REPORT DOCUMENTATION PAGE

Form Approved
OMB No. 0704-0188

1. REPORT DATE *(DD-MM-YYYY)*	**2. REPORT TYPE**	**3. DATES COVERED** *(From - To)*
02-04-2015	Master of Military Studies Research Paper	September 2014 - April 2015

4. TITLE AND SUBTITLE

Army Aviation and the Megacity: Winning In a Complex Urban Environment

5a. CONTRACT NUMBER
N/A

5b. GRANT NUMBER
N/A

5c. PROGRAM ELEMENT NUMBER
N/A

6. AUTHOR(S)

Sickler III, Robert I., Major, AV, US Army

5d. PROJECT NUMBER
N/A

5e. TASK NUMBER
N/A

5f. WORK UNIT NUMBER
N/A

7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)

USMC Command and Staff College
Marine Corps University
2076 South Street
Quantico, VA 22134-5068

8. PERFORMING ORGANIZATION REPORT NUMBER
N/A

9. SPONSORING / MONITORING AGENCY NAME(S) AND ADDRESS(ES)

N/A

10. SPONSOR/MONITOR'S ACRONYM(S)
N/A

11. SPONSOR/MONITOR'S REPORT NUMBER(S)
N/A

12. DISTRIBUTION / AVAILABILITY STATEMENT

Approved for public release; distribution is unlimited.

13. SUPPLEMENTARY NOTES

N/A

14. ABSTRACT

To compete in the complex urban terrain megacities present, Army Aviation must both accomplish traditional missions more responsively and explore new missions uniquely suited to modern helicopters. This paper approaches support to the ground commander in a megacity with the underlying premise that rotary wing aviation can more effectively shape the operating environment if it is employed in a manner that recognizes the effect helicopters have on the enemy. Fourteen years of experience in Iraq and Afghanistan have demonstrated that the mere presence of helicopters has a profound effect on the actions of the enemy. When friendly helicopters are on station, the enemy stops maneuvering. If enemy forces don't, they can be identified and destroyed. Within the megacity, aircraft will never be able to unilaterally compel enemy action without unacceptable collateral damage. However, it is well within the ability of helicopters to restrict the enemy's freedom of maneuver to a level that will give friendly ground forces a relative advantage. Army Aviation can restructure its battalion level units and tactics to maximize this effect in respect to time and create operational depth for the ground commander.

15. SUBJECT TERMS

Army Aviation, urban operations, Megacity, UAS doctrine, Persistent Aviation Support, rotary wing doctrine, helicopter tactics

16. SECURITY CLASSIFICATION OF:			**17. LIMITATION OF ABSTRACT**	**18. NUMBER OF PAGES**	**19a. NAME OF RESPONSIBLE PERSON**
a. REPORT	**b. ABSTRACT**	**c. THIS PAGE**			Marine Corps University/Command a
Unclass	Unclass	Unclass	UU	81	**19b. TELEPHONE NUMBER** *(include area code)* (703) 784-3330 (Admin Office)

United States Marine Corps
Command and Staff College
Marine Corps University
2076 South Street
Marine Corps Combat Development Command
Quantico, Virginia 22134-5068

MASTER OF MILITARY STUDIES

TITLE:

Army Aviation and the Megacity:
Winning in a Complex Urban Environment

SUBMITTED IN PARTIAL FULFILLMENT
OF THE REQUIREMENTS FOR THE DEGREE OF
MASTER OF MILITARY STUDIES

AUTHOR:

Robert I Sickler III
MAJ, AV
United States Army

AY 14-15

Mentor and ~~Oral Defense~~ Committee Member: Dr. William Gordon
Approved:
Date: 4/2/15

Oral Defense Committee Member: MATTHEW J. FLYNN
Approved:
Date: 4/2/15

United States Marine Corps
Command and Staff College
Marine Corps University
2076 South Street
Marine Corps Combat Development Command
Quantico, Virginia 22134-5068

MASTER OF MILITARY STUDIES

TITLE:

Army Aviation and the Megacity:
Winning in a Complex Urban Environment

SUBMITTED IN PARTIAL FULFILLMENT
OF THE REQUIREMENTS FOR THE DEGREE OF
MASTER OF MILITARY STUDIES

AUTHOR:

Robert I Sickler III
MAJ, AV
United States Army

AY 14-15

Mentor and Oral Defense Committee Member: Dr. William Gordon
Approved: _____
Date: _____

Oral Defense Committee Member: _____
Approved: _____
Date: _____

Executive Summary

Title: Army Aviation and the Megacity: Winning in a Complex Urban Environment

Author: MAJ Robert I Sickler III, United States Army

Thesis: Army Aviation allows commanders to gain and maintain a position of relative advantage over the enemy in a megacity by restricting enemy freedom of maneuver and providing the means for ground commanders to conduct timely, informed maneuver.

Discussion: Army Aviation is easily distinguishable from the US Air Force in that the main objective of Aviation branch is to support the ground scheme of maneuver exclusively. To accomplish this task, commanders generally employ their helicopters to accomplish missions originally developed to counter the Soviet Army. To compete in the complex urban terrain megacities present, Army Aviation must both accomplish traditional missions more responsively and explore new missions uniquely suited to modern helicopters. This paper approaches support to the ground commander in a megacity with the underlying premise that rotary wing aviation can more effectively shape the operating environment if it is employed in a manner that recognizes the effect helicopters have on the enemy. Fourteen years of experience in Iraq and Afghanistan have demonstrated that the mere presence of helicopters has a profound effect on the actions of the enemy. When friendly helicopters are on station, the enemy stops maneuvering. If enemy forces don't, they can be identified and destroyed. Within the megacity, aircraft will never be able to unilaterally compel enemy action without unacceptable collateral damage. However, it is well within the ability of helicopters to restrict the enemy's freedom of maneuver to a level that will give friendly ground forces a relative advantage. Army Aviation can restructure its battalion level units and tactics to maximize this effect in respect to time and create operational depth for the ground commander. Future technology, including Unmanned Arial Systems, can and will enhance the ability of Army Aviation to win in a complex urban environment.

Conclusion: By becoming a more responsive force that is able to maintain sustained pressure on the enemy within an air ground team, Army Aviation can significantly increase its ability to support operations in megacities within the tenants of the Army Operating Concept.

DISCLAIMER

THE OPINIONS AND CONCLUSIONS EXPRESSED HEREIN ARE THOSE OF THE INDIVIDUAL STUDENT AUTHOR AND DO NOT NECESSARILY REPRESENT THE VIEWS OF EITHER THE MARINE CORPS COMMAND AND STAFF COLLEGE OR ANY OTHER GOVERNMENTAL AGENCY. REFERENCES TO THIS STUDY SHOULD INCLUDE THE FOREGOING STATEMENT.

Preface

A great theoretical debate is taking place in the US military about what is the best way to spend the precious resources the country has allocated towards defense at the tail end of the nation's longest war. The Army has created a new operating concept to serve as guide for tackling this incredible task in an ever-changing world. Initially, I had planned to address how Army Aviation could support the new operating concept through the lens of my experiences in Iraq and Afghanistan. However, after realizing the enormity of such a project, I decided to pare the scope of my concepts to the emerging phenomena of Megacities. I humbly hope that this body of work may add, in some small manner, to the ongoing debate.

I owe an intense debt of gratitude to several mentors who have assisted me as I fumbled through the arduous task of turning my nebulous concepts into a coherent argument. LTC Adrian Bogart, whose immediate and unwavering conviction in me gave me to confidence to approach this important topic. COL T.J. Jamison, whose aggressive fighting spirit and unrelenting determination in combat inspired the basic premises that the theories in this paper rely on. My father, who listened to me ramble about my ideas for hours, as they slowly matured into the final product. And Dr. William Gordon, who has been with me through every step of the process, prodding me along to make sure that I didn't lose sight of my ultimate goal of a finished product.

Table of Contents

Illustrations

Page

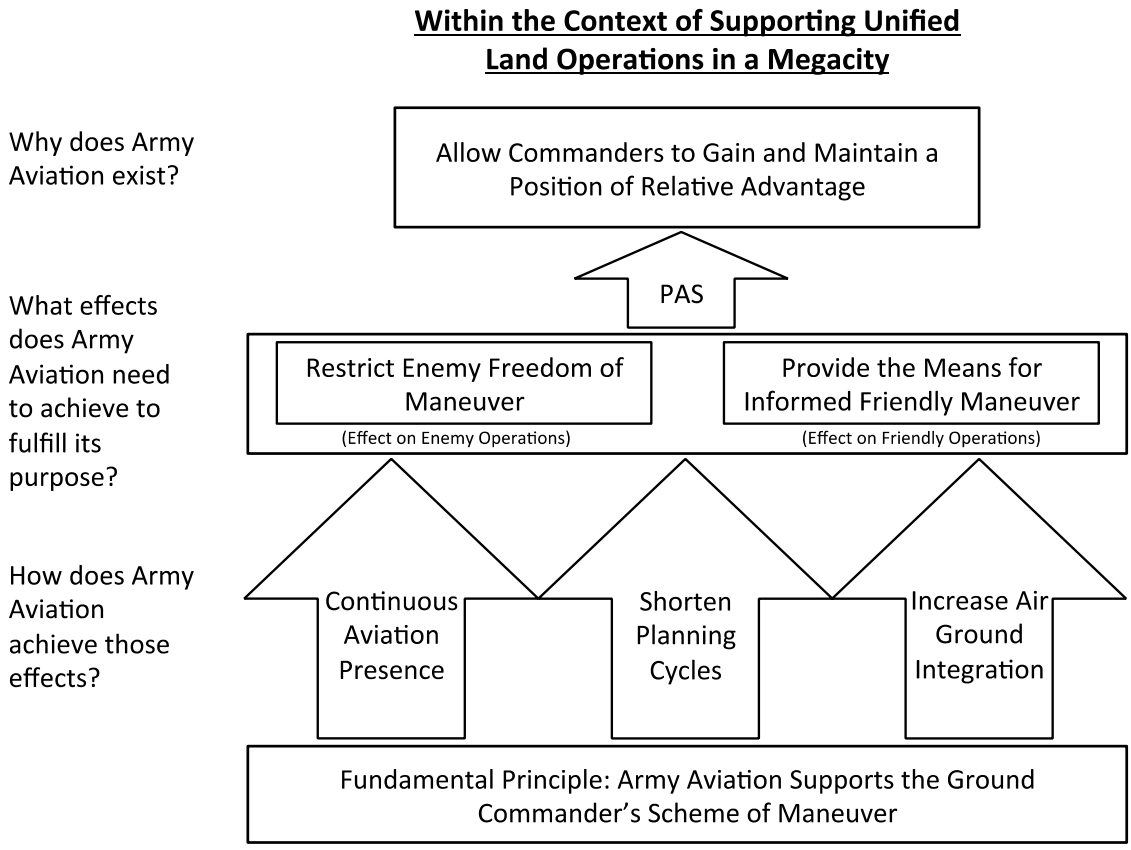

Figure 1: Underlying Logic of Argument

"Forces conduct continuous reconnaissance and security operations to seize, retain, and exploit the initiative over the enemy while protecting the force against dangers."
-The Army Operating Concept[1]

Introduction

Army Aviation must address the challenges that operations in complex urban environments create, just as the Army did when it faced new challenges associated with a formidable Soviet Union military in the mid 1970's. In October 1973, an Arab alliance armed with Soviet equipment and employing similar doctrine launched a surprise attack on a severely outnumbered Israel. After three weeks of intense fighting, the Israeli Defense Force successfully defeated the Egyptian and Syrian armies, through careful application of combined arms and maneuver.[2] While Israel was desperately fighting for its existence, the United States Army was striving to update its doctrine and equipment after conducting Counter Insurgency (COIN) operations for nearly a decade in Vietnam. In this respect, the Yom Kippur War provided an incredible opportunity for Army leadership to collect lessons learned from an actual mid-intensity conflict and refocus doctrine on the looming Soviet threat in Eastern Europe.[3] Many of the insights the Yom Kippur War produced only supported ideas already evolving into a new concept of operations called "AirLand Battle," but the war did reinforce a sense of urgency that the United States Army was ill prepared to fight the Soviets after Vietnam.[4]

Military operations in very large cities represent a new strategic challenge and are analogous to the Soviet threat of the 1970's in several ways. Similar to 1973, the United States Army is once again in the final days of a long war, and Israel has recently conducted operations in an environment similar to one that United States Army Aviation

at present lacks sufficient doctrine in which to dominate. Israel's Gaza Strip operations, Cast Lead in 2008 and Protective Edge in 2014, demonstrate that armies may, by necessity, fight future conflicts in complex urban terrain. As population and geographic area of urban sprawl increase, new challenges arise associated with conducting military operations, and the largest category of complex urban environments is the "megacity." The United Nations defines a "megacity" as a city with more than 10 million inhabitants.[5] Such large populations strain traditional intelligence gathering techniques and complicate the employment of lethal force with an increased chance of civilian casualties. Additionally, the urban structures associated with high population densities present problematic situations that challenge maneuver in a megacity. With only 1.8 million inhabitants, the Gaza Strip is not technically a megacity.[6] However, the challenges the Israeli Defense Force encountered in an area with less than one-fifth the population of the smallest megacity should demonstrate the urgency needed for United States Army Aviation doctrine to address such an important potential operating environment, just as the Yom Kippur War did in 1973.

To transform into a force that can dominate in a megacity, Army Aviation must shift its method of employment to a concept that embraces a continuous aviation presence.[7] This continuous aviation presence along with shortened planning cycles and increased air ground integration forms Persistent Aviation Support (PAS). PAS starts from the idea that helicopters, specifically attack helicopters, can be airborne and conducting operations 24 hours a day, seven days a week. History shows that the mere presence of friendly helicopters on the battlefield will have a significant impact on the enemy. Additionally, the very nature of having helicopters in the air at any given time

will increase the effectiveness of more traditional methods of rotary wing aviation employment in urban operations and create the conditions necessary to shorten planning cycles, especially if commanders strengthen air ground integration. By providing a continuous aviation presence combined with shortened planning cycles and strong air ground integration, Army Aviation can allow commanders to gain and maintain a position of relative advantage over the enemy in a megacity by restricting enemy freedom of maneuver and providing the means for ground commanders to conduct timely, informed maneuver.

This paper will explain this concept in four main sections. First, it will explain the basic assumptions used to develop the concept. Second, it will provide context dealing with what makes a megacity different, why such an operating environment matters, and the current doctrine for rotary wing aviation employment. The third section of this paper is a short overview of the concept. The fourth section of the argument for PAS is a detailed explanation of the concept within the tenants of the current Army Operating Concept. Finally, the paper will conclude by exploring possible technologies that can enhance the effectiveness of this new concept of aviation operations in a megacity and bridge the gap to the future.

Assumptions

There are three main assumptions required to ensure that PAS can provide the desired effects on the enemy. Historical and contemporary combat examples support the validity of the first two assumptions: that just the presence of aircraft influences enemy activity, and that airpower alone cannot destroy all enemy forces in an area of a city. The

third assumption is that commanders can create an area within a megacity with joint shaping operations where the enemy threat to friendly helicopters is sufficiently low for commanders to employ them. All three assumptions must be true for PAS to be both adequate and necessary.

In combat, every friendly action holds the potential to elicit a counter action from the enemy. The mere presence of friendly aircraft can serve as that friendly action. Modern aircraft are outfitted with sensors and weapons that give them an ability to observe, engage, and report that the enemy must account for in their actions. In Operation Enduring Freedom (OEF), dismounted patrols would frequently use fixed wing aircraft to conduct a "show of force." The aircraft, usually a fighter/attack aircraft, would "buzz" the area where friendly forces were conducting operations at a low altitude. Commanders intended the show of force to demonstrate to any enemy operating in the area that there was an aircraft on station that could provide support if there was a fight. The effectiveness of this tactic is difficult to prove, because it requires one to prove the absence of enemy activity is the result of any one specific action. However, those who employed it strongly believed in its validity.[8]

One example where attack aircraft had a documented effect on the actions of the enemy took place in 1981 in Afghanistan, when Mujahedeen fighters conducted an ambush on a Russian convoy in Logar Province. The Russians at the time had developed a pattern of behavior where attack helicopters would fly ahead of convoys to recon for ambushes. The Afghans observed this pattern and used it to their advantage. The Mujahedeen would set their weapons up at their fighting positions early in the morning then return to their houses to eat breakfast. Once the helicopters flew down the route, the

Afghans would take up their positions and wait for the convoy they knew was nearby.[9] In this example, the effect of the presence of helicopters actually was adverse for the force employing aircraft by telegraphing their movements.

Another situation where the presence of aircraft had a verifiable effect on enemy actions unfolded in Mosul, Iraq, in 2007. A team of two OH-58Ds was refueling at Forward Operating Base DIAMONDBACK when the pilots witnessed a large explosion several kilometers north of the airfield in an area known for high enemy activity. The two aircraft immediately completed their refueling and flew straight to the site of the explosion. The total time from explosion to the aircraft arriving "on station" was less than five minutes. When the team arrived overhead, the pilots witnessed a Bradley Fighting Vehicle that had been thrown more than 20 meters by a very large buried Improvised Explosive Device (IED). The turret of the vehicle had separated and was lying near the crater the explosion created. The crew of the Scout Weapons Team (SWT) could see that the turret was pinning a soldier down and that several other soldiers were attempting to free him by lifting it off. The pair of OH-58Ds provided security for the unit as they recovered their casualties and the damaged vehicles they sustained during the explosion. Several days later, a captured insurgent confessed his involvement in the attack and explained that he and others had planned to follow up the attack with a coordinated small arms attack on the soldiers attempting recovery. The enemy aborted the planned small arms attack once the OH-58Ds arrived on station and provided security.[10]

If it were not for the captured insurgent, the OH-58D pilots would not have been able to verify that their action prevented a possibly disastrous enemy attack. The ability

to prove that the presence aircraft have an effect on the enemy is the exception rather than the rule. The handful of documented examples where just the presence of aircraft influence the behavior of the enemy, either positively or negatively, can easily be explained away as outliers. Similar examples could also be provided where the presence of aircraft did not seem to effect the enemy's actions in any way. Attempting to prove that the presence of aircraft alone absolutely influences the enemy is in effect attempting to prove a negative, because it is impossible to truly know what the enemy is thinking and doing at any given time. For example, how can commanders link an increase of flights in an area to a decrease in enemy activity with any certainty? In this regard aircraft influencing enemy actions through presence alone must remain an assumption. However, adequate evidence does exist for this to be a plausible enough assumption to form the base from which PAS will build.

Early airpower theorists such as General Giulio Douhet and Major General William "Billy" Mitchell argued that the aircraft, a new technology in their time, could nearly unilaterally accomplish the goal of a war, with ground forces only providing a supporting effort to an air campaign. However, these early theorists misinterpreted the technological limits of aircraft to bomb enemy population centers and break the will of the enemy to resist.[11] The allure of winning a war with airpower alone persists through the ages due to the relative efficiencies in cost and effort militaries need to employ it.[12] Israel's attempt to capitalize on Effects Based Operations in the 2006 Hezbollah-Israeli War is a good recent example of an over reliance on airpower to achieve success in combat.[13] Lieutenant General Herbert Raymond "H.R." McMaster accurately assessed that only land forces can compel action on an enemy when he spoke at the Association of

the US Army exposition in OCT 2014.[14] Confirming LTG McMaster's comment, the Chief of Staff of the Air Force, GEN Mark A. Welsh III, recently stated that a "ground force will be required" to succeed in operations against ISIS.[15] These assertions are even more appropriate in the complex urban environment a megacity presents. Enemy forces will likely make full use of the protection from aircraft that urban substructures provide, just as Hamas used extensive tunnel networks to counter the Israeli Defense Force (IDF) in Operation Protective Edge.[16] Conceptually, city superstructures present a similar problem as substructures, because the enemy can use them for cover and concealment from aircraft. In order to bypass the debate on the effectiveness of aircraft to achieve victory unilaterally, this paper will assume that rotary wing aircraft cannot in a megacity. PAS relies heavily on the idea that the best use of helicopters in a complex urban environment is in close coordination with ground forces to achieve the ground commander's objectives.

Modern helicopters are not impervious to enemy actions and commanders must employ them in a manner that recognizes this. To truly employ PAS, commanders must establish a protected zone for Army Aviation with joint shaping operations to protect aircraft from enemy air, ground, and electronic warfare threats. Rotary wing aircraft are especially susceptible to enemy fixed wing aircraft. When an enemy fixed wing aircraft engages a helicopter, aircrews are trained to capitalize on the relative agility of the helicopter in an attempt to break contact with the enemy.[17] The speed advantage the fixed wing aircraft holds over the helicopter makes this a questionable technique. For Army aircrews, the best case scenario of employing this action on contact is that the enemy successfully prevents the friendly helicopter from completing its mission. Army

Aviation must rely on a strong joint air defense posture to create a zone where Army helicopters can conduct operations without the threat of being pushed off station by an enemy air threat.

Protecting helicopters from an enemy ground threat is a complicated prospect that requires a mixture of effective tactics and operational level shaping efforts. One of the most common examples of a helicopter falling victim to ground fire in urban combat took place on 3 October 1993 in Mogadishu, Somalia. During a helicopter raid in the city, one of the MH-60 Blackhawks used to drop the Rangers near their target building was shot down. When the enemy shot the helicopter with a Rocket Propelled Grenade (RPG), it was at a hover over the city.[18] The joint publication on aviation urban operations recommends that helicopters maintain at least 60 knots over a city to avoid ground fire.[19] It was likely necessary for the crew of the MH-60 to come to a hover to accomplish their mission; however, this example does illustrate that deviating from established tactics can decrease aircraft survivability over a city. Conversely, adhering to tactics that balance mission requirements with threat can significantly increase survivability.

Aircrews will never be able to rely on any one set of tactics to defeat enemy air defenses, but recognizing this fact will help protect them from enemy ground fire. Just as friendly forces constantly adapt and innovate, so does the enemy. If the enemy discovers that a certain way of engaging aircraft with small arms fire is no longer effective, then they will change until they find a more effective technique. Army aviators can hinder the enemy's attempts to adapt by staying attuned to the evolving nature of tactics in their operating area. As aircrews notice a new trend in enemy activity, they should make a special point to share that information with other units. Conversely, by routinely

employing different tactics in similar situations, aircrews will frustrate the enemy's attempts to discern friendly trends in employment. By avoiding the allure of static tactics and techniques, aircrews can leverage the dynamic nature of combat in a complex environment to their advantage.

Man Portable Air Defense Systems (MANPADS) pose a serious ground threat for Army helicopters in a city that will require a combination of tactics and shaping operations to counter. Unfortunately, the tactics that afford helicopters the greatest protection from MANPADS also make aircraft more susceptible to small arms fire, and large numbers of MANPADS can severely inhibit helicopters' ability to accomplish their mission. The low flight profile crews use to avoid Surface to Air Missiles (SAM) also decreases an attack helicopters effectiveness by reducing the crews' ability to use their sensors in urban terrain. To avoid these undesirable consequences of large numbers of MANPADS in an area where helicopters are operating, operational level commanders must make every effort to limit the availability of MANPADS in the area of operations. The ground commander must aggressively pursue any intelligence that indicates locations of MANPADS, and he should attempt to isolate the enemy from sources of MANPADS procurement.

Just as operational shaping efforts must protect Army aircraft from large numbers of MANPADS, commanders must take similar actions to prevent the adverse effects of enemy electronic warfare. Communications are critical to the conduct of aviation operations in close coordination with ground forces. At a minimum, aircraft must be able to communicate with the ground units they are supporting. The complex environment forces will encounter in a megacity leave little margin for error. Large civilian

populations and dynamic situations require real time information sharing and tasking between air and ground forces. Communications between separate aviation units operating in distinct areas and to higher headquarters would be preferable for mutual support and deconfliction. However, interference and city structures may preclude these types of communications. CPAC places emphasis on empowering Air Mission Commanders, which will in turn allow Army Aviation to successfully operate in an environment where communications are degraded to some degree, but aircrews must still be able to communicate with the ground units they are supporting at any given time.

Providing a protected zone for helicopters to operate in is critical to employ PAS. The assumption necessary to ensure the validity of PAS is not an absolute protected zone, where helicopters can operate in with impunity. Rather, it must be relatively safe enough to allow rotary wing aviation to employ adequate tactics to achieve a favorable balance between survivability and accomplishing the mission. The protected zone is a condition that can be set by operational level efforts to establish local air superiority, limit the number of MANPADS the enemy can employ, and ensure at least minimum communications requirements. As a condition that friendly actions can set, a protected zone is feasible and a necessary assumption for PAS to succeed.

Context

Megacities pose emerging operational and strategic risks for the nation. In 2007, the world's population crossed an important threshold with more people living in cities than in rural areas. By 2050, the United Nations predicts that two thirds of the world's population will live in cities.[20] Many of these people will live in megacities swelling

their numbers from 23 current mega cities world wide in 2014 to 41 by 2030.[21] The rising number of megacities increases the chances that a theater of operations will contain one or more of these concentrations of people. Commanders will not be able to ignore or bypass this important key terrain within their area of operations. At the same time urban populations are growing, the world's total population living in rural area likely will start declining after 2020 as people migrate to cities.[22] From a strategic stand point, the combination of a decreasing rural population and a near exponential growth in urban populations makes conflict in urban environments more likely in the near future and growing even more likely as this trend continues. The most challenging urban environment in which unpredictable circumstances may force the United States to conduct operations is any one of the growing numbers of megacities.

A megacity is more than just a normal city only larger. The effects of such a large population living in close quarters build on each other and present an unfamiliar and challenging environment for friendly forces to conduct operations. Megacities are complex adaptive systems with a "large number of components that interact and adapt or learn."[23] This means that the population of a megacity forms a stable equilibrium as millions of individuals pursue their own goals and objectives and learn to adapt to a changing environment that may produce obstacles to those goals.[24] The same way the cells within the human body repair damage associated with a broken bone, the individuals in a functioning city will repair damaged buildings. This resiliency is an emergent property of cities, and its strength grows with the size of a population. To counter this phenomenon associated with a large complex adaptive system, commanders must interrupt the natural equilibrium of the city to a point where it cannot repair itself easily.

Current doctrine is insufficient to overcome the emergent resiliency of a megacity due to the effects of the large population, complex terrain, and massive geographic dimensions of the largest urban environments.

The shear size of the population in a megacity stresses conventional doctrine. Modern doctrine relies heavily on detailed intelligence, and FM 2-91.4 *Intelligence Support to Urban Operations* explains that operations in urban environments require "a higher degree of specificity and fidelity in intelligence products than required in operations conducted in other environments."[25] FM 2-91.4 goes on to explain that "intelligence sections may not always expect to be able to initially provide the level of specificity and number of products needed to support commanders."[26] The lack of sufficient intelligence resources is magnified by the enormous size of megacities. In a megacity, it can be difficult to determine what information must be passed on to commanders and what can be discarded. The number of people present in the city combined with the complexity of city networks can saturate collection assets and overwhelm analysts with irrelevant information. FM 2-91.4 refers to individual urban operations. If commanders conduct numerous large operations within multiple megacities concurrently, the stress on the available intelligence assists becomes even more problematic.

Just as modern doctrine relies heavily on intelligence, fires are critical to successful operations.[27] Large numbers of civilians in a megacity increase both the risk and the cost of collateral damage associated with the employment of both kinetic and non-kinetic fires during combat operations. Commanders will have to be extremely judicious in the use of fires in a megacity to avoid unacceptable levels of collateral

damage.[28] Even if commanders take measures to encourage non-combatants to vacate an area before combat operations commence, such as in Fallujah, Iraq in 2004, there is no guarantee civilians will leave their homes to venture out in an unpredictable and likely hostile environment.[29] Additionally, commanders may not elect to displace large numbers of civilians, because it could be counterproductive in a COIN operation by creating a legitimate grievance within the population on which the insurgents can capitalize.[30] Any amount of collateral damage will certainly generate a legitimate grievance for some portion of the population. That portion of the population increases as the amount of collateral damage the commander causes increases. It is even more critical in a megacity than in other operating environments that commanders do not create unnecessary grievances that can make a civilian population uncooperative or even openly hostile, because of the incredibly large number of civilians that can be present in the battlefield. If only a small fraction of the population mobilizes in reaction to the grievance, it would still be such a large number of people that they would provide a significant new problem for the commander.

The number of people in a megacity makes employing current doctrine impractical in relation to force ratios. Contemporary COIN doctrine determines force ratios based on the size of the population in the area of operations, not just the number of enemy present. 20 to 25 friendly soldiers are required for every 1,000 people. This creates unrealistic force requirements for a counter insurgency in a megacity. A megacity with a population of 20 million would require a force of 400,000 soldiers.[31] Historically, armies have determined the appropriate size of their force for conventional operations based on the number of enemy soldiers and the assigned mission. For example, the

traditional force ratio of three to one for attacking a prepared defense is widely accepted as the minimum requirement for success.[32] If only 1 percent of the same megacity with 20 million inhabitants are enemy combatants, then this approach would require a friendly force of 600,000 soldiers.[33] Modern doctrine accounts for the advantage weapons systems like tanks and artillery can have over infantry by applying intangible effects to increase or decrease the necessary force ratio.[34] For example, an armor company provides much more relative combat strength in open terrain than an infantry company, and this difference must be accounted for. These intangible factors explain how numerically inferior forces can dominate their foes, such as in Operation Desert Storm. However, the complex terrain associated with the urban environment significantly decrease the effectiveness of many combat multipliers the US Army can employ and bring the required force ratios closer to historical constants.

Many of the apex weapons systems the US Army employs today, including the M1 Abrams and the AH-64 Apache, were designed to support the AirLand Battle Concept of the early 1980's, which envisioned a large conventional enemy fought in the relatively open terrain of Eastern Europe.[35] As a result, these weapons systems are appropriately optimized for long range and fast moving combat. There have been substantial improvements to these systems in the last 30 years. However, these improvements increase their ability to perform their intended mission, rather than fundamentally change the capabilities of the weapons systems. For example, the optics of a M1A2 Abrams are far superior to the first optics fielded and increase the tank's ability to identify and engage targets at greater ranges, but they do not fundamentally

change the nature of the heavy main battle tank that is designed to destroy other tanks in open terrain.

The complex structures associated with high population densities reduce the advantages US forces enjoy from advanced weapons systems by limiting visibility and maneuverability. Visibility will be limited to urban canyons up and down streets at best.[36] This limited visibility will make it impossible for vehicles to support each other in the dispersed formations their crews would employ in open terrain. Vehicle movement is limited to roads rather than mobility corridors, which place additional restrictions on the formations and mobility of friendly forces. The stand off that advanced optics and weapons afford will be limited in the same manner as visibility. This can force friendly vehicles to close well within the range of enemy weapons to engage, a situation that is normally avoided in less restrictive terrain.

The same structures that limit mobility and visibility also hamper communications. Today's line of sight radios have trouble transmitting and receiving between ground stations with large numbers of even smaller buildings in between them.[37] When units conduct unavoidable operations in sub-structures, such as subways and tunnels, radio communications become impossible. This undesirable effect can be magnified by the multitude of radio transmitters in a modern city. Everything from cell phone towers to children's toys have the potential to interfere with radio communications. Modern doctrine relies on sufficient communications to coordinate efforts between units. Critical support functions like fires and medevac also require sufficient communications to link the supporting with the supported. Operations in megacities will suffer the ill effects of communications degradation more than those in smaller cities due to a greater number of

potential sources of interference and the dense urban structures associated with larger populations.

Finally, the large geographical area of a megacity makes current doctrine even more questionable in practicality. Current Urban Operations doctrine dictates that isolating the urban environment is critical for success.[38] If the commander could isolate a city physically and virtually, the enemy would not be able to receive support or direction from higher headquarters located outside the city. The friendly commander would effectively limit his problem set to a finite magnitude, while retaining the ability to receive support and communications to conduct operations. This would be ideal, however, a megacity is so geographically large that the commander would require an incredible amount of resources to achieve its physical isolation. For perspective, the perimeter of Tokyo, Japan is approximately 143 miles, and the Korean Demilitarized Zone (DMZ) is 150 miles long, with hundreds of thousands of troops needed to secure the DMZ.[39] That force requirement would amount to just a shaping operation for isolating a megacity. The force requirements for operations within the city would be additive along the magnitude of the calculations previously discussed. Virtually isolating a megacity with a communications infrastructure designed to service tens of millions of would be even more difficult than physical isolation.[40] A commander conducting operations in a megacity would be forced to face the enemy without the advantages isolation could provide.

Helicopters in the Megacity

Rotary wing aviation is subject to several aviation specific challenges created by the large population and complex terrain present in megacities. Large civilian populations make target identification difficult for aircraft. Firefights in cities are chaotic, and from the air the appearance is best described as "kicking over an anthill." People run in every direction, towards the fight, away from the fight, and laterally. Everyone, combatant and civilian alike, seeks cover. However, the buildings distort audio signatures of gunfire and make it difficult for people to identify the precise direction of the threat, unless they are relatively close to the source.[41] The fluidity of the situation on the ground can overwhelm aircrews and the less familiar the crews are with the specific environment in which they are conducting operations, the more profound this effect is. When viewed through thermal sights, even uniforms can be challenging to identify for inexperienced crews. Insurgents, who most likely would not wear uniforms, can capitalize on this situation and use the civilian population to conceal themselves from aircraft.

The physical terrain of the urban environment poses a challenge to the whole range of helicopter operations. City structures give enemy forces ample opportunity to seek cover from aircraft, because dismounted enemy can easily take refuge in buildings and tunnels to avoid detection. In a very dense urban environment, where the buildings share walls and substructures, it becomes near impossible for aircraft to track and engage enemy combatants. These high population density areas hamper lift operations by reducing the number of suitable landing zones.[42] The few open areas that may be available become very dangerous for crews to land in due to the ability of the enemy to

conceal themselves in buildings nearby and engage aircraft when they are the most vulnerable. The dynamic nature of urban combat can make suitable landing zones become quickly untenable, either by the presence of enemy in the area or the devastating effects high intensity combat have on urban structures. A soccer field could be clear one day, and could be completely covered in rubble from a collapsed building the very next day.

Potential Adversaries in the Megacity

The future threats commanders must be ready to dominate in the challenging physical environment created by the megacity will range from insurgents to near peer competitors.[43] Ironically, many combat leaders currently in the US Army feel more comfortable visualizing future conflicts where the opposing force is an irregular, or insurgent, threat rather than a large conventionally armed foe. Fourteen years of continuous combat, where the vast majority of that time was spent combating insurgencies, means that the real world combat experience of all but senior officers and NCOs is almost exclusively COIN centric. Concepts like legitimacy and considering the civilian implications of every action are firmly rooted in today's leaders.[44] These leaders would quickly recognize the challenges the massive population and complex terrain of megacities pose to COIN operations. Interconnectedness of social networks combined with the massive population from which insurgents can draw support will make countering an insurgency in a megacity much more difficult than in even a large city like Bagdad. The vast area of a megacity will require significant resources in time and manpower to complete the clear and hold portions of current COIN doctrine.[45] However,

thanks to the experiences built in Iraq and Afghanistan, junior leaders may be best prepared to face this type of threat in the future.

A near peer advisory may be much more difficult for the Army to defeat in a megacity. There has not been a major force on force engagement in even a large city using modern weapon systems. Even the fight for Bagdad in 2003 is a poor example, with the Iraqi army's capabilities falling far short of the US military's. An enemy with technology and force structure comparable to the United States' would face many of the same challenges friendly forces would have to overcome. Constricting terrain and large numbers of civilians would hamper an enemy's combined arms efforts, just as it would the United States' ability to synchronize and employ forces. The difference may very well be who is living in the city. If people allied with the country the United States is engaging populate the city, such as Stalingrad was for the Germans, the population would present completely different problem sets for the two armies. Collateral damage calculations may be different based on the enemy's responsibility to protect their population or desire to maintain infrastructure for a strong post conflict economy. On the other hand, it is not hard to imagine a handful of evil governments who would readily sacrifice large numbers of their own people to win, a prospect that is not possible for the US Army.

A more dangerous, and more likely, course of action for a conventional army faced with a United States military action in one of their cities would be to use the population to form a hybrid threat. A hybrid threat is the combination of regular and irregular forces working together to achieve a common objective.[46] A hybrid threat in a megacity would be the most dangerous enemy the United States could face because the

enemy would be able to capitalize on the favorable conditions a large population and constricted terrain present for an insurgency and reinforce them with conventional weapons. One section of a megacity could be a traditional force on force fight, and another could be a classic COIN operation. It is not hard to imagine how much more dangerous insurgents in Bagdad would have been if they could have employed supporting arms such as modern armor and artillery. Additionally, an insurgent with access to incredibly lethal modern weapons may be less concerned with civilian casualties without a rigid command structure imposing strict rules of engagement. Conventional wisdom would suggest that large numbers of civilian casualties would diminish the insurgent's support from the population. However, operations in Iraq and Afghanistan have shown that the enemy rarely hesitates to cause collateral damage, and may even intend to cause it for their own propaganda efforts. Any successful concept for the employment of rotary wing aviation in a megacity must be able to counter this dangerous and likely threat, as well as a pure insurgency or conventional adversary.

Current Army Aviation Doctrine

The basic doctrine commanders use to employ the majority of Army Aviation against the full spectrum of potential adversaries today was born out of the same strategic outlook that produced the machines themselves, and is optimized for large scale combat in open terrain. However, over the last 14 years, many innovative commanders have successfully adopted these employment methods to counter insurgencies both in open and constricted terrain. Unfortunately, future commanders may not be able to enjoy such success in the megacity. The challenges of a megacity will demand more from Army

Aviation than the current doctrine can provide. There are 16 missions that Army Aviation conducts in support of ground forces.[47] For simplicity, this paper departs from strict interpretation of doctrine and breaks these missions down to four basic sub-missions that aviation commanders combine or modify to accomplish each of the 16 missions. These sub-missions are air assault, interdiction attacks, close combat attack, and reconnaissance.[48]

Air assault in its most basic sense is moving troops by helicopter to capitalize on the speed and agility helicopters can provide. An air movement is a repositioning of troops and equipment not designed to come in contact with the enemy, and air assaults are an aspect of the ground commander's scheme of maneuver utilizing vertical envelopment to enable soldiers to assault decisive points.[49] To avoid confusion, this paper will combine these two actions, because at the core both missions move troops and equipment from one place to another via helicopter. Air assault originated in the Air Mobility concept following the Korean War. The army recognized the advantage they could gain with the ability to bypass difficult terrain, and the new helicopter was an ideal machine to accomplish this. The doctrinal underpinnings of employment can be seen in the airborne operations of World War II.[50] A large air assault in combat is an extremely complicated mission with many different ancillaries, whose actions commanders must be carefully plan and synchronize to ensure success. For example, the 101st Airborne Division conducted an air assault in February 1991 to move more than 2,000 soldiers and associated equipment with 118 helicopters. To successfully conduct such an incredible undertaking deep in enemy held territory, commanders had to carefully plan and sequence the movements and timing of literally thousands of moving pieces.[51]

Recent combat experience has led the army to develop techniques for hasty air assaults that will be critical in the megacity. The deliberate air assault planning process involves several meetings for the aircrews, ground commanders, and a combination of the two.[52] When time permits, Aviation planners build strict timetables that include landing zone analysis, the mission briefs, rehearsals, and synchronization matrices for execution. These measures are incredibly important for large air assaults in support of large ground units. However, many units conducting platoon size or smaller air assaults in Afghanistan, sometimes three or four a night for different supported units, found the strict planning timelines associated with traditional air assault doctrine impractical. These units developed SOPs that would allow them to support multiple units with compressed timelines.[53] In a megacity, the dynamic nature of combat operations will make long and complicated planning cycles even less practical. Commanders will need the flexibility to move their troops around the battlefield on short notice to capitalize on a rapidly changing situation.

Interdiction attack missions are the use of armed helicopters to destroy planned targets that are not actively engaged with friendly forces.[54] Employing helicopters to accomplish interdiction attacks gives Army commanders organic assets to accomplish this mission. The concept of air interdiction was critical to AirLand battle, when commanders intended to use attack helicopters to destroy Soviet forces arrayed in depth in order to establish an extended battlefield and overwhelm the enemy before they could engage friendly forces.[55] In 2003, the 11th Attack Helicopter Regiment (AHR) conducted an interdiction attack to destroy the Iraqi Medina Republican Guard Division. However, the AH-64 crews used out dated maps for planning and overflew several cities along the

route of flight, which gave the enemy located at the target ample warning of the approaching helicopters. By the time the Apaches reached their target, enemy air defenses were prepared for the helicopters. Every one of the 30 aircraft used for the attack was damaged, and the Iraqis captured two pilots.[56] This example casts doubt on the viability of using helicopters to conduct interdiction attacks over heavily populated terrain.

Close combat attacks are also intended to destroy enemy targets. However the enemy is in close proximity to friendly forces, and the targets are rarely pre-planned.[57] Air ground teams used close combat attacks with great frequency and success in urban environments in Iraq.[58] The responsiveness of attack helicopters and the relatively low collateral damage associated with the weapons helicopters employ are ideally suited for employment in a megacity.[59] However, the method the Army uses to allocate attack helicopter support for units leaves large portions of time where there is no aviation support for ground forces. When a crew reports for duty each day, the battalion operations officer assigns missions for the pilots based on how much time steady state maintenance can support the team to fly. For example, if the team is on shift for eight hours, the planning metric for flight hours may only be five hours per day. This leaves three hours during the eight hour shift that the ground forces will not have helicopters airborne. If there is a large mission that requires a surge in aviation support for several hours during a day, the crew may be limited to even less flying time. Normally the crews remain on standby when they are not flying so they can still respond to emergencies if they are needed, but the response time of an attack weapons team on the ground is much longer than one that is already flying. This method of support allocation grew out of the

same doctrine that inspired air assaults and interdiction attacks, when commanders employed aircraft in large numbers for short periods of time to accomplish specific missions. It does not account for the continuous combat the US Army must conduct to win in the megacity.[60]

All helicopters conduct reconnaissance every time they fly. A Blackhawk conducting a routine air movement could be the source of invaluable intelligence, just as an OH-58D conducting a specific reconnaissance mission could. Helicopters are excellent vehicles for crews to conduct reconnaissance from, because they can provide the advantage of an aerial vantage point without the disadvantage of high speeds associated with fixed wing aircraft. A helicopter pilot can literally see the expression on the faces of people on the ground as they fly.[61] This level of detail can add to the commander's understanding of a situation in a city significantly. In a megacity, current allocation methods for reconnaissance missions suffer from the same gaps in coverage that close combat attack allocations do. Additionally, in complex urban terrain there are ample opportunities for enemy forces to conceal their location or activity until the scout passes by, magnifying this effect. UASs have the ability to fly at an altitude that the enemy cannot detect their presence, but they lack the situational awareness a manned ISR platform can provide. Commanders have successfully adopted doctrine rooted in concepts designed to counter a large force employing Soviet tactics to the needs of COIN operations over the last 14 years, but the megacity presents such a complex and foreign environment that simply adopting old concepts may not be enough to defeat a determined enemy.

Overview of Persistent Aviation Support

Persistent Aviation Support will be able to counter the challenges associated with a megacity building from the basic premise that a continuous aviation presence combined with strengthened air ground integration and shortened planning cycles will improve the effectiveness of current aviation capabilities and provide ground commanders with the position of relative advantage that they will need to win in a complex urban environment. Contemporary attack helicopters are incredibly efficient weapons systems. The combination of advanced sensors, precision weapons, and ballistics computers create an effect where the helicopter can engage and destroy any appropriate target within range with near certainty. Because the mere presence of helicopters forces the enemy to react, the best course of action for an enemy that is unable or unwilling to withstand an assault by armed aircraft is to avoid contact in areas where attack helicopters are present.

There are numerous examples of enemy forces in combat and training avoiding detection by armed aircraft to support this important tenet of PAS. In the 2006 Israeli war, Hezbollah fighters would not set up their Katyusha rockets to target Israeli targets until after lookouts could verify there were no Israeli aircraft in the area.[62] In Mosul, Iraq in Feb 2008, US Army engineers were attempting to build a combat outpost near a traffic circle on the west side of the city where enemy activity was very high. Shortly after the construction began, the soldiers received harassing small arms fire from a nearby building. While the engineers were relatively safe in their armored construction equipment, the small arms fire nevertheless presented a serious threat to the soldiers and impeded progress. A team of OH-58Ds responded to provide security for the construction site. As soon as the helicopters arrived, the enemy fire stopped. Both the

aircrew and the commander of the engineers believed that the enemy had fled and the Scout Weapons Team (SWT) moved to another part of the city to conduct reconnaissance. As soon as the helicopters flew out of sight, the insurgents began shooting at the engineers again. The helicopters returned and the fire stopped once again. This cycle repeated several times until the engineers determined that they could not locate the enemy fire with the helicopters on station. The SWT and ground force commander worked out a plan for the helicopters to move off station just long enough for the enemy to telegraph their location. Unfortunately, the complex terrain prevented the engineers from finding the enemy before the helicopters had to break station for a higher priority mission.[63] In training, COL TJ Jamison recalls an observation he made as an Observer Controller (OC) at the National Training Center (NTC). He noticed that when Armored Cavalry Regiments would push their aircraft forward of the ground vehicles and conduct continuous reconnaissance, the presence of the helicopters would force the opposing force reconnaissance elements to alter their movements and hide from the friendly helicopters. This would deny the enemy valuable intelligence and give the friendly unit a position of advantage. COL Jamison notes, "who ever won the counter-reconnaissance fight always succeeded in their main effort fight."[64]

In each of these examples, if the aircraft could have identified the enemy, they would have engaged them. This is an important aspect of relying on the enemy to avoid contact with armed aircraft. If the enemy believes that even if the aircraft can identify the enemy the aircraft will not engage, then the enemy will not avoid contact with the aircraft. In 2007 in Iraq, 1-82 ARB deployed with an improved sensor for the AH-64. The new sensor could positively identify enemy at a much greater distance than the legacy sensor.

The 1-82 aircrews quickly identified enemy emplacing IEDs that did not seem to alter their actions based on the aircraft's proximity to their activity. The insurgents did not believe that the AH-64s posed a threat because Apaches had been operating in that area for years, and the aircraft would not engage the enemy unless they were much closer than the 1-82 aircraft. What the enemy did not realize was that the 1-82 Apaches had improved sensors that could see what they were doing at a much longer distance, and every time it ended badly for the insurgents.[65] This example illustrates that armed aircraft must not only be present to force the enemy to avoid contact, but must also make the enemy believe through the aircrafts' past actions that the helicopters pose a lethal threat.

The NTC example of denying the opposing force intelligence on friendly positions by forcing their reconnaissance elements to avoid contact with the scout aircraft is exactly how commanders can capitalize on this phenomenon. The presence of a credible threat from armed aircraft can force the enemy to alter their actions to avoid contact, effectively giving friendly ground forces a position of relative advantage. In World War II, US Marine Corps aircraft armed with .50 caliber machine guns would strafe Japanese bunkers, as the infantry waded through the surf to the beach.[66] The machine guns were not nearly powerful enough for pilots to hope to eliminate the threat the bunkers posed for the approaching infantry, and many enemy soldiers lived to oppose the landing.[67] Even though the aircraft could not destroy the enemy bunkers, the aircraft were able to alter the enemy gunners' actions by preventing the enemy from placing effective fire on the approaching US infantry. The strafing missions by the US Marine Corps aircrews helped shape the environment the infantry was assaulting, and aided in

the eventual success of the landings. The aircraft did not have to destroy the enemy positions, only restrict the enemy's ability to carry out the machine gunners' mission.

In a megacity, the complex terrain will allow enemy light infantry in smaller units to easily avoid contact with helicopters. That is why PAS can only provide a position of relative advantage for friendly ground forces instead of an absolute advantage. This relative advantage is still enough to give ground forces the upper hand. Attack helicopters can prevent the enemy from maneuvering heavy weapons in the streets and employing armor or other vehicles against the friendly ground forces. In contrast, US forces operating under the umbrella of protection PAS provides will not have a similar restriction to their freedom of maneuver. This will allow US forces to maneuver and employ vehicles or heavy weapons while the enemy cannot. The enemy would not even be able to maneuver large numbers of infantry without the helicopters identifying their movements. PAS will effectively limit the enemy to employing small units of light infantry or other weapons previously hidden in buildings. With absolute freedom of maneuver only limited by the terrain, the US ground forces will enjoy a significant position of relative advantage over the enemy.

To capitalize on this position of relative advantage, PAS maintains that the aviation presence must be continuous, or as continuous as environmental considerations like weather will allow. If attack helicopters do not support ground forces continuously, the enemy will just wait for them to leave just as they did for the engineers in Mosul, Iraq. This is a significant departure from current doctrine, and essentially changes the underlying concept of employing rotary wing aircraft in combat. 4-6 ACS embraced this method of employment with measurable success. The Kiowa squadron in Mosul, Iraq

flew at the very limits of what maintenance could support in an attempt to decrease the deadly IEDs that were causing the majority of friendly casualties at the time. During the first 10 months of their 15 month deployment, IEDs in the city dropped by more than 50%. The Kiowa pilots flew nearly all day every day, and made sure they were airborne during the times of night when the enemy dug in their IEDs. After several months of eliminating as many as five IED crews a week, 4-6 ACS forced the enemy to stop emplacing IEDs when the helicopters were present. Additionally, the fewer IEDs that the enemy managed to emplace were smaller and were often simply laid on top of the road or in old IED holes. These hastily emplaced IEDs were far less dangerous for the ground forces than the hidden large IEDs buried deep in the ground.[68] Previous units in Mosul had not attempted to remain airborne as much as possible, and many IED emplacers were able to evade friendly aircraft as a result. These previous units would use UASs to find and identify IED teams. Then they would run to their aircraft and engage the enemy. Many times, by the time the aircraft arrived on station, the enemy had completed their task and were safely concealed by the urban environment.

Another added benefit to a continuous aviation presence is the constant stream of intelligence the aircraft produce. Military operations in a megacity will produce significant intelligence requirements. Any aircraft that is flying over the city to restrict the enemy's ability to maneuver will also be conducting reconnaissance and can provide real time intelligence to the commander. The actions of the massive population in a megacity will be hard to anticipate, and helicopters overhead can keep ground commanders aware of any developing situations. The aerial perspective helicopters enjoy is invaluable to ground units who cannot see more than a block in any direction except

down the street. Helicopters overhead can alert commanders of any developing situation that the ground commander would be otherwise unaware of. Helicopters can also provide real time intelligence to the ground forces related to the physical terrain outside of the ground commander's line of sight. Combat can drastically change the landscape in a city in a very short period of time. Satellite imagery may show that a street was clear in the morning, but a helicopter overhead would be able to see if the enemy blocked the street just before ground forces arrived.

The constant flow of intelligence gives the ground commander the advantage of informed maneuver. Rather than relying on stale reports in a dynamic environment, commanders can act to take advantage of developing situations. To maximize this effect, PAS places special emphasis on air ground integration. Aircrews and ground forces must know and trust each other. Commanders must make every effort to grow and enhance a close working relationship between aviators and ground forces. The commanders on the ground must come to view the aircraft overhead as an extension of their own forces, rather than a support element that is used only when needed. When a pilot tells a ground force commander that he should take one street over another, there must be a bond of trust between the two individuals that allows the ground commander to accept the pilot's recommendation without hesitation. Once commanders build this level of trust, air and ground can work together as a single entity in pursuit of a common goal.

PAS will enhance this informed maneuver by employing hasty air assaults with planning cycles short enough to allow commanders to exploit the opportunities created by their position of relative advantage, allowing commanders to maintain that advantage. In Afghanistan, a US Marine Corps infantry company learned of the location an enemy

stronghold. The company commander requested helicopters to conduct an air assault near the location. However, the planning cycle for the air assault was several days, and by then the enemy would be gone. The company conducted the movement by truck, because they could conduct the ground assault almost immediately. By the time the company conducted the eight hour ground movement and arrived at the target house, the enemy had fled. Physical evidence and local Afghans informed the Marines that they had missed the enemy by just a couple of hours.[69] This simple example illustrates the importance of responsive lift support to exploit recent intelligence. In the dynamic environment of a megacity, responsive lift support will be even more critical. The air assaults possible in such complex terrain will be, by necessity, smaller and lend themselves to shortened planning cycles. Additionally, constant attack helicopter presence will ensure that commanders will have a clear picture of the tactical situation at potential landing zones at all times. The ISR "soaking" of the landing zones to gather intelligence of possible threats will have already been completed by the attack helicopters.

To support a continuous aviation presence and provide responsive lift, PAS postulates that the basic unit of employment for Army Aviation should be an Aviation battalion that is optimized to conduct these missions. The battalion would have two AH-64D companies, one UH-60 company, and the support elements already resident in current aviation battalions. Two attack companies would be able to support a single Air Weapons Team (AWT) airborne 24 hours a day, seven days a week between the two of them. This organization is similar the aviation task forces employed with great success in Afghanistan during OEF. Each Apache company would have a UAS platoon assigned to that company commander. The basic AWT would grow to two AH-64s plus a UAS

rather than just the two AH-64s in a team today. By assigning a UAS to each AWT as a third member of the team, the air mission commander can maximize the strengths of both the manned and unmanned aircraft. 4-6 ACS successfully employed a similar construct by allowing aircraft to communicate directly with UAS operators and even control their activities to some degree.[70] The organic UH-60 company would be able to provide responsive lift support to the ground commander and build a working relationship with the attack aviators that will be critical to execute short notice air assaults as a matter of routine. By shifting the basic concept of employment for rotary wing aircraft from one of distinct missions extensively planned and executed in a short period of time to one of a continuous effort to maintain pressure on the enemy, Army Aviation will be able to restructure its force in a way that will capitalize on the aspects of PAS that will be critical for success in a megacity.

The Army Operating Concept and Persistent Aviation Support

When Army leadership developed AirLand Battle, it was not in response to the Yom Kippur War per se. Rather, observations from this real world conflict produced an impetus for change within the Army and provided an opportunity for the Army to confirm some of the ideas that would become AirLand Battle.[71] In this same way, Israel's wars in the Gaza Strip do not form the inspiration for PAS, they only indicate the reality that war in a megacity is likely and will provide a new problem set for Army Aviation. The Army Operating Concept released in October 2014 is the construct that informed the development of PAS and forms the foundation by which it should be judged. At the core of the Army Operating Concept are eight tenets that "guide the generation

and application of combat power."[72] These tenets are initiative, simultaneity, depth, adaptability, endurance, lethality, mobility, and innovation. This paper will explain how PAS applies the combat power of Army Aviation in line with each of these tenets.

Initiative

Just as adding energy to a system before it has a chance to react to previous inputs can force it into chaos, PAS prioritizes initiative to give friendly commanders the tools to induce disorder in enemy efforts.[73] The Army Operating Concepts defines initiative as "assessing a tactical or operational situation and acting to dictate the terms of operations."[74] This definition implies that friendly forces must create a short feedback loop to ensure that commanders take appropriate actions to produce desired results. Initiative in the complex and fluid environment of a megacity will require rapid detection of enemy activity, immediate reaction, and follow on maneuver to exploit success before the enemy can alter their approach.

PAS provides an ideal framework to quickly assess a rapidly evolving battlefield and relay that information to commanders to make timely decisions. While the enemy may still manage to maneuver within the urban substructure undetected by aircraft, they will not be able to move in the open without aviation assets observing their movements. Aircrews will be able to coordinate efforts with supported ground forces and provide immediate counteraction to enemy movements through both aerial fires and the informed maneuver ground forces will enjoy with aircraft overhead. This effect will reach beyond just the immediate vicinity of enemy contact as well. Helicopters acting as airborne retransmission platforms will be able to relay information of the changing tactical

situation to headquarters far removed from the battle when the complex structures of a city would otherwise prohibit ground forces using line of sight communications. This will allow commanders to use this new information about the battle unfolding to plan new operations that capitalize on the situation.

The shortened planning cycles for air assault missions PAS emphasizes will give commanders more options to employ in reaction to the information they receive from aircraft at the far edge of the battlefield. Responsive air assault missions will give ground commanders the ability to bypass congested city streets and employ vertical envelopment, possibly even using the tops of buildings as landing zones. Planning timelines for air assault missions should be as short as possible. Standing operating procedures for airmobile assaults in Vietnam in 1963 dictated that crews maintain the ability to execute missions in less than one hour.[75] Planning cycles anywhere near this short would require battle drills and standard procedures that train aircrews to receive mission specifics, plan the flight, link up and brief with supported ground forces, and execute the mission quickly for a wide range of intended landing zones and tactical situations. The close working relationship between the assault aviation company and supported ground forces fostered in PAS will significantly enhance this endeavor. For example, loading and unloading drills and rehearsals could become a continuous training objective rather than a step in the planning cycle. Similarly, assigning both attack companies and assault companies to the same battalion will encourage SOPs and familiarity between the aircrews to assist coordination when lift aircraft need armed escorts for unsecured landing zones.

Army Aviation will likely have to lower the mission risk approval authority for high risk missions to the aviation battalion commander to shorten planning timelines. Many air assault missions in combat under current assessment tools are considered high risk, especially those that would involve urban landing zones. Current aviation regulations dictate that commanders retain high risk mission approval at the brigade level.[76] This requires battalion commanders to establish communications with their brigade commanders and relay the necessary information for the brigade commander to make an informed decision. Even if this channel of communication is available, which it may not be in a megacity, this process takes extra time to coordinate. The Army Operating Concept emphasizes the need for commanders to delegate authority to employ capabilities like aviation "so subordinate units have the resources to act immediately."[77] There is historical precedence for battalion commander maintaining the authority to approve high risk missions. In the Armored Cavalry Regiments of the mid 1980's through the late 1990's, the aviation squadron commander worked directly for the regimental commander and approved all aviation missions.[78] Any measures aviation commanders can take to shorten planning cycles for air assaults will aid ground commanders in their efforts to conduct operations in the dynamic megacity.

Once friendly commanders are operating inside the enemy decision cycle, the continuous nature of PAS will ensure friendly forces maintain the initiative. Gaining initiative for a short period of time, then halting operations to reset for follow on missions, provides the enemy with undesirable windows of opportunity. If commanders allocate aviation support to employed units only for specific periods of time, enemy activity during uncovered periods will remain undetected. By advocating a continuous aviation

presence, PAS not only creates a short feedback loop for friendly commanders but also prevents the enemy from enjoying the advantages of their own initiative. Every time the enemy attempts a different approach, the helicopters overhead will observe the activity, provide the means for immediate counteraction, and relay the information to ground commanders to form a scheme of maneuver to account for the new realities in the operating environment.

Simultaneity

Combat is an incredibly complex system where each actor within the system takes action and makes decisions based on the actions of every other actor. Faced with such a system, a commander can never just take one action and expect predictable results due to the multiple and cascading second and third order effects of that action. To combat this phenomenon, commanders must make multiple inputs to the system, each one reinforcing the other and moving the tangled web of interactions between actors towards a desired result.[79] The Army Operating Concept addresses this approach by stressing the importance for commanders to conduct multiple supporting operations simultaneously. PAS incorporates this tenet by strengthening the relationship between aviation and ground units, collecting intelligence while restricting enemy freedom of maneuver, and setting the conditions to plan and execute assault mission in concert with conducting attack and reconnaissance tasks.

The importance of Air Ground Integration (AGI) cannot be overstated. Commanders must foster strong AGI at every opportunity and make strengthening it a consideration for everything from home station training events to the location of the mess

hall in combat. Commanders should lay the foundation for this relationship long before the underlying factors that might cause a conflict in the world start to materialize. Army leadership can designate static supported brigades for PAS aviation battalions to habitually work with. The aviation battalion commander should be as familiar to the supported brigade commander as any one of his assigned battalion commanders. It should be as natural for aircrews to attend unit events like organizational days as it is for them to attend air mission briefs for training events. Ground planners should account for an aviation aspect to every training event, and aviation planners should never consider a tactical training event that doesn't support an actual, not notional, ground unit. This will require additional coordination for staffs, but the payoff in combat will be an integrated air ground team that is familiar with each members' strengths and weaknesses. Once units deploy to combat, they should be collocated to the greatest extent that the situation allows. When aircrews and ground forces share living spaces like mess halls and gyms, an emergent property forms from the bond the units build and the team becomes greater than a sum of the parts. A team employing true AGI will be able to seamlessly apply combat power from both the air and the ground to produce and effect that the enemy will not easily overcome.

Attack aircraft with their UAS teammates provide simultaneous inputs to the system when they conduct their continuous aviation presence. The commander gets the benefit of a constant source of intelligence from the aircraft along with the ability to restrict the enemy's freedom of maneuver by employing just one asset, the AWT. UASs alone and obstacles can achieve each of these effects on the enemy as well. However, obstacles take time to emplace, and employing UASs and manned aircraft separately

increases the number of distinct aviation elements for the staff to coordinate. There will be times when a commander may want to utilize these assets in this manner, and aviation could never replace physical obstacles. However, an AWT is an efficient solution to accomplish these tasks quickly and without relying on staffs to coordinate extra moving pieces on an already hectic battlefield. The current method of employing AWTs for specific periods of time only provides the intelligence for that time when they are airborne. Additionally, without a continuous presence, restricting the enemy's freedom of maneuver is a temporary condition that merely shifts the enemy's movements. It would not provide an enduring relative advantage for friendly ground forces.

A continuous aviation presence enhances the ability to conduct shortened air assault planning cycles and can provide a convenient means to employ military deception. If hasty air assault missions become routine, the efficiency of relaying information about the route and landing zone will become the element in the planning cycle that determines how long planners must prepare for a mission. The attack aircraft providing a continuous aviation presence can simultaneously conduct air route and landing zone reconnaissance and relay this information to assault planners in real time as the situation unfolds. There will be no need to rely on stale intelligence on landing zones or to conduct missions to verify information used for planning remains relevant. Also, just as the Russian attack helicopters telegraphed the movement of convoys in Afghanistan, specific missions to prepare for an air assault could provide the enemy with valuable intelligence. The high density of aircraft over the area of operations will prevent the enemy from observing the reconnaissance phase of planning and repositioning to impede the assault. To an enemy observer on the ground, the aircraft movements will appear random and fit the pattern he

had been observing since friendly forces arrived in his sector. By simultaneously employing air ground teams, restricting enemy freedom of maneuver, collecting intelligence, and conducting hasty air assault operations to capitalize on fleeting opportunities in the dynamic megacity, PAS provides the commander with several different vectors to provide input to the battle and push it towards a desired endstate.

Depth

Depth is the synthesis of initiative and simultaneity. Commanders conduct operations across "time and space to prevent enemy forces from recovering from simultaneous efforts" to achieve depth.[80] Depth in time is the critical aspect of PAS. Recognition that combat is continuous is the core idea that all other aspects of PAS derive from. PAS not only allows commanders to conduct operations in depth as it relates to time, but also provides a capable and scalable structure that allows operational commanders to achieve great depth in space as well.

To effectively counter the enemy across time, commanders must be able to maintain a firm understanding of the operating environment to anticipate how the battle will unfold. PAS provides commanders with a constant stream of useful intelligence to shape the operating picture in a way that persistent unmanned ISR platforms alone cannot. It is important to draw a distinction between useful intelligence and data, because they are different both in quantity and quality. Any number of UASs can gather vast amounts of data and push it back to headquarters far removed from enemy contact. Data places the onus on annalists with varying degrees of familiarity with the operations at hand to sort through and determine which pieces of data may be important. Aircrews that are

seeing the environment first hand possess unrivaled situational understanding and produce intelligence by reporting those facts that are most applicable to the situation. Aircrews can provide commanders with an initial filter to avoid information overload within headquarters, and ensure that commanders receive the useful information they need to visualize the current state of the battle as it unfolds and predict the direction it is moving.

If one can imagine a static linear battlefield with opposing armies facing each other, it would not make sense for a commander to pull a portion of his troops off the line and leave a gap for the enemy to assault through. This same idea transfers to time. In a continuous battle, like the one friendly forces are likely to encounter in a megacity, a commander would be ill advised to stand his troops down for a period of time and not make arrangements for their defense during the down time.[81] This is essentially what the current method of employing attack aviation does. Aircrews conduct missions for a set period of time, and then return to the airfield to leave the ground forces with no aviation support overhead. PAS addresses this concern by providing a continuous umbrella of support for ground forces conducting operation in a megacity. By producing useful intelligence and maintaining a continuous aviation presence, PAS allows commanders to achieve depth in time.

Initially it may seem that PAS relinquishes the classic "deep fight" to the enemy by minimizing the importance of employing attack helicopters to conduct Air Interdiction, however it merely recognizes that this tactic may not be appropriate for the megacity. Depth in space has historically meant that commanders focused operations against forces that enemy commanders have not yet committed. Examples would include attacks

designed to "disrupt the movement of operational reserves or [to] prevent the enemy from employing long-rage cannon or rocket fires."[82] This application of depth in space was perfectly suited to Soviet forces operating in vast rural areas, and the attack helicopter is an excellent weapons system to employ in this manner.[83] However, if helicopters conduct Air Interdiction attacks deep within a megacity, they will be exposed to observation from enemy forces nested in the complex urban terrain enroute to the engagement area, just as the 11th AHR apaches were when they attacked the Medina Division in 2003. In a megacity, these types of missions may be best suited for fixed wing aircraft that can arrive at a target much quicker and prevent the enemy from receiving early warning from observers enroute. The responsive air assault capability of a PAS battalion will still give ground commanders the ability to conduct more traditional influence of the "deep fight" with a PAS Air Ground team, which is a more appropriate use of helicopters in the megacity. To compliment this effort, the retransmission ability inherent in the supporting attack aviation would give commanders a tool to overcome the communications issues associated with urban structures.

As well as providing the means to conduct operations in depth spatially under the classic definition of depth, the effects of a PAS aviation battalion are scalable in nature, which provides an operational commander the ability to achieve depth in space when viewed through the lens of the Army Operating Concept. The Army Operating Concept expands the concept of depth from focusing on uncommitted forces to imploring commanders to "make decisions that allow their forces to retain and exploit the initiative."[84] Employing PAS across the entire breadth of operations will ensure that the enemy cannot find refuge within the area of operations to recover from the initiative and

simultaneity of produced by PAS. Every friendly ground unit would enjoy the same benefits of constant aviation presence. If commanders attempt to identify specific units to receive aviation support, leaving others wanting, the enemy will be able to avoid the strong points associated with supported units and focus efforts against those supporting units that lack the relative position of advantage gained by employing PAS. By viewing a PAS battalion as an inherent combat multiplier for every unit in the formation to be spread across the entire area of operations, operational commanders will achieve depth in space and deny the enemy opportunities to avoid the continuous nature of PAS.

Adaptability

"Winning in a Complex World" is a deceptively simple explanation of an incredibly rich concept. The word "complex", when used in this sense, means more than just "complicated." Complex systems contain element that comprise the system that interact with each other under ill defined and ever changing rules of interaction.[85] The Army Operating Concept correctly defines the Complex World "as an environment that is not only unknown, but unknowable and constantly changing."[86] To compete in such a daunting environment, units must be adaptable. An adaptable unit is able to react to any new situation quickly and retain the ability to accomplish the mission.[87] PAS enhances adaptability by decentralizing combined arms and retaining a flexible organizational structure.

Giving ground commanders TACON authority over PAS battalions makes units more adaptive by promising commanders the tools they need to quickly interpret the situation and refocus efforts. The Army Operating Concept recognizes the importance of this aspect of PAS when it notes, "operating in urban environments will require

decentralized combined arms."[88] As previously discussed, PAS units provide commanders with timely, useful intelligence and responsive lift support. With these capabilities already TACON to ground commanders and habitual relationships formed, there would be no lag as higher headquarters conducts the mission analysis and allocation necessary to reassign these assets to the unit that requires them. Commanders know they will have these abilities inherent to their formations going into an uncertain environment and can factor them into contingency plans. Perhaps even more important than planned contingencies, commanders can be certain they will have these tools available for unexpected developments as combat alters the operating environment. The dynamic nature of combat in a megacity will place special importance on flexible units that less complex situations may not require.

The very nature of placing special emphasis on a TACON relationship for PAS support to ground commanders enhances flexibility at the operational level. LTG John J. Tolson advocated assigning aviation units organically to enhance the relationship between ground and aviation soldiers in his study on Air Mobility in Vietnam.[89] This approach would be ideal if the end goal was to produce the very best AGI possible. The ACR construct of the 1980's and 1990's embraced this idea and enjoyed significant success as a result.[90] However, this is not the best construct for PAS, which is designed to counter a wide array of potential threats across any number of current or future megacities. Assigning organic aviation units to ground maneuver units effectively fixes the ratio of aviation to ground in employment. There might be situations where a commander of a maneuver brigade requires the support of an aviation battalion for a specific operating environment. Other times, an infantry battalion may require the same

battalion's worth of aviation support. By retaining the Aviation Brigade construct with TACON battalions to support operations, PAS allows for a flexible ratio of ground to air that operational commanders can tailor to the situation at hand.

PAS dictates that the basic unit of aviation employment is a battalion with two attack companies, one lift company, and necessary support elements, therefore these PAS battalions should be permanent units rather than ad hoc aviation task forces. The two main reasons that even units that routinely deployed to Afghanistan as aviation task forces did not retain that structure in garrison are because it reduces aviation standardization and it complicates other task organization constructs. Standardization in training and operations is very important in aviation units. It allows aircrews and teams from one unit to work seamlessly with other units while ensuring a minimum level of safety and proficiency across a commander's entire unit. PAS does not minimize this aspect of aviation operations, however strict emphasis on standardization across an entire Aviation Brigade's worth of assault companies is not as important if the basic idea of employment minimizes the number of times these companies would be employed together. If the default employment method for aviation does not include crews from one company conducting missions as a team with a crew from another company, it may be more important for those companies to build close relationships in garrison with the aviation battalion headquarters they will answer to in combat than to maintain absolute interoperability with other companies.

A lower level of standardization of like companies across an Aviation Brigade will hamper efforts to build other Aviation Task Force configurations, however the special emphasis PAS places on the aviation battalion as a set of capabilities for the

ground commander minimizes this risk. A PAS battalion is more than just a couple of attack companies augmented with UASs and a lift company. It is the ability for a ground commander to maintain one AWT airborne indefinably plus responsive lift support TACON as a unit. This means that the minimum number of assets necessary to provide these emergent capabilities from the aviation unit is a full PAS battalion. Aviation Brigades must still make special efforts to ensure standardization across like units within the brigade in case an unexpected situation dictates commanders further task organize the PAS battalion, but this should be the exception rather than the rule due to the decrease in capabilities this aviation task force would provide for the supported ground commander. Every Aviation Brigade has very senior Standardization Pilots on the BDE staff that could facilitate these efforts.

Endurance

All of the promises of PAS are hollow if the continuous operations are unsustainable. Many skeptics would likely argue that while an airborne AWT twenty four hours a day seven days a week would certainly be beneficial, it is asking too much of the Army's current fleet of attack helicopters. Further more, the additional friction created by the megacity will only make that herculean effort less attainable. These are valid concerns, which are likely reinforced by anecdotal evidence of historic operational tempo rates of army aircraft. PAS recognizes endurance is the limiting factor in truly achieving the promising effects of its employment and used the question, "what would it take to actually do this?" as the starting point for building the PAS basic unit of employment. The force structure of a PAS battalion provides adequate airframes to

conduct true continuous operations while preserving enough of the current construct to retain existing Aviation Brigade maintenance and support structures.

Two AH-64D companies with eight aircraft each is the minimum requirement to maintain a single AWT airborne indefinitely. To support this bold claim, one must consider the performance of Task Force Wolfpack in OEF 11-12. The Apache company in this aviation task force averaged over 90 flight hours a month per aircraft for an entire year long deployment employing a concept similar to PAS at the company level. This meant that the company flew at the limits of maintainability without risking mission failure due to maintenance. This operations tempo is the result of only one company's efforts under very specific conditions including an ample supply of parts and a supportive chain of command.[91] However, this one data point shows that, even in a system that is not optimized for these types of operations, 90 hours per aircraft per month is sustainable. If the PAS battalion maintains two AH-64Ds airborne for 24 hours a day at an average of 30 days per month, they will sustain a 90 hours per aircraft per month operations tempo.

These calculations may be overly optimistic based on a single data point. In practice, it will be highly unlikely an Aviation unit will enjoy a full month of flyable weather, which will lower the required number of flight hours per month to some degree. Those times when the aircraft are grounded by weather will decrease the relative advantage created by PAS, however this "down time" is unavoidable with current aircraft and the traditional method of attack aviation employment suffers from the same weakness. If 16 aircraft prove to be insufficient to maintain continuous operations in practice, commanders should add additional aircraft to the formation to retain the capability. The key idea of applying the Army Operating Concept tenet of endurance to PAS is that

commanders start with the desired end state of continuous attack aviation coverage then build units to support it rather than start with the current unit configuration then determine what capabilities it provides.

The advantage of maintaining two companies of eight AH-64s each in the PAS battalion is that it minimizes changes to the current Aviation Brigade structure. After the Aviation Restructure Initiative is complete, each Aviation Brigade will consist of two Attack Helicopter Battalions and an Assault Helicopter Battalion with three companies each. This would make an easy transition to three PAS battalions with two attack companies and an assault company in each battalion with no overall change to the number or types of aircraft in the Aviation Brigade. This means that the current Aviation Support Battalion structure would not have to change at all to support the shift. There will be some number of special tools within the Assault Helicopter Battalion maintenance company that the Army will need to procure to ensure adequate redundancy in maintenance support at the battalion level. However, this limited expenditure is a relatively small price to pay to provide ground commanders with the responsive lift support they will require to succeed in the megacity.

The megacity will present special challenges to support such a high operations tempo for aviation units. The complex urban terrain provides the enemy opportunity to impede supply convoys and attack aircraft on the ground. By maintaining support bases on the periphery of the megacity, commanders will be able to minimize much of this friction. Returning to the megacity of Tokyo, an airbase on the edge of the administrative areas of Tokyo would be within 40 km of any location within the city.[92] That is approximately a fifteen-minute flight at cruise speed of an Apache or Blackhawk. For

perspective, many bases in Afghanistan were up to an hour away by air from where helicopters conducted operations. A base outside the megacity will be much safer to stage aircraft without tall buildings overlooking the flight line. Additionally, ground lines of communication will be much easier to secure, ensuring a more reliable and robust supply of parts and fuel. The challenges associated with generating, protecting, and sustaining aviation forces in the high tempo operations dictated by PAS are significant yet not insurmountable with the right force structure.

Lethality

Lethality is critical to the success of PAS. The earlier example of the 1-82 ARB Apaches in Iraq demonstrated how commanders must impart the credible threat of lethal force on the enemy for the presence of attack helicopters to have the desired effect on the enemy. However, the PAS's application of lethality, as dictated by the Army Operating Concept, extends beyond just a prerequisite for success. PAS also enhances the lethality of the air ground team within the megacity by providing a platform for precision fires when commanders need it and placing special emphasis on air ground integration.

Attack aviation can provide fire support to ground commanders in the megacity, where urban considerations make artillery less effective. Buildings over three stories tall create significant dead space that shields enemy positions from artillery. Even high angle mortars have a dead space that is half the height of a building between the mortar position and the target.[93] Consider an urban area such as down town Manhattan. The buildings are so tall and close together that there would be virtually nowhere friendly forces could employ indirect fires. To offset this effect, FM 3-06 recommends, "repositioning artillery

as targets change."[94] In a congested city, it will likely be unpractical or even impossible to reposition quickly enough to keep pace with the dynamic conditions of combat. Even in situations where commanders can employ indirect fires with a high degree of confidence the enemy is not in an area protected by nearby buildings, the high concentration of non-combatants in a dense urban environment will make the risk of civilian casualties prohibitively high. Attack helicopters can reposition at will to gain a clear line of fire with enemy forces and employ precision weapons to offset both of these concerns.

The unpredictable nature of combat makes it difficult for commanders to determine when they may need to employ fires to create overmatch against the enemy. Under the traditional manner of employing attack aviation, this is a significant advantage indirect fires holds over attack aircraft for immediate fire support. Artillery crews can maintain a constant state of readiness to provide responsive support at any time. AWTs that support ground units for specific time periods are only able to provide the same level of responsiveness during the mission window they are airborne. In a unit employing PAS, those same AWTs are airborne continuously, and ground commanders could rely on them to provide needed fire support quickly at any time.

Just as the Israeli Defense Force learned in the Gaza Strip, even immediate fire support alone will not be enough to counter an enemy that makes efficient use of the megacity's substructure. PAS accounts for this potential enemy source of advantage through its special emphasis on air ground integration. Potential tunnels and complex urban structures make effective air ground teaming even more critical in a megacity than other operating environments. When operating as a team, air and ground units can focus

on their areas of relative strength while allowing the other to concentrate on aspects of operations that are impossible to affect from the air or ground alone. For example, while infantry units are conducting clearing operations in buildings or tunnels, aviation crews can maintain situational awareness for the team in areas visible from the air. Attack aviation can provide ground commanders with a significant relative advantage in lethality, but only through effective integration with the air ground team will they be able to maintain that advantage in the megacity.

Mobility

Every since the French in the Algerian War first employed helicopters in significant numbers, commanders have valued helicopters for the drastic increase in mobility they provide.[95] The US Army's concept of helicopter employment in Vietnam was actually called Air *Mobility.* The Army Operating Concept acknowledges the critical role mobility plays to allow commanders to "gain positions of relative advantage, conduct high tempo operations, and concentrate combat power against decisive points while operating dispersed across wide areas."[96] The Army Operating Concept further explains mobility is combined with firepower and protection to allow maneuver. PAS augments firepower through the application of lethality and increases protection by providing a continuous umbrella of aviation support that restricts enemy freedom of maneuver. When commanders combine these two elements with mobility created by responsive air assault support and enhanced by constant intelligence, PAS significantly increases the ability for a unit to maneuver.

Helicopters are especially capable of providing timely mobility in a megacity where roads may be constricted by civilian traffic or totally blocked by enemy activity. Any number of unpredictable situations may lead a commander to concentrate forces quickly at a decisive point in a megacity. The enemy may present an opportunity the commander wishes to exploit, or the enemy could force a commander to react in order to maintain a relative advantage. The shortened timelines associated with hasty air assaults that PAS enables will assist commanders with these timely movements. Simply relying on ground vehicles for this sort of short notice movement may not be possible in a megacity. In Mogadishu, the enemy was able to block off city streets from ground convoys attempting to reach the Blackhawk crash site. Similar situations could unfold in future urban operating environments, but lift aircraft using urban landing zones like parks, roof tops, and sports fields will allow commanders to bypass these obstacles.[97]

PAS also enhances ground mobility through a continuous stream of updated intelligence. Military ordinance has a devastating effect on buildings. Even if friendly forces are extremely judicious in their application of high explosives, the enemy likely will not be so reserved. Every explosion in a city holds the potential to drastically change the traficability of a route. Even if ground units consult updated imagery of potential routes, the enemy could intentionally block the road just out of the sight of vehicles. Attack helicopters overhead would be able to provide real time route updates to ground convoys to ensure they do not get trapped in an urban canyon. Additionally, these helicopters could identify alternate routes and direct convoys to their intended destination with ease.[98] In this manner, PAS not only provides a new avenue for mobility in the

form of responsive lift support, but also enhances ground mobility with real time intelligence.

Innovation

Where the Army Operating Concept describes adaptability as "reacting to new needs or changes," it defines innovation as "the conversion of new ideas into valued outcomes."[99] In other words, adaptability is reactionary and innovation is anticipatory. AirLand Battle was innovative when TRADOC leaders critically assessed the strengths and weaknesses of the Soviet military as they related to the US military's own capabilities. The resulting operating concept capitalized on combined arms maneuver to defeat an echeloned Soviet force.[100] PAS encourages innovation by decentralizing the authority and tools needed for operations to give the warfighters who are conducting those operations the freedom to develop new approaches. When an armor sergeant in Normandy with the scrap metal to build tank plows and the authority to try it developed an innovative technique to overcome hedge rows, he demonstrated the utility of this idea.[101] Similarly, giving ground commanders TACON authority over the basic unit of aviation employment, assigning UASs at the company level, and building strong air ground teams will set the conditions for innovative methods of aviation employment.

PAS fosters innovation between aviation battalions and supported commanders through the TACON command relationship. When commanders encourage innovation by allowing subordinate leaders to try new approaches, those commanders are accepting risk. Commanders will not accept this risk without sufficient trust in the competence and judgment of subordinate leaders. Leaders build trust slowly over time through shared

experiences generated by close working relationships.[102] PAS creates an environment for aviation battalions to exercise these close relationships through the TACON authority ground commanders execute over the aviation battalion, because TACON is a much closer relationship than even the Direct Support relationship that aviation units routinely employ today. Once commanders gain trust in their supporting PAS battalions, they will be more likely to accept situations where the air ground team experiments with innovative approaches to operations.

At the team level within the aviation battalions, commanders must be able to extend a similar trust to the Air Mission Commanders (AMC) providing the constant aviation presence. The AMC is the aviation commander's representative on the battlefield and must possess the capability to exercise disciplined initiative in pursuit of mission accomplishment in a complex environment. A key principle of PAS is that aviation leaders must carefully select then extensively train AMCs to the point that commanders have trust in them to execute decentralized operations with minimal guidance from higher headquarters.[103] With a greater trust gained through PAS command relationships and AMC philosophy, Army Aviation will become a self organizing system operating under mission command principles at all levels and constantly seeking more effective means of winning in a complex urban environment.

Just as landing obstacles on the beach provided the armor sergeant with the means to innovate, PAS provides leaders with the raw material they need to shape into new ideas.[104] Assigning UASs to aviation companies will create an environment that fosters manned and unmanned teaming techniques. A/4-6 ACS in Iraq is a great example of this effect in combat. A troop enjoyed a very close working relationship with the shadow

UAV Company attached to 4-6 ACS that operated in Mosul at that time. In the fall of 2007, the troop Standardization Pilot (SP) developed an innovative technique to coordinate the efforts of the OH-58s and the shadows. The enemy would never emplace IEDs when the Kiowas were on station, but they could not hear the shadows overhead and routinely emplaced IEDs right underneath them. The troop SP's idea was to saturate an area of high IED activity for a full day with Kiowas, then replace the OH-58s with shadows right after sunset. This would deny the enemy the ability to emplace IEDs for a long period of time. Then the absence of helicopters would appear to give them a safe window of opportunity to emplace their IEDs. However, the UAVs would be able to identify the enemy activity. This technique worked very well until the enemy reacted to the new tactic.[105] Even though this approach only worked for a short while, it demonstrates that friendly forces can stay one step ahead of the enemy if they have the tools and authority to innovate.

PAS's enhanced air ground integration creates a more capable air ground team, which is a tool to innovate as well. A/4-6 ACS again exemplifies this. There was a particular warehouse on the east side of Mosul that the enemy routinely used to conduct small arms and RPG ambushes against friendly convoys. Once the enemy created a recognizable pattern, the ground unit started requesting air support for missions that traveled near the warehouse. The enemy did not fire when the helicopters escorted the convoys. Unfortunately, there were not enough aviation assets in Mosul to provide security for every convoy, and the enemy would still occasionally conduct successful ambushes. The infantry platoon leader contacted the AMC that routinely flew during that time of the day and they coordinated a plan to draw the enemy into a fight then destroy

them with the helicopters. As the convoy approached the warehouse the next day, the AMC positioned his aircraft just out of audible range of the enemy on the backside of a small hill. When the enemy opened fire on the convoy, the aircrew already knew where their target would be and only had to conduct last minute clearance of fires with the ground commander as they approached on their inbound run. Because the AMC was familiar with the location and had pre-coordinated fire control measures with the ground force commander, the AMC could quickly clear the area of non-combatants and engage before the enemy could react to the aircraft rushing in. The engagement was successful, and that was the last time the warehouse was used as an ambush location for the rest of the deployment.[106] PAS will encourage this type of tactical innovation by placing special emphasis on AGI and decentralization to give leaders the tools and authority to try new approaches.

The Future - Technology

The relationship between doctrine and technology is similar to that of the chicken and the egg. Should the Army focus technological advances to enhance concepts of employment, or should the Army capitalize on advances in technology to develop new approaches? The right answer is likely somewhere in the middle. A concept informed by current technology that has the potential to grow as that concept in turn drives new technology would be ideal. The Army ensured AirLand Battle was practically implementable with the technology available at the time. However, AirLand Battle was also designed to evolve into AirLand Battle 2000 as new technology became available through the 1990's that would strengthen key capabilities and enhance the effectiveness

of principles critical to successful implementation of AirLand Battle in combat.[107] In this same sense, PAS is absolutely within the capabilities of existing Army equipment, but advances in certain technologies will increase the effectiveness of aviation operations in the megacity. The same key principles of continuous aviation presence, shortened planning timelines, and strengthened AGI will still underpin operations, but the specific methods of achieving these principles will likely change with technology. The possibilities of even near term technological advances are literally limitless, especially when the rapid pace of new discovery is considered. To avoid pure conjecture and in an attempt to remain concise, this paper will focus on how technologies that are either possible or are in their infancy today in the areas of weapons, manned aircraft, and UASs can enhance CPAC.

Weapons

Army Aviation should focus weapons development to enhance the same characteristics that make helicopters specially suited for fire support in a megacity, precision and low collateral damage, to improve the effectiveness of PAS. These two attributes of air to ground weapons are inextricably linked. More precise weapons ensure that fewer munitions miss their target and harm individuals and structures unintentionally, which reduces collateral damage. More precise delivery methods also enable weapons that produce the same target effects with lower explosive yields that will reduce damage to nearby individuals and structures, even when munitions hit their target. Reducing collateral damage through precision and the lower weapons effects enabled by precision

will be critical in COIN operations, where the enemy would likely capitalize on failures to protect civilians and infrastructure to gain support from the population.

Precision and low collateral damage weapons are just as important against a hybrid or near peer advisory. More precise weapons will require fewer munitions to achieve the same effect. This means that there will be a reduced strain on the supply system and aircraft will not have to leave ground forces without aviation support as often to return to base and rearm. Achieving the desired target effect with the minimum collateral damage possible, outside of Law of Armed Conflict considerations, will avoid unnecessarily cluttering the urban battlefield with destroyed structures, which would limit mobility. Reducing damage to urban structures will also pay dividends in the stability operations that follow a successful urban combat operation.[108] Any technological advance, such as smaller yield guided missiles and more capable weapons processors, that increases precision and lowers collateral damage for air to ground munitions will enhance the effectiveness of PAS in a megacity against the whole spectrum of possible adversaries.

Manned Aircraft

Aircraft improvements are very expensive, and their impacts are normally felt for decades. Some technologies will increase the effectiveness of virtually any method of employment and can be pursued with out forcing future commanders to employ forces in a specific manner. Other advancements are optimized for specific threats or environments and may degrade effectiveness in situations other than those engineers designed them for. Many aircraft advancements that increase the effectiveness of PAS

fall in the first category, such as greater endurance and better sensors. However, some technologies may present trade-offs in capabilities and efficiencies, like sensor placement and aircraft size, and will force the Army to assess the likelihood of urban combat over the lifespan of an aircraft against the negative impact that optimizing aircraft for cities may have on operations in other environments.

Any technology that increases endurance will enhance PAS and reduce support requirements. Aircraft systems can reduce pilot workload through more autonomous sub systems or more effective means of presenting mission information to aircrews. Semi autonomous systems are already present in many modern combat aircraft in the form of computer assisted stability control. As computing power and programing techniques advance in the future, these systems can improve to the point where they will significantly decrease the effort required to fly future helicopters. In a similar manner, computers already control the display systems that relay important information to pilots, like oil pressure and engine temperature. Those same computers could display simple color coded messages rather than the actual values of these measurements, which requires aircrews to interpolate this information while they perform combat.[109] Measures that decrease aircrew workload will allow pilots to fly longer periods of time before they become fatigued and will reduce the number of aircrews commanders require to employ PAS.

More efficiently identifying the true life span of individual components rather than replacing them early can optimize maintenance procedures for higher operations tempos. Current maintenance procedures require maintainers to replace many components on an aircraft at a predetermined number of flight hours regardless of the

actual condition of that component. Engineers determine the lifespan of these components by identifying lowest performing parts from a normal distribution, then reducing that number further to provide a margin of safety for the aircrews. This means that maintenance personnel replace many components long before they approach the actual point of failure. Advances in micro sensors that can measure the performance of components coupled with a system that could actively monitor all the micro sensors in an aircraft will make this extra maintenance unnecessary.[110] By decreasing the amount of maintenance required for a given number of flight hours, future technologies can reduce support requirements and increase operational endurance, which will allow commanders to employ PAS more efficiently.

More fuel efficient aircraft will provide better support for ground commanders and reduce the support requirements associated with high operations tempos. The Army Operating Concept calls for aircraft that are twice as fuel efficient as they are today.[111] Better fuel efficiency will mean that aircraft can stay on station supporting ground forces longer by reducing the amount of time aircraft spend refueling. This will be especially important in situations where the environment forces commanders to place Forward Arming and Refueling Points on the periphery of a megacity, requiring longer transit times for aircraft between fuel and their supported elements. Greater fuel efficiency will also reduce the amount of fuel needed to achieve a continuous aviation presence and make PAS easier to sustain. Increasing aircraft endurance will improve commanders' ability to restrict enemy freedom of maneuver and conduct informed maneuver by making PAS more efficient.

Aircraft sensor and sight improvements can also significantly enhance the effectiveness PAS in a megacity. An aircraft sensor is an electronic visual system that aircrews use to fly the aircraft, and sights are similar systems used to employ weapons systems. Some aircraft, the AH-64D is an example, can use the same equipment as a sight or a sensor. Sensors that give pilots better visibility in degraded environments will be beneficial in megacities where pollution can reduce visibility. In turn, the ability to fly in lower visibility caused by pollution or weather will reduce the amount of time aircraft are grounded and are unable to provide the constant aviation presence PAS relies on. Technological advances might also allow engineers to modify these sensors to identify electrical wires. In cities, wires often span between buildings rather than from utility poles. This makes them difficult for aircrews to see, because pilots often identify potential wires from a distance by spotting the poles that support them. A sensor that allows aircrews to see wires will allow them to spend less time looking for obstacles and more time supporting operations. Greater endurance and better sensors will benefit commanders employing PAS as well as those that use other concepts, and the Army can pursue them without forcing future commanders to employ their helicopters in a specific manner. However, some possible technological advances present a tradeoff that can negatively affect other operational approaches.

The placement of an improved sight or sensor on an aircraft is an important consideration that represents one such trade off that forces the Army to invest in technology optimized for a specific method of employment and environment. The Kiowa is a good example of this concept. Engineers designed the OH-58D's Mast Mounted Sight (MMS) to allow scout crews to mask behind terrain features and still retain the

ability to conduct reconnaissance. The MMS works extremely well for its intended purpose, especially when aircrews employ hovering tactics. In urban environments in Iraq however, aircrews learned that the position of the site hindered their ability to use it in the city. Because the sight is on top of the mast, there is a large cone of unobservable area directly below the aircraft. This forced aircrews to increase stand off from the area they were trying to observe. Unfortunately, this often caused buildings to interrupt the aircrew's line of sight in dense urban environments.[112] With this limitation in mind, any aircraft sight that the Army intends to effectively employ in a city should be located on the aircraft in a position that will allow aircrews to observe the area directly below the aircraft. Ideally, this placement would actually allow a 360 degree view of the world below the aircraft, which is not possible with current nose mounted sights.

The size of lift aircraft represents another trade off that the Army must consider as it designs aircraft for future conflicts. Larger aircraft that can carry more personnel and equipment allows the Army to purchase fewer aircraft to accomplish the same mission and represents possible efficiencies in cost. However, smaller aircraft are better suited for employment in a megacity, because the limited number of possible landing zones for aircraft becomes even more limited the larger an aircraft is. If the Army pursues larger lift aircraft with higher carrying capacities, the aircraft could become too large to land in a dense urban environment where the only suitable landing zones may be sports fields and parking lots. If a new lift aircraft is too heavy, even possible rooftop landing zone become untenable. Aircraft small enough to land between buildings in empty lots or streets would be best suited for operations in a megacity. Additionally, spreading personnel and equipment across a large fleet of smaller aircraft would make the loss of

one aircraft less detrimental to successful mission accomplishment, an important consideration in complex environments where events have unpredictably cascading effects.[113] Fortunately, relying on many small aircraft will have minimal impact on other methods of employment.

In the unpredictable world that the Army Operating Concept explains, relying too much on assumptions based on a current vision of future combat can be disastrous, but the Army can mitigate this risk by ensuring technological advancements are useful in multiple possible scenarios.[114] Placing aircraft sensors in a position to see below the helicopter and employing smaller lift aircraft will significantly enhance PAS without catastrophically affecting operations in rural environments. Abandoning the MMS for reconnaissance aircraft will sacrifice the ability to mask behind terrain features in more open areas, but in return the Army will gain aircraft that can effectively employ their sensors in multiple likely future operating environments.[115] Similarly, commanders can operate smaller lift aircraft just as effectively in rural as in urban environments, but cannot employ larger aircraft in cities very well. In this sense, these advancements represent a balanced approach to leveraging technology trade offs that maintains the operational flexibility the Army will need to win in a complex world.

Unmanned Aircraft

Unmanned aircraft sit on the precipice of massive technological advances, and in some ways these changes will likely influence the way commanders conceptualize and employ Army Aviation in the future. New methods of user interfaces between UAS operators and the aircraft they control can improve the situational awareness of commanders and add value to the AWTs that UASs are members of in PAS. Then as

technology continues to increase, even more revolutionary methods of UAS employment will become possible. Secretary of Defense Chuck Hagel identified autonomous systems in a speech in November 2014 as a key aspect of a future third offset strategy that will ensure US continued military dominance.[116] The autonomous capabilities Secretary Hagel spoke of combined with UASs will create completely new systems that promise to propel the advantages gained through PAS to new levels.

A major drawback to replacing manned aircraft with UASs is the lack of situational awareness operators can gain with current systems. Some have compared trying to gain situational awareness from a UAS to looking at the battlefield through a soda straw. In some ways this is true due to the lack of contextual information operators can gather when they observe an object in a narrow field of view. Training can help remedy this, and placing UAS operators in the aviation companies as PAS advocates will accelerate this effort. However, new technology can also assist UAS operators as they struggle to advance from situational awareness to situational understanding. AH-64D copilot gunners view the world through a single camera lens, especially on a dark night when there are no outside references to asset their efforts. Apache crews maintain situational understanding because they can slave the camera to their natural line of sight and turn the aircraft sensor into a type of night vision device. Applying this same method to UAS operators can give them a similar level of contextual information from the environment surrounding their UAS. This system will be able to provide even better situational understanding as emerging virtual reality systems become more practical to employ. Future UAS operators could wear virtual reality headsets slaved to cameras on the aircraft that will give them the same level of visual fidelity of the surrounding

environment that pilots enjoy in manned aircraft today. With a system this powerful, UASs would be nearly as useful to an AWT as a third manned aircraft with the added benefit of the ability to employ flight profiles that are too dangerous for a manned aircraft.

The next leap in UAS technology will likely come as semi-autonomous systems that can enhance the operator's ability to identify relevant information from the environment become available. The Army Operating Concept predicts, "Aided target detection, tracking, and recognition capabilities will improve UAS capability to achieve enhanced situational understanding, greater lethality, and improved survivability."[117] An operator using current UASs without computer assisted target identification must first identify possible enemy from a wide field of view, then zoom in to a narrow field of view to investigate whether a potential enemy posses a threat or not. This creates a large area around the target of interest that the operator cannot observe outside the narrow field of view and reduces the operator's situational awareness. Semi-autonomous UASs could potentially retain the situational awareness a wider field of view affords and still identify enemy personnel. Once the computer algorithm determines a target is enemy, it could then pass that information to a manned aircraft for a final decision and target prosecution. The semi-autonomous UASs could also "cover" the manned aircraft to ensure other enemy in the area do not move into position to engage aircraft while aircrews are focusing on the identified target. The ability to maintain observation of a large number of individuals and still identify enemy personnel would be especially useful in a megacity where large populations force UAS operators to closely inspect a great number of people in a narrow field of view. Ultimately, these types of systems will shorten the amount of

time between when the enemy exposes himself and the aircraft identify him, which will enhance the effect of restricting the enemy's freedom of maneuver.

Semi-autonomous UASs also introduce the ability to employ swarming tactics. An UAS swarm is a large number of semi-autonomous or fully autonomous aircraft that communicate and coordinate their efforts with each other to produce an emergent property to accomplish the mission.[118] A single UAS operator could control several different semi-autonomous systems simultaneously in a swarm. This means in a given area that a single UAS not employing swarming tactics would normally cover, a large number of swarming UASs could operate without overly burdening command and control systems.[119] This would be extremely beneficial in a megacity, because multiple points of view will remove the large number of blind spots behind urban structures that are unavoidable with a single UAS. Swarming UAS tactics teamed with manned aircraft can even further reduce the time aircrews need to identify enemy personnel and improve survivability.

Until technology reaches a point where the Army can be certain that the environment or the enemy cannot break the communications links between operators and semi-autonomous aircraft, manned aircraft will remain necessary to execute PAS.[120] Fully autonomous UASs likely will not be appropriate for commanders to employ in the megacity due to the large number of civilians intermixed with enemy combatants. There must be a human in the decision cycle to apply discretion to the use of lethal force. However, if technology reaches the point that it can ensure the communications links with UASs, the Army will have to ask, "what effects on friendly and enemy operations do commanders seek with UAS swarms operating independent of manned aircraft?"

PAS can provide a conceptual base for commanders to employ semi-autonomous UASs in place of manned aircraft in certain roles, and these new tools could help PAS reach its full potential. Commanders can employ independent UAS swarms to achieve the same effects as a PAS AWT, with the added benefit of achieving them across a wide area simultaneously. Additionally, large numbers of self organizing UASs demonstrate "swarm resiliency," where nearby UASs compensate for the loss of a single UAS.[121] This capability could reduce the burden on operational commanders to create the protected zone for rotary wing aviation operations necessary for them to employ PAS with manned aircraft. PAS shifts the paradigm of aviation support in a megacity from one of discrete missions carefully planned and executed for specific objectives over a short period of time to one that envisions using aircraft to persistently restrict enemy freedom of maneuver and provide the ground commander with the means for informed maneuver. In this manner, PAS can serve as an intermediate step and conceptual link between current aviation doctrine with contemporary machines and a future aviation force employing swarms of semi-autonomous aircraft in complex urban environments.

Conclusion

The world's population is migrating to cities at an increasing rate.[122] Recognizing that war is a clash of wills and a human endeavor, it is likely that the Army will have to conduct future operations where the people are, in complex urban environments.[123] The distinction between a megacity and a large city, 10 million people, is artificial and misleading. A city with 9.9 million people living in it will undoubtedly present similar

challenges as a true megacity.[124] Even if the Army does not find itself conducting operations in a true megacity, urban operations in future conflicts are almost certain.

To win in these complex urban environments, Army Aviation must restrict the enemy's freedom of maneuver while simultaneously providing friendly ground commanders with the means for informed maneuver. This will impose an artificially slow tempo on the enemy, while allowing friendly commanders to retain the ability to adapt to enemy actions quickly with a wide range of options. To achieve these effects in a megacity, commanders should achieve a continuous aviation presence, shorten planning cycles, and strengthen air ground integration. These three actions will force the enemy to react to multiple dilemmas and improve the timeliness and effectiveness of traditional rotary wing aviation missions.[125] In a dynamic environment, a commander is more likely to enjoy an advantageous outcome if he can move his forces more quickly to the places where they can be the most effective with reduced enemy influence. PAS gives commanders the information and the means necessary to gain and maintain this position of relative advantage.

Effective doctrine takes time to develop, and paradigms of warfare even longer to change. Methods of employment that maximize the capabilities of a new technology evolve over time, because they often require commanders to adopt a new way of viewing operations. PAS is intended to develop a way to visualize aviation support to ground commanders in a megacity that implements the tenants of the Army Operating Concept and is informed by the lessons learned in Iraq and Afghanistan. However, the true utility of Persistent Aviation Support may lie in its ability to bridge the gap between manned

Army Aviation Doctrine and methods of employment optimized for semi-autonomous UASs.

[1] U.S. Army Training and Doctrine Command, *The Army Operating Concept: Win in a Complex World*, TRADOC Pamphlet 525-3-1 (Joint Base Langley-Eustis, VA: U.S. Army Training and Doctrine Command, October 7, 2014), 16.
[2] Christopher Robin Lew, "Yom Kippur War: East-West testing ground," *Military History* 15, no. 4 (October 1998): 34, http://search.proquest.com.
[3] Saul Bronfeld, "Fighting Outnumbered: The Impact of the Yom Kippur War on the U.S. Army," *The Journal of Military History* 71, no. 2 (April 2007): 469-470. http://search.proquest.com.
[4] Paul H. Herbert, *Deciding What Has to Be Done: General William E. DePuy and the 1976 Edition of FM 100-5, Operation,* Leavenworth Papers, Number 16 (Fort Leavenworth, KS: U.S. Army Combined Arms Center Combat Studies Institute Press, 1988), 8, 31-36, 99-100.
[5] Department of Economic and Social Affairs, Population Division, *World Population Prospects: The 2011 Revision, Highlights* (New York: United Nations, 2012), 6, http://ipcc-wg2.gov/njlite_download2.php?id=8085.
[6] "Gaza Strip," The Central Intelligence Agency, *The World Factbook.* Last updated June 22, 2014, https://www.cia.gov/library/publications/the-world-factbook/geos/gz.html.
[7] CAP (Continuous Aviation Presence) is a term coined by COL T.J. Jamison who employed this concept as a squadron and brigade commander in Iraq and Afghanistan with great success.
[8] Craig Hoyle London, "Royal Air Force showcases Tornado's Afghan Versatility," *Flightglobal,* January 28, 2010, http://www.flightglobal.com/news/articles/royal-air-force-showcases-tornado39s-afghan-versatility-337745/.
[9] Ali Ahmad Jalali and Lester W. Grau, *Afghan Guerrilla Warfare: In the Words of the Mujahideen Fighters* (St. Paul, MN: MBI Publishing Company, 2001), 15.
[10] Author's personal experience.
[11] Edward Waner, "Douhet, Mitchell, Seversky: Theories of Air Warfare," in *Makers of Modern Strategy: Military Thought from Machiavelli to Hitler,* ed. Edward Mead Earle (Princeton: Princeton University Press, 1943), 487-490 and 498-499.
[12] The Economist, "Airpower: An Enduring Illusion," *The Economist Newspaper Limited,* August 28, 2006, http://www.economist.com/node/7826962.
[13] Matt M. Matthews, *We Were Caught Unprepared: The 2006 Hezbollah-Israeli War,* The Long War Series Occasional Paper 26 (Fort Leavenworth, KS: U.S. Army Combined Arms Center Combat Studies Institute Press, 2008), 2.
[14] H.R. McMaster, "McMaster discusses the Army Operating Concept," Video, 26:01, Posted by US Army TRADOC, October 28, 2014, https://www.youtube.com/watch?v=0UgilGxyYIs.

[15] U.S. Department of Defense, "State of the Air Force press briefing by Secretary James and General Welsh in the Pentagon Briefing Room," News Transcript, January 15, 2015, http://www.defense.gov/Transcripts/Transcript.aspx?TranscriptID=5571.
[16] Jeremy Binnie, "IDF Ground Forces Go After Gaza's 'Terror Tunnels,'" *Jane's Defense Weekly* 51, no. 34 (July 16, 2014), http://search.proquest.com; Matthew Poletti, "Rockets, Tunnels Still Pose Threat to Israelis," *Military Periscope Special Reports* (July 30, 2014): 1, *International Security & Counter Terrorism Reference Center*, http://search.ebsco*host*.com.
[17] Headquarters, Department of the Army, *Aircrew Training Manual OH-58D Kiowa Warrior,* TC 1-248 (Washington, DC: Headquarters, Department of the Army, April 12, 2007), 4-100.
[18] Frank W. Tate, "Army Attack Aviation Returning to the Close Fight: Impact of the MOUT Environment," (Master's thesis, School of Advanced Military Studies, January 2001), 45, http://www.dtic.mil/dtic/tr/fulltext/u2/a389374.pdf.
[19] U.S. Army Training and Doctrine Command, Marine Corps Combat Development Command, Navy Warfare Development Command, Curtis E. LeMay Center for Doctrine Development and Education, *Aviation Urban Operations: Multi-Service Tactics, Techniques, and Procedures for Aviation Urban Operations,* ATP 3-06.1, MCRP 3-35.3A, NTTP 3-01.04, AFTTP 3-2.29 (Joint Base Langley-Eustis, VA: Air Land Sea Application Center, April 2013), 63. The ATP specifically sates "Aircrews should maintain airspeeds above 60 knots to avoid effective small arms fire." While an RPG is not generally considered "small arms fire," the same concept applies to avoid RPG fire as for small arms fire, because they are both unguided munitions.
[20] Department of Economic and Social Affairs, Population Division, *World Urbanization Prospects: The 2014 Revision, Highlights* (New York: United Nations, 2014), 7, http://esa.un.org/unpd/wup/Highlights/WUP2014-Highlights.pdf.
[21] UN, *World Urbanization Prospects 2014*, 2.
[22] UN, *World Urbanization Prospects 2014*, 10.
[23] Samuel Solvit, *Dimensions of War: Understanding War as a Complex Adaptive System* (Paris: L'Harmattan, 2012), 88.
[24] John F. Schmitt, "Command and (Out of) Control: The Military Implications of Complexity Theory." In *Complexity, Global Politics, and National Security,* ed David S. Alberts and Thomas J. Czerwinski (Washington, D.C.: National Defense University, 1997), 105.
[25] Headquarters, Department of the Army, *Intelligence,* ADP 2-0 (Washington, DC: Headquarters, Department of the Army, August 31, 2012); Headquarters, Department of the Army, *Intelligence Support to Urban Operations,* FM 2-91.4 (Washington, DC: Headquarters, Department of the Army, March 20, 2008), 5-1.
[26] Headquaters DA, FM 2-91.4, 5-1.
[27] Headquarters, Department of the Army, *Fires,* ADP 3-09 (Washington, DC: Headquarters, Department of the Army, August 31, 2012), 1.
[28] Headquarters, Department of the Army, *Urban Operations,* FM 3-06 (Washington, DC: Headquarters, Department of the Army, October 26, 2006), 4-8.
[29] Maj Matthew Stiger, telephone interview with the author , Maj Stiger was a platoon commander for the duration of this operation.

[30] Department of State, Bureau of Conflict and Stabilization Operations, *Interagency Conflict Analysis Framework: ICAF 2.0,* Guidance Note (Washington, D.C.: Department of State, April 2014), 7.
[31] Chief of Staff of the Army Strategic Studies Group, Megacities Concept Team, *Megacities and the United States Army: Preparing for a Complex and Uncertain Future, Tab A* (Arlington, VA: Chief of Staff of the Army Strategic Studies Group, 2014), 17; Headquarters, Department of the Army, *Commander and Staff Officer Guide.* ATTP 5-0.1 (Washington, DC: Headquarters, Department of the Army, September 14, 2011) 4-18.

[32] Strategic Studies Group, *Megacities Tab A,* 16.
[33] Strategic Studies Group, *Megacities Tab A,* 17.
[34] Headquarters DA, ATTP 5-0.1, 4-18.
[35] U.S. Training and Doctrine Command, *The Airland Battle and Corps 86,* TRADOC Pamphlet 525-5 (Obsolete) (Fort Monroe, VA: U.S. Training and Doctrine Command, March 25, 1981), 4.
[36] U.S. Army TRADOC, ATP 3-06.1, 9.
[37] U.S. Army TRADOC, ATP 3-06.1, 9.
[38] Strategic Studies Group, *Megacities Tab A,* 17; Headquarters DA, FM 3-06, 7-5.
[39] "Tokyo's History, Geography, and Population," *Tokyo Metropolitan Government,* http://www.metro.tokyo.jp/ENGLISH/ABOUT/HISTORY/history02.htm; "Demilitarized Zone," *History.com,* http://www.history.com/topics/demilitarized-zone.
[40] Strategic Studies Group, *Megacities Tab A,* 18.
[41] Author's personal experience.
[42] Headquarters DA, FM 3-06, 10-19.
[43] U.S. Army TRADOC, *The Army Operating Concept,* 8.
[44] Headquarters, Department of the Army, *Counterinsurgency,* FM 3-24 (Washington, DC: Headquarters, Department of the Army, December 15, 2011), 1-19.
[45] Headquarters DA, FM 3-24, 9-1.
[46] Headquarters, Department of the Army, *Hybrid Threat,* TC 7-100 (Washington, DC: Headquarters, Department of the Army, November 26, 2010), v.
[47] Headquarters, Department of the Army, *Army Aviation Operations,* FM 1-100 (Washington, DC: Headquarters, Department of the Army, February 21, 1997), ii.
[48] This simplification of current doctrine is the author's personal opinion. The goal is to relate the missions of Army aviation in a way that facilitates the explanation of PAS.
[49] Headquarters, Department of the Army, *Aviation Brigades,* FM 3-04.111 (Washington, DC: Headquarters, Department of the Army, December 7, 2007), 3-7; Headquarters, 101st Airborne Division (Air Assault), *Gold Book,* (Fort Campbell, KY: Headquarters, 101st Airborne Division (Air Assault), June 1, 2014), xiii.
[50] John J. Tolson, *Airmobility: 1961-1971,* Vietnam Studies (Washington, D.C.: Department of the Army, 1973), 4.
[51] James W. Bradin, *From Hot Air to Hellfire: The History of Army Attack Aviation* (Novato, CA: Presidio Press, 1994), 201; John. Kifner, "101st Airborne Stages Biggest Chopper Assault," *Chicago Tribune,* February 25, 1991, http://articles.chicagotribune.com/1991-02-25/news/9101180260_1_helicopters-troop-carrying-iraqi-battalion-commander.

[52] Headquarters, Department of the Army, *Airborne and Air Assault Operations,* FM 3-99 (Washington, DC: Headquarters, Department of the Army, March 6, 2015), 9-4.
[53] Author's personal experience; 101st Airborne, *Gold Book,* C-34.
[54] Headquarters DA, FM 3-04.111, 3-1.
[55] Douglas W. Skinner, *Airland Battle Doctrine* (Alexandria, VA: Center for Naval Analyses, 1988), 19.
[56] James. Kitfield, "The Plan Unfolds." *National Journal* 35, no. 14 (April 5, 2003): 1044-1051, http://search.proquest.com; Barry R. McCaffrey, "Joint Firepower Wins Wars: Apache Helicopters Are Getting a Bad Rap," *Armed Forces Journal* (October 1, 2003), http://search.proquest.com.
[57] Headquarters DA, FM 3-04.111, 3-1.
[58] Author's personal experience.
[59] Tate, "Attack Aviation MOUT Environment," 49.
[60] Headquaters DA, FM 3-06, 4-7.
[61] Hugh L. Mills Jr., *Low Level Hell: A Scout Pilot in the Big Red One* (Novato, CA: Presidio Press, 1992), 43.
[62] Matthews, *2006 Hezbollah-Israeli War,* 17.
[63] Author's personal experience, 17 Feb 2008.
[64] COL T.J. Jamison, e-mail message to author March 22, 2015.
[65] CW4 Steve O. Crandall, telephone interview with the author, CW4 Crandall was an AH-64D instructor pilot on this deployment.
[66] Fred H. Allison, "Marine Air Support," *Marine Corps Gazette* 90, no. 11 (November 2006): 32-38, http://search.proquest.com.
[67] Donald. Tyson, "All might not go as expected," *Proceedings* 125, no 11 (November 1999): 54-56, http://search.proquest.com.
[68] Author's personal experience.
[69] Maj Mark Montgomer, interview with the author, Maj Montgomery was the Forward Air Controller on this mission.
[70] Author's personal experience.
[71] Bronfeld, *Impact of Yom Kippur War,* 4.
[72] U.S. Army TRADOC, *The Army Operating Concept,* 18.
[73] Glenn E. James, *Chaos Theory: The Essentials for Military Applications* (Newport Rhode Island: Naval War College, 1996), 17.
[74] U.S. Army TRADOC, *The Army Operating Concept,* 19.
[75] Tolson, *AirMobility 61-71,* 37.
[76] Headquarters, Department of the Army, *Aviation Flight Regulations,* AR 95-1 (Washington, DC: Headquarters, Department of the Army, March 11, 2014), 9.
[77] U.S. Army TRADOC, *The Army Operating Concept,* 19.
[78] COL T.J. Jamison, e-mail message to author March 22, 2015.
[79] Robert Jervis, *System Effects: Complexity in Political and Social Life* (Princeton, New Jersey: Princeton University Press, 1997), 10 and 271.
[80] U.S. Army TRADOC, *The Army Operating Concept,* 19.
[81] Headquarters DA, FM 3-06, 4-7.
[82] Headquarters, Department of the Army, *Unified Land Operations,* ADP 3-0 (Washington, DC: Headquarters, Department of the Army, October 10, 2011),12.

[83] U.S. Joint Chiefs of Staff, *Joint Interdiction,* Joint Publication 3-03, Change 1 (Washington, DC: U.S. Joint Chiefs of Staff, October 14, 2011), II-7-II-8.
[84] U.S. Army TRADOC, *The Army Operating Concept,* 19.
[85] Bruce A. Waltuck, "Exploring Chaos and Complexity," *The Journal for Quality and Participation* 34 no. 3 (2011): 20-21, http://search.proquest.com/docview/907556542?accountid=14746.
[86] U.S. Army TRADOC, *The Army Operating Concept,* iii.
[87] U.S. Army TRADOC, *The Army Operating Concept,* 19.
[88] U.S. Army TRADOC, *The Army Operating Concept,* 10.
[89] Tolson, *AirMobility 61-71,* 56.
[90] COL T.J. Jamison, e-mail message to author March 22, 2015.
[91] Author's personal experience.
[92] "Tokyo's History, Geography, and Population," *Tokyo Metropolitan Government,* http://www.metro.tokyo.jp/ENGLISH/ABOUT/HISTORY/history02.htm.
[93] Headquarters DA, FM 3-06, 4-9.
[94] Headquarters DA, FM 3-06, 4-9.
[95] John Everett-Heath, *Helicopters in Combat: The First Fifty Years* (New York, NY: Sterling Publishing Co. Inc., 1992), 60-61.
[96] U.S. Army TRADOC, *The Army Operating Concept,* 20.
[97] U.S. Army TRADOC, ATP 3-06.1, 65.
[98] Author's personal experience in Iraq: Directing lost convoys in Mosul, Iraq from the air was a common occurrence, especially at night.
[99] U.S. Army TRADOC, *The Army Operating Concept,* 19-20.
[100] Skinner, *AirLand Battle Doctrine,* 7-11.
[101] John McManus, "Busting the Bocage," *World War II Presents Normandy Campaign* (2004): 48-56, 98, http://search.proquest.com.
[102] Headquarters, Department of the Army, *Mission Command,* ADP 6-0 (Washington, DC: Headquarters, Department of the Army, May 17, 2012), 3.
[103] U.S. Army TRADOC, *The Army Operating Concept,* 18.
[104] McManus, "Busting the Bocage."
[105] Author's personal experience.
[106] Author's personal experience.
[107] Skinner, *AirLand Battle Doctrine,* 21-25.
[108] U.S. Joint Chiefs of Staff, *Stability Operations,* Joint Publication 3-07 (Washington, DC: U.S. Joint Chiefs of Staff, September 29, 2011), I-5.
[109] Josh C. Sauls, "Defragging the Hard Drive: A Change in Aviation Training Philosophy," *Aviation Digest* 3, no. 1 (January-March 2015): 5.
[110] Gary Nenninger, "Aviation Condition Based Maintenance," (Power Point Presentation, DOD Maintenance Symposium, November 13, 2007). http://www.sae.org/events/dod/presentations/2007garynenninger.pdf.
[111] U.S. Army TRADOC, *The Army Operating Concept,* 36.
[112] Author's personal experience.
[113] James Gleick, *Chaos: Making a New Science* (New York: Penguin Books, 1987), 20.
[114] U.S. Army TRADOC, *The Army Operating Concept,* iii.
[115] U.S. Army TRADOC, *The Army Operating Concept,* 10.

[116] Patrick Tucker, "The Pentagon's New Offset Strategy Includes Robots," *Defense One*, November 17, 2014, http://www.defenseone.com/technology/2014/11/pentagons-new-offset-strategy-includes-robots/99230/.
[117] U.S. Army TRADOC, *The Army Operating Concept*, 36.
[118] Paul Scharre, *Robotics on the Battlefield Part II: The Coming Swarm* (Washington, DC: Center for a New American Security, 2014), 24.
[119] Paul Scharre, "Commentary: Swarming the Battlefield," *DefenseNews*, January 5, 2015, http://www.defensenews.com/story/defense/commentary/2015/01/05/commentary-swarming-battlefield/21290287/.
[120] Adam Rawnsley, "Welcome to Ukraine's Electronic War," *Real Clear Defense*, March 8, 2015, http://www.realcleardefense.com/articles/2015/03/08/welcome_to_ukraines_electronic_war_107713.html. UAS operators working for independent observers in Ukraine have lost contact with their UASs.
[121] Scharre, *The Coming Swarm*, 14.
[122] Chief of Staff of the Army Strategic Studies Group, Megacities Concept Team, *Megacities and the United States Army: Preparing for a Complex and Uncertain Future* (Arlington, VA: Chief of Staff of the Army Strategic Studies Group, 2014), 4.
[123] United States Army, United States Marine Corps, and the United States Special Operations Command, *Strategic Landpower: Winning the Clash of Wills* (Joint Base Langley-Eustis, VA: U.S. Army Training and Doctrine Command, 2013), 1, http://www.tradoc.army.mil/FrontPageContent/Docs/Strategic%20Landpower%20White%20Paper.pdf.
[124] Strategic Studies Group, *Megacities Tab A*, 2 footnote 5.
[125] U.S. Army TRADOC, *The Army Operating Concept*, 15.

Bibliography

Allison, Fred H. "Marine Air Support." *Marine Corps Gazette* 90, no. 11 (November 2006): 32-38. http://search.proquest.com.

Binnie, Jeremy. "IDF Ground Forces Go After Gaza's 'Terror Tunnels.'" *Jane's Defense Weekly* 51, no. 34 (July 16, 2014). http://search.proquest.com.

Bousquet, Antoine. "Chaoplexic Warfare or the Future of Military Organization." *Internal Affairs* 85, no. 5 (2008): 915-929.

Bradin, James W. *From Hot Air to Hellfire: The History of Army Attack Aviation.* Novato, CA: Presidio Press, 1994.

Bronfeld, Saul. "Fighting Outnumbered: The Impact of the Yom Kippur War on the U.S. Army." *The Journal of Military History* 71, no. 2 (April 2007): 465-498. http://search.proquest.com.

Chief of Staff of the Army Strategic Studies Group, Megacities Concept Team. *Megacities and the United States Army: Preparing for a Complex and Uncertain Future.* Arlington, VA: Chief of Staff of the Army Strategic Studies Group, 2014.

Chief of Staff of the Army Strategic Studies Group, Megacities Concept Team. *Megacities and the United States Army: Preparing for a Complex and Uncertain Future, Tab A.* Arlington, VA: Chief of Staff of the Army Strategic Studies Group, 2014.

Combined Arms Combat Developments Activity (Provisional). *Organization and Employment of Attack Helicopters.* United States Army Combined Arms Center (Provisional), June 30, 1973. http://cdm16040.contentdm.oclc.org/utils/getdownloaditem/collection/p4013coll11/id/170/filename/174.pdf/mapsto/pdf/type/compoundobject/cpdtype/monograph/show/170.

Department of Economic and Social Affairs, Population Division. *World Population Prospects: The 2011 Revision, Highlights.* New York: United Nations, 2012. http://ipcc-wg2.gov/njlite_download2.php?id=8085.

Department of Economic and Social Affairs, Population Division. *World Population Prospects: The 2012 Revision Comprehensive Tables.* New York: United Nations, 2013. http://esa.un.org/wpp/Documentation/pdf/WPP2012_Volume-I_Comprehensive-Tables.pdf.

Department of Economic and Social Affairs, Population Division. *World Urbanization Prospects: The 2014 Revision, Highlights.* New York: United Nations, 2014. http://esa.un.org/unpd/wup/Highlights/WUP2014-Highlights.pdf.

Department of State, Bureau of Conflict and Stabilization Operations. *Interagency Conflict Analysis Framework: ICAF 2.0.* Guidance Note. Washington, D.C.: Department of State, April 2014.

"Demilitarized Zone." *History.com.* http://www.history.com/topics/demilitarized-zone.

Ellis, T'Jae. "Army Researchers Gather to Discuss Aviation Initiatives." *Army.mil.* January 14, 2015. http://www.army.mil/article/141106.

Everett-Heath, John. *Helicopters in Combat: The First Fifty Years.* New York, NY: Sterling Publishing Co. Inc., 1992.

Filkins, Dexter. "The Shadow Commander." *The New Yorker,* September 30, 2013. http://www.newyorker.com/magazine/2013/09/30/the-shadow-commander.

Gawrych, George W. *The 1973 Arab-Israeli War: The Albatross of Decisive Victory.* Leavenworth Paper no. 21. Fort Leavenworth, KS: Combat Studies Institute, US Army Command and General Staff College, 1996.

"Gaza Strip." The Central Intelligence Agency. *The World Factbook.* Last updated June 22, 2014. https://www.cia.gov/library/publications/the-world-factbook/geos/gz.html.

Gleick, James. *Chaos: Making a New Science.* New York: Penguin Books, 1987.

Headquarters, 101st Airborne Division (Air Assault). *Gold Book.* Fort Campbell, KY: Headquarters, 101st Airborne Division (Air Assault), June 1, 2014.

Headquarters, Department of the Army. *Airborne and Air Assault Operations.* FM 3-99. Washington, DC: Headquarters, Department of the Army, March 6, 2015.

Headquarters, Department of the Army. *Aircrew Training Manual OH-58D Kiowa Warrior.* TC 1-248. Washington, DC: Headquarters, Department of the Army, April 12, 2007.

Headquarters, Department of the Army. *Army Aviation Operations.* FM 1-100. Washington, DC: Headquarters, Department of the Army, February 21, 1997.

Headquarters, Department of the Army. *Aviation Brigades.* FM 3-04.111. Washington, DC: Headquarters, Department of the Army, December 7, 2007.

Headquarters, Department of the Army. *Aviation Flight Regulations.* AR 95-1. Washington, DC: Headquarters, Department of the Army, March 11, 2014.

Headquarters, Department of the Army. *Counterinsurgency.* FM 3-24. Washington, DC: Headquarters, Department of the Army, December 15, 2011.

Headquarters, Department of the Army. *Commander and Staff Officer Guide.* ATTP 5-0.1. Washington, DC: Headquarters, Department of the Army, September 14, 2011.

Headquarters, Department of the Army. *Fires.* ADP 3-09. Washington, DC: Headquarters, Department of the Army, August 31, 2012.

Headquarters, Department of the Army. *Hybrid Threat.* TC 7-100. Washington, DC: Headquarters, Department of the Army, November 26, 2010.

Headquarters, Department of the Army. *Intelligence.* ADP 2-0. Washington, DC: Headquarters, Department of the Army, August 31, 2012.

Headquarters, Department of the Army. *Intelligence Support to Urban Operations.* FM 2-91.4. Washington, DC: Headquarters, Department of the Army, March 20, 2008.

Headquarters, Department of the Army. *Mission Command.* ADP 6-0. Washington, DC: Headquarters, Department of the Army, May 17, 2012.

Headquarters, Department of the Army. *Operations.* FM 100-5 (Obsolete). Washington, DC: Headquarters, Department of the Army, August 20, 1982.

Headquarters, Department of the Army. *The Soviet Army: Troops, Organization, and Equipment.* FM 100-2-3. Washington, DC: Headquarters, Department of the Army, June 6, 1991.

Headquarters, Department of the Army. *Unified Land Operations.* ADP 3-0. Washington, DC: Headquarters, Department of the Army, October 10, 2011.

Headquarters, Department of the Army. *Unified Land Operations.* ADRP 3-0. Washington, DC: Headquarters, Department of the Army, May 16, 2012.

Headquarters, Department of the Army. *Urban Operations.* FM 3-06. Washington, DC: Headquarters, Department of the Army, October 26, 2006.

Herbert, Paul H. *Deciding What Has to Be Done: General William E. DePuy and the 1976 Edition of FM 100-5, Operations.* Leavenworth Papers, Number 16. Fort Leavenworth, KS: U.S. Army Combined Arms Center Combat Studies Institute Press, 1988.

Hewson, Harry J. "Light/attack helicopter operations in the three block war." *Marine Corps Gazette* 83, no. 4 (April 1999): 25-27. http://search.proquest.com.

Jalali, Ali Ahmad and Lester W. Grau. *Afghan Guerrilla Warfare: In the Words of the Mujahideen Fighters.* St. Paul, MN: MBI Publishing Company, 2001.

James, Glenn E. *Chaos Theory: The Essentials for Military Applications.* Newport, Rhode Island: Naval War College, 1996.

Jervis, Robert. *System Effects: Complexity in Political and Social Life.* Princeton, New Jersey: Princeton University Press, 1997.

Kedzior, Richard W. *Evolution and Endurance: The U.S. Army Division in the Twentieth Century.* Santa Monica, CA: RAND Arroyo Center, 2000.

Kifner, John. "101st Airborne Stages Biggest Chopper Assault." *Chicago Tribune.* February 25, 1991. http://articles.chicagotribune.com/1991-02-25/news/9101180260_1_helicopters-troop-carrying-iraqi-battalion-commander.

Kitfield, James. "The Plan Unfolds." *National Journal* 35, no. 14 (April 5, 2003): 1044-1051. http://search.proquest.com.

Lew, Christopher Robin. "Yom Kippur War: East-West testing ground." *Military History* 15, no. 4 (October 1998): 34. http://search.proquest.com.

London, Craig Hoyle. "Royal Air Force showcases Tornado's Afghan Versatility." *Flightglobal.* January 28, 2010. http://www.flightglobal.com/news/articles/royal-air-force-showcases-tornado39s-afghan-versatility-337745/.

Matthews, Matt M. *We Were Caught Unprepared: The 2006 Hezbollah-Israeli War.* The Long War Series Occasional Paper 26. Fort Leavenworth, KS: U.S. Army Combined Arms Center Combat Studies Institute Press, 2008.

McCaffrey, Barry R. "Joint Firepower Wins Wars: Apache Helicopters Are Getting a Bad Rap." *Armed Forces Journal* (October 1, 2003). http://search.proquest.com.

McManus, John. "Busting the Bocage." *World War II Presents Normandy Campaign* (2004): 48-56, 98. http://search.proquest.com.

McMaster, H.R. "Continuity and Change: The Army Operating Concept and Clear Thinking About Future War." *Military Review* 95, no. 2 (March-April): 6-19.

McMaster, H.R. "McMaster discusses the Army Operating Concept." Video. 26:01. Posted by US Army TRADOC, October 28, 2014. https://www.youtube.com/watch?v=0UgilGxyYIs.

Metz, Steven. "Strategic Insights: The Landpower Robot Revolution Is Coming." *Strategic Studies Institute,* December 10, 2014. http://www.strategicstudiesinstitute.army.mil/index.cfm/articles/Landpower-Robot-Revolution/2014/12/10.

Mersheimer, John T. “Assesing the Conventional Balance: The 3:1 Rule and Its Critics.” *International Security* 13, no. 4 (Spring, 1989): 54-89. http://www.jstor.org.

Mills Jr., Hugh L. *Low Level Hell: A Scout Pilot in the Big Red One.* Novato, CA: Presidio Press, 1992.

Nenninger, Gary. “Aviation Condition Based Maintenance.” Power Point Presentation. DOD Maintenance Symposium, November 13, 2007. http://www.sae.org/events/dod/presentations/2007garynenninger.pdf.

Peters, Ralph. “Our Soldiers, Their Cities.” *Parameters* (Spring 1996): 43-50. http://strategicstudiesinstitute.army.mil/pubs/parameters/Articles/96spring/peters.htm.

Poletti, Matthew. “Rockets, Tunnels Still Pose Threat to Israelis.” *Military Periscope Special Reports* (July 30, 2014): 1. *International Security & Counter Terrorism Reference Center*, http://search.ebsco*host*.com.

Rawnsley, Adam. “Welcome to Ukraine’s Electronic War.” *Real Clear Defense,* March 8, 2015. http://www.realcleardefense.com/articles/2015/03/08/welcome_to_ukraines_electronic_war_107713.html.

Sauls, Josh C. “Defragging the Hard Drive: A Change in Aviation Training Philosophy.” *Aviation Digest* 3, no. 1 (January-March 2015): 5.

Scharre, Paul. “Commentary: Swarming the Battlefield.” *DefenseNews.* January 5, 2015. http://www.defensenews.com/story/defense/commentary/2015/01/05/commentary-swarming-battlefield/21290287/.

Scharre, Paul. “Next-Generation Drone Warfare: Interview with Paul Scharre.” By John Waters. *Real Clear Defense,* February 24, 2015. http://www.realcleardefense.com/articles/2015/02/24/the_next_generation_in_drone_warfare_107660.html

Scharre, Paul. *Robotics on the Battlefield Part II: The Coming Swarm.* Washington, DC: Center for a New American Security, 2014.

Schmitt, John F. “Command and (Out of) Control: The Military Implications of Complexity Theory.” In *Complexity, Global Politics, and National Security,* edited by David S. Alberts and Thomas J. Czerwinski, 99-111. Washington, D.C.: National Defense University, 1997.

Skinner, Douglas W. *Airland Battle Doctrine.* Alexandria, VA: Center for Naval Analyses, 1988.

Smith, Douglas I. “Army Aviation in Operation Just Cause.” Individual study project, U.S. Army War College, April 15, 1992. http://www.dtic.mil/dtic/tr/fulltext/u2/a251409.pdf.

Solvit, Samuel. *Dimensions of War: Understanding War as a Complex Adaptive System.* Paris: L’Harmattan, 2012.

Tate, Frank W. “Army Attack Aviation Returning to the Close Fight: Impact of the MOUT Environment.” Master’s thesis, School of Advanced Military Studies, January 2001. http://www.dtic.mil/dtic/tr/fulltext/u2/a389374.pdf.

The Economist. “Airpower: An Enduring Illusion.” *The Economist Newspaper Limited.* August 28, 2006. http://www.economist.com/node/7826962.

“Tokyo’s History, Geography, and Population.” *Tokyo Metropolitan Government.* http://www.metro.tokyo.jp/ENGLISH/ABOUT/HISTORY/history02.htm.

Tolson, John J. *Airmobility: 1961-1971.* Vietnam Studies. Washington, D.C.: Department of the Army, 1973.

Tucker, Patrick. “The Pentagon’s New Offset Strategy Includes Robots.” *Defense One,* November 17, 2014. http://www.defenseone.com/technology/2014/11/pentagons-new-offset-strategy-includes-robots/99230/.

Tyson, Donald. “All might not go as expected.” *Proceedings* 125, no 11 (November 1999): 54-56. http://search.proquest.com.

United States Army, United States Marine Corps, and the United States Special Operations Command. *Strategic Landpower: Winning the Clash of Wills.* Joint Base Langley-Eustis, VA: U.S. Army Training and Doctrine Command, 2013. http://www.tradoc.army.mil/FrontPageContent/Docs/Strategic%20Landpower%20White%20Paper.pdf.

United States Joint Forces Command. *Design in Military Operations: A Primer for Joint Warfighters.* The Joint Warfighting Center Doctrine Pamphlet 10. Suffolk, VA: United States Joint Forces Command, September 20, 2010.

United States Joint Forces Command. *The JOE 2010: Joint Operating Environment.* Suffolk, VA: United States Joint Forces Command, February 18, 2010.

U.S. Army Training and Doctrine Command, Marine Corps Combat Development Command, Navy Warfare Development Command, Curtis E. LeMay Center for Doctrine Development and Education. *Aviation Urban Operations: Multi-Service Tactics, Techniques, and Procedures for Aviation Urban Operations.* ATP 3-06.1, MCRP 3-35.3A, NTTP 3-01.04, AFTTP 3-2.29. Joint Base Langley-Eustis, VA: Air Land Sea Application Center, April 2013.

U.S. Department of Defense. “State of the Air Force press briefing by Secretary James and General Welsh in the Pentagon Briefing Room.” News Transcript, January 15, 2015. http://www.defense.gov/Transcripts/Transcript.aspx?TranscriptID=5571.

U.S. Joint Chiefs of Staff. *Joint Interdiction.* Joint Publication 3-03, Change 1. Washington, DC: U.S. Joint Chiefs of Staff, October 14, 2011.

U.S. Joint Chiefs of Staff. *Stability Operations.* Joint Publication 3-07. Washington, DC: U.S. Joint Chiefs of Staff, September 29, 2011.

U.S. Training and Doctrine Command. *The Airland Battle and Corps 86.* TRADOC Pamphlet 525-5 (Obsolete). Fort Monroe, VA: U.S. Training and Doctrine Command, March 25, 1981.

U.S. Army Training and Doctrine Command. *The Army Operating Concept: Win in a Complex World.* TRADOC Pamphlet 525-3-1. Joint Base Langley-Eustis, VA: U.S. Army Training and Doctrine Command, October 7, 2014.

Waltuck, Bruce A. "Exploring Chaos and Complexity." *The Journal for Quality and Participation* 34, no. 3 (2011): 20-21. http://search.proquest.com/docview/907556542?accountid=14746.

Waner, Edward. “Douhet, Mitchell, Seversky: Theories of Air Warfare.” in *Makers of Modern Strategy: Military Thought from Machiavelli to Hitler,* edited by Edward Mead Earle, 485-503. Princeton: Princeton University Press, 1943.

Weinert, Richard P. *A History of Army Aviation: 1950-1962.* TRADOC Historical Monograph Series. Fort Monroe, VA: Office of the Command Historian United States Training and Doctrine Command, 1991.

Yarrison, James L. *The Modern Louisiana Maneuvers.* Fort McNair, DC: U.S. Army Center of Military History, 1999.

Zabecki, David T. “A Line in the Sand.” *Military History* 25, no. 2 (May-June 2008): 34-41. http://search.proquest.com.