CONSIDERATIONS FOR THE MANEUVER COMMANDER: COULD THE EMERGENCE OF UNMANNED AERIAL VEHICLES SPELL THE DEMISE OF THE ARMY'S RAH-66 COMANCHE IN THE ARMED RECONNAISSANCE ROLE?

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ABSTRACT

CONSIDERATIONS FOR THE MANEUVER COMMANDER: COULD THE EMERGENCE OF UNMANNED AERIAL VEHICLES SPELL THE DEMISE OF THE ARMY'S RAH-66 COMANCHE IN THE ARMED RECONNAISSANCE ROLE? by Maj David W. Barnes, 101 pages.

The U.S. Army finds itself at a crossroad in the development and fielding of both unmanned aerial vehicles (UAVs) and the RAH-66 Comanche helicopter to fulfill the armed reconnaissance role for its future Objective Force (OF). Ever-increasing UAV capabilities, especially the ability to arm these platforms with Hellfire missiles, is forcing a blending of roles that were once solely the domain of manned platforms. This paper attempts to answer the thesis question posed above by using the OF characteristics of survivability, lethality, and responsiveness and comparing the effectiveness and efficiency of the Army's Class IV UAV systems (Hunter TUAV, Shadow 200, the Extended Range Multi-Purpose (ERMP), the Hummingbird 160 UCAR, and the Air Force's Predator A and B) against similar capabilities found in the Comanche. The analysis also highlights what the maneuver commander should consider in employing these future combat systems. The author concludes, based on the above criteria, that future UAV capabilities (up to the 2009 year timeframe) should not preclude the need for the Army to field the Comanche.

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ACRONYMS

AoA	Analysis of Alternatives
ATDC	Aided Target Detection Classification
COE	Contemporary Operating Environment
DoD	Department of Defense
ERMP	Extended Range Multi Purpose
FCS	Future Combat System
FM	Field Manuals
GCS	Ground Control Station
ISR	Intelligence, Surveillance, and Reconnaissance
MUM	Manned-Unmanned
NRT	Near-Real Time
OF	Objective Force
OPFOR	Opposing Force
PEO	Program Executive Officer or Office
RSTA	Reconnaissance, Surveillance, and Target Acquisition
TOC	Tactical Operations Center
TRADOC	Training and Doctrine Center
TTPS	Tactics, Training, and Procedures
TUAV	Tactical Unmanned Aerial Vehicle
UA	Unit of Action
UAV	Unmanned Aerial Vehicle

UCAV	Unmanned Combat Aerial Vehicle
UCAR	Unmanned Combat Aerial Rotorcraft
UE	Unit of Employment

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CHAPTER 1

INTRODUCTION

Establishing the Objective Force

It is approaching four years since Chief of Staff, Army, General Eric Shinseki, unveiled a new strategic vision for the U.S. Army. Critics decried how the U.S. Army was still postured for a Cold War conflict in Europe and that the divisions were too "heavy" to effectively and rapidly deploy to meet various world crises (U.S. Army War College 2001, 1-2). In light of the horrific terror attacks on the World Trade Center Towers on 11 September 2001, Army transformation has been "kicked into high gear." In February 2002, Secretary of the Army, Thomas E. White mentioned the impact of the 11 September attacks on Army transformation. "If transformation was an imperative before 9/11, it is now absolutely essential and fundamental" (Kozaryn 2002, 2). The U.S. Army is committed to turning its strategic vision of "transformation" into reality.

The Army's thirty-year transformation plan runs along three parallel paths: The first path is the legacy force, which consists of current Army systems and the present day force structure. The second path, the interim force, will serve to bridge the legacy force with the third path, the objective force (OF). The intent of the interim force, according to Secretary White, is to close the "capabilities gap" between today's heavy forces and the lighter forces of the future (Kozaryn 2002, 2). *How the Army Runs*, describes the premise of the OF.

> The objective force is not driven by a single platform, but rather the focus is on achieving capabilities that will operate as a "system of systems." Transformation to the Objective Force will take thirty years with the key being the development of enabling technology to meet the seven desired characteristics--Responsiveness,

> Agile, Deployable, Versatile, Lethal, Survivable, and Sustainable. (U.S. Army War College 2001, 1-4)

The Comanche and the UAV Bridging the Gap

To bridge the gap between the interim force and the objective force, Army aviation is looking to the RAH-66 Comanche as the next generation armed reconnaissance helicopter. The Comanche has been billed as Army Aviation's "cornerstone" platform of the OF. This state of the art helicopter will replace the AH-1 Series Cobra, light attack helicopter; the OH-6A Cayuse; and the OH-58A/OH58D Kiowa light observation helicopter (Wiggins 2001, 3). In concert with fielding the Comanche, Army aviation is also aggressively pursuing the varied capabilities provided by UAVs and Tactical Unmanned Aerial Vehicles (TUAVs). These UAVs and TUAVs will not only be made available to the Interim Brigade Combat Team but will also populate the Army's varied echelons from corps to platoon levels.

Posing the Thesis Question

Since the Army is undertaking these two converging paths in fielding armed reconnaissance systems in the near term (2002 through 2009), there exists a distinct possibility that both may not be required. Herein lies the problem, with the exponential growth of UAV technology, the perceived low cost of these systems, and the UAV's capability to detect, assess, and engage the threat, will the emergence of UAVs spell the demise of the Army's RAH-66 Comanche helicopter in the armed reconnaissance role? Benefits of both systems will include their capability to provide the maneuver commander "a dominant eye on the battlefield" and to serve as combat enablers and multipliers. Additionally, both of these systems will populate the Army's OF structure and dictate the scheme of maneuver and the employment of firepower at the operational and tactical levels of war.

The characteristics presented in the Army's OF provide an excellent starting point for comparing the Comanche and the UAV. These include responsiveness, agility, deployability, versatility, lethality, survivability, and sustainability. The author has selected three of the seven tenets that best lend themselves to comparison in the armed reconnaissance role of the UAV and Comanche. This thesis will focus on the following three OF characteristics: survivability, lethality, and responsiveness. These three areas will provide the reader a comprehensive backdrop of the varied capabilities of the two systems and will serve to point out each of the system's inherent strengths and weaknesses. To guide measures of effectiveness and efficiency of both systems, this thesis will highlight employment considerations for the maneuver commander.

The Collision Course

Although the Comanche and the UAV may appear to be on a "collision course" when considering their analogous capabilities, it is important to briefly introduce a few of the struggles the Comanche has faced as it has progressed through the acquisition process. The importance of highlighting this information is not to paint the Comanche in a negative light, but rather to show how developing UAV technologies have reached the point where one questions whether a UAV should be used in lieu of the Comanche.

According to the *Armed Forces Journal*, "Comanche's essential place in the Objective Force vision was acknowledged by the Army last April when it unveiled its latest Aviation Modernization Plan. The plan reaffirmed the Service's earlier intention to buy more than 1,200 of the helicopters" (Goodman 2001, 1). What the article does not mention however is that Comanche production “has gone from an original mid-1980s goal of 5,000 to 7,000 to 1,292, to be produced at a rate of 72 per year . . . beginning in 2006” (Wilson 1999, 42). The latest word concerning the Comanche’s force restructure (23 October 2002) shows the Defense Acquisition Board slashing the procurement to 650 helicopters with the maximum annual procurement dropping to 60 (Trimble 2002, 1).

The point to emphasize is that even though the Comanche will reach the Army’s OF it has fought a difficult acquisition and development period to reach even the initial rate production phase. The ever-decreasing production numbers certainly point to problems with the program and may serve as a harbinger of competing technologies found in UAV systems. The Army’s difficulties in producing this world-class helicopter may point to future improvements in the materiel development process of manned systems or may serve as the future catalyst for shifting development to UAVs.

Coupled with the continued cuts in numbers, the Comanche’s next hurdle may lie in competing technology. The situation is somewhat analogous to purchasing a new computer. By the time one brings it home there is a newer, improved version on the shelf. This phenomenon is known as Moore’s Law--“processing power continues to double every eighteen months” (Hewish 2002, 49). “The RAH-66 Comanche was initiated as the Light Helicopter Family (LHX) in 1982 when an Army Aviation Mission Area Analysis (AAMA) identified the need for an armed reconnaissance aircraft” (Galindo 2000, 1). The first Comanche prototype was flown in 1996 and will be operationally fielded in September 2009. From this timeline, the Comanche will have taken over twenty-five years from initial inception to operational fielding. Clearly technological advances in the

UAV arena may have rendered the Comanche obsolete in its role as an armed reconnaissance platform.

While the Comanche seems to struggle on its path to operational fielding, UAVs have enjoyed a much greater success. Military forces worldwide realize the potential and versatility of these platforms and are building UAV fleets comparable to the U.S.. UAVs continue to prove their worth, not only as reconnaissance and intelligence gathering platforms, but as offensive weapons systems as well. Interim plans highlight the Army's pursuit in arming the Hunter TUAV while it conducts testing and fielding of an Extended Range Multi-Purpose (ERMP) UAV that will likely possess an offensive capability.

Assumptions

This thesis attempts to capture the most recent information concerning the different UAVs to be fielded by the U.S. Army (and applicable Air Force UAVs) by 2009 and the latest developments for procuring "sufficient" numbers of the Comanche. The feasibility and applicability of this thesis is based on the following assumptions. First, that Congress will continue to approve funding for UAV development. Second, the Comanche will continue to be adequately funded and fielded. Lastly, the Army continues to promote "transformation" with the OF as its ultimate goal.

Definitions

This thesis will use the UAV abbreviation as the "catch-all" acronym to denote the Army's Class IV type UAVs and the Air Force's Predator UAV. Specifically, this "UAV" definition will include the RQ-5 Hunter, the RQ-7 Shadow 200, the Hummingbird 160 unmanned combat aerial rotorcraft (UCAR), the ERMP UAV and the RQ-1 Predator A and B systems.

A basic understanding of the definition of armed reconnaissance will also play a key part of the foundation for the analysis. Joint Pub 1-02, *Department of Defense Dictionary of Military and Associated Terms,* (April 2001) defines armed reconnaissance as "a mission with the primary purpose of locating and attacking targets of opportunity, i.e., enemy material, personnel, and facilities, in assigned general areas or along assigned ground communications routes, and not for the purpose of attacking specific briefed targets." Coupling this definition with three of the seven desired characteristics espoused by the Army's OF, survivability, lethality, and responsiveness will provide the rest of the foundation for this thesis. The appeal of using these OF characteristics is that they appear to run like a common thread through the most recently published Army Field Manuals (FMs) and will provide an excellent platform in which to compare the UAV and the Comanche in the armed reconnaissance role.

Since FM 101-5-1, *Operational Terms and Graphics* does not provide a definition for effectiveness or efficiency, these terms will be defined from *Webster's Scholastic Dictionary*. Effectiveness is defined as producing the desired effect; to produce; to cause; to fulfill; or execute. Efficiency is defined as the state or character of being effecting or capable. Definitions of effectiveness and efficiency will be used in comparing the Comanche and the UAV.

The last definition that warrants discussion is the Common Operational Environment (COE). According to JP 1-02 the Operational Environment (OE) is "a composite of the conditions, circumstances, and influences that affect the employment of military forces and bear on the decisions of the unit commander." The COE is defined as "The OE that exists in the world today and is expected to exist until a peer competitor arises" (Opposing Force Doctrine CD 2002). While these definitions are often used interchangeably, the COE definition appears to better encapsulate the environment and the threats that will be facing the Army's interim and objective forces. *FM 7-100, OPFOR, Opposing Force Doctrinal Framework and Strategy,* (29 August 2001) provides the details on why the Army has shifted from the previously established bi-polar threat model to the newer OE. In the broadest sense, the future enemy will employ asymmetric warfare using his advantages against the U.S. forces' weaknesses. The enemy will seek to exploit the parameters of time and space, setting the tempo, and initiating hostile actions at the time and place of his choosing.

Limitations

This thesis will be constrained by a number of different factors. First, the information collected for this thesis was unclassified. Second, although comparative costs are mentioned; cost characteristics are not assessed. Third, this thesis will only compare the Army and Air Force's current and envisioned UAV programs up to 2009. Fourth, in order to provide the best comparative analysis, this thesis will not focus on the future capabilities of the Unmanned Combat Aerial Vehicles (UCAVs). The Army is favoring both a fixed wing and rotary wing variant and the Air Force has already flown the X-45A UCAV prototype. Fifth, this paper will focus solely on U.S. manufactured UAVs that are currently in use or scheduled for fielding.

The final limitation is very important because the Army is pursuing the Manned-Unmanned (MUM) teaming concept in concert with its UAV development. The Army plans on taking the best of both systems by employing its UAVs synergistically with the Comanche. The problem is that this MUM linkage may dilute the comparison between the two systems. This paper will introduce and incorporate the MUM concept in the analysis but will attempt to focus this capability on what it can bring to the maneuver commander. The thesis will attempt to remain “pure” in comparing the Comanche and the UAV as individual systems as opposed to combining the capabilities of both.

It is hoped that by keeping one primary objective in mind the reader will develop insight into the premise and relevance of this thesis: Why does the Army need to “push” for fielding a manned armed reconnaissance helicopter when UAVs can provide similar armed reconnaissance capabilities in an analogous time frame? Chapter 2 will provide a summary of the research and development of the Comanche and the Army’s UAV programs. This chapter will help set the stage for the methodology and the follow-on analysis chapters of this thesis.

CHAPTER 2

LITERATURE REVIEW

Debating the Manned-Unmanned Systems Dynamic

Both the U.S. Army and the U.S. Air Force are beginning to realize the full potential of the UAV and the incredible capabilities that it can provide the maneuver commander. Both components are working diligently to field these systems and are adjusting their future force structures accordingly. Ever-increasing UAV capabilities, especially the ability to arm these platforms, is forcing a blending of roles that were once the sole domain of manned platforms. The rapid growth of UAV technology will send ripple effects throughout the entire Department of Defense for the next twenty years. It appears ironic that at the turn of the twentieth century the world was heralding the possibility and capabilities of manned flight while the turn of the twenty-first century the focus has shifted to unmanned flight. This chapter will highlight current information concerning the development of the Comanche and the Army's UAV systems and attempt to piece together some of the on-going research and thoughts on employing these platforms.

Seeking Relevance

The author's primary reason for constructing this paper is to shed light on whether the Army and Air Force's existing and developing Class IV UAV armed reconnaissance systems could replace those proposed by the Comanche. The primary thesis question evolved partly from the following lines of reasoning: First, the explosive growth of UAV technology and the capabilities that an unmanned system brings to the battlefield adds an entirely new dimension to systems employment. Second, what factors will the maneuver commander consider most important--speed of processing data, loiter time over target, or simply the ability to get to the target area, are all critical elements that must be considered. At issue is whether a manned helicopter or a UAV can best perform these roles. The last issue centers on accountability. Since the Army Aviation Program Executive Office (PEO) is charged with fielding both the Comanche and the Army's UAV systems, it would appear that "outside" objectivity could be lacking. In aviation parlance, the author is "checking six" to determine if the current parallel progression of these systems is on a common-sense flight path.

A Chronological Viewpoint

While the above issues may have set the scene for the reader and established the reasoning for accomplishing such a study, the literature review may best be accomplished by taking a chronological view of the need and the development of both the Comanche and the Army's UAV programs. This review will highlight a few of the primary and secondary resources used in compiling this thesis. The premise of this review is to highlight how these systems have developed, to build on the differences and similarities between the two systems, and to discover the general underlying patterns of research and debate on manned and unmanned systems.

RAH-66 Comanche

There is a great amount of primary and secondary data concerning the need and development of the Comanche. The Federation of American Scientist provides a website that includes the Comanche's Operational Requirements Document (ORD) that details the need and roles of the RAH-66. Much of the documented test and development revolves around written articles in the aerospace and acquisitions development arena.

This paper will tap heavily into those resources. Since the Comanche has struggled through the Department of Defense (DoD) acquisition process, the U.S. Congress has placed special emphasis on the development of this project. Therefore, congressional reports and analyses provide insight into the political-military interface, as well as highlighting impacts to the cost and fielding of this helicopter. Information from these reports will also be incorporated in this thesis. A brief historical snapshot concerning the evolution of the RAH-66 will provide the reader with the latest efforts in the development and fielding of the Comanche.

Evolution of the Comanche

The Comanche's genesis was initiated in 1982 when an Army Aviation Mission Area Analysis (AAMAA) identified the need for an armed reconnaissance aircraft (Galindo 2000, 1). According to a *FDCH Government Account Reports* from June 2001 the Comanche was designed as a ". . . high technology, low-cost aircraft that would replace the Army's light helicopter fleet, which includes the AH-1 Cobra, OH-58 Kiowa, OH-6 Cayuse, and the UH-1 Iroquois (Huey)" (Wiggins 2001, 3). From its initial inception the Army had planned for the Comanche to replace existing armed and reconnaissance airframes. The age of these older helicopters precluded recapitalization as a viable alternative so a new materiel acquisition solution was sought. By the mid-1980s, the Army's goal was 5,000 to 7,000 of these airframes (Wilson 1999, 43). Ten years elapsed while the helicopter worked its way through the acquisition process marked by a red-letter date, 4 January 1996, when the first Comanche prototype took flight.

Struggling Through the Acquisition Process

James Wiggins' detailed article, *Comanche Program Objectives Need to be Revised to More Achievable Levels*, *FDCH Government Account Reports*, 7 June 2001, highlights the struggles the Comanche has had to overcome. "Since its inception, the Army has restructured the Comanche program five times, significantly delay(ing) the development schedule, and reduced planned quantities" (2001, 2). Additionally in April of 2000 the estimated cost of the Comanche program increased from $43.3 billion to $48.1 billion (2001, 2). When the dust finally clears from all the acquisition battles, the first Comanche battalion will be ready in 2008 with "the first aircraft due at Ft. Rucker, Alabama by May 2006 [and] training operational crews . . . in June 2006" (Wall 2001, 105).

Wiggins' article is just one of many that point to the associated cost overruns and continued timeline adjustments associated with the Comanche's development. These cost overruns and sliding timeline adjustments have caught the interest of Congress and materiel developers. Critics decry that this "never ending loop" of the Comanche's development cycle requires closure. The proven value of UAVs in the armed reconnaissance role now shifts the focus on whether the Comanche may even be required. This thesis will mention and site references associated with the costs of these systems but will not conduct a cost analysis.

The Comanche and the Objective Force

Glenn Goodman's article, "Vertical Transformation: Helicopters Will Play Essential Role in U.S. Army's Future Objective Force," *Armed Force Journal International*, April 2001, mentions how the U.S. Army acknowledged the Comanche's essential place in the Objective Force. According to former Chief of Staff General Gordon R. Sullivan, the Comanche “is the only existing system of the Objective Force” (2001, 1). This same article reaffirmed the Service’s earlier intention to buy more than 1,200 of the helicopters. The Comanche will also double as a potent attack helicopter, with production slated for 2004. The first Comanche unit will be equipped by December 2006. As recently as 22 October 2002, Stephen Trimble, in an *Aerospace Daily* article states that the “Defense Acquisition Board (DAB) members slashed the Comanche procurement by nearly half, from 1,213 helicopters to 650, and reduced the maximum procurement rate from 95 to 60. The DAB approved the Army’s sixth major restructuring of the Comanche program since it began in the early 1990s, keeping the troubled program alive” (2002, 1).

This brief timeline shows that even though the Comanche has never flown in combat, it has already survived many battles with Congress. Of interest is the steady decline in total numbers of helicopters required. The factors driving this decline could be the result of the Comanche failing to meet certain milestone objectives but more importantly, it could be the result of the Army starting to realize the viability of future UAV systems.

For the Comanche program to last as long as it has, certain elements of the development process could be considered praiseworthy. Jimmy Downs’ article, *What Right Looks Like*, *Program Manager*, accentuates the positive aspects of the Comanche program. “[This was the] first Army program to use Analysis of Alternatives [AoA] Methodology (combines cost, effectiveness, programmatics, risk, and item level analysis) and TRADOC provided interagency lead as a focal point” (2000, 64). The importance of this AoA methodology is that it shows material developers are considering the dual capabilities of Comanche and UAVs. However, during this phase of the Comanche's development, this particular AoA focused on a teaming concept of the Comanche coupled with the use of UAVs. The premise of this thesis is to compare the armed reconnaissance capabilities between the two systems as opposed to analyzing the synergistic effects of both linked together.

It is difficult to determine why the Comanche has taken so long to field from its initial inception in the early 1980s. A *CRS Report for Congress* sums up the debate over mission and capabilities and shows the context and depth of analysis that exists on the Comanche as a future weapons system.

> Critics of the Comanche program argue that there is no need for a highly sophisticated, very low observable armed reconnaissance helicopter in today's threat environment. They contend that Comanche's capabilities and mission requirements were developed in response to a Cold War threat environment that no longer exists. Furthermore, the Apache and Kiowa helicopters performed very well as a hunter-killer term during Operation Desert Storm (1991). Critics also argue that the Comanche's role and capability is too similar to the Apache's to justify the costs of the helicopter's development and production.
>
> Proponents of the RAH-66 agree that the Cold War threat has disappeared, but counter that today's low-intensity regional conflicts (such as Kosovo and Somalia) place even greater burden on Army aviation. . . . Furthermore, proponents argue that Comanche is an unparalleled force multiplier. It makes the whole force more effective and will reduce the Army's maintenance burden. (Bolkcom 2000, 3)

Army Aviation is well aware of the challenges and the hurdles that the Comanche has had to overcome. Part of their overall strategy may be found in the versatility and the dynamics offered by current and future UAV systems. The premise of linking manned and unmanned systems may hold the key to the Comanche's survival and unlock the door to how Army Aviation will employ its Class IV UAVs in future fights.

Manned-Unmanned (MUM) Teaming Concept

The Army has been engaged in MUM development over the last five years. The premise of MUM is to "determine the operational value and synergism gained from teaming manned and unmanned aerial platforms and to understand how these teamed platforms could best support Objective Force operations" (Bergantz 2002, 5). The Comanche PEO is currently linking the Comanche with UAVs to further develop the MUM platform linkage. Major General Joseph Bergantz, Program Executive Office for Army Aviation, has written an illuminating article in *Aircraft Survivability*, Fall 2002, on the studies and experimentation concerning MUM. Appendix A, Table 1, *Manned Unmanned (MUM) Experimentation*, provides a synopsis of the four levels of experimentation and highlights the differing levels of the manned aircrew's interface with the UAV.

The MUM Experimentation table in Appendix A shows how the synergistic effects of the Comanche and the UAV will shape the future battlefield. The Army's approach of employing a $3 million UAV (Predator A) airframe to accomplish the "dangerous" work of identifying the enemy while the $37 million dollar Comanche acts as the killer, in this hunter-killer type arrangement makes good sense. Two other key aspects brought out in table 1 may provide additional focus for future DoD UAV or UCAR development. These include the number of UAVs controlled before reaching pilot task saturation and the impact of Vertical Take-off and Landing (VTOL) type UAVs versus fixed wing UAVs on overall mission effectiveness. The Army's approach in coupling these weapon systems will additionally pave the wave for its sister components.

One can easily envision the Navy or the Air Force coupling the manned Joint Strike Fighter with a number of UCAV wingmen.

Enter the UAVs

While historical documentation clearly highlights the varied problems associated with fielding the Comanche, UAVs have been enjoying much more favorable press. In particular, the Predator UAV has been praised as an offensive platform during the on going Global War on Terror. Hellfire missiles mounted on the Predator have spelled the demise of terrorist cells in Afghanistan and Yemen. It appears that not only the U.S. military, but also militaries from across the world are enamored with the prospect of what the UAV can provide. Historical publications show that UAVs have been around since the early 1970s, although they were referred to as unmanned drones at that time. The UAV derives its roots from its role as an intelligence, surveillance, and reconnaissance (ISR) gathering platform.

Similar to the Comanche, there is a vast amount of information concerning the need and development of future UAVs. A brief timeline concerning the evolution of the U.S. military's UAV development may put things in perspective and give the reader a better feel for the reference material used in the analysis of these two systems.

Evolution of the UAV

The earliest reference the author could find concerning unmanned U.S. systems was 28 July 1971. "The U.S. government announced July 28 a suspension of American intelligence-gathering missions over Communist China by manned SR-71 reconnaissance planes and unmanned drones" (*World News Archive* 1971, 1). Nearly twenty years later, UAVs started to make their presence known on the battlefield. During Operations Desert

Shield and Desert Storm the U.S. Army, Navy, and Marines utilized six operational units of the RQ-2 Pioneer to fly over 300 combat missions (*Periscope* 2000, 1). Additionally the U.S. Army's Shadow 600 flew over 700 hours (*Periscope* 2000, 1). September of 1990 saw the first flight of JIMPACS (later the Hunter UAV). According to a Goodman article, in 1996 the Army canceled the Hunter program but decided to retain forty-two air vehicles (2002, 56). In 1998, the Army's Aviation Applied Technology Directorate pursued teaming UAV with the Apache under the Manned and Unmanned System Technology (Goodman 2002, 57) and in December 1999 the Army selected the Shadow 200, built by AAI Corporation of Hunt Valley, Maryland as its TUAV. As previously mentioned, the Shadow 200 went into full rate production in September 2002 and is fielded with the III Corps' 4 ID at Fort Hood, Texas.

From 1999 to 2000, the UAV began emerging as the platform of choice for signal intelligence and the Army began testing mini UAVs and Organic UAVs. During the Kosovo conflict the Hunter system again saw wide use as well as the Air Force's Predator. In addition to fixed wing models such as the Hunter and Shadow, the Army in January 2002 unveiled the A160 Hummingbird VTOL UAV. The A160 prototype made its first flight the same month. Army leadership mentions that they may want to take over management of the program by the end of 2003 (Goodman 2002, 57).

The DoD has begun to realize the UAV's impact amongst the service components and has produced the *UAV Roadmap 2000*, a joint reference that outlines DoD's plan for the UAV from 2005 to 2025. While this is a start, many joint issues concerning UAVs remain. The main issues revolve around the different approaches the services will take in fielding their particular unmanned systems, the interoperability of such systems, and

DoD’s role as an “honest broker” in ensuring the combatant commanders obtain the ISR requirements they need. Other service components can use the Army’s case of competing technologies between the Comanche and the UAV as precedence for future systems development and integration. With the added emphasis on incorporating science and technological solutions into future combat systems (FCS), the blending of manned and unmanned roles will surely surface again. The last aspect concerning UAVs, which is closely associated with echelonment, is the Army’s tiered approach to employing its various UAV systems. Understanding the Army’s tiered approach to its UAV employment will aid the reader during the future analysis section found in chapter 4.

Army’s Tiered Approach to UAV

The Army is aggressively pursuing UAV capabilities throughout its entire force structure. While the term UAV has been used throughout this thesis in a broad sense, it is important to realize that as a whole, UAVs consist of varied platforms with differing roles and capabilities. The following Responsive UAV Support Diagram, figure 1, succinctly encapsulates the Army’s tiered approach for its UAV development.

TRADOC Pamphlet 525-3-91, *Operational Requirements Document for the Future Combat Systems* states the echelonment is broken down in terms of classes of systems. These include UAV Class I at the Platoon level, UAV Class II at the Company level, UAV Class III at the Battalion level, and UAV Class IV at the Brigade level and higher.

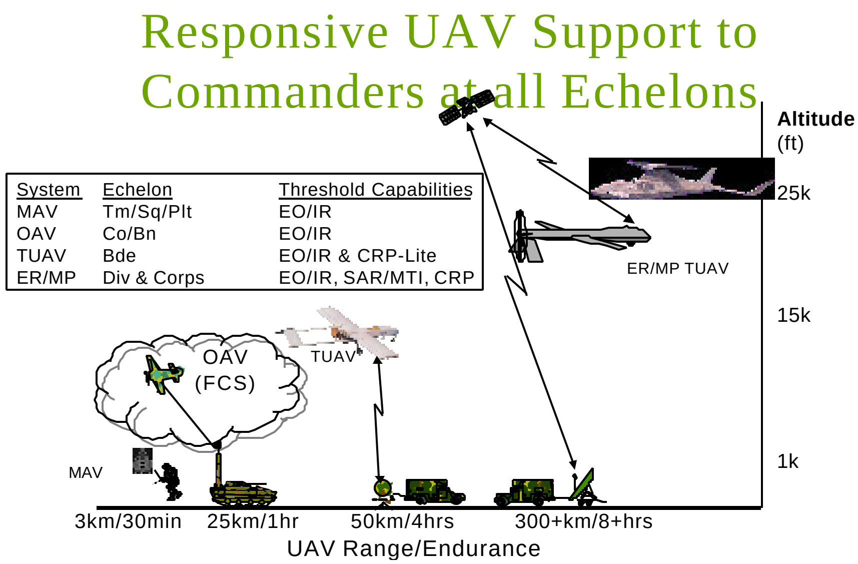

Figure 1. Army Unmanned Aerial Vehicle Strategy. Source: TRADOC Brief (September 2002)

UAV Class I, Class II, and Class III will employ the small unmanned aerial vehicles (SUAV). The SUAVs consist of the micro aerial vehicle (MAV) and the organic aerial vehicle (OAV). These systems are designed to be carried in a person’s rucksack and may be hand-launched. The OAV will provide support to battalions and may be launched and recovered from FCS vehicles or may be hand-launched as well.

UAV Class IV will employ the Hunter UAV in the interim and the Army has just recently started fielding the Shadow 200 TUAV. These systems will provide support to Army ground maneuver brigades. Finally, there is the ERMP UAV, this platform will be found at the division and corps levels. The Army is considering using the Hummingbird 160 to fill the ERMP role and is conducting research on fielding a new ERMP that may be either fixed or rotary winged. These systems will be the most versatile and possess the greatest payload capacity. Therefore when discussing UAVs versus Comanche comparisons, this thesis is referring to the upper end of the Army's tiered spectrum; UAV Class IV assets found at the brigade, division, and corps levels.

The intent of this chapter was to provide the reader a glimpse at the scale and some of the associated areas of discussion concerning these two emerging systems. Additionally, the cited primary and secondary reference materials provide a general vector on where these programs are headed. Chapter 3 will provide the framework for analysis and set the stage for chapter 4 analysis.

CHAPTER 3

RESEARCH METHODOLOGY

Determining the Relevance

The primary assertion underlying this thesis is whether UAVs should circumvent the need for the Army's RAH-66 Comanche helicopter in the armed reconnaissance role. Chapter 2 points out the various debates between the two systems: quality versus quantity, competing technologies, future capabilities, and perceived costs. Continued advances in UAVs will pose a conundrum for military acquisition planners and the aerospace defense industry. The question is rapidly becoming whether to continue producing manned systems or to shift the effort into acquiring unmanned platforms? Both in the near and far terms, questions will arise as to what roles and missions the UAVs should fulfill that have previously been the sole domain of manned aerial reconnaissance and combat platforms.

Taking a Comparative Approach

While there are various methodologies to perform this research, this thesis will rely on a comparative approach between the Comanche and the Army's Class IV type UAVs. The point to emphasize is that the systems comparison will revolve around primary and secondary sources of data that focus on future capabilities up to the 2009-year time frame. In the case of the UAV, more concrete examples are available since U.S. forces around the globe currently employ these systems. In the case of the Comanche, only documented research information can foretell what the system will be able to provide. By focusing on historical data concerning the need, development, and capabilities of these systems, one can deduce whether the UAV can accomplish the armed reconnaissance role comparable to or better than the Comanche.

<u>Comparison Criteria</u>

The Army's OF characteristics include responsiveness, agility, deployability, versatility, lethality, survivability, and sustainability. Of these seven tenants, the writer has chosen survivability, lethality, and responsiveness because they lend themselves best to comparison in the armed reconnaissance mission. Even though there may be many different ways of comparing the two weapon systems, the validity of this approach is underpinned by two key parameters. First, the Army's commitment to transform into the OF with the Comanche and the UAV serving as key reconnaissance and weapons platforms. Second, the Comanche and the UAV will perform similar armed reconnaissance missions. Now that the foundation for comparison is established, a closer look at the criteria is required and how these tie into the overarching thesis question.

<u>Survivability</u>. The Army has FM 5-103, (10 June 1985), which is devoted entirely to and entitled *Survivability*. While this FM highlights protection of aviation Forward Arming and Refueling Points, aviation combat support elements, and protection of aircraft while parked on the ground, it does not address the aspect of how well an aircraft can survive lethal fires. FM 1, *The Army*, provides a better description of what this criterion is expected to encapsulate. "Ground and air platforms that employ the best combinations of low observability, ballistic protection, long-range acquisition and targeting, early attack, and high first-round hit-and-kill technologies will be required to ensure the desired degrees of survivability" (2001, 4-2). Two questions that have been around since the dawn of combat aviation are now posed once more. What is the cost

versus the loss of these systems? Is it better to go with quantity over quality? One more added dimension of this criterion is worth noting, the political ramifications or escalation of tensions if an armed attack helicopter or a UAV crashes in enemy territory.

Lethality. FM 1 goes beyond just using the term lethality instead using "enhanced lethality." This characteristic "will allow Army forces to destroy any opponent quickly, with shattering effect . . . Army forces can combine the elements of combat power to provide overwhelming and decisive force at the right time, at the right place, and for the right purpose" (2001, 4-2) One may ask how the Predator UAV, which carries two Hellfire anti-tank missiles stacks-up against the Comanche which can carry fourteen? Yet, this criterion brings up many interesting questions that highlight one of the Comanche's strengths and points to the limited payload capabilities of the current day UAVs. Therefore, the following questions emerge. Will the payload capabilities of UAVs ever be enough to match the firepower available in the Comanche? Is it possible to launch missiles off the rail without a "man-in-the-loop"? Lastly, if the UAV is limited by payload, what is the future and capability of employing smaller, more lethal munitions such as the Brilliant Anti-armor Technology (BAT) munitions?

Responsiveness. According to FM 1, responsiveness "has qualities of time, distance, and sustained momentum. . . . It demands close, continuous coordination between Army component commanders and joint and interagency decision making bodies" (2001, 4-1). For a weapons system, responsiveness is paramount, especially in dealing with time critical elements on the battlefield. In comparing the systems, two corollary questions require further inspection: How quickly can threat data be assimilated into information and how quickly can this information be made available to the commander? In addition to the time dimension, what types of information will be provided to the maneuver commander?

Weighing the Results

Now that the comparison criteria have been established it becomes merely a matter of weighing the results. It is important to note that the goal of this thesis is not to advance one weapon system over the other. It is more an exercise to determine if the armed reconnaissance mission proposed for the Comanche helicopter can be met with the existing and developing Army and Air Force UAVs. Since the methodology revolves around a qualitative assessment, it becomes more the subjective opinion of the author that establishes the results.

After each criterion is analyzed, a subjective determination will be made considering the effectiveness and the efficiency of how well the UAV compares to the Comanche in the armed reconnaissance role. Measures of both effectiveness and efficiency will be scored with a (+) designating that the UAV is at least comparable to the Comanche or a (-) designating that the Comanche exceeds UAV capabilities in the particular area being analyzed. Considerations of what the systems will provide to the maneuver commander and how well these systems imbue the characteristics espoused by the OF will aid in determining the results.

Chapter 3 has laid the foundation of analysis and has defined various aspects of the environment and the structure in which the Comanche and the UAVs will be employed. Chapter 4 will now provide the answers to those primary and secondary thesis questions posed in the earlier chapters.

CHAPTER 4

ANALYSIS

Providing a Roadmap

The layout of this chapter will revolve around the three OF characteristics sited in chapter 3: survivability, lethality, and responsiveness. The first section will highlight the survivability attributes of the Comanche and the UAV. Threats inherent in the COE, how the systems are designed to survive in this environment, and the implications to the maneuver commander will be considered. The second section will focus on the myriad of issues found in the lethality arena. Of particular interest is the analysis concerning the need for a "man in the loop" and the payload characteristics of current and future Class IV UAVs. Implications to the maneuver commander will again be addressed. This section looks at the "armed" aspect of the armed reconnaissance role. The third and concluding section of the analysis will focus on the responsiveness of both systems. This section looks at the "reconnaissance" aspect of what the Comanche and Class IV UAVs will provide the maneuver commander.

After each section, a plus (+) or minus (-) assessment will be made to determine the effectiveness and efficiency of Class IV UAVs against those armed reconnaissance capabilities found in the Comanche. The analysis will now begin by looking at what the Comanche and the UAV can expect to face in the COE.

Surviving Threat Capabilities within the COE

Associated with the COE are those inherent threats found within the framework. Defining these threat capabilities will give the reader a better sense of the survivability measures that will be required in future UAV systems and the Comanche. TRADOC

Pamphlet 525-3-91, *The United States Army Objective Force, Tactical Operational and Organizational Concept for Maneuver Units of Action* (DRAFT 6 November 2001 v2) provides the threat capabilities that the U.S. military will encounter in the COE.

1. Precision networked fires--dispersed and at greater ranges

2. Complicates targeting -cover, concealment, deception and terrain masking

3. Sanctuary in complex terrain, dispersal and masking--using non-combatants

4. Combinations of asymmetric and conventional capabilities

5. Dispersed -nonlinear attack and defense, with less distinguishable patterns

6. Greater lethality in the close fight--killing at tactical standoff

7. Understands his battlespace and his enemy--denies us same

8. Advantages weather, terrain and light conditions

9. Tech focus on force effectiveness vice system overmatch

10. Simple and effective ISR, will leverage other 's technical means

11. Masses at the time and place of his choosing

12. Maintains threat of Chemical and Biological and other mass effects weapons

While capabilities determination provides a broad basis for understanding the threats inherent in the COE, the *TUAV Concept of Operations,* January 2001, does an excellent job in detailing the particular enemy systems that the Comanche and the UAVs will face in the projected threat environment. These include:

> . . . full range of antiaircraft systems including conventional small arms, automatic antiaircraft weapons, Man Portable Air Defenses (MANPADs), and crew-served systems using radar, optics, and electro-optics for detection, tracking, and engagement. The threat will also include shoulder-fired SAMs, launcher mounted SAMs, air-to-air weapons launched by fixed wing aircraft, helicopters, and counter-UAV UAVs, anti-radiation missiles, and directed energy weapons. Airborne and ground components will be susceptible to the same threat as the unit

> they support. Airborne and ground computers, communications/data links (networks) may be subjected to enemy EW and signals intelligence (SIGINT) exploitation and attack as well as computer network attack (CNA) (2001,10).

This wide list of threats points to the fact that both manned and unmanned aircraft will require robust survivability characteristics while operating in the COE. “Aviation assets represent the type of targets an opponent, exercising asymmetric tactics, would seek to attack to demonstrate there is no sanctuary” (TRADOC Pamphlet 525-3-04, 2002).

Another external threat revolves around geography and weather. Both the Comanche and UAV systems will have to survive and operate in diverse climatic regions throughout the world. It would appear that the Comanche might have the advantage on current UAV systems concerning performance in extreme weather conditions. UAV deployments in the Balkans have shown problems with the Hunter UAV concerning flight in icing conditions. UAVs also do not perform well in gusty conditions and heavy rain. The Predator is limited to ten-knots of crosswind for practicing touch and go landings, while the Army’s new Shadow 200 system does not have a “de-icing capability and therefore troops avoid flying them in visible moisture” (Winograd 2002, 1).

Although extreme weather conditions may limit UAV capabilities, the UAV does possess an inherent psycho-political benefit over manned systems. Focusing on the latest Predator UAV shootdown over Iraq in December 2002, “this was the first known incident of an Iraqi aircraft shooting down a coalition aircraft in either no-fly zones” (Rhem 2002, 1). Yet, this significant incursion mixed with the politically charged atmosphere of the impending U.S.-led coalition to oust Saddam Hussein from power, resulted in hardly a "blink" from either side. Clearly political dynamics become significantly altered when fatalities or prisoners are taken after a manned aircraft is downed.

The Israeli Air Force's (IAF) use of its attack helicopters may provide even a better example concerning this phenomenon. The IAF provides definitive guidance to its helicopter pilots when engaged in operations against settlements in the West Bank. "Helicopter pilots have been ordered to avoid flying low unless it's absolutely necessary when operating over hostile territory. There is a deep concern that the loss of even a single aircraft would provide a huge morale boost to the opposition, even if it were due to a technical malfunction, rather than damage from ground fire" (Wall 2002, 27). The point to emphasize is stated within the *UAV Roadmap 2000,* ". . . survivability considerations are often traded for lowered costs; higher attrition becomes a more acceptable risk without an aircrew being involved" (2001, 17). The implications of downing a manned aircraft vice an unmanned aircraft certainly appear to favor the use of UAVs.

RAH-66 Survivability Characteristics

When digesting the survivability characteristics of the Comanche, one can readily surmise why this helicopter is Army Aviation's cornerstone of the OF. The Comanche appears to be designed with the premise of survivability as a focal point. figure 2, Comanche Survivability Characteristics from a Redstone Arsenal Comanche Overview Briefing shows the layered survivability characteristics inherent in the RAH-66.

The RAH-66 clearly possesses the capability to operate and survive in the COE. Survivability aspects of this platform will allow the maneuver commander the confidence to employ this system not only in the armed reconnaissance role, but also in screening operations, in force protection, and attack roles as well.

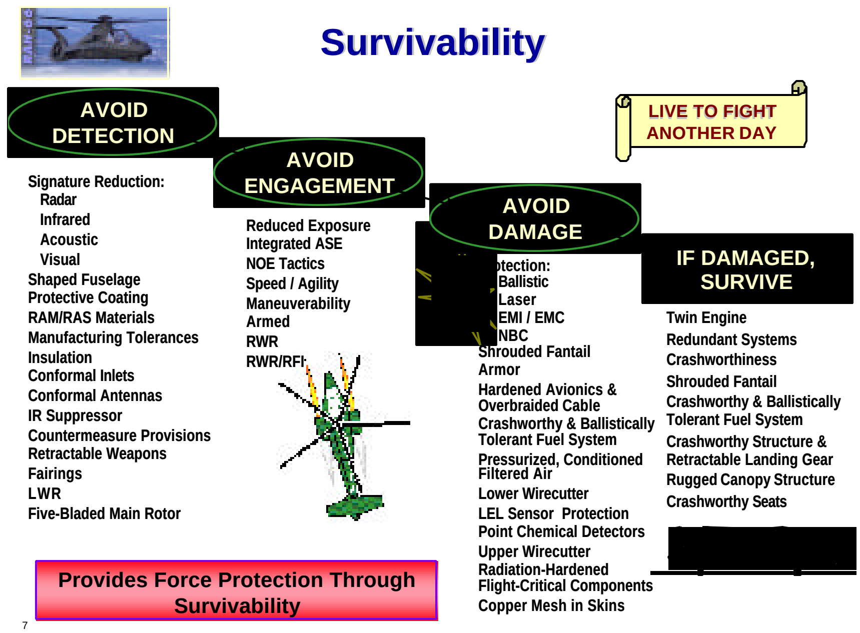

Figure 2. RAH-66 Comanche Survivability Characteristics. Source: Redstone Arsenal Comanche Overview briefing, June 2002

One particular aspect of the Comanche’s survivability characteristics that may play a future role in UAV development is its signature reduction. While not a billed as “the stealth” helicopter, the RAH-66 has impressive credentials in the low observable realm. Figure 3, Comanche Low Observables Characteristics shows a comparison between the Comanche and two other Army helicopters.

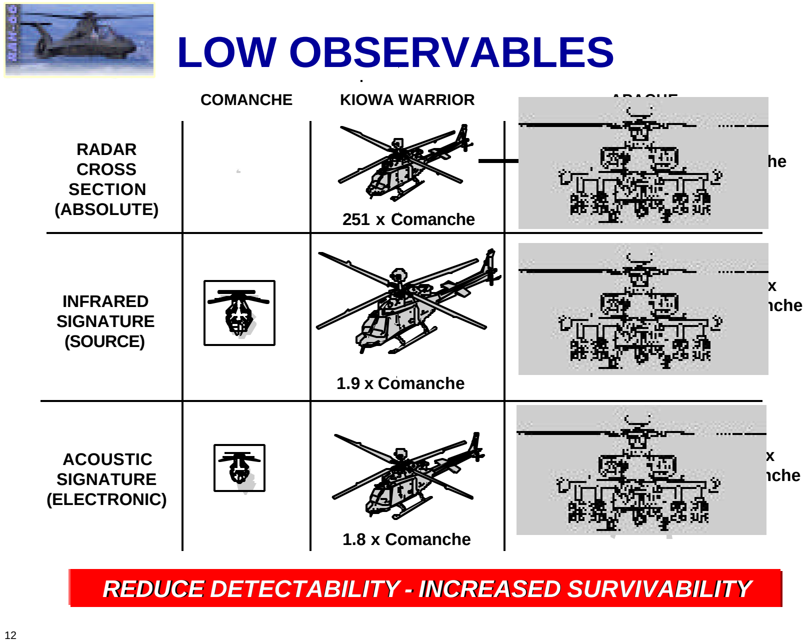

Figure 3. RAH-66 Comanche Low Observables Characteristics. Source: Redstone Arsenal Comanche Overview briefing, June 2002.

Although, not compared directly with various UAVs, the diagram does point to two areas of interest. The first is how much improved the Comanche is over the Kiowa (OH-58) and the Apache (AH-64). The second is how low observable technology found on the Comanche may be applied to UAVs without significantly increasing the overall weight of the airframe. Each of the three areas denoted in figure 3, radar cross-section, infrared signature source, and acoustic signature are important to "masking" the whereabouts of the Comanche. A smaller radar cross-section makes the Comanche harder to detect by enemy radar systems. A smaller signature in the infrared (IR) spectrum, usually accomplished by masking exhaust areas or "hot" parts of the helicopter, also increases survivability by allowing the Comanche to slide undetected past IR sensors.

Lastly, the more difficult it is to "hear" the rotors of the helicopter, whether by acoustic sensors or by the human ear, the more difficult it is to detect.

UAV Survivability Characteristics

When comparing the survivability aspects of the UAV with the Comanche, it appears that one is looking at two opposite ends of the survival spectrum. On one end is the Comanche with its incredible array of low observable technology, redundant systems, and combat protection. On the other end of the spectrum is the UAV, a platform in which manufacturers have not placed survivability high on their checklist of priorities. Perhaps the answer for this difference lies in acquisitions and development. Part of the appeal of the UAV is how quickly it has found its way through the DoD development cycle. The Advanced Concept Technology Demonstration (ACTD) process has definitely proved its worth. A *Defense Link News Release* sites how "the ACTD process enabled a Predator deployment to the Balkans less than 19 months after the program's start (as contrasted with an average defense development time of 11 years)" (1999, 1).

This rapid development and fielding of the UAV may be one of the many causes for the two differing schools of thought that have emerged concerning UAV employment. The first school of thought is that UAVs are expendable. If a UAV is lost, no problem--there is no pilot to worry about and the loss of the vehicle and payload is relatively small. Since the UAV is designed for those missions consisting of "the dull, the dirty and the dangerous," certainly losses can be expected (*UAV Roadmap* 2001, ii). The second school of thought is that UAVs should be considered just as valuable as any other high value airframe. This line of thinking has recently emerged as more people are becoming aware of the costs and capabilities of these airframes. Part of the reason for the change is that commanders are beginning to see the value of the UAV in directing the tactical picture and payloads are becoming more expensive (Cibula 2002, 2).

Mr. Jim Young, Systems Vulnerability Branch Head and Survivability R&D Program Manager for the Navy provides some solid reasons for increasing the survivability of UAVs:

> For tactical UAVs (from micros to the Predator) air vehicle cost is relatively low in comparison to a tactical aircraft providing the same data. The cost driver becomes the payload, and sophisticated sensor payloads may be worth four or five times the air vehicle cost.
>
> A typical UAV system consists of at least one control station and three to four air vehicles. One vehicle loss may not jeopardize mission readiness, but two or more air vehicle losses will mean substantially reduced operational capability with limited replenishment capability. (Young, 2002, 9)

Mr. Young's article provides an excellent read and discusses simple design modifications that can make the UAV more survival. Some of these modifications include incorporating self-sealing fuel tanks, increasing surface projectile resistance, reducing the acoustic signature and "providing the UAV operator with increased situational awareness and simple countermeasures" (2002, 10). Clearly, manufacturers and project managers are seeing the importance of making UAVs more survivable.

Another area concerning survivability is speed. This is another area that U.S. manufacturers have not emphasized in development. The cruise speed of the Shadow 200 is 80 to 135 knots while that of the Predator is 70 knots. Needless to say, these airframes are not "blazing" through the sky. Conversely, the *UAV Roadmap2000* points out a key finding concerning the lack of a U.S. high speed UAV. "The one niche common to a number of other countries but missing in the U.S. UAV force structure is a survivable penetrator for use in high threat environments" (2001, 12). While high speed UAVs may not be in the U.S.'s current development and fielding, this key finding may provide the impetus for enhanced survivability for future, faster flying UAVs.

One final aspect concerning UAV survivability warrants analysis. The foundation for this discussion can be found in an excerpt from the *Operational Requirements Document (ORD) for Future Combat Systems (FCS)*. It appears that one of the worst enemies that the UA will face is enemy helicopters and UAVs. The *ORD for FCS Family of Systems (FOS)* mandates that future systems must be able to defeat helicopters and UAVs.

> Rationale: The UA circular error probable (CEP) showed a significant threat to the FCS-equipped UA when enemy UAVs were employed. This constituted the most important counter-recon task that the UA performed. UAVs are proliferating at an alarming rate; over 100 countries are pursuing UAV systems and technology and UAVs are in use in over 40 countries. Reconnaissance and attack UAVs can currently detect UA forces at 15-17 km and can identify, designate, and/or attack UA forces or assets from over 8 km. . . . Similarly RW (rotary wing) threats such as the HOKUM can engage at 10 km with AT-16. Early warning and self-defense capabilities in all platforms, longer range counter-air capabilities in selected FCS platforms . . . improved platform stealth and survivability, attack operations, UE air and missile defense, and joint capabilities will combine in a networked, integrated way to defeat enemy air. (2002, 45)

The *FCS ORD* has justly posed the problem of the UA coming under attack from enemy RW and UAV assets. Therefore, the maneuver commander must realize that as he is "seeking" the enemy with his UAVs, the enemy will be doing the same with his own UAVs. Colonel John D. Rosenberger, commander of the 11th ACR, U.S. Army Opposing Force at the National Training Center, has written an illuminating article on techniques used to defeat both UAV and RW threats. The entire article is a worthwhile read and is enclosed in Appendix B of this thesis. While the information Colonel Rosenberger presents is unclassified, he presents innovative methods such as physical and thermal decoys to deceive UAV pilots and analysts. Most striking is the technique used to establish air defense ambushes to destroy UAVs:

> We place actual unmanned, usually inoperable combat equipment, such as an armor or air defense system, into a position where the enemy would expect to find them. We will throw in a blanket of smoke to attract their attention and really draw them in. We ring this equipment with multiple organic air defense radar and missile systems, camouflaged well with engines cold. Basically, we lure UAVs into an area. Once we visually or acoustically acquire the UAVs-which can be easily acquired by their sound-and determine they are within range, we unmask and fire. Using this technique, we routinely destroy 50%-75% of UAVs employed against us during the course of an NTC training exercise. In case you're wondering, we employ systems that accurately replicate ZSU-23-4s, SA-18s, SA-8s, and SA-9s. By the way, the hand-held, shoulder-fired S-18 air defense missile is our most effective ADA system against both rotary wing and UAV capabilities. (Rosenberger 2002, 3)

In a sense, it all goes back to Sun Tzu’s dictum of “knowing the enemy and knowing yourself.” A thinking enemy employing like systems and tactics will certainly counter the rapidly evolving roles of the UAV. The *FCS ORD* and the NTC OPFOR appear to have the proper focus on making the best use and enhancing the survival of the U.S. military’s UAV systems.

So What Does All This Mean to the Maneuver Commander?

Whether engaged in shaping actions through the UE or engaged in the close fight in the UA, survivability boils down to the “new tactical paradigm based on the ‘quality of firsts’--the capability to see first, understand first, act first, and finish decisively” (*ORD FCS* 2002). The Comanche appears to be designed to survive in the COE and meets the Army’s “quality of firsts.” Certainly the combat developers at Redstone are aware that they are paving the way for the future of unmanned systems as well--synergistic effects and interoperability of manned and unmanned systems, UAV enhanced cognitive reasoning and more autonomous control. By melding manned and unmanned systems the

Army is seeking to find the optimum synergistic effects for the maneuver commander. Particularly for the Army's tiered UAV system, a UCAR may appear to provide optimum loiter capability and reduce pilot task saturation with its capability to hover.

Paradoxically, while the Comanche searches for its own identity and role in the OF, it is using the UAV as a subset to enhance its responsiveness and survivability in the armed reconnaissance role. By focusing on the MUM, Army aviation is inextricably linking the Comanche with the UAV. While the OF stresses the interoperability and connectivity of the FCS system of systems, weapons platforms will have to stand on their own merits. Certainly the survivability characteristics of the Comanche make the Kiowa and Cobra pale in comparison.

Additionally from a survivability aspect, the Comanche does pose some interesting revelations. First, the Comanche, as the Army's first OF weapon system, appears to have the capability to accomplish a myriad of Army aviation missions but its cost places it in a "high-value" category. Will the maneuver commander feel "comfortable" in employing the Comanche as he now does the Kiowa or Cobra helicopter? Second, OF characteristics come with a price. By blending survivability, versatility, lethality, and sustainability, etc. into a single weapon system, costs increase, weights increase, and development times increase. The Comanche, by trying to incorporate all these characteristics, has faced a difficult, lengthy acquisition and development process. By attempting to become the "be all" of helicopters it has come precariously close to following the footsteps of the Crusader.

Current Army and Air Force UAVs lack organic survivability traits. Whether due to rapid development cycles or the drive to have them remain relatively low in cost, UAV developers must do more to increase survivability of these systems. The UAVs relative size compared to manned systems already makes them difficult to acquire visually or by radar. While the current fleets of UAVs (Shadow, modified-Hunters, Predator Bs) do not possess capabilities to survive in a medium to high threat environment, this should not preclude the maneuver commander from using these assets as he deems necessary.

The onus now falls on Army aviation to determine what path UAV development will take. Current tactics, training, and procedures (TTPs), low survivability attributes, and the lethal mid-level altitudes at which the UAVs are employed will mean that these platforms will continue to be destroyed by enemy fires. It is a matter of determining quality over quantity. Tactical UAVs are heralding a new age for Army aviation. By restructuring into the OF, the Army stands at the dawn of developing once more its own "Army Air Force." Reliance on sister services for ISR, SEAD, and air interdiction may now be found in the tiered UAV approach the Army is pursuing. Perhaps the Army already possesses the answers in the fact that the Comanche will provide the needed "quality," while the UAV provides the needed "mass." Perhaps the best direction is found in the words of a Shadow UAV system operator when told that the system may face accelerated schedules and block upgrades, "No, I don't want it to change at all. Keep it simple like it is. Use it for what it's meant--just quick reconnaissance" (Winograd 2002, 1).

Assessing the Data

This section of the analysis really points to the dichotomy of the Comanche with current and future UAV systems in the survivability arena. The Comanche is designed to survive and operate in the entire threat envelope spectrum, while Class IV UAVs are designed to survive in a permissible to low threat environment. The fact that UAVs do not require a pilot is what makes these systems effective. So even though a UAV may be "lost," the impacts of such loss are considerably negated. This characteristic will continue to allow these systems to be employed in the same threat regimes as the Comanche even though they may suffer significant losses. As compared to the Comanche, the author scores Class IV UAVs as effectively survivable (+) when employed in the armed reconnaissance role but not very efficient (-) especially due to their low airspeeds and the altitudes in which they are employed.

The next area of analysis will focus on lethality. While the Army has emphasized the reconnaissance aspect in its current UAV development, the Predator has made the premise of an armed UAV a reality. An analysis of the munitions and payload capabilities of these future OF systems will allow the reader more of an opportunity to compare these systems in the "armed aspect" of the armed reconnaissance role.

Framing the Lethality Comparison

A recent article in the *Wall Street Journal* clearly raises the issue whether the money being spent on the "$48 billion Comanche program--the Army's largest weapons program" could be better spent on unmanned ISR and combat aircraft. "A classified document prepared for Defense Secretary Donald Rumsfeld this year to guide the services' budgets suggests that unmanned planes capable of performing the Comanche's surveillance and precision-strike roles will be 'available to the Army prior to the maturing of the Comanche system'" (Jaffe 2002, 1). The Army contends however that this new technology will not be available in the next ten years to replace the capabilities that the Comanche will provide. This section of the thesis will delve into this debate by comparing the lethality aspects of the Comanche against the evolving tactical capabilities of armed UAV systems.

Aviation systems in the OF are inextricably linked to the air-ground teaming concept. By employing long-range and stand-off munitions, such as the Army's proposed advanced air to ground missile (AGM) and long-dwell loitering munitions, Army aviation will have the capability to engage the enemy in practically any weather or battlefield conditions, and in open or urban terrain whether "concealed or fleeting." The Central Intelligence Agency by launching Hellfire missiles from the Predator has in a sense, opened Pandora's Box. Since lethality is tied to fires and the OF proposes using long-range and stand-off weapons, one could assert that UAVs may now usurp the Army's helicopter fleet in undertaking certain combat roles such as armed reconnaissance, CAS, and SEAD. One of the key issues when analyzing the continued need for manned systems may be found in the Army's view of the importance of having a "man-in-the-loop."

<u>Why the "Man-in-the-Loop"?</u>

It appears that UAV developers and the Army's Aviation PEO are of the opinion that UAVs require human interaction especially if and when employing lethal fires. Major General Bergantz, PEO Army Aviation, explains the Army's reasoning for the MUM concept and the limitations of the UAV in cognitively assessing dynamic battlefield conditions (italics and bold print from original article).

> Manned systems provide the critical human dimension well forward *on-site--not from a distance.* They develop an **all-around** situational awareness and understanding, by analyzing and combining sensor data with their **"feel"** for the battle. A soldier is able to immediately **adapt** to the unforeseen or anticipated situation and find the best way to utilize his equipment--even when it does not function as advertised. Man-in-the-loop describes the eyes-on *agility of thought* and *focus of purpose* to carry on when the situation is unclear, complex,

> communications fail, systems malfunction, and people die. Until technology can truly replicate the complex intangible functions performed by soldiers, teaming will remain the solution. (2002, 5)

The Army's chief scientist, Mike Andrews, agrees with this assessment. "Andrews said he expects there will always be a human presence in UCAR operations. . . . That will be particularly necessary for recogni(z)ing targets and shooting . . . " (Burger 2001, 1). Without proper fire controls designed into the UAV, the risk of fratricide or other inadvertent lethal "fires" increases over those found in manned systems. This thinking stems from the limited fields of view and the apparent lack of overall battlefield situational awareness provided by current UAV systems. The Army, by incorporating the man-in-the-loop with its UAVs, can help to ensure that the 5 percent U.S. friendly fires losses in Operation Desert Storm will not be repeated in the next major conflict.

RAH-66 Lethality Characteristics

A good starting point in discussing the armaments and the fire control measures found in this state-of-the-art helicopter is found in table 1, Attack and Reconnaissance Helicopter Capabilities.

This table provides a comparison between the Comanche and the other attack and reconnaissance helicopters in the Army's inventory. While not a direct comparison between UAV armaments and capabilities, this table will provide the reader a snapshot of how the Comanche stacks up against the Kiowa and the Cobra helicopters which it is scheduled to replace, and the Apache, which it is scheduled to augment. Drawing a baseline comparison between these helicopters will aid in the forthcoming analysis of UAV systems.

TABLE 1. Attack and Reconnaissance Helicopter Capabilities

Weapon System	OH-58D Kiowa Warrior Upgrade	AH-1F Cobra	AH-64D Longbow Apache Upgrade	RAH-66 Comanche
Weapon Air-to-air stinger (ATAS)	Hellfire 2.75" rocket ATAS .50 cal gun	TOW 2.75" rocket 20-mm gun	Hellfire 2.75" rocket ATAS 30-mm gun	Hellfire 2.75" rocket ATAS 20-mm gun
Max Speed (kts)	200		197	166 (Dash speed w/ radar)
Normal Cruise Speed (kts)	90-100		120	149 w/ radar
Fuel Capacity (Gal)	112	262	370	112 internal 2 x 200 external
Consumption (Gal/hr)	41	98	124	
Endurance (Hrs)	2.0	2.3	2.3	2.5
Max Range mi)	250	441	1024	1200
Targeting System/Sight	TIS sight TVS sight Laser Range	TV, FLIR Laser Design	TADS sight Gen II FLIR / MMW/TV Longbow Radar Laser Design	Gen II FLIR/ MMW/TV ATDC Longbow Radar EO Laser Desig
Payload/Norm Mission		1,293	4,090	3,339
Max Gross Wt (lbs)	5200	10,000	17,400	12,339 primary mission wt
Stealth	No	No	No	Advanced
Night Flight	Limited	Yes	Yes	Yes
Length Blades Unfolded	40'6.4"	53'1"	57'1"	46'9"
Width (Tread)	6'5.4"	7"0"	6"6"	7'6"
Main Rotor (Diameter)	35'	44'	49'	39'

Sources: *Appendix C, Aircraft Capabilities*, U.S. Army, FM 1-100, February 1997; *Sikorsky and Boeing Websites* 2003; *CRS Report for Congress*, October 2000).

Referring to table 1, the Comanche brings a great deal of firepower to the maneuver commander. While billed as an armed reconnaissance platform, this platform with its "extended range and lethality (could also perform the roles of) light attack . . . and deep strike missions" (Bergantz 2000, 50). According to Glenn Goodman's article on *Vertical Transformation*, the Comanche, "once fielded . . . will be the primary source of tactical reconnaissance information for Army ground units. The agile and stealthy helicopter will operate as their forward scout, using its advanced sensors to identify enemy positions-day or night and in adverse weather-to an extent never before possible" (2001, 5). The premise is that the Kiowa and the Cobra, both vintage Vietnam War-era airframes are becoming to cost prohibitive to maintain. The Army requires a new reconnaissance helicopter and the Comanche is destined to fulfill that role.

Another reason for developing the Comanche was that the Kiowa did not have the range or the speed to keep up with the Apache, the Comanche will. The thought was that the stealth, range, and speed characteristics of the Comanche would allow it to identify and designate targets day or night, in good or bad weather, at which time the Apache, as the "killer" in this "hunter-killer" arrangement would destroy the target.

A closer look at table 1 does however point out a salient issue--the similarities between the capabilities of the Comanche and the Apache. In Chris Bolkcom's *CRS Report to Congress*, he mentions that critics argue that the "Comanche's role and capabilities are too similar to the Apache's to justify the cost of the helicopter's development and production. They would cancel the RAH-66, and use the savings to upgrade the OH-58 aircraft and the AH-64D Apache's Longbow target acquisition capabilities" (2000, 3). This same report also gives other reasons why the Comanche should be cancelled. First is a historical perspective on how well the Kiowa and the Apache performed as hunter-killer teams during Operation Desert Storm. Second, critics argue that the Comanche was initially developed to counter a Cold-War threat that no longer exists.

The one major factor that Comanche detractors will note is whether the cost of the weapons system is worth the "advanced" capabilities it will bring to the fight. Additionally, will Objective Force UE commanders feel justified in sending these expensive weapon systems into harms way. This debate hinges on the age-old debate on quality over quantity. This is where UAVs may pose an advantage. The latest Comache buy of 1,213 airframes puts the cost of a Comanche at nearly $37.7 million dollars per unit (Bolkcom 2000, 2). Differing sources place the price between $32 to $37 million based on the quantity of airframes purchased. Other Army and Air Force systems, such as the M-1A1 and the Predator UAV are significantly less expensive, with a cost of $3 to $4 million per tank and per airframe. For the cost of a single Comanche, the Army could field 12 front-line tanks or 12 Predator airframes. Critics say that if the Army cuts the Comanche program the savings could be spent on other OF future combat systems. Proponents decry that cutting the Comanche will severely impact Boeing and Sikorsky, the principal manufacturers. Additionally, the advance systems technology found on this helicopter is paving the way for future applications to other weapons platforms.

Another lethality aspect of the Comanche is its Aided Target Detection Classification (ATDC) system coupled to the Longbow radar. This system will allow for a high probability of detection and classification for both air and ground targets, operating on IR imagery it can function in all seasons, through obscurants, and in both day and night conditions (Redstone RAH-66 Brief 2002). The Longbow radar system allows the Comanche to track 256 targets simultaneously; with the system automatically identifying the 16 most hazardous targets "based on an on-board computer 'library'. It can then hand-off targeting information to other Apache and Comanche helicopters, and attack, all within less than 30 seconds after initiating the radar scan" (CBO www site, 2002).

While the Comanche will possess these incredible identification and targeting systems, detractors question whether these robust capabilities are even required in the non-contiguous battlespace of the COE. Proponents will say that this capability will allow the Comanche to work in a target rich environment and meets the OF tactical paradigm of "seeing and killing the enemy first." Proponents will further add that such robust targeting and acquisition systems will allow the Comanche to fulfill the OF vision of decisively defeating the enemy in the full spectrum of combat operations. Detractors will submit that identifying and processing 256 targets is overkill. With the advent of the COE, the enemy is now found dispersed in a non-contiguous environment, such as that found in recent operations in Afghanistan. The COE also submits that the enemy will attempt to nullify lethal fires by seeking concealment or congregating in urban areas.

Another interesting discussion concerning the Comanche's lethality is its turreted gun system. While UAV and UCAV arming have focused on the employment of air-to-ground and air-to-air missiles, the idea of mounting a gun system onto a UAV has yet to be explored. Four reasons for this lack of development come to mind: payload considerations, required fire controls, weapons effects, and the perceived role of the UAV in the armed reconnaissance role versus that of close air support.

Since the UAV is just beginning to find its place in various combat roles, payload considerations have focused more on ISR type sensors located internal to the aircraft with missiles being mounted to hard points on the wings and fuselage. The added weight of a gun system will impact endurance, range, and may "bump" required electo-optical (EO) and infra-red (IR) sensors from the electronic storage bays. Additionally, with the Army's premise of having a "man-in-the-loop" to ensure adequate fire controls, future-armed UAVs platforms will likely continue to employ only air-to-air and air-to-ground type missiles.

Another reason for not placing a gun system on UAVs deals with effects-based employment. To meet the definition of armed reconnaissance, a platform must be able to locate and attack targets of opportunity . . . (vice) attacking specific briefed targets (JP 1-02 2001). In the case of an armed UAV, two Hellfire missiles could provide adequate lethal fires to accomplish the mission. If stronger enemy forces are identified by the UAV then the "armed" mission could fall to the Apache, Comanche, or other combat platforms. Likewise, if the enemy is identified but not attacked, then the reconnaissance aspect becomes paramount. In this case, mission accomplishment hinges on locating the strength and disposition of the enemy, if possible by remaining undetected and recovering the platform to fight another day.

One may argue whether a gun system on an armed reconnaissance platform is more for self-protection and close air support. Ask any Apache driver and they will gladly tell you how the gun and its blast effects can take out enemy armor as well as personnel. An added benefit is that the twenty millimeter rounds found on the Comanche are a lot less expensive then Hellfire missiles. In Desert Storm, some Apache units were flying with a basic load of two Hellfire missiles because demand for these munitions was so great. There is little doubt that the Comanche's gun system provides more lethality and more versatility than current or short-termed planned UAVs.

The Debate on Comanche's Weight

The final debate concerning the lethality of the Comanche is based on perception. There is a common perception that the Comanche, due to its heavier weight and thrust available from its tandem engines, is limited to lightweight arms configurations and less than maximum fuel loads. The problem with this perception is that certain Army aviators are of the belief that the Comanche will not perform as well as advertised. "The General Accounting Office (GAO) . . . noted that the Army had not been able to tell it how much the Comanche's performance would be affected by design changes, although the radar alone was expected to knock 11 kts off the cruising speed. For some missions, the Army is considering either carrying external fuel tanks or installing fuel tanks in the weapon bays, displacing weapons to the helicopter's removable wings" (Sweetman 2000, 39). Moving weapons from the internal bomb bay will only serve to negate one of the Comanche's strongest design characteristics--it's stealth. Perhaps even worse, is that such skeptical reports, like the above mentioned GAO report and the earlier referenced CRS report to Congress, paint the Comanche in a negative light and will continue to propagate the perception that the Comanche is simply "too heavy" to perform to its maximum capabilities.

UAV Lethality Characteristics

Looking at the *Army Aviation Warfighting Concept of Operation (CONOPs)* (TRADOC 525-3-04, 31 December 2002) it's hard for the reader to delineate the role of the UAV and that of the Comanche. It appears that everytime Comanche is mentioned a reference to the UAV closely follows. Army Aviation is correct in placing a strong focus on the synergy provided by the MUM teaming concept, whether it is the combination of the Apache or the Comanche teamed with Army tactical UAVs. However, while it may fly in the face of the recently released *Army Aviation's Warfighting CONOPS,* a more pointed question to ask is how UAVs can perform while working in conjunction with other UAVs (Hunter-Killer Teams) or simply by themselves? This question does not mean to detract from the Army's vision of incorporating the connectivity of the FCS system of systems, it is more a rhetorical question that may provide a better analysis of UAV lethality.

As previously mentioned in chapter 3, when comparing the UAV against the Comanche, this thesis is referring to the upper end of the Army's tiered spectrum; UAV Class IV assets found at the brigade, division, and corps levels. In this group, the Air Force's Predator A and Predator B will also be considered since it is aligned with how the Army will employ its Class IV UAVs. The focus now shifts to the Army and Air Force's plan to arm these UAVs.

Arming Class IV UAVs

The Army has made great inroads with its release of its *Operational Requirements Document (ORD) for FCS* (25 November 2002). The reader can now focus on the intent, rationale, and the parameters on why these future combat systems are being developed. Concerning UAV requirements, it is interesting to note that in the *ORD for FCS* there is "no unique requirement" for lethality. Clearly with the many UAV Advanced Concept Technology Demonstrations and the Pentagon's push towards "spiral" development, it appears that the Army is focusing solely on the ISR aspect of the UAV. By analyzing how the Army proposes to arm its Class IV UAVs one can draw better conclusions on how these systems may fulfill the armed reconnaissance role.

RQ-5 Hunter

Weight 1,600 pounds, Length 23 feet, Wingspan 29.2 feet, Ceiling 15,000 feet, Radius 144 nautical miles, Endurance 11.6 hours, Payload 200 pounds (*UAV Roadmap 2000,* 2001, 4). The "workhorse" of the Army's UAV fleet, this UAV has seen extensive use in Kosovo in support of NATO. The maker of the Hunter, TRW is modifying the aircraft with a center wing addition to allow for direct-fire engagements. The Hunter completed testing in Oct 2002 with the BAT submunition and the next phase includes testing laser-guided and GPS-guided BATs. "The Army wants to put a BAT anti-armor munition under each Hunter wing. The operator would then simply drop the unpowered, smart submunition . . . (allowing its) acoustic and infrared sensors to find its target" (Wall 2002, 28). The center wing modification has a NATO standard rack and the possibility of employing the Hellfire missile (Keeter 2002, 1). The Shadow 200 is scheduled to replace the Hunter.

RQ-7 Shadow 200

Weight 327 pounds, Length 11.2 feet, Wingspan 12.8 feet, Ceiling 15,000 feet, Radius 68 nautical miles, Endurance 4 hours, Payload 60 pounds (*UAV Roadmap 2000,* 2001, 5). Billed as the Brigade UAV, the Shadow was approved for full-rate production in September 2002. At this time it looks as if the Shadow will function solely as an electro optical and infra red gathering platform. Mission payloads are expected to slowly increase each subsequent year of production (Fiscal Year 2004 funded Shadows-six hour endurance, 60 pound payload and Fiscal Year 2005 funded Shadows-six hour endurance with a 75 pound payload). Even with this increasing payload capability, the Shadow 200 will still not possess the payload capability to employ the Hellfire or other miniaturized munitions.

Hummingbird 160 (UCAR)/Extended Range/Multipurpose (ERMP) UAVs

Weight 4000 pounds, Length 36 feet, Rotor Diameter, Ceiling 3000 nautical miles, Endurance 24 plus hours, Payload 300 plus pounds (*UAV Roadmap 2000*, 2001, 9). According to John Sundberg, the Army's deputy program manager for UAVs, "In a long-range plan, officials hope to develop an unmanned combat rotorcraft, or UCAR, that would be analogous to the Air Force's fixed-wing UCAV" (Wall 2002, 28). The Hummingbird 160 offers promise if a version can carry a payload heavier than the 300-500 pound limit in current designs. Possible munitions for the UCAR include the Loitering Attack Missile-Aviation and the AGM-114 Hellfire missile (Burger 2001, 1). The Hummingbird is still in the base technology development stage.

ERMP UAV

The Army is also seeking inputs from industry on its future ERMP UAV. The Army is seeking a UAV that will both replace the Hunter and provide more capability than the Shadow 200. "The Army envisions a fairly aggressive program that would start in (2002), lead to testing of existing systems and a competition in 2003 and 2004, and an initial operational capability around 2006" (Wall 2002, 28). This aggressive timeline shows that Army UAVs will clearly possess the "new technology" in the next ten years to replace "some" of the capabilities that the Comanche will provide (Jaffe 2002, 1).

Predator A and B

Weight 2,250 pounds, Length 25.7 feet, Wingspan 40.7 feet, Ceiling 25,000 feet, Radius 400 nautical miles, Endurance 24 plus hours, Payload 450 poundss (*UAV*

Roadmap 2000, 2001, 3). According to Air Force Chief of Staff General John Jumper, the Air Force is “extremely high on the (Predator) program” (Fulghum 2001, 1). Recent successes in Afghanistan and Yemen have proven the validity of using this platform as an armed interdictor. According to an article in *Aviation Week and Space Technology*, the follow-on Predator B will bring even a greater capability to the armed reconnaissance mission. It is a pathfinder program, meaning it will reach operational capability quickly. It is “optimized for the hunter-killer mission of finding, observing, and . . . destroying ground targets,” its payload will increase from 450 pounds (Predator A) to 750 pounds, it will cruise faster (210 knots from 118 knots), and will fly at higher altitudes (45,000 feett ceiling vice 25,000 feet) (Fulghum 2002, 20).

At this time the Predator is setting the standard for armed UAVs. However, since the Army’s interim UAVs do not possess the payload capability of the Predator, a discussion of munitions research is also warranted.

Munitions Research for UAVs

Payload considerations have been mentioned as a key factor in determining how many and what types of munitions can be placed on future UAVs. The *UAV Roadmap 2000* appendix devotes a section to weapons integration for UAVs and shows the scale of research presently underway. “The munitions programs include Precision Direct Attack Munitions (PDAM), Small Smart Bomb Range Extension (SSBREX), Low Cost Autonomous Attack System (LOCAAS), and Small Munitions Dispenser (SMD)” (2001, 60). The intent of the research is to improve “kills per sortie” (*UAV Roadmap 2000*, 2001, 60).

At first glimpse, the premise of miniaturizing weapons may seem to allow even the Shadow 200, with a payload capability of 75 pounds to carry munitions. This however is not the case. Miniaturization does not necessarily equate to lighter-weight munitions. Rather this research is focused on effects. For example, developing a 250-pound weapon that possesses the effects of a 2,000-pound bomb.

So What Does All This Mean to the Maneuver Commander?

The Comanche will provide the maneuver commander not only the versatility but also the lethality he requires to accomplish the myriad of armed reconnaissance and attack missions that are required in today's COE. Since critics deride that the Comanche is nothing more than a "stealth Apache," the Army should consider using the Comanche in more of an attack type role.

Employ the Comanche more in an Attack Role

The fire power and fire controls aboard the Comanche make it a platform designed to fulfill the attack helicopter's mission: that is to destroy enemy forces using fire, maneuver, and shock effect (FM 1-112 1997a, 1-3). With the Comanche's stealth characteristics, the platform is also uniquely designed to accomplish the maneuver commander's deep strike missions. (Operations directed against enemy forces that currently are not engaged but could influence the division and corps close operations within the next twenty-four to seventy-two hours (FM 1-112 1997a, 1-6)). High altitude Class IV type UAVs could provide the "picture" without compromising the scenario, the Comanche, using its stealth capability could penetrate "deep" to "attack to destroy." Conversely one may contend that a number of armed UAVs could do the same without the risk of losing a “high value” asset and aircrew, once more pointing to the premise of mass (UAVs) versus quality (Comanche).

Employ UAVs in the Low-Risk Attack or Armed-Reconnaissance Missions

On the medium to low end of the attack mission is attack to disrupt. This mission may be more suited to the UAV due to its limited armament and survivability characteristics. Attack to disrupt will allow the maneuver commander the opportunity to “break apart an enemy’s formation and tempo, interrupt the enemy’s timetable, cause premature commitment of forces, and/or piecemeal their attack. Risk is based on the friendly loss he is willing to accept, the location of the attack, or the number of attacks that will be made” (FM 1-112 1997a, 1-14). Limited munitions payloads relegate the UAV to these types of attack missions. One could contend that these lower-risk attack missions are analogous to an armed reconnaissance type mission. The UAV detects a target of opportunity, applies lethal fires to delay and confuse the enemy, only to recover the UAV either to fight another day or re-arm and attack again.

Comanche in the Defense

Another mission area where the ground maneuver commander can more advantageously apply the Comanche than the UAV is in the defense. “The objective of defensive operations is to cause the enemy attack to fail, preserve the force, facilities and installations, control key terrain, gain time, and concentrate elsewhere” (FM 1-112 1997a, 1-14). Whether in an area or mobile defense, the engagement capabilities of the Comanche coupled with its range and munitions suite makes it ideally suited for the defense. While the UAV has the loiter time and range, its limited arms capability places it at a disadvantage in fulfilling this role.

Assessing the Data

Based on the above considerations the UAV is scored a (-) in effectiveness and a (-) in efficiency when assessing its lethality against the Comanche. Current and future Class IV UAVs are simply not comparable to the effects derived from the Comanche. The Comanche's robust firepower, especially its turreted gun system and its ATDC system, makes it more effective and efficient than the UAV in nearly all attack and defensive roles. The Comanche will continue to be more efficient then UAVs due to the fact that these systems do not yet possess the cognitive ability and situational awareness to exploit the battlespace like a pilot in a manned helicopter.

This lethality analysis focused on the armed capabilities of the Comanche and Class IV UAVs. Certain considerations were also presented for the ground maneuver commander in employing these systems in the attack role. In the next section, "Responsiveness," the reader will have a chance to assess the reconnaissance capabilities of both these platforms.

Responsiveness

In keeping with the debate on the comparison of the Comanche and Class IV UAVs, are the continued improvements UAVs have made in the area for which they were originally designed--ISR. The *UAV Roadmap 2000* depicts how Unified Command and Service staffs have prioritized certain mission areas in terms of desirability for being performed by UAVs. The first priority was reconnaissance, the second was target designation, and the third was a tie between signals intelligence and communications and data relay. This assessment is closely aligned with the nine Unified Commanders Integrated Priority Lists (IPLs) that included the highest priority as reconnaissance and the second priority as communications and data relay. The viewpoint “from the field” is that UAVs can serve to fill the requirements needed by the Unified Commanders. In keeping with the above priorities and IPLs, this section will look at what information will be made available to the commander, how fast that information can be passed, and how these platforms stack-up against one another when considering time-sensitive targeting (TST).

RAH-66 Responsiveness

The Comanche is designed to fulfill the OF tactical paradigm of the “quality of firsts-- the capability to ‘see first, understand first, act first, and finish decisively.’” Proponents of the Comanche say that a big advantage over UAVs is the capability of the platform to not only “see” the battlespace but to interpret it as well. According to Army Chief of Staff, General Shenseki, “Our ability to see the enemy right now is not as good as we would like it to be, Comanche will give us enough details about the enemy's location so that we can decide when and where to initiate contact” (Jaffe 2002, 1).

A manned system provides the inherent ability to “understand” the unfolding dynamics of the battlespace. The Comanche, with its ATDC system will possess the capability to act immediately against known targets or targets of opportunity. As part of the Army’s FCS system of systems it will also be able to transmit this data to others. This “integrated sensor data fusion” will allow the Comanche to not only recognize a wide array of targets, but will reduce false targets as well (PEO Webpage, 2003). Additionally with its stealth characteristics and its ability to both designate and destroy the enemy, the issue of time sensitive targeting becomes solely a matter of whether the pilots have prior permission to engage.

Another strong suit of the Comanche is its robust communications suite. The Comanche will possess the capability to thrive in the joint environment. It will have two data nets (Link 16 and SATCOM) as well as four voice nets--common Multi-Band Receiver and Transmitter Modules VHF-AM/FM, SINCGARS, and UHF-AM. This robust communications capability also provides a distinct advantage over UAVs, the ability for the Comanche to direct the tactical air order of battle or interface directly with ground personnel. UAVs do not possess communications packages with built in UHF, VHF, or FM capabilities. Therefore, UAV communications during a screening maneuver or in conjunction with a ground recon unit has to be relayed through the ground control station.

UAV advocates say that it is the ideal platform for performing the “dirty” missions--for example those involving nuclear, biological, or chemical (NBC) contamination. However, the Comanche can perform equally as well in this environment with its sealed overpressure cockpit, integral full-time filtration system, and materials resistant to NBC agents and contaminants (Redstone Arsenal Brief 2002). The NBC threat will pose similar problems both to manned and unmanned platforms. One may say the advantage lies with the UAV since it does not have a pilot. That assertion can be debated because the UAV, like the Comanche, will have to be decontaminated upon landing. UAV ground controllers and personnel at the launch and recovery site have to be aware of the potential hazards of recovering an aircraft that may have flown through contaminates.

Lastly, are considerations of the Comanche’s speed and loiter characteristics. In the near-term, the Comanche does possess the capability to fly faster then most U.S.

made tactical UAVs. However, the Predator B will have a cruise speed of nearly 50 knots over the Comanche (166 knots versus 210 knots). In order to continue to work inside the enemy's decision cycle, speed is critical. The faster a platform can reach a named area of interest, the quicker the maneuver commander can decide his course of action.

Loiter or endurance characteristics definitely favor the use of UAVs in the reconnaissance role. The Shadow 200 has a 4-hour endurance; the Hummingbird 160 and the Predator both have endurance of over 24 hours. Once must consider the myriad of trade-offs this capability provides. Longer loiter times may allow UAV operators to climb above or move beyond the range of approaching inclimate weather patterns. In a sense, the platform has the capability to "wait out" the weather while remaining airborne. Longer loiter times will provide the commanders the ability to accomplish surveillance and intelligence gathering as well as reconnaissance. In the armed combat role, longer loiter times may be negated once the UAV's limited ordnance is dispensed. Limited munitions will mean that the UAV will have to fly back to the launch/recovery site to re-arm. With the Army's interest in fielding a UCAR ERMP, the capability also exists for the hovercraft to land and conserve fuel. The bottomline is that the UAVs loiter time does provide a solid advantage over the Comanche in an ISR type role.

UAV Responsiveness

What a difference a decade makes. In the 1990-1991 Gulf War, commanders often had to wait days to see reconnaissance photos, in Afghanistan UAVs were presenting real-time streaming video of operations (Fulghum 2002, 20). In Afghanistan the demand was so great for the limited number of Predators, the Air Force and the Army "knocked heads" on whether they should be used to search for high-value targets or aid the Army in support of Operation Anaconda. Lieutenant General Bob Noonan, head of Army Intelligence, while discussing this conflict seems to capture the prevailing attitude of how most commanders feel about the UAV. “We don’t have enough organic UAVs. When you have a scarcity of assets . . . somebody has to make a call where is that thing flying.” (Strass 2002, 1).

The UAV has the potential to accomplish many missions. While the IPLs rank reconnaissance as the highest priority, UAVs can also accomplish surveillance, target acquisition, and serve as communications relays. The Reconnaissance, Surveillance, and Target Acquisition (RSTA) units of the Army’s OF plans to use Class III and IV UAVs to accomplish route recon, define and develop NAIs and Objective Areas, and serve to detect obstacles.

The UAV has the capability to carry a variety of sensors. Currently the Predator and the Shadow carry an electro optical and infra red camera. The IR camera provides night capabilities. The Predator also carries a laser designator to mark targets as well as a synthetic aperture radar. Other UAV payloads in development include interchangeable communications relay and foliage-penetrating radar payloads, chemical and biological detectors, and moving target indicators (MTIs) (Fulghum 2002, 20).

With the UAV’s near-real-time (NRT) video capabilities, its ability to designate targets, and its ability to launch air-to-ground munitions, it is becoming a platform of choice in accomplishing TST. According to Lieutenant Colonel Douglas Boone, deputy chief of the reconnaissance systems division for Air Force Acquisitions, “We want a shorter kill chain; that’s why we’re weaponizing Predator and Predator B. We decided that all future Predators would have hard points to carry weapons and a laser designator”

(Fulghum 2002, 20). Analogous to the Comanche pilot, it boils down to the ground controller knowing the wartime rules of engagement and having proper approval before engaging the target.

Critics of the UAV say that the thirty-degree visual cone provided by the UAV is too narrow a field-of-view and is analogous to looking through a soda-straw. UAV operators, however, appear to be pleased with the two-dimensional picture they are viewing. “You can’t read the license plate off a car, but you can definitely tell the difference between a car and a van or a truck” (Winograd 2002, 1). Lieutenant General John M. Riggs, the Army’s modernization chief states, “Often we’re identifying whether there are soldiers in the school bus or school children in it. Right now we can’t get that kind of fidelity from our unmanned systems” (Jaffe 2002, 1). In order to rectify the situation, two options exist. The first is to rely on MUM teaming, leaving the Comanche to provide wide area recon and provide “human eyes” on-site. The second option is to upgrade the visual identification systems payloads. The *UAV Roadmap 2000* points to emerging technologies in imaging systems: uncooled IR sensors, microelectro-mechanical systems, and multiple aperture optical systems.

Coupled with the UAVs limited field of view are the altitudes at which they are employed. There is a trade-off concerning altitude. The higher the UAV flies, the wider the field of view but the worst the resolution. The lower the altitude, the better the resolution but the narrower the field of view. In testing direct fire weapons on the Predator the initial altitude was 2000 feet and increased from there. The Shadow 200 has an optimum altitude of 8000 feet. This low to medium level environment leaves the UAV highly susceptible to various enemy threats.

Although employment altitudes may place the UAV at risk of various enemy systems, the Army and DoD's tiered approach to UAV development may provide a way to mitigate some of the risk. This example from *Soldier of Fortune* magazine may show how the Army can couple their future Class IV UAVs in a "hunter killer" type scenario. "When the B-1s and the B-52s left the region in early January, the task of taking out the Taliban and al Qaeda leaders fell mostly to unmanned aircraft. Global Hawk [Air Force's high-altitude UAV] would find the enemy, and Predator would fry them with Hellfire missiles" (Cooper 2002, 70). By employing the "hunter" at a higher altitude, the Army not only deconflicts the UAV from low-flying helicopters but also adds to the platform's survivability by employing it above small arms and shoulder-fired SAMS.

The *TUAV CONOPs* points to an employment consideration that appears to play to the UAVs disadvantage. Although UAVs have the ability to track mobile targets, they may be "tricked" by tracking a decoy vehicle. "Exclusive use or heavy dependence on TUAV NRT video imagery provides the enemy a relatively cheap means of deception, which can tie up the system against targets of little or no value" (*TUAV CONOPS* 2001). It is highly unlikely that such a scenario would befall the Comanche. Similarly, UAV critics decry that this NRT video capability will have the division or brigade commander camping out at the tactical operation center (TOC) trying to "micro-manage" his subordinates. One could counter that the OF will provide this capability in most of its FCS. The point is to increase situational understanding, not for commanders to micromanage the fight.

There is one final reconnaissance aspect that involves the UAV that focuses on non-lethal affects. The following event occurred to the OPFOR during a recent Hunter

Warrior Advanced Warfighting Experiment and similar incidents have been recorded by the OPFOR at the NTC. Every time a UAV would appear the enemy believed they were being targeted. “The OPFOR commanding officer noted in his after-action report that the sight of a drone forced constant displacements that led to a real decrease in combat effectiveness” (Catto 2001, 52).

A Big Problem for the Army’s Objective Force

A critical problem that came to the forefront during operations in Afghanistan and may affect all of the Army’s FCS, is the number of satellites providing needed bandwidth to maneuver commanders. In the 1990’s, “ubiquitous satellite communications and unlimited bandwidth seemed the destiny of the world” (Jaffe 2002, 1). However, the telecommunications industry found the world of fiber optics the key to the future. Therefore, the Army is relying on a robust series of satellites to provide the bandwidth to control and relay information for its beyond line of sight (BLOS) systems. The problem--there is simply not enough satellites currently in orbit. According to one source, “as a result (of the problem) . . . the military has only been able to keep a couple of Predators and one Global Hawk airborne 24-7 over Afghanistan. The DoD plans to increase satellite bandwidth when it launches its own satellites in a couple of years, but they will be able to provide less than half of the gigabytes per second Predator and Global Hawk will require” (Cooper 2002, 70). The Army is working hard to alleviate this problem of the ever-increasing need for bandwidth. While the Army is strongly advocating the ability for every airborne vehicle to serve as an airborne relay, the UAV provides an excellent platform for a relay node due to its endurance characteristics.

So What Does All This Mean to the Maneuver Commander?

FM 17-95, *Cavalry Operations* provides a starting point for discussing how best to employ the Comanche and Class IV UAVs. According to the FM, "the fundamental role of cavalry is to perform reconnaissance and to provide security in close operations" (1996, 1-1). Additionally, "a fundamental for cavalry reconnaissance missions is to deploy the maximum reconnaissance force forward. Normally scout platoons, or aeroscouts are not held in reserve" (1996, 1-1). This would imply that UAV armed reconnaissance operations will work closely with cavalry recon ground elements, just as the Kiowa does today.

FM 17-95 also provides information on security operations. "Security operations obtain information about the enemy and provide reaction time, maneuver space, and protection to the main body. Security operations are characterized by aggressive reconnaissance to reduce terrain and enemy unknowns, gaining and maintaining contact with the enemy to ensure continuous information, and providing early and accurate reporting to the protected force" (1996, 4-1). In a sense, security operations are a form of reconnaissance that serves to protect and enable the maneuver force. Both the Comanche and UAV will serve as active participants in future security operations.

Route Recon

Per FM 17-95, "route reconnaissance is directed effort to obtain detailed information of specified route and all terrain from which the enemy could influence movement along that route (Road or axis of advance)" (1996, 3-1). The Comanche and UAV are ideally suited to accomplish this role by identifying avenues of approach, geographic points of interest, or NAIs. The maneuver commander will have to determine the most advantageous way to employ his helicopters and UAVs. If a movement to contact operation is expected, the MUM teaming concept or employing UAV hunter-killer teams may provide an option vice sending out a single UAV.

Zone Reconnaissance

Per FM 17-95, "zone reconnaissance is a directed effort to obtain detailed information concerning all routes, obstacles, terrain, and enemy forces within a zone defined by boundaries. Obstacles also include chemical and radiological contamination. A zone recon is a deliberate and time-consuming task" (1996, 3-1). The definition of zone reconnaissance leads one to believe that this type of operation was specifically designed for UAVs. Although the TUAV CONOPS states that the Shadow 200 is "more effective when cued against targets than when operating in a wide search mode," this may be more applicable to this particular type of UAV, vice the Predator or the future ERMP that can employ at higher altitudes. UAV endurance characteristics allow it to perform the "dull" task inherent in zone recon missions.

One may counter by saying a manned helicopter is more applicable for providing detailed information concerning routes, obstacles, and terrain. The Comanche can fly at tree-top level and hover, its maneuverability, lethality, and survivability characteristics will allow it to perform a hasty or deliberate attack if the enemy is sited. Since UAVs do not operate at treetop level and their optical systems are not as refined as the "human eye," zone reconnaissance may favor the use of the Comanche.

Area Reconnaissance

Per FM 17-95, area reconnaissance is a directed effort to obtain detailed information concerning the terrain or enemy activity within a prescribed area. An area recon is a specialized form of zone recon and proceeds faster because the effort is more focused (1996, 3-1). Analogous to the discussion above, the Comanche and the UAV can accomplish area recon. The question to ask is whether contact with the enemy is expected and how quickly does the area need to be "scoped?" Faster recon efforts may favor employing the Comanche.

Screen

FM 17-95 states, "The primary purpose of a screen is to provide early warning to the main body. It may also destroy enemy recon and impede and harass the enemy. A squadron normally conducts a screen" (1996, 4-1). Screening missions seem ideally suited for the Army's-tiered UAV systems. Whatever the class of UAVs, these platforms are designed to serve as the "dominant eye" of the maneuver commander. Class IV UAVs screen in the "deeper" battlespace for divisional moves, while the Shadow 200 accomplishes the same purpose at the brigade-level. One of the big limitations may be available bandwidth to relay NRT video back to the ground control station (GCS) and the speed at which this information can be relayed from the RSTA squadron to maneuver elements that require the information.

Guard

FM 17-95 states, "A guard force accomplishes all the tasks of a screening force. Additionally, a guard force prevents enemy ground observation of and direct fire against the main body. A guard force reconnoiters attacks, defends, and delays as necessary to accomplish its mission" (4-1). In this context, one would consider using UAVs to screen while employing the Comanches to guard. Increasing payload capabilities may allow the UAV to serve in a guard type role. Meshing perfectly with the Army's integration of

FCS, UAVs can serve to screen, passing enemy disposition to the Army tactical operation center (TOC). From the TOC a determination can be made whether to have a Comanche helicopter or another UAV engage the target.

Getting Information to the Maneuver Commander

While this section expounded upon a few pluses and minuses of employing the UAV in the reconnaissance role, there is one more aspect that warrants comment. The issue deals with system proponency. Since the RSTA squadron controls the UAVs, they need to insure the proper mechanisms are in place so that those members needing the information provided by the UAVs have it readily accessible. Naturally, this arrangement would require the UAV GCS being located near the TOC. Since, the RSTA is processing or observing NRT video that may be classified (since it is dealing with the strength and disposition of the enemy), access to their "work area" may require special access. One can see the problems inherent in such an arrangement. Limited access often equates to limited distribution.

One can see the debate concerning system proponency. Since UAVs of all types will be so pervasive on the future battlefield, who will be the "main belly button to push" to "synch" all the parts together? Signals branch will be a major player because of the links and the required bandwidth for connectivity. Infantry will be looking for part control since the company and battalion commander will employing Class I, II, and III UAVs to look "over the next hill." One should also include Cavalry in the mix, since reconnaissance and force protection are exact "fits" for employing the UAV.

The last branch to consider is Army Aviation. Previous discussions of the UAV teaming with the Apache and the Comanche will lead one to believe that this synergistic effort should stem from the Multi-Function Battalion (MFB). The MFB is the Army's new helicopter force structure that consists of ten recon (Comanche), ten utility (Black Hawk), and ten attack (Apache) helicopters. This new force structure does not yet possess Class IV UAVs imbedded within the unit. One would surmise that if MUM teaming were required that extensive coordination between the MFB and RSTA would have to occur.

Assessing the Data

Based on the above considerations the UAV is scored a (+) in effectiveness and a (+) in efficiency when assessing its responsiveness against the Comanche. UAV systems are agile systems that bring a great deal of responsiveness to the maneuver commander. The strong suits include speed of deployment, long loiter times, and most importantly, its NRT video capabilities. All these capabilities add up to Class IV UAVs being both as effective and efficient as the responsiveness of the Comanche.

This responsiveness analysis focused on the reconnaissance capabilities of the Comanche and Class IV UAVs. Certain considerations were also presented for the ground maneuver commander in employing these systems in the reconnaissance role. Chapter 5 will serve to tie all the previously discussed elements together and answer the primary thesis question. This chapter will also provide future recommendations and future areas to explore concerning this thesis.

CHAPTER 5

CONCLUSIONS AND RECOMMENDATIONS

> We are prepared for the arrival of the Comanche in the year 2009. Comanche will be a revolutionary cornerstone of the objective force and this networked C4ISR system architecture. It will provide the essential situational curiosity and judgment - you don't get that in an unmanned system--the situational curiosity and judgment that only comes with manned surveillance and reconnaissance assets. Augmented with unmanned aerial vehicles, Comanche will transform army aviation's contributions to the joint warfight by satisfying our most critical, current battlefield deficiency--armed reconnaissance.
>
> General Eric Shinseki, October 22, 2002,
> AUSA Speech

An excerpt from General Shinseki’s AUSA speech is a fitting way to conclude this thesis. He highlights the need for both manned and unmanned systems and the Army’s most critical need for platforms that can accomplish the armed reconnaissance mission. DoD, as well as all the service components, will debate the capabilities of manned aircraft and UAVs well into the twenty-first century. However, in spite of what the Army contends, Class IV type UAVs will be fielded by the time the Comanche reaches aviation units in 2009, and they will possess armed reconnaissance capabilities comparable to or better than the Comanche. This chapter will begin with a wrap-up of the author’s assessment on the three OF characteristics analyzed and finish with recommendations derived from this study.

Drawing a Conclusion

Table 2, Comanche versus Class IV UAVs in the armed reconnaissance role, highlights the author’s assessment of how well the UAV compares to the Comanche using the OF characteristics of survivability, lethality, and responsiveness. Both effectiveness and efficiency are measured against these criteria. A (+) score designates that the Class IV UAVs are at least comparable to the Comanche's capabilities. A (-) score designates that the Comanche provides a better capability than the UAV. This assessment focused solely on the armed reconnaissance role.

Table 2. Comanche versus Class IV UAVs in the Armed Reconnaissance Role

Objective Force Characteristic	Class IV UAV Effectiveness vs Comanche	Class IV UAV Efficiency vs Comanche
Survivability	(+)	(-)
Lethality	(-)	(-)
Responsiveness	(+)	(+)

The assessment shows, when viewing these three particular characteristics, an even split between (+)'s and (-)'s. Clearly the Army will require both of these systems as it modifies its force structure into the OF. The Army's MUM teaming concept is certainly a path in the right direction. Therefore, to answer the primary thesis question stated at the very beginning of this thesis: Will the emergence of UAVs spell the demise of the Army's RAH-66 Comanche in the armed reconnaissance role? Based on the data and the timeframe in which these systems will be fielded (2009), the answer is no. However, the author contends that the Comanche will be the last manned armed reconnaissance helicopter designed and employed by the U.S. Army.

Concerning the survivability aspect, the Comanche is designed to survive and operate in the low to high threat envelope. While Class IV UAVs are considerably lacking in survivable attributes, the very fact they are unmanned, allows these systems to continue to be employed in the same threat regimes as the Comanche. The big consideration revolves around the “cost” versus the “loss” of the particular system. This fact leads the author to score the Class IV UAVs as effectively survivable (+) when employed in the armed reconnaissance role but not very efficient (-) especially due to their low airspeeds and the altitudes in which they are employed.

Concerning lethality, the effects-based fires from current and future Class IV UAVs are simply not comparable to the effects from the Comanche. The Comanche’s robust firepower, especially its turreted gun system and its ATDC system, makes it more effective and efficient in nearly all attack and defensive roles. As payload capabilities of the UAVs begin to increase in future development, this gap will slowly close (effectiveness scored a (-)). The efficiency of the lethal effects from UAV systems will continue to lag behind the Comanche based on the premise of having a “man in the loop.” Until remote cognitive abilities or the capability for unmanned systems to process the changing dynamics of the battlespace become as good as that of the human brain, the Comanche (manned helicopters) will continue to be more efficient then UAVs (-) when lethal fires are required.

Lastly, the responsive characteristics of the UAV are perhaps its strong suit. The speed at deploying the systems, the loiter times, the ever-improving design changes to its EO/IR capabilities, its ability to be employed as an airborne relay, and most importantly, its NRT video capabilities, all add up to the Class IV UAVs being both as effective (+) and efficient (-) as the responsiveness of the Comanche.

Recommendations

While the author subjectively concludes the Comanche is still required in the armed reconnaissance role, numerous recommendations have surfaced during the research. The author proposes the reader should place more credence and gain more insight concerning the manned-unmanned debate by focusing more on the proposed recommendations that the subjective conclusion found above. Specific recommendations will be found in bold print.

1. One may ask why the Army is Army pursuing a fixed wing ERMP UAV when the Air Force already has the Predator A and will soon field the Predator B? **The Predator is the Army's answer to its need for a fixed wing variant for the ERMP UAV at the Divisional and Corps levels. The Army's focus should shift to a rotary wing ERMP UCAR**. MUM testing has shown that a UCAR may prove more effective and provide more ease of coupled control due to its hover capabilities than a fixed wing UAV.

2. Interestingly, the Shadow 200 while just recently entering the Army, should be considered an interim type UAV. The payload capabilities of even the later variants of the Shadow 200 will only be 75 pounds. With such small payloads, the Army is limiting its offensive and defensive capabilities by producing UAVs with payload capacities less than 350 pounds. Even with small diameter bombs, the Hellfire (AGM-114), the BAT or LOCAAS, the weight of these weapons falls in the 100 to 250 pound range**. The Army needs to develop its future Class III and IV UAVs with a minimum of a 350 pound payload capability**. While there is a trade off between the ability to launch a Class III

UAV from the top of a HUMVEE or small clearing, the brigade commander certainly could use armed UAVs to accomplish certain attack and armed reconnaissance roles.

3. Army Aviation finds itself in a unique situation by possessing the DoD's longest acquisition program, the Comanche, and one of its shortest programs, the Shadow 200. **While the author supports the idea of UAV test and development falling under the purview of the Army's PEO, care most be exercised when developing systems of comparable capabilities to accomplish the same roles and missions**

4. **An analytical methodology must be developed to compare man versus unmanned systems**. The manned-unmanned debate will continue to draw heated arguments from both camps, a definitive analytical methodology may provide guidance and the "hard numbers" for other services seeking the same answers.

5. **Other services can gain from the Army's MUM testing**. This testing will continue to provide the Army the ability to span the gap between its legacy to its OF.

6. The DoD *UAV Roadmap 2000* points to the lack of the U.S. producing a high-speed UAV while numerous other countries already possess this capability. **The Army should seek a high-speed capability for its follow-on Brigade UAV and ERMP**.

7. Another element brought out in the DoD *UAV Roadmap 2000* was the fact that UAV technologies should be considered in Analysis of Alternatives (AoA) determination in future combat systems. While the Comanche programmers did consider the UAV in its AoA, they linked UAV capabilities to the Comanche in a MUM role as opposed to considering UAV capabilities separately. **The author contends that definitive, prescriptive AoA guidance be enacted from DoD Acquisitions Office considering more alternatives when dealing with UAV capabilities**. This guidance may include a

comparison of what a separate, comparable class of UAVs can bring to the fight, as well as, alternatives dealing with UAVs as hunter-killer type formations. Such AoA considerations are not only limited to the aviation realm but to the Army's future unmanned ground systems as well. Granted such modeling may be difficult to simulate.

8. JTTP 3-55.1 is woefully out of date. Army Aviation has recently published a TUAV CONOPS that may serve as an excellent update to this joint publication. While, the Air Force and the Army seem to be leading the charge in UAV development and fielding, there are considerable differences in their approach. **Either Army Aviation or the Air Force's UAV office needs to submit recent force structure changes and TTPs to update this joint publication**.

9. Additionally, **the Army needs to develop a comprehensive FM that deals with its echelonment of its UAV systems, how these systems are employed, and the myriad of issues associated with its varied UAV systems**. Doctrine should drive systems employment. The *TUAV CONOPS* written for the brigade commander provides a good starting point for combining doctrine and procedures for operating the Shadow 200. The Army needs to publish a FM solely for UAV Operations. The question ironically becomes who should write it--RSTA, Cavalry, Aviation, Infantry or Intelligence?

10. The pervasive amount of Army UAV systems that will populate the battlespace begs the question of who should serve as the main control element. Air Force Doctrine Document (AFDD)-1 asserts as its master tenant, "centralized control and decentralized execution." While the Army differs from the Air Force in parceling out its weapon systems to different branches, UAV control and operations should reside under the direction of a commander that has "airmindedness." With this premise in mind, **the**

author contends that UAV system proponency should reside with Army Aviation, as opposed to the Armor, Infantry or Military Intelligence branches.

11. A hidden problem of the Army's OF and the employment of its FCS, is the lack of available satellite bandwidth. Although, the DoD plans to increase satellite bandwidth, OF material developers must remain cognizant of this fact. **The future "connectivity" of the OF is reliant on novel solutions to either increase bandwidth capabilities or decrease the amount required by present and future systems**

12. UAV material developers must not lose sight of the inherent strengths found in these systems, those being cost, size and speed of development. More can be done to increase the survivability of these systems without adding too much weight. Lethality aspects of UAVs will continue to improve. **The bottomline is that the designers must continually assess the premise of "cost versus loss," to keep these systems both effective and efficient.**

13. Many joint issues concerning UAVs remain. The main issues revolve around the different approaches the services will take in fielding their particular unmanned systems and the interoperability of such systems. **The DoD must serve as an "honest broker" in considering the varied IPLs of the combatant commanders and the varied UAV approaches posited by the services.**

14. **The maneuver commander must have a sense of how best to employ the aviation assets under his command or working inconjunction with his unit.** The fielding of various UAVs and the potential of employing these systems with manned helicopters will add new dimensions to how he will tactically engage the enemy.

Other Research Areas to Explore

There are many other relevant topics that lend themselves to further research concerning both the Comanche and the UAV. While the Army has taken the lead in the MUM teaming concept, one can research whether a rotary or fixed wing UAV may best be suited for such endeavors. The topic of pilot task saturation based on how many UAVs could be optimally controlled would also pose an interesting study. This MUM concept can easily extend into the world of UCAVs as well; certainly other services need to come on board to the Army's approach to MUM teaming. The *UAV Roadmap 2000* is an excellent source document and may provide the reader many interesting points to discuss or analyze concerning UAV development, especially the appendices which are filled with tantalizing information. One may also consider what is DoD's long range plan in acquiring and fielding UAVs since all the service components appear to be taking divergent paths in constructing their own mini "Air Forces." Lastly, issues concerning Army Aviation's restructuring into the Multi-Function Brigade or an analysis on whether 650 Comanches is enough for the Army's OF could pose interesting research topics.

APPENDIX A

MANNED UNMANNED (MUM) EXPERIMENTATION

Level of Control	Division of Labor	Results of Experimentation
MUM I	"Base Case" Comanche and UAV operating independently in the same battlespace, performing different missions for different commanders. The UAV performed ISR mission while the Comanche performed its armed reconnaissance mission Level 1 Control – direct radio communications between the Comanche and the UAV ground control station (GCS) This communication link enabled the Comanche crew to direct the UAV through the GCS comm network	• 10% reduction of time to conduct the tactical reconnaissance mission • 15% increase in identifying targets • 30% increase in Commander's Critical Information Requirements (CCIR) • Demonstrated mid-level ops of the UAV made it vulnerable to radar guided air defense threats.
MUM II	Collaborative planning between the Comanche and the UAV towards a common objective. Division of labor—UAV was used to generally sweep the open terrain while Comanche look in the nooks and crannies of the hills and to put "eyes on the target" using target detection cues from the UAV. Level of Control eliminated the GCS. Comanche crew had direct communications to the UAV. Intent was to use the UAV as a remote sensor controlling the azimuth, depression angle, an zoom factors of the UAV sensor payload	• Visual imagery of the UAV to the cockpit of the manned system was used to increase the effectiveness and survivability of the team. • Manual control of the UAV sensor payload plus control of the UAV platform operations by the Comanche crew could not be conducted effectively. Team survivability was negatively affected by the cognitive skills paralysis that occurred at the point of task overload.
MUM III	Continuation of MUM Level II Imagery presented the same way for the UAV and the Comanche sensors UAV imagery processed through the Comanche's aided target detection classification (ATDC) system, presented to the crew as a cropped image UAV also identified in the image Also examined Rotorcraft Pilot's Associate (RPA) tech to reduce crew workload	• VTOL TUAV platform and sensor characteristics enabled employment at standoff ranges for security of both air and ground maneuver forces • VTOL TUAV employed at low altitudes could utilize the survivability enhancements provided by terrain masking and radar clutter • UAV, coupled with RPA technology, improved the overall mission effectiveness of the MUM team
MUM IV	Capitalize on cognitive decision aiding to enable the Comanche crew to realistically manage the workload associated with employing level 4 control of multiple UAVs Examined the number of UAVs a manned system can reasonably control	• Cognitive decision aiding tools are absolutely necessary if the Objective Force concept continues to add remote weapons and sensors to unmanned systems. • Based on automation simulation, two UAVs is the number that a crew can reasonably control

Source: Aircraft Survivability: Bergantz, Manned and Unmanned Experimentation, Enabling Effective Objective Force Operations, Fall 2002

APPENDIX B

THE INHERENT VULNERABILITIES OF TECHNOLOGY: INSIGHTS FROM THE NATIONAL TRAINING CENTER'S OPPOSING FORCE

by Colonel John D. Rosenberger, U.S. Army

Introduction

Good morning ladies and gentlemen. To the 2,500 troopers of the 11th Armored Cavalry Regiment, the Opposing Force (OPFOR) at the U.S. Army's National Training Center (NTC), it came as no surprise to watch the 3d Serbian Army march back into Serbia virtually unscathed by the relentless attacks of NATO air power during the Kosovo conflict this past year. Moreover, it came as no surprise to see the Serbian Army employ a wide variety of physical and electronic deception techniques, remain tactically well-dispersed, and hide their combat systems in the infrastructure of cities and villages to preserve their combat power.

This is old news to the combined-arms team of the NTC's Opposing Force. These same Serbian adaptations have been learned and employed successfully by the OPFOR at the NTC since 1994-adaptive countermeasures critical to preserving combat capability at the tactical level of war against the impressive array of intelligence collection and attack technologies employed by America's joint team. Moreover, this is only one of several insights the OPFOR can provide into the limitations and vulnerabilities of the current warfighting technology that underpins America's style of warfare in the 21st Century.

Limitations and Vulnerabilities of Air Power and Reconnaissance Platforms

In the past six years, the NTC OPFOR has exposed many limitations and vulnerabilities inherent to the warfighting technologies our joint services are currently pursuing. Moreover, they've learned to defeat them just like any adaptive and savvy opponent will do-just as the Serbian Army did this past year. In my view, these vulnerabilities that we have exposed are compelling, not simply to make smarter technological investments in the years ahead, but equally important, ensure we do not forfeit combat effectiveness, the ability to deter, or the ability to quickly defeat our enemies at both the operational and tactical levels of war in the years ahead.

To begin with, we have learned that active and passive force protection measures are vital to preserving combat power against asymmetric technologies, asymmetric in this case meaning some technological capability that provides a decisive advantage over an opponent in combat. For example, cruise missiles, laser-guided bombs, satellite reconnaissance systems, high altitude reconnaissance aircraft, and unmanned aerial vehicles have provided us an asymmetric combat advantage over all our opponents this past decade.

In response to these capabilities, we have learned that thermal deception, vehicle and unit dispersion, decoys of all types, camouflage, concealment, and electronic deception are vital means and ways to protect and preserve our ground combat power. Furthermore, the OPFOR has learned that air power and overhead intelligence acquisition systems have significant limitations and are inherently vulnerable to deception-even in desert and mountainous terrain. And by extension, even more so in densely forested areas and jungles, not to mention complex and urban terrain.

Take fixed-wing attack aircraft. It is not difficult to survive against the existing suite of joint close air support aircraft (F-16, F-18, A-10, and equivalents), attacking at altitudes above 15,000 feet, even in the desert.

Given the target acquisition capability and the speed in which these aircraft fly, target acquisition and target recognition at these altitudes is difficult at best. We have learned that if we limit our movement, don't create dust clouds, remain tactically dispersed, use camouflage, and employ decoy equipment, we will absorb few losses to fixed wing attack above 15,000 feet-the same methodology of force protection the Serbian Army and para-military forces employed in the dense forests, cities, and villages in Kosovo.

By using a combination of these force protection techniques, the effectiveness of high-altitude, fixed-wing attack against ground forces can be limited and thereby endured. Moreover, this ability to eliminate the effectiveness of high-altitude fixed-wing attack, in turn, places an even higher value on overhead target acquisition platforms like satellites, JSTARS, and unmanned aerial vehicles. And as we have learned, these overhead intelligence collection systems-the operators and analysts-are inherently easy to deceive. Take reconnaissance satellites in low earth orbit. Given our experience, it takes about 18 hours to complete the targeting process using these sensors-from acquisition, to imagery analysis, to integration into the ATO, to effective attack. Consequently, we've learned to move critical combat systems every 10-12 hours to protect them and keep them in the fight. Frequent survivability moves, in small packets of vehicles are an essential technique to employ to preserve combat power.

Or take JSTARS. This impressive Air Force reconnaissance system, providing both Moving Target Indicator data and Synthetic Aperture Radar images, is able to acquire and track moving vehicles within a 10,000 sq/nm area, depending on weather and terrain conditions. Under the right conditions, this formidable capability can provide commanders at many levels a near-real time appreciation of the enemy's size, strength, composition, movements, or the array of forces throughout a Joint Forces Commander's battlespace. Mountainous terrain and weather degrade its capability, but it still remains an invaluable instrument of war for both tactical and operational commanders. However, we have learned how to deceive the operators and analysts behind the JSTAR screens, and leverage them to set conditions for success.

Since JSTARS cannot reliably acquire and define the composition and types of vehicles in a column of vehicles, the OPFOR routinely organizes battalion-size truck columns, perhaps led by 2-3 armored vehicles, all dragging 20-30 ft. lengths of concertina wire. This column, easily acquired by JSTARS, is then employed along an expected route of march towards the enemy. This imaginative technique is aimed at deceiving the enemy commander as to our intended point of attack or main effort. Being told that this is an armored column by his JSTAR data analyst, the enemy commander will typically react and shift targeting assets, or his mobile reserves to interdict the advance. This technique in offensive operations can be used to create a weakness in the enemy's defense permitting rapid penetration and exploitation. Employment of this technique has set conditions for OPFOR tactical success several times in the past.

The other technique that works to defeat JSTARS is infiltration-the movement and concentration of a large mobile organization by moving it in small packets of vehicles along multiple routes, seemingly without any pattern-concentrating forces over time. The Serbs used similar techniques to preclude effective air attacks against their ground combat forces and deceive NATO forces of their actual strength, disposition, and location. Even more ingenious, they used the appreciation of this vulnerability to lure NATO attack aircraft, cued by JSTARS, into attacking organized columns of civilian vehicles, then exploiting the scenes of carnage via the international media-information warfare at its best, designed to attack the solidarity of the NATO coalition.

In short, against a savvy opponent, JSTARS acquisitions have little intelligence value to tactical and operational commanders unless the data or images are confirmed quickly by another real-time imagery system such as a UAV, AFAC, or a well-trained reconnaissance team that has the capability and optical resolution to discern the exact composition and type of vehicles acquired. The same goes for unmanned aerial vehicles (UAVs). In response to the presence of UAVs on the battlefield, we have developed several techniques to deceive and defeat its capabilities. We use a combination of physical and thermal decoys to deceive the UAV pilots and image analysts, and thereby nullify the effects of indirect fires while preserving our actual combat systems and crews.

For example, we will construct deception fighting positions and in them place tank decoys made of fiberglass turrets, gun tubes made out of steel/PCV pipe, and other materials to create a realistic physical image. Furthermore, we cut 55 gallon barrels in half, and place them where the engine compartment of the tank is located, then we fill them with burning charcoal to create a realistic thermal signature. Flying at an altitude of 2000-5000 feet, and looking through the narrow field of view to achieve resolution, a UAV image analyst, unless very experienced, cannot tell it's a decoy. From these altitudes, they look just like tanks. We also use vehicular decoys made of fabric and wood frames, just like the Serbs employed. They work.

Finally, we have become adept at conducting air defense ambushes to destroy UAVs. We place actual unmanned, usually inoperable combat equipment, such as an armor or air defense system, into a position where the enemy would expect to find them. We will throw in a blanket of smoke to attract their attention and really draw them in. We ring this equipment with multiple organic air defense radar and missile systems, camouflaged well with engines cold. Basically, we lure UAVs into an area. Once we visually or acoustically acquire the UAVs-which can be easily acquired by their sound-and determine they are within range, we unmask and fire. Using this technique, we routinely destroy 50%-75% of UAVs employed against us during the course of an NTC training exercise. In case you're wondering, we employ systems that accurately replicate ZSU-23-4s, SA-18s, SA-8s, and SA-9s. By the way, the hand-held, shoulder-fired S-18 air defense missile is our most effective ADA system against both rotary wing and UAV capabilities.

Vulnerabilities of Information and Communications Systems

Another important lesson we've learned is this: the key to defeating forces equipped with sophisticated collection, targeting, and situational awareness technologies is to quickly gain information dominance in the initial phase of the operation. We have learned that if we focus reconnaissance assets and lethal/non-lethal fires to acquire and destroy or disrupt the enemy's ability to move information across the battlefield, then we can quickly level the playing field, negate this asymmetric advantage, and thereby set conditions for success. Against the Army's current situational awareness, information, and communications systems, fielded or in development, it is not a difficult task given the capabilities we possess.

Take the Army Tactical Command and Control System (ATCCS), a suite of 5 different software systems (MCS, ASAS, AFATADS, FAADC3, and CSSCS), designed to provide critical combat information to commanders and staffs at brigade, division, and corps level. These information systems, in various stages of development, employ a line-of-sight communications system called the Mobile Subscriber Equipment (MSE) system, as the means to move information across the battlefield between commanders and staffs from battalion to corps level.

Based upon mission requirements, the MSE system operates at multiple frequency ranges from tactical VHF to SHF ranges above 15 GHz using a digital communications signal. We have learned that the electronic signature is a relatively easy target to acquire and jam, using a technique we call dual harmonic jamming. Basically, the MSE signal frequencies lie above our ability to jam with the systems we have, but we have learned that by taking 2 jammers and jamming 1/3 of the primary carrier wave and = of the primary carrier wave frequency simultaneously, the combination of these attacks affects 5/6 of the carrier wave therefore most of the transmission is not received. No MSE transmission, then no ATTCS-no ATTCS, then no situational awareness from brigade to corps level.

Furthermore, because it is a stationary, line-of-sight system, the MSE system is limited in its positioning to easily predictable terrain locations and the node centers present a large physical signature. They can be easily acquired by aerial and ground reconnaissance teams and have very little security, if any, surrounding these sites. They will be one of the first set of targets we attack. In short, destroy the brigade MSE node complex with indirect fires or direct attack, and you stop the flow of information and sustainment of both friendly and enemy situational awareness. In other words, by attacking this vulnerability, the OPFOR has learned how to level the playing field very quickly and eliminate its opponent's asymmetric information advantage.

Or take the Army's Force XXI Battle Command Brigade and Below system, FBCB2, the Army's flagship information technology designed to create common situational awareness between crews, leaders, and units on the battlefield below brigade level-a "tactical internet" for the Army's combined-arms team. FBCB2, the Army's tactical internet currently in development, employs two line-of-site communications systems as a means to move digital information across the battlefield between computer systems mounted in combat vehicles and headquarters. More specifically, the situational awareness information created by computer software, internal to crews and platoons, is carried on a backbone of the Single Channel Ground and Airborne Radio System (SINCGARS SIP), operating in the VHF band.

At platoon leader/platoon sergeant level and above-all the way up to the brigade commander-the situational awareness information is carried on a backbone of the Enhanced Position Location Reporting System (EPLRS), a UHF radio. Both operate in the frequency-hopping mode.

Of the two radios, EPLRS is the primary means of moving data across the battlefield and creating icons on computer screens that reflect the current location of every combat vehicle/crew on the battlefield. In other words, it is the principal means of creating both friendly and enemy situational awareness throughout a brigade task force. Information is transmitted via data transmissions through a network of stationary base stations-5 per division and 1 per brigade-positioned on high ground within a division's area of operations. Furthermore, it has an embedded relay system. This provides a jam-resistant, robust, high-speed, high-volume communications network to multiple, simultaneous users. In fact, the OPFOR's current legacy IEW systems are unable to electronically acquire and locate these systems on the battlefield. Of note, however, some current commercial off-the-shelf electronic warfare systems have the capability to track and capture the limited hop-set group of frequencies in EPLRS, and through the use of wide-band barrage jamming techniques and multiple jamming systems, transmissions can be blocked or severely disrupted.

However, the OPFOR has learned to attack EPLRS's principal vulnerability, the physical signature of the EPLRS base station; a group of vehicles, antennas, and generators normally co-located with MSE node sites adjacent to the brigade tactical operations center. The location of these stationary, and relatively immobile communication node centers is easy to predict, given a line-of-site analysis within an area of operations. There are a limited number of accessible positions where comprehensive line of sight communications can be established and sustained.

Find the MSE communication sites and you'll find the EPLRS base station. Accordingly, the OPFOR tasks both its division and regimental reconnaissance teams to find these large, easily identifiable communication sites during the reconnaissance phase of an operation, then we attack these sites with accurate long-range artillery, rockets, or fixed-wing assets during the first phase of offensive or defensive operations-to include persistent and non-persistent chemical strikes. This stops the flow of digits, quickly levels the playing field, and eliminates the asymmetric advantage afforded by the technology. As a side note, the JSTARS downlink, the Common Ground Station, is also co-located with the brigade tactical operations center. Successful attack of this complex will also eliminate JSTARS feed to the brigade commander.

The second piece of the system, the SINCGARS tactical VHF radio, is a line-of-sight radio easily disrupted by hills and mountainous terrain, unless continually supported by multiple aerial or ground retransmission stations positioned within the brigade's area of operations. Furthermore, it is even more limited, if not ineffective, when fighting in cities; a lesson painfully-learned by the Russians in Grozny, Chechnya in 1996 and again this past year. While they struggled to maintain FM communications to control operations, the Chechnyans used cellular telephones and commercial satellite communications to coordinate their defensive operations within the city.

Although invulnerable to our current electronic warfare systems, the OPFOR has discovered that the range of the SINCGARS radio is cut almost in half when placed in the frequency-hopping mode. Consequently, in order to sustain communications, operators will switch to single-channel mode to extend the range of the radio and re-establish communications. A SINCGARS radio, passing digital packets of information in the single-channel mode, is the easiest communications signature to acquire, locate, and jam with our current suite of jammers. We can quickly block the transmission.

Although we have not been permitted to jam FBCB2 yet, we have become very adept at acquiring and jamming similar information systems employed by our Army's fire support team-TACFIRE, IFSAS, and AFATADS-thereby precluding the execution of fire support during battle. It follows then, that our FBCB2 system, when fielded, will be similarly vulnerable to disruption. Furthermore, there are available commercial off-the-shelf systems that can capture and track the SINCGARS hop-set, thereby making the system vulnerable to disruption by barrage jamming, using multiple jammers. If you can disrupt transmissions through barrage jamming, then the SINCGARS radio loses system synchronization. Once synchronization has been lost, the operator is required to re-enter the net in the single channel mode, a mode easy for us to acquire, locate, and attack. Equally important, disrupting synchronization stops the flow of situational awareness information from the computer system.

On the ominous horizon, we foresee the proliferation of GPS jammers-small, effective, and inexpensive jammers that will block GPS signals eliminating GPS navigation and precision guidance capabilities within an extensive area of operations. For $40,000 today you can buy an effective lightweight, portable GPS jammer from the Russian firm

AviaConversia-in fact they make four different variants. These GPS jammers have an output power of 4-8 watts-making them very tough to acquire-and can effectively block GPS signals out to ranges of 150-200 kilometers, depending on terrain, even more if mounted on a UAV. I understand that business is picking up. By the way, the SINCGARS radios supporting FBCB2 depend on GPS signals to sustain synchronization and sustain situational awareness. Take out GPS signals-no SINCGARS-no SINCGARS-no FBCB2 or situational awareness internal to platoons and companies.

For a joint force that has become GPS-dependent for its style of warfare and effectiveness, this is a classic asymmetrical response that will level the playing field, perhaps eliminating the dominating capabilities our technology has provided us the past decade. We plan to introduce GPS jammers in our Opposing forces in the near future. It's increasingly clear that we learn-or re-learn-how to fight without GPS capability.

No Substitute For Ground Reconnaissance Teams

Finally, the we have learned that there is no substitute for well-trained ground reconnaissance teams in warfighting at the tactical level of war. Despite all the intelligence and information technology provided to our brigade task force commanders over the pasts 6 years, the OPFOR regimental commanders, using 1960s-1970s technology and unaided by any overhead reconnaissance systems, have always had better, near-perfect information about the strength, composition, location, and disposition of their opponents. Their opponents, on the other hand, have remained and continue to remain relatively blind despite the bloom of technology.

This ability to see the battlefield better than their opponents, despite the introduction of sophisticated technologies, is provided by our division and regimental reconnaissance teams, undoubtedly some of the best trained tactical reconnaissance teams in the world. The indisputable fact is that well-trained observers (reconnaissance teams) in sufficient number to establish observation throughout the depths of the battlefield, armed with effective, secure communications, easily offset the supposed asymmetric advantages of overhead reconnaissance platforms in the business of close combat at brigade level and below. Moreover, from a practical perspective, overhead reconnaissance platforms cannot classify a bridge and determine if it will support the movement of forces, find and determine feasible fording sites across rivers or streams, find minefields or bypasses, or provide any accurate information about enemy strength and dispositions within cities, the most likely battlefields in our future.

Conclusion

In conclusion-if the insights provided in this presentation cause you to question the direction, design, and investments we've made in trying to create information dominance at the tactical level of war, that's good. If these insights foster a change in your perspective about the practical value and utility of technology by exposing its limitations and vulnerabilities, that's good, too. If it drives our joint team to pursue more prudent technological investments in the future, or drives the creation of better organizations, equipment, doctrine, tactics, and techniques for employing technology in the future, that's even better. If it convinces you that we should keep teaching our Soldiers and marines how to read a map and navigate with compass in hand, or keep teaching artillerymen how to survey their firing positions, or teach our staffs what to do when the screens go blank, that's icing on-the-cake.

Finally, if it convinces you that our Opposing Forces at our combat training centers can provide critical insights into the limitations and vulnerabilities of technology, informing our judgment to ensure we wisely adapt and dominate our threats in the 21st Century, then my objective has been accomplished. One thing is for certain. If we ignore the lessons and successful countermeasures our Opposing Forces have made and continue to make against technology, then we ignore the work of these great Soldiers at our peril. Thank you for the opportunity to share this with you today.

GLOSSARY

Armed Reconnaissance. A mission with the primary purpose of locating and attacking targets of opportunity, i.e., enemy material, personnel, and facilities, in assigned ground communications routes, and not for the purpose of attacking specific briefed targets. (Joint Publication 1-02, 12 April 2001)

Contemporary Operational Environment (COE). The COE is defined as "The OE that exists in the world today and is expected to exist until a peer competitor arises." (Opposing Force Doctrine CD, Apr 02)

Deep Strike Mission. Operations directed against enemy forces that currently are not engaged but could influence the division and corps close operations within the next 24 to 72 hours. (FM 1-112: *Attack Helicopter Battalion*)

Effectiveness is defined as producing the desired effect; to produce; to cause; to fulfill; execute. (*Webster's Scholastic Dictionary,* 1975)

Efficiency is defined as the state or character of being effecting or capable. (*Webster's Scholastic Dictionary,* 1975)

Lethality. This characteristic will allow Army forces to destroy any opponent quickly, with shattering effect…Army forces can combine the elements of combat power to provide overwhelming and decisive force at the right time, at the right place, and for the right purpose. (FM 1: *The Army*, 14 June 01)

Operating Environment (OE). The OE is a composite of the conditions, circumstances, and influences that affect the employment of military forces and bear on the decisions of the unit commander. (JP 1-02, Apr 12, 2001)

Responsiveness. Responsiveness has qualities of time, distance, and sustained momentum.…It demands close, continuous coordination between Army component commanders and joint and interagency decision making bodies. (FM 1, *The Army*, 14 June 01)

Survivability. Ground and air platforms that employ the best combinations of low observability, ballistic protection, long-range acquisition and targeting, early attack, and high first-round hit-and-kill technologies will be required to ensure the desired degrees of survivability. (FM 1, *The Army*, 14 June 01)

Unit of Action (UA). UAs are the tactical warfighting echelons of the (OF). For analytic purposes UAs comprise those echelons brigade and below. Maneuver (UAs) are the smallest combined arms units that can be committed independently. Their function is to finish decisively by closing with and destroying enemy forces through integrated fire and maneuver, and tactical assault…The span of control of the UA brigade is four to six battalions. (TRADOC Pamphlet, *Operational Requirements Document for the Future Combat Systems* 525-3-91, Nov 25, 2002)

Unit of Employment (UE). UEs perform tasks assigned today to divisions and higher service headquarters. They resource and execute combat operations; designate objectives…and employ long range fires, aviation and sustainment; while providing command, control, communications, computers, intelligence, surveillance and reconnaissance (C4ISR) and tactical direction to UAs. (TRADOC Pamphlet, *Operational Requirements Document for the Future Combat Systems* 525-3-91, Nov 25, 2002)

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FM 3-0. 2001a. See U.S. Department of the Army. 2001a.

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