better for this aircraft, or is the reliability of two engines better? Positive information is available for both sides of the question(13:116).

Another consideration is the choice between building an expensive multi-role aircraft or the less expensive option of building another CAS-only aircraft. The AirLand Battle doctrine calls for a multi-role replacement aircraft(19:94). But, can we really afford to go back to the "do-everything" aircraft, especially with the successes of the A-10? Maybe we can't afford not to(28:120).

Expanding technology certainly may play a big role in the selection of the next CAS fighter. Although timing and cost are certainly primary factors, major breakthroughs in "stealth" and stand-off weapon technology may be such "force-multipliers" that they must be seriously considered in the decision process. Other technology breakthroughs must also be considered, when and if they occur.

With this list of criteria in mind, what are the possible choices for the next CAS aircraft?

CHAPTER V

THE CHOICES

With the adoption of the Army's AirLand Battle doctrine and a new definition of the battlefield environment, the Air Force has begun to try to identify the appropriate replacement aircraft for the A-10. The Air Force has already accomplished a detailed study of the available options, and has arrived at its own preferred course of action. However, the Congress, believing the Air Force study is incomplete, is requiring, among other things, a competitive fly-off among at least four possible candidates, the A-7, the A-10, the A-16 and the AV-8B(14:21). To comply with Congress, the Department of Defense is proposing a series of tests, within the next three years, to attempt to resolve the dilemma over the new CAS aircraft(16:97).

The proposed testing will provide a detailed look at the choices. The following is my preliminary assessment of the possible options.

Option #1: A New Aircraft Design

If the only considerations involved in choosing a new CAS aircraft were aircraft capabilities, this option would probably be the ideal choice. The Air Force has at least six new designs it is reviewing. The designs range from low cost, low sophistication to high cost, high sophistication (15:84).

Advantages.

Clearly the advantage of this approach is that you can look at the criteria needed and build an aircraft that suits your needs. The required capabilities can be mixed and matched, almost like following a recipe. If the only consideration is to find the most capable aircraft possible, this would be the way to go.

Disadvantages.

Unfortunately, capabilities are not the only considerations. As I've mentioned, costs and timing will also be major factors. Both of these factors are serious disadvantages and make the selection of a new design very unrealistic(24:70). Experts say that a new aircraft will cost \$3 billion to develop and take around eleven years to field(15:84)(6:80). This is entirely too expensive for serious consideration. Plus, since the aircraft is being developed for the battlefield of the 1990's, there just isn't enough time to bring on a new design. In eleven years, the battlefield environment will have changed enough to make current new designs outdated.

Option #2: A Modified A-10

As has already been discussed, the A-10 is a special aircraft. It was the ideal CAS aircraft through the 1980's, and, with the addition of some modern technology, it could be again in the 1990's. The aircraft became operational in 1977 with final delivery of the 713th A-10 in March 1984. The

A-10 is a two-engine, flying "tank-killer". It is built around an extremely lethal, 30mm, internally mounted, Gatling gun. In addition, it can carry 16,000 pounds of mixed ordnance to include various types of free-fall weapons and the "Maverick" air-to-surface missile. Since its sole mission is to support the Army, it was designed to fly low and slow for long distances and remain in the target area for long periods of time without refueling. Although a relatively large aircraft, it survives by being very maneuverable, very hit tolerant, and very reliable. Its simple instrumentation includes inertial navigation, some electromagnetic countermeasures gear, and laser seeker equipment(33:179)(1:90-91).

Proposed improvements for the A-10 include the following: a forward-looking infrared system to improve its all-weather and night capability; an automatic target hand-off system to improve target acquisition and battlefield communications(12:49); and increased thrust engines to increase its slow speed(16:97).

Advantages.

Obviously, if the modified A-10 is good enough to fulfill the role demanded, its main advantages will be in costs and timeliness. Estimates for the initial modifications (not including new engines) now call for \$3 million per aircraft(31:28). This is much cheaper than any of the other options (even with the engine costs added) and

will take much less time to implement. Further, with an average age of less than ten years, retiring the A-10 now, well before its designed life had been reached, would be an extreme waste(16:97). Another advantage is unquestionably the A-10's extremely lethal firepower. With the soon-to-be-completed addition of an air-to-air missile capability plus its existing firepower, the aircraft is extremely potent. Finally, another of its big advantages is in its agility, durability, and responsiveness. It flies sortie after sortie in the toughest of conditions, it is able to stay in the combat zone for long periods of time, and it is able to withstand enormous amounts of battle damage(18:74)(13:117)(1:90-91). The A-10 is the only aircraft, of those being considered, that enjoys the luxury of having two engines. The new proposed improvements should make it even more responsive in all weather and lighting conditions.

Disadvantages.

As far as the A-10 is concerned, survivability is the big question mark. Can an aircraft designed for the battlefield of the 1970's still survive in the high threat battlefield environment of the 1990's? The A-10 has used its ability to maneuver, its adaptability for the low altitude environment, and its ability to repeatedly put its massive firepower quickly on target as its source of survival. Air Force experts have been saying that this just isn't good

enough any more. According to the Air Force, a faster aircraft is needed, one that can penetrate deep into enemy territory and can avoid being hit while doing so is desired (27:13)(26:94). Further, since force packaging is an important concept to the Air Force, the new CAS aircraft must be able to keep up with the rest of the force. If it cannot the package becomes more vulnerable(26:94). As is, the A-10 lacks the speed and flexibility required to fly deep into enemy territory. New engines will increase speed, but it still will not be as fast as other options. The increased speed will also increase fuel consumption, which will decrease loiter time(11:41). And finally, without planned improvements, the A-10 is essentially a day-only attack aircraft with only limited bad weather capability. For the A-10 to be acceptable, the planned modifications must make dramatic performance improvements to insure that the A-10 can still do the required mission.

Option #3: A Modified A-7

The A-7 is a single-seat, single-engine, subsonic, CAS and interdiction aircraft. Although none are now in service with active Air Force units, it is currently in the Air National Guard units of ten states plus Puerto Rico. The aircraft performed extremely well in Southeast Asia. Its equipment includes: a computer controlled continuous-solution navigation and weapons-delivery system; an all-weather radar bomb delivery system; a laser seeker system; and an

internally mounted 20mm cannon. It can carry up to 15,000 pounds of mixed ordnance to include: free-fall bombs; air-to-air or air-to-surface missiles; rockets; mines; or gun pods(33:178).

Proposed improvements include: a new afterburner equipped engine to increase speed; a modified flight control system to improve maneuverability; and an upgraded avionics system to improve all-weather and night capabilities(14:22).

Advantages.

Although modifications for the A-7 are extensive, the basic airframe is a proven design. Cost and timing considerations are acceptable, falling somewhere between figures for a modified A-10 and the A-16(11:41). Avionics modifications will improve an already impressive weapons delivery system, and give it an extremely formidable all-weather capability. The new engine will greatly improve the A-7's force packaging compatibility, and give it flexibility for "behind enemy lines" missions. Faster speed and more maneuverability means improved survivability for the A-7.

Disadvantages.

Even though costs and timing for the modified A-7 fall within "acceptable" ranges, the upgrades are very extensive and would cost much more than the A-10 modifications. The A-7 is not a "hardened" CAS aircraft. It is not armor protected around the engine or cockpit. The engine modification requires the stretching of the fuselage,

which increases the aircraft vulnerable area significantly (16:97). In short, gains made by the modified A-7 in flexibility, speed, and maneuverability may not adequately offset its vulnerability to attack. And, even though costs are labeled "acceptable", they may still be too high.

Option #4: A Modified F-16

The F-16 is one of the best fighter aircraft in the world. It is a state-of-the-art, single-engine, supersonic, computer assisted, light-weight fighter. Except for the re-engined A-7, it is the only one of the candidates with supersonic speed. It is an extremely maneuverable aircraft. Its equipment includes: an advanced radar; an advanced radar warning receiver; computerized flight controls; a 20mm cannon; and seven external stores stations. The F-16 can carry various types of stores to included: free-fall bombs; air-to-air missiles; fuel tanks; and a wide range of other air-to-ground munitions. It has a computerized fire control system that is extremely accurate and reliable (33:177).

Planned improvements are as follows: a terrain following radar and forward looking infrared system to improve night and poor weather capability; an automatic target hand-off system to improve target area communications; structural improvements to better protect vulnerable areas; and improved self-protection and electronic countermeasures equipment to increase survivability(11:41).

Advantages.

There is a tremendous cost and time savings when buying an aircraft that is still in production. Since the F-16 is still in production, these savings allow the F-16 to be a very valid and acceptable option. The modified aircraft would be called the "A-16". Its main advantages would be in the areas of flexibility and survivability. The A-16 could be used for any tactical mission the Air Force required. It could fly CAS, deep interdiction, and even counter-air missions without any problem. Therefore, it would probably be the most flexible aircraft the Air Force has ever had. Further, the high speed and maneuverability of the A-16, make the aircraft very survivable. When modified, the automatic target hand-off system will also improve survivability by allowing pilots to identify and strike targets on the first pass, rather than requiring lengthy loitering in the battle zone(17:30). Finally, the A-16's infrared and terrain following radar modifications will make a tremendous improvement in the Air Force's ability to support the Army at night and in bad weather. For years this capability has been sought, but the A-16 will be the first to possess a reliable ability to perform with consistently adequate results(7:54).

Disadvantages.

As strange as it may seem, even though flexibility and survivability are considered advantages, they are also serious disadvantages for the A-16. Flexibility is a dis-

advantage if, as many suspect will happen, A-16's are diverted from their CAS role to fly counter-air or other type missions(6:80). Critics believe that, if the air battle started going badly, despite the best of intentions, the Air Force could not resist diverting one of its most capable air-to-air fighters to that role. Survivability is a weak point from the standpoint of being able to withstand battle damage. Even though planned structural changes do result in some "hardening," the A-16 has many more vulnerable areas than the A-10. It must depend on hit avoidance through its speed, maneuverability, and sophisticated target acquisition systems to survive(13:117)(16:97). High speed can also be a disadvantage for a CAS aircraft(16:97). Target identification and acquisition become very difficult. Even with laser identification and automatic target hand-off, the problem will be tremendous in an all-out battle(13:116). The A-16 is so sophisticated and depends on so much high technology, that this too could be a serious disadvantage in combat(20:76). Maintenance and parts supply for all this equipment may become extremely difficult. And finally, even though the costs are acceptable, \$15 million dollars per aircraft is still a lot of money for an aircraft that has not proved itself in the CAS role(17:30).

Option # 5: The AV-8B

The AV-8B is a unique aircraft, unlike anything operated by the U. S. Air Force. It is currently being

procured for the Marine Corps as an improved version of their AV-8A(24:66). The AV-8B is a single-engine, attack aircraft which is capable of vertical or short distance take-offs and landings(VTOL/STOL). It is equipped with a 25mm cannon and capable of carrying approximately 9,000 pounds of mixed ordnance to include: free-fall bombs; air-to-air and air-to-ground missiles; cluster bombs; rockets; gun pods; or laser guided munitions. It can accommodate radar warning receivers, electronic countermeasures equipment, and infrared sensors. Its vectored thrust engine makes the AV-8B extremely maneuverable. Although it is capable of vertical take-off and landings and hovering flight, vertical take-offs are not possible with combat loads. A short take-off roll would be required(20:75)(30:124-126).

Required improvements for an Air Force night attack version would include: a forward looking infrared system to improve night vision capability; new compatible radios to allow communication with ground controllers; and a halon gas fire fighting system to improve CAS survivability(17:30).

Advantages.

The AV-8B was built for the Marines as a CAS aircraft. It fits the particular needs of the Marine Corps perfectly(20:75). It is extremely responsive to the CAS role because it will operate from close proximity to the ground troops it will support. Fixed bases are not critical for it because it does not need long concrete runways for take-offs

and landings(14:21). This would be a big advantage since concern for fixed base survivability is very real(6:79). In some cases, it will only need a small clearing from which to operate, although full combat loads will require short runways (1200 feet)(30:124-126). The aircraft is extremely maneuverable, which will increase its survivability tremendously. The required improvements will give the aircraft an adequate night and bad weather capability.

Disadvantages.

The uniqueness of the aircraft is its biggest disadvantage. Its mode of operation would be so different from standard Air Force operations that it would be extremely expensive just setting up AV-8B logistics support. Transportation and replenishment requirements to forward operating locations would be extremely expensive. The time required to establish such an infrastructure would also be prohibitive(14:21). Compared to the A-16, the AV-8B is much slower, which hampers survivability and force packaging. Plus, its combat range and endurance are much less than that of the A-10 (of course since it is designed to operate in close proximity to the ground troops it supports, this may not be a serious disadvantage, except for deep attacks) (30:124). Airframe costs for the aircraft exceed those for the A-16 by \$3 million per aircraft (\$18m vs. \$15m)(17:30). Establishing new training requirements for such a radically

different aircraft would also be very expensive. In short, this would be a very expensive option to choose from almost every standpoint.

Other Options

There are certainly other options that have been mentioned by assorted "experts" as possible candidates for the new generation CAS aircraft; the Navy's F/A-18 strike fighter; the Navy's A-6E medium attack aircraft; the European "Tornado" deep strike aircraft; or the Navy's developing tilt-rotor aircraft, the V-22 "Osprey" have all been mentioned(24:66)(4:33). After analyzing each of these, I did not consider any of them realistic or affordable choices. They were all too expensive and too time consuming to develop. None of the serious Department of Defense or Air Force studies have deemed it feasible to pursue any of these options for the CAS aircraft for the 1990's. They may be considered further for 21st century requirements.

A great deal of information has been assembled. It is now time to analyze and consider appropriate conclusions. Which of the choices is/are best?

CHAPTER VI

CONCLUSIONS/RECOMMENDATIONS

From my examination and analysis of the preceding factors, several conclusions have become rather self-evident, while others have become more difficult to deduce. I will begin by discussing the more obvious conclusions.

The Future of CAS

Even though there are numerous issues that sometimes cloud the final resolution, it is obvious that CAS is a mission that is still required today, and will be well into the foreseeable future(12:72). Even though the modern battlefield has become more dangerous, what began as a gentleman's agreement between General Eisenhower and General Spaatz will continue through the dedicated efforts of the Tactical Air Force.

In Europe, our enemy has amassed a force that far outnumbered the allied forces of NATO. His concentrated air defenses are extremely lethal to all who would dare challenge them. The survivability of CAS assets will be seriously in doubt. Even so, at present there are no other options available to provide the support required by the Army. Therefore, regardless of the risk, CAS aircraft must continue to fulfill this requirement.

Further, even though the Congress has requested a study to determine the feasibility of transferring the CAS

mission from the Air Force to the Army(17:30), this option is not realistic. Besides the enormous administrative, training, and logistics costs involved, neither the Army nor the Air Force is interested in such a drastic change. Both services benefit from the teamwork developed between them and are pleased with their current relationship(19:96). Therefore, I see virtually no chance that this study will change anything. The Air Force will continue to provide CAS for the Army in the same professional way it always has.

Is A New CAS Aircraft Required?

As previously explained, the Army estimates the nature of the battlefield environment in which it expects to fight. It then formulates a doctrine on which to base its strategy for fighting its next war. After doing all this, the Army informs the Air Force of the damage it must impose on the enemy. The Air Force then determines the equipment and tactics it will use to accomplish these results. The Army and Air Force both agree on the Army's assessment of the future battlefield. They also both agree that the requirement for CAS is still extremely valid(19:96). The agreed upon environment for the new battlefield of the 1990's is very different from the old battlefield of the 1970's. Therefore, it is clear that either a new aircraft must be developed, with characteristics to cope with the new battlefield, or existing aircraft must be modified to do so. Either way, the improved nature of the enemy's defenses,

plus the increased requirements of the Army's doctrine, demands better performing CAS aircraft, just to survive.

However, what is also clear is that the European battlefield of today is just that, a European battlefield. This same battlefield will not be found world-wide. Therefore, since the Air Force has world-wide commitments, it must also be prepared to fight equally well on the other battlefields of the world. This tells me that we do need a new CAS aircraft to meet the challenges of the European battlefield. But, we must also have an aircraft that is prepared to fight on other battlefields around the world.

The remainder of this chapter involves conclusions which are not so defined and assured.

An Assessment of the Criteria

The criteria found in Chapter IV of this report are all quite valid. If an aircraft could be developed with 100% effectiveness in each of the criterion listed, it would indeed be an outstanding CAS asset. Unfortunately, this is not possible. Even if the Air Force had unlimited funds, the perfect CAS aircraft would take much too long to develop. Even then, it is extremely doubtful that 100% of every good attribute could be included in the design without some degradation of capabilities taking place somewhere. At any rate, the Air Force does not have unlimited funds. The limited funds that are available, for the development of a CAS aircraft, must be closely watched and wisely spent.

Therefore, rather than buying the perfect CAS aircraft, the Air Force must use its limited money to buy an aircraft that is as perfect as it can afford.

As I have already stated, cost becomes the all important criterion. The difficult part becomes compromising on the other criteria. The Air Force must prioritize the others and acquire as much of each as is possible. After cost and timeliness, I believe responsiveness, survivability and lethality must be at the top of the priority list. The Air Force places a great deal of importance on flexibility. This translates into the capability to do both CAS and BAI. It also means more sophisticated and complex systems, instead of simple and easy to maintain systems. I think that the Air Force is right to require this flexibility in some of the CAS fleet, but I do not think all of our CAS assets need this capability. World-wide it certainly is not needed, and I do not believe the European battlefield will always remain as impregnable as it undoubtedly will be on day one of the war. As the European war wears on, enemy assets will be attrited as well as friendly assets. Thus, probably making the need for sophisticated capabilities less important as the war continues. Therefore, I think a mixture of aircraft, some with simple systems and others with more complex systems, is the correct philosophy to adapt.

The Choices

The Air Force has carefully studied the options available. Initially, they reportedly favored replacing the A-10 with a mixture of modified A-7's and A-16's(11:39) (24:68). However, after receiving a Congressional mandate to conduct further tests, including a fly-off, this initial position may be changing(31:28)(16:97). The following is my assessment of the options.

New Aircraft.

This is not a realistic option. No doubt the best aircraft would come by designing it from the ground up. But this option is just too expensive and would take too long to develop. This could be a possibility for the CAS aircraft for the year 2000 and beyond.

The AV-8B.

This aircraft has intriguing possibilities. Its maneuverability and capability to operate out of unprepared areas, close to the battle zone are extremely desirable. Plus, its lack of dependence on air bases for operations is very appealing. However, this option is also much too expensive to take seriously. Airframe costs alone are more expensive than costs for the modified F-16. But, the real expense would come with trying to incorporate new training concepts and forward area logistics support(11:41). This

option is just too expensive to pursue seriously. However, vertical take-off and landing aircraft seem to be worth serious consideration for the next generation CAS aircraft.

The A-7.

This option seems to be very appealing. It is relatively inexpensive compared to the cost of a new aircraft or the AV-8B. It is a proven, though highly modified airframe and availability appears to be no problem. However, the airframe design is much older than the A-10. If the A-10 were replaced by the A-7, the Air Force would have to absorb the hidden costs of retiring the A-10 well before its designed life had expired. The modified A-7 would be improved in several ways; however, the new engine would also increase its vulnerable areas, thus making it less survivable. The money spent on A-7's would of course not be available to spend on a more long-term solution. The modified A-7 seems like a quick fix for the short-term, but little, if any, help for the long-term. Therefore, this option also seems to be unrealistic and a waste of money that could be better spent on other alternatives.

The A-16.

The A-16 is not the ideal CAS aircraft. In many ways it is too "soft" to be the ideal choice in this competition. I believe A-16 survivability is a problem, and I also believe that it is too fast to allow target identification and acquisition on the first pass. Even so, the A-16 appears to

be the best choice to fulfill this mission. If the planned modifications work as promised, its sophisticated equipment should improve these questionable areas tremendously. It is a state-of-the-art aircraft which is still in production. This means that the A-16 is not only a short-term solution, but a long-term solution as well. The A-16 should definitely be one of the options chosen.

The Modified A-10.

The modified A-10 should be the other half of the solution. As a proven two-engine, CAS aircraft with plenty of design life left, it would be available, in modified form, in a short period of time for an acceptable price. Modifications would greatly improve its all-weather and night time capability. However, survivability would continue to be a concern. Even with new engines, the A-10 would not be as fast as the A-16. It therefore would not be a suitable aircraft for deep interdiction missions on the European battlefield. It would have to continue to depend on its agility and durability to survive. The A-10 is probably the most responsive aircraft in the Air Force. Its simplicity and ability to fly over and over again would help to overcome concerns for its survivability(1:90-91). In addition, these attributes would continue to make the A-10 a valuable asset outside the European theater as well.

Recommendations

Based on the above conclusions and in addition to my preceding assessments, I am making the following recommendations:

- 1) The required tests involving the A-10, A-7, A-16 and AV-8B should proceed as planned. The "fly-off" among these candidates should definitely take place. The results of these tests should be used as the determining factors in the aircraft selection.
- 2) The report to Congress regarding the transfer of the CAS mission to the Army should be submitted in the negative. The CAS role should be maintained as an Air Force mission.

Finally, the decisions to be made concerning a new CAS aircraft are difficult decisions. There are no easy solutions. I believe the A-10, as currently configured, does need to be replaced. We need a different CAS aircraft to meet the challenges of the 1990's. I believe the Air Force should continue its close teamwork with the Army by continuing to fly the close air support mission. And, I also believe that the modified A-10 and the A-16 are the correct aircraft mix that will serve us well as we fulfill our CAS commitments to the Army. These decisions must be made on the basis of factual evidence and fair competition. They are just too important to do otherwise.

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GLOSSARY

AGM-65 "Maverick"	An air-to-ground missile
BAI	Battlefield Air Interdiction
CAS	Close Air Support
Cluster Bomb	A casing filled with smaller bomblets
ECM	Electronic Countermeasures
Fixed-Wing	Any aircraft equipped with a wing
Fly-Off	A competition in which the choices are judged by actual flying
Force Multiplier	An attribute that causes value to be multiplied because of its presence
Force Package	A group of aircraft with different roles combining as a team to accomplish a mission
Free-Fall Munition	A weapon with no locomotive capability of its own, once dropped it falls to the Earth
GAU-8 Gatling Gun	A 30mm cannon
Hardened	Protected in some way
Infrared System	Equipment that detects or "see's" heat sources
Laser Seeker	Equipment used to locate targets that have been highlighted by laser beams
Look-Down/Shoot-Down	The capability to detect a low flying target on radar and launch an air-to-air missile to destroy it

MOA	Memorandum of Understanding
Multi-Role	Capable of accomplishing more than one type of mission
NATO	North Atlantic Treaty Organization
Rotary-Wing	A helicopter
Stand-Off Munition	A weapon that can be launched a long distance away from its ground target
Stealth	A name which refers to Low Observables technology
STOL	Short (Distance) Take-Off or Landing
TAC	Tactical Air Command
TAF	Tactical Air Forces
Terrain Following Radar	A system which maintains aircraft altitude at a constant height by use of radar
USAF	United States Air Force
VTOL	Vertical Take-Off and Landing