A Pilotless Army in the Megalopolis

A Monograph

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14. ABSTRACT

This monograph answers the question, "Can unmanned aerial vehicles (UAVs) supplant manned United States Army attack and reconnaissance helicopters in the conduct of future urban operations" and the answer is, "not completely." The future of US involvement in urban operations is likely to increase. Given that urban operations are of high probability in the future, the public's probable aversion to casualties and the military's conservative doctrinal approach to urban operations, the Army must find a way to counter the asymmetric advantages our potential enemies may possess in urban combat. Although Army aviation can provide mobility, intelligence gathering, and massive precision fires, its current aviation systems are highly vulnerable within the urban environment and a solution may lie in the employment of UAVs. UAVs were designed with a twofold purpose in mind. First, UAVs were intended to reduce the risk to pilot, crew, and equipment. The potential economic burden of losing high-altitude reconnaissance aircraft or manned systems that may result in prisoners of war or personnel killed in action was significant enough to induce research and development to counter their loss. Secondly, freeing machines from the limitations of man expands the envelope for operations. Thus, the principal advantage of UAVs is a cost-effective system with greater capability and less risk to humans. Five criteria are used throughout this monograph to determine whether UAVs can supplant Army attack and reconnaissance helicopters. The criteria are capability, feasibility, acceptability, sustainability, and suitability. These criteria establish the test and focal lens by which research into fact, opinion, doctrine, theory, and historical evidence lead to conclusions and a recommendation for the future role and employment of UAVs in urban operations. An examination of the effects of urban sprawl and four case studies of urban operations since 1968 help determine the challenges for Army aviation to counter the growing threat of urban combat and the solutions that technology may afford in the future. In order to mitigate the risk to its aviators, equipment, and the supported ground forces, the Army needs to revise current doctrine to address the employment of Army aviation's attack and reconnaissance aircraft teamed with UAVs in urban operations. The analysis of this monograph demonstrates that Army aircrews are not able to independently complete the missions that may be required of it within the growing urban environment. Nor can UAVs be fielded to the units of action and be expected to independently conduct the current missions of attack and reconnaissance aircraft. The most effective solution lays in teaming manned and unmanned aviation assets and applying new doctrinal employment.

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ABSTRACT

A PILOTLESS ARMY IN THE MEGALOPOLIS by Major Robert G. Wegner, United States Army, 63 pages.

This monograph answers the question, "Can unmanned aerial vehicles (UAVs) supplant manned United States Army attack and reconnaissance helicopters in the conduct of future urban operations" and the answer is, "not completely." The future of US involvement in urban operations is likely to increase. Given that urban operations are of high probability in the future, the public's probable aversion to casualties and the military's conservative doctrinal approach to urban operations, the Army must find a way to counter the asymmetric advantages our potential enemies may possess in urban combat. Although Army aviation can provide mobility, intelligence gathering, and massive precision fires, its current aviation systems are highly vulnerable within the urban environment and a solution may lie in the employment of UAVs. UAVs were designed with a twofold purpose in mind. First, UAVs were intended to reduce the risk to pilot, crew, and equipment. The potential economic burden of losing high-altitude reconnaissance aircraft or manned systems that may result in prisoners of war or personnel killed in action was significant enough to induce research and development to counter their loss. Secondly, freeing machines from the limitations of man expands the envelope for operations. Thus, the principal advantage of UAVs is a cost-effective system with greater capability and less risk to humans.

Five criteria are used throughout this monograph to determine whether UAVs can supplant Army attack and reconnaissance helicopters. The criteria are capability, feasibility, acceptability, sustainability, and suitability. These criteria establish the test and focal lens by which research into fact, opinion, doctrine, theory, and historical evidence lead to conclusions and a recommendation for the future role and employment of UAVs in urban operations. An examination of the effects of urban sprawl and four case studies of urban operations since 1968 help determine the challenges for Army aviation to counter the growing threat of urban combat and the solutions that technology may afford in the future. In order to mitigate the risk to its aviators, equipment, and the supported ground forces, the Army needs to revise current doctrine to address the employment of Army aviation's attack and reconnaissance aircraft teamed with UAVs in urban operations. The analysis of this monograph demonstrates that Army aircrews are not able to independently complete the missions that may be required of it within the growing urban environment. Nor can UAVs be fielded to the units of action and be expected to independently conduct the current missions of attack and reconnaissance aircraft. The most effective solution lays in teaming manned and unmanned aviation assets and applying new doctrinal employment.

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CHAPTER 1: INTRODUCTION

Urbanization

> In an uncontrollably urbanizing world, we will not be able to avoid urban deployments short of war and even full-scale city combat. Cities have always been the center of gravity . . . Once the gatherers of wealth, then the processors of wealth, cities and their satellite communities have become the ultimate creators of wealth. They concentrate people and power, communications and control, knowledge and capability, rendering all else peripheral . . . a military unprepared for urban operations across a broad spectrum is unprepared for tomorrow.
>
> Ralph Peters, Our Soldiers Their Cities

To mitigate the risk to its aviators, equipment, and the supported ground forces, the Army may need to rethink the execution of aerial attack and reconnaissance within the urban environment. What lies ahead may be a solution to cost, risk, and effectiveness issues for future Army aviation warfighting in the urban environment—unmanned aerial vehicles (UAVs) able to attack tactical targets as well as conduct reconnaissance, surveillance, and target acquisition (RSTA).

This monograph will answer the question, "Can unmanned aerial vehicles supplant manned United States Army attack and reconnaissance helicopters in the conduct of future urban operations?" For the purpose of this monograph, 'future' is defined by the years 2010 through 2025. These dates represent the earliest production capability of the acquisition cycle and the 20-year outlook (midterm) for future systems and threats. Attempting to define a future threat or friendly capability beyond the year 2025 may be speculative and unreliable.

Five criteria are used throughout this paper to determine whether UAVs can supplant Army attack and reconnaissance helicopters. The criteria are capability, feasibility, acceptability, sustainability, and suitability. These criteria establish the test and focal lens by which research into fact, opinion, doctrine, theory, and historical evidence lead to conclusions and a recommendation for the future role and employment of UAVs in urban operations.

To clearly understand what this monograph seeks to answer, one must first understand the key terms referenced throughout the monograph. The criteria used are defined below.[1]

1. Capability: The capacity to be used for a specific purpose.
2. Feasibility: The determination that a specific task can be successfully accomplished.
3. Acceptability: Adequate to satisfy the military and political need.
4. Sustainability: Providing for and maintaining a required level of materiel readiness.
5. Suitability: Possesses the qualities that are appropriate for the purpose.

According to Joint Publication (JP) 1-02, *Department of Defense Dictionary of Military and Associated Terms*, which defines all joint-use terminology, an unmanned aerial vehicle is:

> . . . a powered, aerial vehicle that does not carry a human operator, uses aerodynamic forces to provide vehicle lift, can fly autonomously or be piloted remotely, can be expendable or recoverable, and can carry a lethal or non-lethal payload. Non-lethal refers to electronic warfare, incapacitating agents, and other similar characteristics. Ballistic or semi-ballistic vehicles, cruise missiles, and artillery projectiles are not considered unmanned aerial vehicles.[2]

According to the United States Army Field Manual (FM) 3-06, *Urban Operations*, which describes the impact of the urban environment on military operations, urban operations consist of "offense, defense, stability, and support operations conducted in a topographical complex and adjacent natural terrain where manmade construction and high population density are the dominant features."[3] The urban environment in which these operations take place is also defined by FM 3-06 as that which,

> . . . includes the physical aspects of the urban area as well as the complex and dynamic interaction and relationships between its key components—the terrain (natural and man-made), the population, and the supporting infrastructure—as an overlapping and interdependent system of systems.[4]

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[1] The five criteria are defined using an online dictionary source because the OPLAN criteria in JP 1-02 provided definitions that lacked required detail. Available online: www.dictionary.com, accessed 4 December 2003.
[2] US Department of Defense, Joint Publication (JP) 1-02, *Dictionary of Military and Associated Terms* (Washington D.C., 12 April 2001, as amended through 17 December 2003), 557.
[3] US Department of The Army, Field Manual 3-06 (90-10), *Urban Operations* (Washington D.C., June 2003), 33-glossary.
[4] Ibid.

An urban area is a subset of the urban environment and "focusing on urban areas means concentrating on the physical aspects of the area and their effects on tactics, techniques, and procedures."[5] According to joint doctrine, urban areas have three distinguishing characteristics that together are referred to as the urban triad. The urban triad is defined by JP 1-02 as "complex manmade physical terrain, a population of significant size and density, and an infrastructure upon which the area depends."[6] While physical terrain and population density are relatively simple terms, a concise definition of infrastructure is provided by FM 3-06: "Urban infrastructures are those systems that support urban inhabitants and their economy. They link the physical terrain to the urban society. Destroying, controlling, or protecting vital parts of the infrastructure can isolate a threat from potential sources of support."[7]

According to an online dictionary, "A megalopolis is a region made up of several large cities and their surrounding areas in sufficient proximity to be considered a single urban complex."[8] The megalopolis may offer a potential adversary a heightened ability to gain industrial and citizen support. Within cities, an adversary can easily hide, find food, water, and shelter, and blend with the populace for easy movement and transition throughout the megalopolis. The significance of forces operating within a megalopolis is the requirement to root out the enemy while unavoidably subjecting friendly forces and non-combatants to enemy fire, and doing so with great potential for excessive collateral destruction while returning fire, or political harm by killing innocent civilians.

A megalopolis or even an individual city provides a defensive benefit because unlike typically modeled conventional warfare, such as on a European plain or a Middle Eastern desert,

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[5] Ibid.
[6] JP 1-02, *Dictionary of Military and Associated Terms*, 558.
[7] FM 3-06, *Urban Operations*, 2-19.
[8] Lexico Publishing Group, LLC, *Dictionary.com*, copyright 2004, http://dictionary.reference.com/search?q=megalopolis, accessed 6 September 2003.

it presents more than just horizontal topography. Instead, "in fully urbanized terrain . . . warfare becomes profoundly vertical, reaching up into towers of steel and cement, and downward into sewers, subway lines, road tunnels, communications tunnels, and the like."[9]

Army forces may conduct urban operations as a single operation and single component or in a joint and multinational effort that may include the full spectrum of Army operations. Joint urban operations (JUO) are defined by JP 1-02 as "all joint operations planned and conducted across the range of military operations on or against objectives on a topographical complex and its adjacent natural terrain where manmade construction or the density of noncombatants are the dominant features."[10] As the world becomes more populated and complex, one must consider the joint definition outlined above, which expands urban operations to include all joint operations across the spectrum of military operations.

World population expansion and gravitation to urban areas should be of significant interest to our military. Dr. Russell Glenn of the RAND Institute[11] notes that urban growth in the developing world is pronounced.

> Only three of the world's ten largest cities were in developing nations five years after World War II. By 1990, seven of the top ten were Third World cities. In late 1993, seventeen of the twenty-five most populated cities in the world fell into that category. The inability of some governments to handle the social, infrastructure, cultural, and a myriad of other problems make their cities potential sources of unrest. [12]

According to Dr. Glenn, the potential for unrest in the cities may cause city infrastructures to collapse. If infrastructure systems collapse, conflict or catastrophe, such as famine, are likely. A global increase in urban population, the bulk of which will occur in the developing world,

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[9] Ralph Peters, "Our Soldiers Their Cities," *Parameters*, XXVI, no. 1 (Spring 1996): 45.
[10] JP 1-02, *Dictionary of Military and Associated Terms*, 291.
[11] The RAND Institute is a non-profit research and analysis institution.
[12] Russell W. Glenn, *Combat in Hell: A Consideration of Constrained Urban Warfare* (Santa Monica: RAND, 1996), 3, MR-780-A/DARPA.

foreshadows a potential increase in urban deployment of US military personnel. [13] "The growth of cities is inevitable - and irreversible. Standing at 2.4 billion in 1990, the world's urban population will rise to 3.2 billion in the year 2000 and 5.5 billion in 2025. The developing countries' share in these totals: 63% in 1990, 71% in 2000 and will rise to 80% in 2025."[14]

According to FM 3-06, half of the world's population resides in urban areas and by the year 2015, it's estimated that Asia will have 17 cities with over ten million residents, including three cities with populations above 20 million. The rapid pace with which global urbanization is occurring has overcome the supporting resources, fragile economic bases, and weak infrastructures of some nations, especially those of developing countries where urbanization is most evident.[15]

In his article, *The Strategic Corporal: Leadership in the Three Block War,* former United States Marine Corps Commandant, General Charles Krulak addresses his perception of the future nature of war and describes the strategic implications of tactical decisions. He cites the numerous accounts of urban operations around the world in recent years and states that urban operations represent the likely battlefield of the twenty-first century. He explains that the rapid proliferation of technology, numerous transnational factors, and increasing globalization have combined to create complex national security challenges. He comments about urban sprawl by saying:

> By 2020, 85 percent of the world's inhabitants will be crowded into coastal cities—cities generally lacking the infrastructure required to support their burgeoning populations. Under these conditions, long simmering ethnic, nationalistic, and economic tensions will explode and increase the potential of crises requiring US intervention.[16]

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[13] Ibid.
[14] Jonas Rabinovitch, "Practical Approaches to Urban Poverty Reduction," in The International Forum on Urban Poverty Governance and Participation held in Florence 10-13 November 1997, internet: http://magnet.undp.org/Docs/urban/Urbpov.htm, accessed 10 February 2004.
[15] FM 3-06, *Urban Operations,* 1-2.
[16] Charles C. Krulak, "The Strategic Corporal: Leadership in the Three Block War," *Marines Magazine,* January 1999. 30.

According to FM 3-06, while the focus in ancient times was the conquest of the city to gain resources or property, modern urban warfare occurs because it is unavoidable. Insurgents, terrorists, and other threats find refuge within the city and can execute overt or covert actions, travel freely throughout the city under the guise of local populace, and trap forces in one city while obtaining their actual objective in another. Regardless of these and many other challenges presented by the urban environment, FM 3-06 states that major operations can no longer avoid its influence (with the exception of desert warfare).[17] If past battles and current doctrine are accurate indicators of the future, then urban warfare may be an integral and permanent part of future military operations.

Dr. Glenn's summary of an urban operations conference held at the Washington RAND office includes the opinion of conference attendees[18] that alternatives to commitments of US forces into urban areas and subsequent engagement of an adversary at close range are desirable, primarily because of the American public's intolerance of large numbers of casualties.[19] Conversely, FM 3-06 fails to discuss alternatives or TTPs to close range urban engagements and instead describes the basic advantages of Army aircraft in the urban environment. The advantages listed are high-speed maneuver, useful platforms for observation, reconnaissance, attack, and insertion of forces. However, the manual goes on to state,

> . . . buildings of varying height and the increased density of towers, signs, power lines, and other urban constructions create obstacles to flight and the trajectory of many munitions (masking). These obstacles can limit low-altitude maneuverability in the urban airspace. Excellent cover and concealment afforded enemy gunners in an urban area

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[17] FM 3-06, *Urban Operations*, 1-3, 3-13, 3-16.
[18] Attendees included 61 representatives from a diverse number of organizations, such as: SARDA, J6 and J8 Joint Staff sections, DCSOPS, Natick Research Center, TRADOC, US Army War College, DCSINT, HQDA Strategy-Plans-Policy Division, among many others. For an expanded list of attendees and offices see next footnote and refer to pp. 35-36.
[19] Russell W. Glenn, et al., *Denying the Widow Maker* (Santa Monica: RAND, 1996), x-xi, 12. This summary of proceedings is from the RAND-DBBL Conference on Military Operations on Urbanized Terrain, held at the RAND-Washington, D.C. office on 24-25 February 1998.

increases aviation vulnerability to small arms and man-portable air defense systems (MANPADS), particularly when supporting ground forces.[20]

Given that the Army's urban operations doctrine, prominent urban experts, and urban operations conference-attending professionals alike, state that urban operations should be conducted with ample stand-off range or avoided altogether, the question rises, how does one conduct urban operations without being in the urban environment? Given that urban operations are of high probability in the future, the public's probable aversion to casualties and the military's conservative doctrinal approach to urban operations, [21] it's apparent that another solution is needed. In the future, repeating mistakes or not changing in respect to discovered weakness would be both shameful and deadly. The next section examines a brief history of urban operations in order to learn from the past.

History of Urban Operations

According to Dr. Roger Spiller, a professor of military history at the United States Army's Command and General Staff College, urban warfare has often resulted in the siege or destruction of cities and slaughter of their inhabitants from the days of the ancient battle of Troy to modern times. History is full of examples of urban siege, surrender and destruction, particularly during the twentieth century, such as what happened on 21 February 1916, when the German Fifth Army attacked Verdun along an eight-mile-wide front. Verdun was a strategic battle that the Germans had hoped would cause the French to sue for peace and the English to

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[20] FM 3-06, *Urban Operations*, 2-5.
[21] The public's aversion to casualties is evident in statements by Dr. Glenn (see footnote 18) and in the removal of forces from Somalia following the debacle that ensued during Operation Restore Hope in Mogadishu (see Operation Restore Hope case study in chapter 2).

follow suit. After ten months of fighting, the battle consumed one million casualties, of which 600,000 were killed.[22]

The Second World War ushered in a new paradigm for urban combat, demonstrating both the utility of cities for defense and the slaughter that occurs when battle ensues within their confines. Stalingrad is an example of urban warfare that consumed the lives of thousands of Russian and German forces in the Second World War. Stalingrad's population in 1942 exceeded 500,000 and the city stretched parallel to the Volga for 30 miles, but was less than two miles in width. Stalingrad had no intrinsic value in geographical location but it contributed as a pivot point about which forces maneuvered. The Russians sought to maintain control of the city but Hitler's plan included going beyond the Volga to the oil fields of the Caucasus. Both sides, however, found that the city provided the desired carnage and rapid attrition of the opposing force.[23]

The German Luftwaffe's Eighth Air Army provided cover for the ground forces as they moved to the city in August 1942. Continuous bombing had already leveled the city but the Luftwaffe continued to bomb the rubble, furthering the inner-city mobility problems. By September of 1942, the Russians had 55,000 men in place against 95,000 Germans.[24] Attrition took its toll on the Russians. Two Russian divisions originally totaling 14,000 men were evacuated in October with less than 1,000 remaining alive.[25] By December, the Germans mustered 275,000 men to Stalingrad but the Russians were able to fix them in the city and swell their own forces to nearly one million men in preparation for a counter-offensive. Stalingrad

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[22] Roger J. Spiller, *Sharp Corners: Urban Operations At Century's End* (Fort Leavenworth: CGSC Press, 2000), 58-59.
[23] Ibid, 59-62.
[24] Ibid, 59-64.
[25] Russell W. Glenn, *Combat in Hell: A Consideration of Constrained Urban Warfare* (Santa Monica: RAND, 1996), 2, MR-780-A/DARPA.

demonstrates the large number of forces required, high casualty rate, and destruction that occurs in urban combat.[26]

Sun Tzu wrote, "The worst policy is to attack cities. Attack cities only when there is no alternative."[27] There are many obvious reasons to avoid combat in the urban environment and World War Two provided numerous examples of those reasons. An offensive force in an urban environment faces many challenges that can compromise the accomplishment of its mission. The great urban battles of the Second World War led to distaste for combat in urban areas. US Army doctrine from 1976, FM 100-5, *Operations*, clearly reflects the hesitation to engage in urban combat in two ways. First, the manual does not sufficiently deal with urban combat and only mentions *urban* in nine instances throughout the manual. Secondly, the manual advises commanders to avoid committing forces to the attack of urban areas unless the mission absolutely requires doing so.[28]

The urban environment accommodates a defending force by providing cover, resources, and the potential compromise of the attacker's rules of engagement (ROE) through excessive collateral damage. Ironically, FM 3-06 cites numerous operational and strategic reasons that may compel forces to operate in urban areas. Economics, political power, and cultural significance can all contribute to a requirement for forces to operate within a city. Cities are generally the regional center of population and are obvious providers of useful infrastructure, communications, geographical location or resources. FM 3-06 recognizes that recent experiences in urban operations, such as those conducted in the cities of Hue, Panama City, Mogadishu, and Grozny

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[26] Roger J. Spiller, Sharp Corners: Urban Operations At Century's End, 63.
[27] Sun Tzu, *The Art of War*, Translated and with an introduction by Samuel B. Griffith and foreword by B.H. Liddell Hart (Oxford: Oxford University Press, 1963), 78.
[28] US Department of The Army, Field Manual 100-5, *Operations* (Washington D.C., May 1976), 8-2.

have caused Army and joint doctrine writers to embrace urban operations and continue to expand on the military's role, as evident in the current editions of FM 3-06 and JP 3-06.[29]

However, these publications do not inform the Army flier about the tactical employment of helicopters within the urban area. Furthermore, while the 1993 version of JP 3-55.1, *Joint Tactics, Techniques, and Procedures (JTTP) For Unmanned Aerial* Vehicles,[30] discusses non-lethal employment of UAVs, particularly the RSTA mission, it fails to integrate UAVs into urban operations as a primary weapon system. Perhaps the growth of technology and urban sprawl are ample reasons for its ongoing revision. If doctrinal experts realize the significant limitations of helicopters and UAVs employed independently in the urban environment, then perhaps they will incorporate manned-unmanned teaming to maximize the attributes of each system. The Army aviation community may need to review the appropriate means for employment of helicopter-UAV teams and include the findings in the draft version of JP 3-55.1, *Joint Tactics, Techniques, and Procedures For Unmanned Aerial Vehicles*.[31]

Doctrinal implications of urban operations continue to develop from recent operations in Iraq and Afghanistan. Dr. Mike Stewart of the US Army Center for Military History shared this thought with the 2003-2004 class of the Advanced Military Studies Program, concerning the effect of manned-aviation in an urban environment: "Air power [manned] was most effective with only a few US soldiers on the ground to direct it. Air power was least effective in a

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[29] FM 3-06, *Urban Operations*, 4-2 – 4-3.
[30] US Department of Defense, Joint Publication 3-55.1, *JTTP For Unmanned Aerial Vehicles* (Washington D.C., 27 August 1993), 2-1. Electronic copy available: http://www.fas.org/irp/doddir/dod/jp3-55_1/index.html, accessed 10 January 2004.
[31] US Department of Defense, Joint Publication 3-55.1, *Joint Tactics, Techniques, and Procedures For Unmanned Aerial Vehicles (DRAFT)* is not yet published nor accessible to reference the changes made from the earlier 1993 version of JP 3-55.1.

complex, close-quarters battle against a hidden foe."[32] If recent experience in urban operations indicates the inadequacies of manned aircraft in the complex terrain of the urban environment, perhaps the paradigm is about to shift and find part of the solution to urban operations by employing UAVs in tactical and operational missions required within the urban environment.

CHAPTER 2: URBAN CASE STUDIES

This section presents an analysis of four urban operations occurring between 1968 and 1996. The analysis presents evident changes in urban operations and draws lessons learned for aviation from each operation to provide further understanding of urban operations that may be encountered in the future. Sean Edwards of the RAND Arroyo Center and Russell Glenn present their findings about these particular urban operations in a monograph titled *Mars Unmasked: The Changing Face of Urban Operations*.[33] The following urban operation case studies represent the nature of urban operations conducted repeatedly in modern military operations. The four case studies will focus on the cities of Hue in 1968, Panama City in 1989, Mogadishu in 1993, and the first battle for Grozny in the war in Chechnya from 1994 to 1995.

The Battle for Hue, South Vietnam: 31 January 1968

Dr. James J. Wirtz, Professor in the Department of National Security Affairs at the Naval Postgraduate School and author of *The Tet Offensive*[34] and contributing writer to *Soldiers in*

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[32] Quote taken with permission from Dr. Mike Stewart, Chief, Histories Division, US Army Center for Military History, while speaking to the AMSP class of 2004 on the role of air power in Operation Iraqi Freedom, 16 December 2003.

[33] Russell Glenn provided research oversight for Sean Edwards and together they discovered trends in the conduct of urban operations. Also contributing to this area of research is Michael Desch, Editor of *Soldiers in Cities: Military Operations on Urban Terrain.* This literary work is a result of a conference on "Military Operations in an Urban Environment" cosponsored by the Patterson School of Diplomacy and International Commerce on Military Affairs and the US Army War College.

[34] James J. Wirtz, "*The Tet Offensive: Intelligence Failure in War* (Ithaca: Cornell University Press, 1991).

Cities: Military Operations on Urban Terrain,[35] writes that the battle for Hue validates modern doctrine for urban operations. He believes that the key to controlling urban combat or strife is the isolation of disturbances. Prevention requires intervention by soldiers and therefore a key planning consideration for urban combat is whether to hold forces in reserve that can respond to urban attacks or isolate disturbances. He posits that Army units are already short personnel and if positioning soldiers around the globe to respond to and isolate conflict is required, then a planning dilemma may exist.[36]

On January 31, 1968, the North Vietnamese launched an attack on the city of Hue. This city was a significant objective of the North Vietnamese because at its heart was the citadel—the center of Vietnamese culture and site of the old Imperial capital—the ancient symbol of authority. Capturing Hue would send a message indicating the North's political goals. The attack coincided with the Chinese lunar New Year referred to as Tet. The purpose of the Tet Offensive was to lead to a general uprising, or "People's War," which in turn would lead to the disintegration of the Army of the Republic of Vietnam (ARVN) and Saigon government. The desired endstate of the North Vietnamese was a collapse of the ARVN, an urban revolt that would force negotiations aimed at the United States' withdrawal and Communist unification of Vietnam.[37]

The Tet Offensive was to be the culminating point of "People's War" because of the general uprising of multiple urban populations, Saigon and Hue in particular. Differently than in Saigon, the People's Army of Vietnam (PAVN) occupied Hue with a division-sized element before the United States forces and the ARVN were able to respond.[38]

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[35] James J. Wirtz, "The Battles for Saigon and Hue: Tet 1968," Michael Desch, ed., *Soldiers in Cities: Military Operations on Urban Terrain*, (Carlisle, Strategic Studies Institute, 2001).
[36] Ibid, 85.
[37] Ibid, 75.
[38] Ibid, 76-77, 80.

Elements of two regiments of the PAVN, one battalion, and two sapper companies[39] infiltrated Hue on January 31, 1968. The ARVN intelligence had indicated that the city was not the aim of an attack, therefore light preparations were made for its defense. The PAVN managed to occupy most of the city before American and allied forces realized what happened and on 1 February, the attackers released approximately 500 Viet Cong (VC) troops from the Hue jail.[40] As the round-up of South Vietnamese and Americans began, a French correspondent reported,

> The new masters of the city went through the streets in groups of ten. In each group, there was a leader who spoke to the people through a bullhorn . . . The other members of the team…knocked on doors and passed out pamphlets and leaflets. Joking and laughing, the soldiers walk in the streets and gardens without showing any fear.[41]

While the PAVN took hold of the city and erected defenses, they failed to destroy a key bridge that would facilitate the relief of American forces. Unfortunately, the Americans moved forces into the city more slowly than the PAVN. The Marines secured the southern portion of the city by February 10, and the First Air Cavalry Division cut off the PAVN's resupply routes from caches outside the city.[42] The PAVN was postured to defend the city from an outside threat. The ARVN launched counterattacks from within the city but bad weather temporarily hampered the employment of American artillery and air support, so on 13 February, the Marines began a ground assault that regained the Citadel within ten days. Although the effort to retake Hue was successful, it destroyed the symbolically important city and took an entire month to accomplish. The costs of urban combat at Hue resulted in 10,573 homes damaged or destroyed, 116,000 refugees displaced, and 1,728 civilians killed or wounded. Total allied casualties were 3,799 dead or wounded and 5,113 prisoners of the PAVN.[43] The battle of Hue demonstrates that if an

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[39] Sapper units specialize in infiltration, tunneling, and engineering tasks.
[40] James J. Wirtz, "The Battles for Saigon and Hue: Tet 1968," 81.
[41] Ibid.
[42] Logistical support of PAVN forces was enabled by a supplies cache in the A Shau Valley, which runs North-South and is positioned just west of Hue.
[43] James J. Wirtz, "The Battles for Saigon and Hue: Tet 1968," 82, 87.

enemy force is determined to defend and fortify a city, then friendly forces may be required to lay siege to the city at the potential cost of numerous casualties, destruction from heavy weapons, and extensive time to regain the city. The battle of Hue also shows that a city must be isolated quickly, no matter whether the disturbance is insurrection, terrorism or general uprising. Ground forces were unable to immediately isolate the city from reinforcements or logistics in order to deplete ammunition or isolate pockets of resistance. Although the PAVN had the time to occupy and fortify the city with supplies and defenses, they failed to eliminate American and the ARVN pockets of resistance within the city, resulting in internal and external attack on their forces. The battle of Hue also shows us that an uprising can occur quickly and without warning to residents or even forces already within the urban environment.

Today, forces may not be readily able to quell potential chaos within a city. Hue shows us that failure to react quickly may result in significant destruction and loss of life. Modern urban operations will be conducted before a global audience and political ramifications and effects on public support will be immediate.[44] Determining which units or capability can respond quickly enough with the flexibility to suppress city-wide disturbance is the planner's immediate concern. Hue is a lesson in the need for intelligence, rapid action and control that demonstrates the significant destruction and loss of life that can occur when these qualities are absent.

Operation Just Cause, Panama City, Panama: 1989

Manuel Noriega rose to power in the 1980s and was of use to the United States intelligence community for his contributions to the counter-narcotics effort. After allegations of his rigging the 1984 election, the United States suspended military and economic aid. Noriega curtailed the constitutional rights of Panamanians and was indicted in 1988 by Florida grand

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[44] Ibid, 84-85.

juries of involvement in a drug cartel. President Reagan invoked sanctions in April 1988 and the behavior of the Panamanian Defense Force (PDF) toward American service members stationed in Panama declined. Tensions were high between the PDF and American service members and on December 16, 1989, the PDF killed an American officer. This sparked the beginning of Operation Just Cause.[45]

On December 19, 1989, United States joint forces assaulted 27 objectives in Panama. Targets included the PDF, their garrisons, airports, media, transportation and command nodes. 26,000 troops took part in the operation and were comprised of 13,000 stateside troops and 13,000 already within Panama as part of Joint Task Force (JTF) South. The PDF was comprised of approximately 15,000 troops, a small air force and navy, limited air defense capability, and 28 armored cars.[46]

JTF South Commanding General, Lieutenant General Carl W. Stiner, launched several simultaneous assaults under the cover of darkness to shock and paralyze the PDF through overwhelming force at PDF reinforcement locations, two airfields, key bridges, a naval base, and the PDF HQ compound—La Comandancia. The most complicated urban target was the latter.

The compound consisted of 15 buildings at the center of Panama City and was protected by a ten foot cement wall, just like the Citadel at Hue, Vietnam. While abiding by strict rules of engagement, JTF South's mechanized forces led the infantry to the heart of the city, blowing a hole in the wall of La Comandancia. Sheridan tanks and air strikes provided cover as the American forces approached and entered La Comandancia. Interestingly, the PDF failed to take

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[45] Sean J. Edwards, *Mars Unmasked: The Changing Face of Urban Operations* (Santa Monica: Rand, 2000), 18-19, MR-1173-A.
[46] Ibid, 19.

advantage of the natural ground defense offered by the urban environment and air defense from their stockpile of rocket-propelled grenades (RPG).[47]

The Americans encountered only light fire just prior to taking down La Comandancia and a single M113 troop carrier was hit, resulting in the temporary halt of two columns of vehicles. The lightness of the fire received by American forces enroute to La Comandancia indicates that LTG Stiner's objective of paralyzing the PDF apparently worked.[48]

Additional urban combat occurred outside of Panama City but PDF forces fled their attackers in these locations as well. The PDF was quite unwilling to die for their cause, unlike the PAVN in the battle for Hue. The PDF's lack of dedicated spirit, failure to fully employ air defense assets, and sheer surprise by the attack, contributed to the decisive victory by JTF South. The success of the operation was also due in part to the division of Panamanian support for Noriega's oppressive dictatorship. Without the support of the people to rise up against American presence in Panama, the PDF would fail. Damage to the city was negligible and the operation took only days to complete.[49]

Air support, present in the form of Apache helicopters, AH-6 "Little Birds" and Stealth F-117A fighters, had no significant PDF air force or air defense threat opposing them. Thus, American forces possessed air supremacy and by conducting unimpeded airlift they finished the job in only a few days. The presence of American troops already stationed in Panama also contributed to the operation's success by their inherent knowledge of the urban environment.

Overall, 23 American soldiers and three civilians were killed and 324 were wounded, compared to approximately 314 PDF soldiers and approximately 200-300 civilians killed.[50] Panama City highlights the importance of rapid, uninhibited air maneuver, and the advantages

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[47] Ibid, 20.
[48] Ibid.
[49] Ibid, 20-21.

gained by forces already familiar with the area of operations. Unimpeded air movement and the simultaneous attack of key nodes in a relatively permissive environment set the conditions for a successful urban operation.

Operation Restore Hope, Mogadishu, Somalia: October 3-4, 1993

In 1989, Somali warlord Mohammed Aideed organized a guerrilla campaign to eject Mohammed Siad Barre from power. After displacing Barre in 1991, Aideed fought rival clan warlords for control of the country, especially the capital, Mogadishu. Inter-tribal fighting led to economic breakdown and collapse of governmental authority. As a result, the United Nations (UN) intervened in 1992, with support from the United States, in an attempt to restore order and prevent the population from starving. The UN identified Aideed as the key source of instability in Somalia, and in 1993 the United States sent troops to capture him and his lieutenants.[51]

Unlike the environment presented in the Panama City case study, Somalia varied from humanitarian relief to peace enforcement between 1992 and 1993. Operation Restore Hope began on December 9, 1992, with the arrival of Marines, Navy SEALS, and follow-on forces such as the Army's 10th Mountain Division. While combat in primarily urban areas ensued several times during this period, the focus of this case is the climatic firefight, which occurred on 3-4 October, 1993.[52]

The experience of American forces in Mogadishu during Operation Restore Hope illustrates the volatile nature of urban operations and the danger to soldiers operating from the air or on the ground in that environment. The battle in Mogadishu on 3-4 October also highlights the

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[50] Ibid, 21-22.
[51] Microsoft Encarta Encyclopedia, CD-ROM, 2002, s.v. "Mogadishu."
[52] Sean J. Edwards, *Mars Unmasked: The Changing Face of Urban Operations*, 11.

ability of an unruly and armed mob to offset the technological superiority of helicopters and challenge the mere survival of ground forces.

Aideed's power was in jeopardy the moment the UN began humanitarian relief and, eventually, disarmament of the population. He wanted to force the United States to withdraw, divide the coalition, and prevent the UN from reaching a settlement with other Somali clans. To accomplish these things, the Somali National Alliance (SNA) militia conducted ambushes when the advantage was theirs. On June 5, 1993, the urban guerrilla-like SNA ambushed 24 Pakistani soldiers in Mogadishu. Assuming that Aideed was responsible, the UN issued an order for his arrest on June 17. From this point forward, the SNA became more aggressive and continued attacks on UN peacekeepers. In the course of these stepped-up attacks four United States soldiers were killed in an ambush by the SNA on the eighth of August. President Clinton immediately sent Task Force Ranger, consisting of 130 Delta Force troops, a Ranger company, and elements of the 160th Special Operations Aviation Regiment, to kill or capture Aideed.[53]

What turned out to be a bloody firefight on the night of October 3, 1993, was supposed to be the capture of two of Aideed's lieutenants and rescue of any Somali-held hostages. The air assault force included 17 helicopters, 75 Rangers and 40 Delta Force troops. Troop-carrying Blackhawk helicopters would conduct the air assault with fire support from smaller special operations attack helicopters, AH-6 gunships. The SNA and other clans, armed with RPGs and assault rifles, were ready and waiting for them.[54]

Somali clans placed roadblocks throughout the city to prevent the Americans from being able to leave once they had air assaulted into the city. 24 Somali prisoners were seized immediately after the assault but things went wrong for Task Force Ranger as soon as two

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[53] Ibid, 12-13.
[54] Ibid, 13.

Blackhawks were shot down with RPGs; one east of the target building and one west—less than three miles from the Army's headquarters at the Mogadishu airport.[55]

Aideed organized militia to shoot down the American helicopters, ambush the American ground forces, and overwhelm them with swarming masses of mixed militia clans. The clans joined throughout the city and, using simple communication means such as burning tires and megaphones, they attacked the Americans. The militia was able to blend into the crowds, which were called from their homes to defend against the Americans, and hid their weapons as they encircled the American forces. Somali clans used the city to their advantage by ducking around corners or popping into the open with sudden bursts of fire.[56]

An American rescue force, consisting of a convoy of High Mobility Multi-Purpose Wheeled Vehicles (HMMWV) and five-ton trucks, rushed to the eastern crash site and was able to secure the crew. Planners did not consider the possibility of two helicopters going down so the the hostage rescue convoy made a failed attempt to get to the site of the western crash. The rescue convoy made a second attempt but it turned back after encountering heavy fire. Finally, in an effort to rescue all the stranded ground forces, four Pakistani tanks, 28 Malaysian armored personnel carriers (APC), and soldiers from the 10th Mountain Division forced their way to rescue Task Force Ranger.[57]

With only 18 Americans killed and 73 wounded, pitted against the Somali loss of 500 dead and 1000 wounded, it would appear as an American victory. Tactically, it was a victory. Strategically, however, it was a clear American defeat. The Americans pulled-out of Somalia starting on November 19, 1993. Today we are still living with the strategic ramifications brought

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[55] Sean J. Edwards, *Mars Unmasked: The Changing Face of Urban Operations*, 14-15.
[56] Ibid, 16.
[57] Ibid, 14-15.

about by the American withdrawal.[58] Some of our potential adversaries may consider Somalia as another example of an American obsession with avoiding casualties. This is evident from a 1998 broadcast of a statement by Osama bin Laden, in which he states, "We have seen in the last decade the decline of the American government and the weakness of the American soldier who is ready to wage cold wars and unprepared to fight long wars. This was proven in Beirut when the Marines fled after two explosions. It also proves they can run in less than 24 hours, and this was also repeated in Somalia."[59]

Many things enabled the Somali population to fight effectively. First, the nature of the urban environment allowed clansmen the necessary cover and surprise to engage the Americans with small arms fire or RPGs. American rules of engagement prevented soldiers from always being able to engage the enemy. Had any artillery or naval gun fire been available, it likely would not have been used due to the same restrictions designed to protect the population at large. Secondly, the Somalis came out into the streets to support the various clans. Third, the absence of heavy American armor made breaching roadblocks and inner-city maneuver difficult. Fourth, the Somalis, unlike the PDF in Panama City, were willing to take significant casualties by massing the population against the Americans.[60] Shock from near-real-time media coverage of what Americans thought was only a humanitarian relief mission caused the Americans to leave Somalia. To maintain public support for an operation, the goals of the operation must be clear and justified if the public is going to support the mission when forces endure casualties. Tactical events can have strategic outcomes when the media captures and transmits the action and the public is unwilling to support what they see.[61]

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[58] Ibid, 17.
[59] G.E. Willis, "Remembering Mogadishu: Five Years After the Firefight in Somalia, Some Say US Forces Abroad Still Are Reeling from It," *Army Times*, October 1998, 16.
[60] Sean J. Edwards, *Mars Unmasked: The Changing Face of Urban Operations*, 18.
[61] Ibid, 47-51, 58.

The First Battle for Grozny: December 1994-January 1995

With the collapse of the Soviet Union in 1991, many new independent states formed in the South Caucasus. Within a short time, violent ethnic clashes broke out in territories within their borders. The republics of the North Caucasus remained part of Russia but Chechnya declared its intention to become independent. In December 1994, Russian and Chechen military forces began a short but brutal war for control of Chechnya, ending it temporarily in 1995. The focus of this case study is the devastating urban battle in the Chechen capitol, Grozny.[62]

The Russian government held a geostrategic interest with respect to Chechnya since major Russian oil pipelines ran from the Caspian basin through Chechnya (and other North Caucasus republics) to the Black Sea. Aside from the economic advantages of retaining control of Chechnya, the Russian government was also concerned that successful Chechen independence might spark other republics to seek the same.[63]

On December 11, 1994, the Russian Federation government under President Boris Yeltsin launched an invasion of Chechnya to halt the republic's movement toward independence. Forces totaling 23,800 men, 80 tanks, 208 APCs, and 182 artillery pieces surrounded Grozny from the north, east and west, in order to isolate the capital city.[64] Chechen forces, numbering between 10,000 and 15,000 strong, waited in Grozny for the Russian attack. The Chechens possessed 35 tanks, 40 APCs, 109 artillery pieces, numerous RPGs (of various types), multiple rocket launchers, mortars and air defense weapons. Russian objectives in Grozny were the presidential palace, railroad station, and broadcasting stations. 6,000 Russia troops were positioned along the western side of Grozny. On December 31, 1994, the Russian 131st

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[62] Microsoft Encarta Encyclopedia, CD-ROM, 2002, s.v. "Grozny."
[63] Timothy Thomas, The Caucasus Conflict and Russian Security: The Russian Armed Forces Confront Chechnya, Part I and II (Fort Leavenworth, CGSC Press, 1995), 4.
[64] Microsoft Encarta Encyclopedia, CD-ROM, 2002, s.v. "Grozny."

Motorized Brigade stormed the city from the west with a column of tanks but they failed to employ combined arms tactics by sending the tanks into the city without infantry in support. The Chechens seized the opportunity to draw first blood by using RPGs, Molotov cocktails and other anti-tank weapons to destroy 102 of the 131st Motorized Brigade's 120 tanks.[65]

Within a few days, the Russians learned from their devastating tactical mistake and pulled the tanks back to maximum effective engagement ranges and out of the range of RPGs. They adjusted their rules of engagement (ROE) and employed artillery and airpower to inflict extensive damage to the city's infrastructure. Over the next several weeks, the Russians fought door-to-door, using special shock troops to clear each building and push the Chechens back. This combination of artillery, airpower, armored vehicles, and door-to-door clearing proved highly effective. However, the urban environment soon forced combat to become non-linear and the Russian's command and control was hindered as they continued trying to operate in a non-linear approach. The Chechens discovered this weakness and exploited it to encircle small pockets of Russian troops, cutting them off from command and support, and attritting their forces.[66]

By January 10, the Russians had two lines of communications (LOCs) into the city and could conduct resupply and evacuations. Taking advantage of a temporary cease-fire, Russian troops opened fire with artillery, striking the city-center and seriously attritting unprepared Chechen forces.[67] Artillery struck almost once every ten seconds for over three hours. From 13-14 January, Russian forces blocked the primary departure routes from Grozny, still leaving an

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[65] Sean J. Edwards, *Mars Unmasked: The Changing Face of Urban Operations*, 23-24.
[66] Ibid, 25-26.
[67] Ibid.

escape route to the south. On 15 January, two Russian bombs struck the palace, causing demoralization and temporary withdrawal of Chechen forces to the south.[68]

The Russians still had not encircled Grozny and returning citizens of Grozny began attacks on small pockets of Russian forces at night, hiding below ground level from Russian artillery barrages during the day. By 21 January, Russian forces to the east and west converged on the city-center and the rebel leaders.[69] Grozny was nearly destroyed before the Russians took it in February 1995. Approximately 1,500 Russians died and 5,000-6,000 were wounded in the fighting. Approximately 3,000 Chechen rebels died and an unknown number were wounded. Noncombatant deaths in Grozny were approximately 25,000 through January 1995.[70]

The Russians could not continually provide airpower over Chechnya due to inclimate weather. In the city of Grozny, air assets were unable to provide effective close air support to friendly troops. However, they successfully bombed the Chechen palace, helping promote the Chechen evacuation from the city. Russian helicopters suffered attrition from machine guns mounted atop sport utility vehicles and other Chechen trucks. 14 of 30 helicopters were lost near the end of the first Grozny battle.[71]

Summary Analysis of Case Studies

Air power was used in each of the previous case studies and had mixed results. When air defense systems were lacking, aviation proved valuable in transitioning or assaulting urban areas. However, aviation had challenges that impacted the missions flown and public support of the

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[68] Timothy Thomas, "The Caucasus Conflict and Russian Security: The Russian Armed Forces Confront Chechnya, III The Battle for Grozny, 1-26 January 1995," *Journal of Slavic Military Studies*, Vol. 10, No. 1 (London: Frank Cass, March 1997), 75.
[69] Sean J. Edwards, Mars Unmasked: The Changing Face of Urban Operations, 26-27.
[70] Sean J. Edwards, Mars Unmasked: The Changing Face of Urban Operations, 35. Also refer to table 3, battle statistics for urban case studies.
[71] Sean J. Edwards, *Mars Unmasked: The Changing Face of Urban Operations*, 84-88.

operations. Engagement with noncombatants, restrictive (or too permissive) ROE, poor air-ground communications, bad weather, lack of combined arms employment (sometimes due to restrictive ROE), heavy ground fire (including RPGs), and aircraft losses were all encountered.

From these observations, one can draw the conclusion that aviation assets should remain clear of urban areas if possible and avoid inner-city engagements. The case studies have also shown that the urban environment offers significant cover for ground forces and concealment behind or among noncombatants. The result was often engagement under restrictive rules of engagement, or loss of the initiative to the enemy. Losing the initiative meant trading personal security for noncombatant safety. In the case of the Russians in Chechnya, rules of engagement were initially restrictive and the Chechens used it to their advantage. Chechen inferiority to the Russians didn't stop them from raising the cost of winning the war to devastating levels.[72]

Similarly, the Somalis raised the stakes for the Americans by countering technology with swarms of SNA mixed with noncombatants. In both case studies, rules of engagement were relaxed to some degree and the media captured the appearance of slaughter of enemy and friendly troops. In Somalia, the media captured the dragging of a downed pilot through the streets but also the killing of noncombatants. Public opinion shaped political direction to the military in each case study.[73]

Today, the US Army's involvement in peacekeeping and humanitarian operations continues. The political climate in the US places great emphasis on minimizing casualties, especially when vital interests are not at stake. Therefore, the US military continues to look at

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[72] See Figure 1: Urban Casualties Roll-Up
[73] Sean J. Edwards, *Mars Unmasked: The Changing Face of Urban Operations*, 47-51, 58.

technological developments that contribute to expanded UAV capabilities, especially those that support a reduction in potential casualties from urban operations.[74]

CHAPTER 3: MANNED OR UNMANNED

Challenges to Army Aviation

The former Commandant of the United States Marine Corps, General Charles Krulak, cites the numerous examples of urban operations around the world in recent years and states that urban operations represent the likely battlefield of the twenty-first century. He posits that the rapid proliferation of technology, numerous transnational factors, and increasing globalization have combined to create complex national security challenges.[75]

General Krulak opines that migration of people to city centers across the globe is a problem. Compounding the problem of instability and unrestrained growth is battlefield complexity. Proliferation of technologically sophisticated weapons has effectively leveled the playing field and negated some of the effects our US technological superiority. He contends that improved technology, adaptable adversaries and the three levels of war are beginning to blur as if they are one across the battlefield, and represent a new environment in which tactical decisions influence operational or strategic plans. This environment provides an asymmetrical advantage to our future foe.[76] Perhaps the best definition of the challenges posed by urban operations is provided by his philosophy of the three-block war, which gained great public and policy-maker attention during Operation Restore Hope:

> In one moment in time, our service members will be feeding and clothing displaced refugees – providing humanitarian assistance. In the next moment, they will be holding

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[74] David B. Glade, "Unmanned Aerial Vehicles – Implications for Military Operations," *Occasional Paper No. 16* (Maxwell A.F.B.: Center for Strategy and Technology Air War College, Air University, July 2000), 2.
[75] Charles C. Krulak, "The Strategic Corporal: Leadership in the Three Block War," 30-31.
[76] Ibid.

> two warring tribes apart – conducting peacekeeping operations. Finally, they will be fighting a highly lethal mid-intensity battle. All on the same day, all within three city blocks. It will be what we call the "three-block war.[77]

Although Army aviation can provide mobility, intelligence gathering, and massive precision fires, its current aviation systems are highly vulnerable within the urban environment and are in need of better defensive capabilities if they need to operate within the city.[78] According to FM 3-06, Army aviation can provide attack, lift, and reconnaissance in the urban environment. However, the manual also recognizes that attack and reconnaissance aircraft should provide flank security, direct fire support, personnel movement, command and control through retransmission capabilities, and position confirmation for the attacking ground forces:

> Army aviation may also be inventively task organized . . .. However, Army aviation is a limited and high-value asset; commanders review its use in innovative task organizations. It is particularly vulnerable to urban air defense threats unless used over terrain secured by ground forces. From these positions, aircraft can use enhanced sensors to conduct reconnaissance and use precision weapons with standoff capability.[79]

While this monograph focuses on the possibilities of supplanting attack and reconnaissance helicopters with UAVs, utility helicopters were not considered for inclusion because of their large size, weight, and hauling capacity requirements to perform lift missions. Combat and reconnaissance UAVs can be considerably smaller than manned helicopters because they are not required to lift the significantly greater weight posed by a dozen troops. Perhaps unmanned tilt-rotor or other full-size utility aircraft could do the job but it's the author's opinion that most aircraft passengers would desire for their aircraft to have a pilot onboard instead of controlling it remotely or placing their trust and safety in a totally autonomous UAV.

The most modern Army helicopters that perform attack and reconnaissance missions for the US Army are the AH-64A (Apache), AH-64D (Longbow Apache) and the OH-58D (Kiowa

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[77] Ibid.
[78] Ralph Peters, "Our Soldiers Their Cities," *Parameters*, 48.
[79] Field Manual 3-06 (90-10), *Urban Operations*, 6-15, 6-27.

Warrior). The Apache was first delivered to the Army in 1984 and several models were upgraded to the Longbow in 1997 to take advantage of new technology and offset new threats.[80] The Longbow provides a higher level of lethality, precision, survivability, and digital communication capabilities than its predecessor, the "A" model Apache. The US Army plans to totally refit all "A" model Apaches and create a pure fleet of Longbows. Since the Longbow is a "digitally upgraded" Apache, it will be the aircraft to team with UAVs in the future.[81]

The Longbow is an 'all weather' aircraft, technologically suited for combat day or night. Although the Longbow's design, as inherited from the original Apache, was built for operation in a major theater of war, the Longbow has the agility and flexibility to handle many other more contemporary threats that could arise. The Longbow has numerous capabilities and is able to conduct RSTA, destroy tanks or thin-skinned vehicles, and conduct shows of force. [82] Unfortunately, the Longbow is highly susceptible to the same threats mentioned above when engaging them from within the urban area. Aircrew casualties become more likely when facing an enemy that can easily engage aircraft within a city and then retreat to hiding within the city's structures. Telephone and power lines create another risk to aircrews operating within a city.

The primary modifications to the Apache Longbow (from the basic Apache) are the addition of a millimeter-wave Fire Control Radar (FCR) target acquisition system, the fire-and-forget Longbow Hellfire air-to-ground missile, and digitized cockpits. The weapons remain primarily the same with a standard heavy armor attack load of 16 Hellfire semi-laser designated missiles, capable of ranging over 8000 meters. The Apache can also deliver 76 2.75 inch folding fin aerial rockets and 1200 rounds of 30mm ammunition for use against enemy personnel, light

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[80] See Figure 3: Apache Longbow (AH-64D).
[81] Federation of American Scientists, "AH-64 Apache," available online: http://www.fas.org/man/dod-101/sys/ac/ah-64.htm, accessed on 6 January 2004.
[82] Ibid.

armor vehicles and other soft-skinned targets. The Apache works in teams with other Apaches or the OH-58D Kiowa Warrior armed-scout helicopter.[83]

Using the upgrade concept applied to the Apache Longbow, the OH-58D Kiowa Warrior is rooted in the base model OH-58C and later the OH-58D Kiowa. The creation of the "Kiowa Warrior" model OH-58D came in 1987 as a means to interdict hostile gunboats in the Persian Gulf. In May 1991, the Kiowa Warrior was fielded to the US Army.[84] The Kiowa Warrior's mission is armed reconnaissance as part of a cavalry unit or attack unit. The Mast Mounted Sight (MMS) is one of the key elements of the Kiowa Warrior. Its unique day and night capabilities allow the crew to scan the battlefield with the ability to acquire, identify, and derive the coordinate locations of potential targets. The aircraft is capable of accepting weapon combinations of the semi-active laser Hellfire missile, the Air-to-Air Stinger (ATAS) missile, 2.75" Folding Fin Aerial Rocket (FFAR) pods, and a .50 caliber machine gun, making it a highly lethal scout helicopter. Roughly half the size of the Longbow, the Kiowa cruises at 80 knots and can transport up to 6 troops (externally carried) if necessary. The Kiowa's slower speed and weight bearing capacity limits the aircraft's flexibility and survivability.[85] This aircraft faces the same vulnerabilies as the Apache when operating within a city against an armed foe. The Kiowa Warrior helicopter will be replaced in the near-term by a light utility-reconnaissance helicopter that is still in conceptual stages, although one could expect that this helicopter would also possess the same vulnerabilities as the Kiowa Warrior and Longbow.[86]

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[83] Ibid.
[84] See Figure 4: Kiowa Warrior (OH-58D).
[85] Federation of American Scientists, "OH-58D," available online: http://www.fas.org/man/dod-101/sys/ac/oh-58.htm, accessed on 6 January 2004.
[86] Joe Burlas, "Comanche Project Grounded," *Army News Service*, 23 February 2004, online: http://www.dix.army.mil/PAO/Post04/post022704/ComancheProjectGrounded.htm, accessed 26 February 2004.

In the future operational environment, air maneuver will support objective force operations through the execution of five separate missions: armed reconnaissance, mobile strike, close combat with ground forces, air assault, and vertical maneuver.[87] The Comanche RAH-66 was the US Army's future reconnaissance and attack helicopter to serve all of these missions. On 24 February 2004, the Pentagon announced cancellation of the Comanche program, prematurely ending the equipping of units in 2010 with the Comanche helicopter. Money programmed for the Comanche will divert to Apache Longbow upgrades, Blackhawk (UH-60) utility helicopters, UAVs, and the conceptual light utility-reconnaissance helicopter mentioned above.[88]

Current UAV Programs

An asymmetrical solution to urban aviation operations, containing the same basic capabilities of helicopters, may lie in the technical progress of UAVs. UAVs were designed with a twofold purpose in mind. First, UAVs were intended to reduce the risk to pilot, crew, and equipment. The economic burden of losing high-altitude reconnaissance aircraft or manned systems that may result in prisoners of war or personnel killed in action was significant enough to induce research and development to counter their loss. Secondly, freeing machines from the limitations of man expands the envelope for operations. Thus, the principal advantage of UAVs is a cost-effective system with greater capability and less risk to humans.[89]

The ability of UAVs to operate forward in battle and perform routine, lengthy, or dangerous work are some of the key attributes of UAVs. However, keeping the UAV controller

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[87] White paper, "Manned and Unmanned Air Maneuver Teaming in Objective Force Air-Ground Operations," (Fort Rucker: Directorate of Combat Developments, 30 July 2002), Appendix E, 5-11.
[88] Joe Burlas, "Comanche Project Grounded," *Army News Service*, 23 February 2004, online: http://www.dix.army.mil/PAO/Post04/post022704/ComancheProjectGrounded.htm, accessed 26 February 2004.
[89] David B. Glade, "Unmanned Aerial Vehicles – Implications for Military Operations," 1.

away from the battlefield inhibits his ability to sense of the battlefield. Fort Rucker's Aviation Combat Developments office is working with the teaming of semi-autonomous UAVs and AH-64D helicopters. The concept, called 'Man-in-the-loop,' "adds the critical human dimension 'on-site' and well forward. It describes the ability to fight for information, immediately turning the results of reconnaissance into combat activity."[90] Until total UAV autonomy is a reality, pilot-crew interface through the Future Combat System (FCS) command and control systems can keep the man-in-the-loop to provide the human dimension of battle.[91]

Acquisition of a UAV fleet to augment the FCS capability, reduce expenses and mitigate risk to aircrews is as the forefront of this presidential administration's agenda.

> The Bush administration and Congress are in concert on the goal of developing a fleet of unmanned aircraft that can reduce both defense costs and aircrew losses in combat by taking on at least the most dangerous combat missions.[92]

The Senate Armed Services Committee directed the Department of Defense to aggressively develop and field unmanned aerial systems by the year 2010 and unmanned ground systems by 2015. The requirement states that one-third of our air and ground forces will be unmanned. To further this initiative, the committee added $246 million to accelerate technologies leading to the development and fielding of remotely controlled air combat vehicles and remotely controlled ground combat vehicles.[93]

Logistics historically plays a key role in sustaining a military operation and helicopters require a very large amount of support when they deploy. The bare minimum requirements to

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[90] White paper, "Manned and Unmanned Air Maneuver Teaming in Objective Force Air-Ground Operations," (Fort Rucker: Directorate of Combat Developments, 30 July 2002) 8-11.
[91] Ibid. FCS is the term used to describe a 'system of systems' equipment approach to transformation in the Army.
[92] Charles L. Barry and Elihu Zimet, "UCAVs – Technological, Policy, and Operational Challenges," *Defense* Horizons, October 2001. 1.
[93] United States Senate Press Release, "The Senate Armed Services Committee Completes Markup of the National Defense Authorization Bill for fiscal year 2001," 10 May 2000, http://armed-services.senate.gov/press/01mark.pdf, (accessed 6 October 2003), 4.

sustain aviation assets are pilots and maintenance personnel, repair parts, bulk and packaged petroleum products, special tools, and higher level maintenance support elements. The sheer volume of products and space consumption is somewhat staggering. UAVs do not require the mass volume of overhead in equipment, parts or personnel to maintain their functionality. According to US Army MAJ John V. McCoy, graduate of the US Army's Logistics Executive Development Course, "UAVs have the potential to reduce the risk to human life in combat operations, reduce the logistics footprint in theaters of operations, and improve logistics effectiveness and efficiency."[94] Given improvements in technology, a UAV of the future might be controlled from a remote location with the pilots to fly the mission and an enormous crew of analysts and planners to survey the findings and direct further UAV employment. This concept would remove extra personnel out of the already crowded urban environment and would require only the sustainment enablers of the UAV within its operational range.

United States Army Colonel John D. Burke, the Army's UAV project manager in the Program Executive Office-Aviation at Redstone Arsenal, stated, "When the September 11, 2001, terrorist attacks occurred the Army had only two unmanned aerial vehicle systems [Hunter and Shadow 200] fielded to MTOE units . . . . Two years after that fateful date, the Army fielded two additional companies of Hunter UAVs, seven platoons of Shadows, and a rapid equipping of the Raven small UAV to Operation Enduring Freedom (OEF)."[95] He also notes the acquisition community's deliberate shift in focus to support the warfighting commanders in OEF and Operation Iraqi Freedom (OIF). He goes on to say, "Recently published Army Strategic Planning

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[94] John V. McCoy, "Unmanned Aerial Logistics Vehicle – A Concept Worth Pursuing," *Army Logistician*, (March-April 2004). Available online: http://www.findarticles.com/cf_dls/m0PAI/2_36/114487531/p1/article.jhtml?term=, accessed 5 April 2004.
[95] John D. Burke, "Army UAVs—A Systems Update," *Army Aviation*, 29 February 2004. 26.

Guidance emphasized three areas dependant on UAV systems: Army aviation, the network and actionable intelligence."[96]

The Army's Future Combat System (FCS) program will develop four classes of UAVs. Class One will be a platoon-class small aircraft. Class Two will operate at the company level, Class Three at the battalion and Class Four at the brigade level. Each FCS brigade would have 36 Class One, 36 Class Two, 12 Class Three, and 16 Class Four aircraft. The FCS program generally has been described as a network of ground and air vehicles – both manned and unmanned.[97]

The Army fields its UAV systems as sets to platoons or companies. The Shadow tactical UAV (TUAV)[98] unit set consists of two officers and 20 enlisted members that will operate or maintain four fixed-wing aircraft, two ground-control stations, ground-data terminals, remote video terminals and embedded logistics. The two ground control stations and four aircraft allow for continuous operations.[99]

Current Army UAV capability provides commanders with assets for intelligence, surveillance and reconnaissance (ISR); communications relay; and weapons capability. Additionally, UAVs can conduct many of the same missions and tasks as manned attack aircraft, except perhaps a show of force. While the Shadow tactical UAV, the Hunter medium altitude/medium endurance UAV and the Raven small UAV comprise the near and mid-term equipping of UAVs, the contract for the Firescout was finalized in November 2003 and will provide a system fully integrated with the Future Combat System (FCS). The rotary-wing

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[96] Ibid, 32.
[97] Sandra I. Erwin, "Army to Field Four Classes of UAVs," *National Defense Magazine*; April 2003. Also available online: http://www.nationaldefensemagazine.org/article.cfm?Id=1077, accessed 6 October 2003. 1.
[98] See Figure 5: Shadow 200 (TUAV)
[99] John D. Burke, "Army UAVs—A Systems Update," 26.

Firescout will have common software, communications, training, computer and simulation that is a key part of the FCS systems-of-systems design.[100]

The Hunter UAV[101] systems are distributed and organized in the same manner as the Shadow TUAV. Over the course of the last two years the Hunter has proven the operation of onboard signals intelligence (SIGINT), synthetic aperture radar/moving target indicator (SAR/MTI), and both non-laser guided Brilliant anti-tank munitions (BAT) and Viper munitions, which are laser guided. Unfortunately, the weaponizing of UAVs is currently more limited than manned helicopters. The Hunter's payload capacity is 250 pounds with a range of nearly 150 miles.[102]

The Raven small UAV[103] is a fixed-wing aircraft specifically for employment by infantry, scout and maneuver platoon units. The Raven system consists of three air vehicles, onboard daytime camera and nighttime electro-optical/infrared (EO/IR) sensor, a global positioning system (GPS) receiver and a data link. Rapid acquisition led to deliver five Raven systems to OEF in December 2003.[104] The Raven can normally fly undetected due to its relatively small size and quieter operation than manned helicopters and is easy to sustain, given its few parts and ease of transport.

Colonel Burke explained that demands for UAV systems from division and joint task force commanders continue to increase due to the capabilities to prosecute the war on terrorism. Additionally, UAVs provide a means to conduct laser designation, mine and chemical detection, and the employment of 2.75 inch rockets, BAT, Viper, Hellfire, Stinger and Javelin munitions. Another plus from UAV employment is the capability to fly multiple aircraft non-stop to conduct

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[100] Ibid, 32.
[101] See Figure 6: Hunter UAV
[102] John D. Burke, "Army UAVs—A Systems Update," 26.
[103] See Figure 7: Raven Small UAV
[104] John D. Burke, "Army UAVs—A Systems Update," 26.

battle damage assessment and targeting in real-time.[105] The capabilities of UAVs to conduct RSTA, relay communications, and destroy targets rival the capabilities and risk factors by employing manned helicopters in a high-threat environment.

The Defense Advanced Research Projects Agency (DARPA) is the central research and development organization for the Department of Defense.[106] DARPA and the US Army are developing an Unmanned Combat Armed Rotorcraft (UCAR) from present time through 2009 and expect to field the aircraft in 2012. The intent of the program is to demonstrate the feasibility, military utility, and operational value of a UCAR system to effectively and affordably prosecute armed reconnaissance and mobile strike missions within the emerging Objective Force system-of-systems architecture. To achieve this goal, the UCAR program will design, develop, integrate, and demonstrate the critical and enabling technologies, processes and system attributes pertaining to an objective UCAR system. As an example, the UCAR will not require a controlling ground station as part of the aircraft system set. The FCS command and control vehicle or combat aviation assets will provide necessary control interaction with the aircraft.[107]

The UCAR is an all-weather, day or night capable rotorcraft that can conduct armed escort, mobile strike and reconnaissance. The UCAR is autonomous in flight and will request guidance from a human operator only to receive tasks or weapons delivery. The operator will be digitally connected to the FCS command and control vehicle or combat aviation. The UCAR will be able to accomplish many of the missions of manned aviation and can conduct them autonomously at low level flight. The aircraft will cost less than conventional manned attack or

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[105] Ibid, 27. The non-laser variant of the BAT is referred to as the VIPER. This munition uses GPS technology for trajectory steering.
[106] DARPA's mission statement is found on DARPA's online homepage: www.darpa.mil, accessed 6 February 2004.
[107] DARPA, "UCAR Overview," online: http://www.darpa.mil/tto/programs/UCAR_ overview.pdf, accessed 6 February 2004.

reconnaissance aircraft and save aircrews from the hazards of the urban environment.[108] Steve MacWillie, a contractor working on the UCAR program since its inception at Fort Rucker's Directorate of Combat Developments, states, "We are now running electronic simulation vignettes with manned-unmanned (MUM) teams[109] UCAR and AH-64D in the urban environment to take out specific targets and we've found that having unmanned systems saves [air] crews... no doubt about it."[110]

DARPA is also developing the A160 Hummingbird Warrior[111] for the Army. The Hummingbird Warrior is a small rotorcraft UAV that could perform missions in the urban environment. The aircraft's flight management is autonomous and it can carry a payload ranging from 300 to 500 pounds. The efficient rotor concept operating at the optimum rotational speed produces a low power loiter that enables increased endurance capability. This unique concept makes the Hummingbird Warrior a superior aircraft for strike or reconnaissance missions and it can operate in all environments. The Hummingbird Warrior is capable of hovering, multi-directional flight, 140 knots airspeed, range of 2000 miles, and a 48-hour endurance. Additionally, the aircraft can hover at 15,000 feet and cruise as high as 30,000 feet, making it ideal for the mountainous conditions encountered in Afghanistan.[112]

> The A160 concept is being evaluated for surveillance and targeting, communications and data relay, lethal and non-lethal weapons delivery, assured crew recovery, resupply of

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[108] Sandra I. Erwin, "Army to Field Four Classes of UAVs," *National Defense Magazine*; April 2003. Also available online: http://www.nationaldefensemagazine.org/article.cfm?Id=1077, accessed 6 October 2003. 1.

[109] MUM teams consist of an AH-64D and an unmanned aerial vehicle. The connection is made through FCS command and control and the UAV is provided tasks, coordinates, and weapons release authority through the digital connection.

[110] Steve MacWillie, interview by author, internet instant messaging, 27 February 2004. Steve MacWillie is a defense contractor, US Army Aviation Combat Developments, Fort Rucker, AL, and has worked on the UCAR program since its inception. An electronic transcript of the interview was made by the author with permission, and used in preparation of this monograph.

[111] See Figure 9: A160 Hummingbird Warrior

[112] White paper, "Manned and Unmanned Air Maneuver Teaming in Objective Force Air-Ground Operations," Appendix B-2.

> forces in the field, and special operations missions in support of Army, Navy, Marine Corps, and other Agency needs. It is being developed as a component of the DARPA/Army Future Combat Systems (FCS) Program. In fiscal year 2003 this program received $1.6 million additional funding from Congress to repair and upgrade the first test air vehicle.[113]

Currently, the A-160 demonstrator is performing test flights and DARPA is working on the Hummingbird Warrior's vertical take-off and landing capabilities.[114] The Hummingbird Warrior will continue to develop its flight envelope over the next several years and may function as part of both the Future Combat System (FCS) Battalions and Units of Employment (UE) to accomplish a wide range of tasks.[115]

The X-50[116] is another highly advanced UAV and is under initial testing with Boeing's Phantom Works, in support of DARPA. The X-50 is the next generation of high-speed (approximately 500 knots), vertical takeoff and landing (VTOL) aircraft that employs a forward wing, or canard, during high speed flight and rotates the canard during slower operation and hovering tasks. Known as the Dragonfly, the X-50 uses a turbofan engine and directs thrust to the aft jet nozzle for high speed flight or to the rotor tips for rotational drive without the extra mechanical weight of standard helicopter drive systems. Missions for the Dragonfly could incorporate armed escort, reconnaissance, communications relay, and logistical support.[117]

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[113] Van Olinger, "A160 Hummingbird Warrior," 29 March 2004, available online: http://www.darpa.mil/tto/programs/hum_war.html, accessed 2 April 2004.
[114] John D. Burke, "Army UAVs—A Systems Update," *Army Aviation*, 26-27.
[115] White paper, "Manned and Unmanned Air Maneuver Teaming in Objective Force Air-Ground Operations," Appendix B-2. UE refers to a divisional element that will control up to seven Units of Action (UA), or battalions. More UE/UA information is available online: John Pike, "Units of Action," http://www.globalsecurity.org/military/agency/army/ua.htm, accessed 5 April 2004.
[116] See Figure 10: X-50 Dragonfly
[117] Steve Bass, interview by author, telephone, 12 December 2003. Steve Bass is the program manager for the X-50 UAV at Phantom Works. Phantom Works is the research and development unit of Boeing. Additionally, a PowerPoint presentation was provided via e-mail on 12 November 2003 by Colonel John D. Burke, "US Army Overview of UAV Systems," 17 October 2003.

A strong focus on logistics is necessary to sustain such valuable and growing assets as UAVs and permit their non-stop employment. Colonel Burke explained, "Contractor field service representatives augment the maintenance personnel in Shadow and Hunter units. These personnel have become part of the unit's operational planning, including deploying and billeting in the same remote locations as the brigade UAV platoons." [118] The approach is based on collocating UAV systems with forward repair areas, transportation nodes, and parts stockage. The endstate for maintenance support is the capability for brigade commanders to maintain high readiness rates of their UAV systems (85 percent) to ensure non-stop UAV operation, without the need for excessive leadership involvement in maintenance or sustainment. [119]

Advancements in UAVs, such as the Hunter armed with Viper Strike or the highly versatile A160 Hummingbird Warrior, may soon provide a UAV that is as agile in the city as it is lethal. In the future, autonomous UAVs will become more capable but are not expected to exceed the effectiveness of MUM teams in the same urban operation.

Success and the Road Ahead

Contrary to the failures often experienced by manned aviation in the case studies discussed in chapter two, there were a number of successes by UAVs in the 1999 air war over Kosovo, named Operation Allied Force. Predator and Hunter UAVs were used significantly and quite successfully to provide real-time video imagery to commanders and planners, without the risk of aircrew losses. Many UAVs were flown as low as 1000 feet to make secondary threat identification for firing aircraft, mitigating the risk of having to send in aircrews. However, the close proximity of UAVs to the threat resulted in several UAVs being shot down or encountering

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[118] John D. Burke, "Army UAVs—A Systems Update," *Army Aviation*, 27.
[119] Ibid.

some type of mechanical failure, but flying these more dangerous or classified missions was worth the risk of UAV loss if it meant saving aircrews.[120]

Operation Allied Force involved the employment of UAVs in many varying ways. Sometimes the Predator was used to confirm and validate target sites or moving ground forces instead of conducting reconnaissance to locate the enemy. This technique was used to facilitate the constraining ROE of having two confirmations of a target prior to engaging it. Real-time video feeds of engagements and BDA also became a widely used technique. UAVs loitering over some of these well-protected targets or flying repeatedly over the same threat location, waiting for an engagement to occur, were at high risk of being shot down. The frequent use of UAVs and their loitering activities created a greater need to deconflict their presence with that of manned aircraft for collision avoidance. The final tally of UAV losses was 25 by all allies, of which 16 were US losses over the course of a 78-day operation. Overall, UAV employment led to a successful air war and discovery of the advantage of close targeting and mitigation of risk to our aircrews.[121]

The Army is currently undergoing an organizational restructuring initiative. One of the impacts to Army aviation is the incorporation of UAVs in every aviation brigade. Army Chief of Staff, General Peter Schoomaker is reorganizing the Army to create a more modular and lethal force. Starting with the Third Infantry Division and followed by the 101st Airborne Division, the concept is to turn three brigades into five rapidly deployable brigade units of action that are slightly smaller in combat troops, but independently deployable and interchangeable with any

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[120] Benjamin S. Lambeth, "NATO's Air War for Kosovo: A Strategic and Operational Assessment" (RAND, 2001) 94-97. Available online: http://www.rand.org/publications/MR/MR1365/, accessed 15 March 2004.
[121] Ibid.

division.[122] The Army's ten aviation brigades will be realigned to create identically structured organizations within each aviation brigade. The resulting new aviation brigades will each consist of 24 Apaches, 38 Blackhawks, 14 Chinooks, and a UAV company consisting of an unspecified quantity of Predator or Shadow UAVs.[123]

UAVs distributed evenly throughout the units of action (UA) will greatly enhance the organic ISR capability of the UA organizations. However, UAVs can not be expected to independently conduct the current missions of attack and reconnaissance aircraft. Advancements in technology have provided opportunities for DARPA engineers to weaponize more advanced UAVs, but joint and service component doctrine have not yet added the tactics, techniques or procedures (TTP) for the employment of UAV-launched lethal and non-lethal weapons in urban areas. The updates to the draft Joint Publication 3-55.1, *JTTP For Unmanned Aerial Vehicles*,[124] may have incorporated lethal and non-lethal means of UAV employment in the urban area, but this remains to be seen. UAVs have performed weapon launch tests successfully in the past, destroying selected targets with precision. Once part of our doctrine, UAVs may provide the asymmetrical edge in urban combat. Additionally, independent or cooperative use (teaming) of UAVs with manned aircraft should be pursued to maximize the capabilities each brings to urban combat.[125]

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[122] Gary Sheftick, "Army to Reset into Modular Brigade-Centric Force," *Army News* Service, available online: http://www4.army.mil/ocpa/print.php?story_id_key=5703, accessed 27 February 2004. See also: Sergeant First Class Triggs, "3rd ID reorganizes into modular force," *Fort Leavenworth Lamp*, *Army News Service*, 22 January 2004, 2.

[123] Ann Roosevelt, "Army Chief Approves Major Aviation Restructuring," *Defense Daily*, 30 January 2004, 4.

[124] JP 3-55.1, *JTTP For Unmanned Aerial Vehicles* (Washington D.C., 27 August 1993), 2-1. Electronic copy available: http://www.fas.org/irp/doddir/dod/jp3-55_1/index.html, accessed 10 January 2004.

[125] See Figure 2: Evaluation Criteria Analysis Chart

An issue that may be impeding the progress of UAV employment is cited by Pentagon analysts, "The Army remains unnecessarily wedded to the importance of manned aircraft and thus is unwilling to exploit fully the potential of UAVs." The Office of the Secretary of Defense also fears that the Army's (and sister services') pilot-centric community is slowing down UAV development.[126] However, with the loss of the Comanche program on February 24, 2004, the Army has the economic opportunity to pursue not only a cost-effective system, but perhaps a necessary solution to the discontinuation of the Comanche helicopter program. This program was started in the early 80's and will cost about $600 million to cancel. The upside is that the savings of $30 billion will pay for development of a new reconnaissance helicopter to replace the underpowered-overweight OH-58D armed-reconnaissance helicopter. The savings will also upgrade current AH-64D digital systems to control UAVs in the teaming concept, and further develop tactical UAVs.[127]

CHAPTER 4: CONCLUSION

Analysis

The effects of global urbanization will significantly impact military operations across the spectrum of conflict. If General Krulak is correct in that by the year 2020, 85 percent of the world's population will be urbanized, then the US Army could expect to deal with civil strife, economic depression, and genuine requirements to conduct urban operations on a regular basis in a non-permissive environment. The Army could suffer many casualties and the 'staying power' of our nation will be put to the test.

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[126] John R. Guardiano, "Manning and Unmanning Army Aviation," *Aviation Today*, http://www.aviationtoday.com/cgi/rw/show_mag.cgi?pub=rw&mon=1202&file=1202rorep.htm, accessed 10 December 2003.

The urban environment presents significant challenges to large rotary wing aircraft, especially the 17,000 pound Apache Longbow. FM 1-100, *Army Aviation* Operations, posits that the risk to mission and pilot encountered by operating in this environment is significantly dangerous and could make rotary wing employment inadvisable. According to FM 1-100, *Army Aviation Operations*,

> Urban operations present unique and complex challenges to aviation units . . .. The following factors affect aviation operations in the urban environment: restricted landing zones or pickup zones; increased tower, antenna, and wire hazards; foreign object damage to aircraft from flying debris; operating in areas with high concentrations of civilians; collateral damage to property; night vision system operations in the vicinity of city lights; degraded communications; and the high risk to aircraft from close–range, small arms fire, complicated by the proximity of noncombatants.[128]

The enemy in an urban environment can use the defensive attributes of the city to offset the inferiority of his own weapons. In this environment the enemy is able to hide behind manmade obstacles until an aircraft is within the effective range of his weapons, thus possibly removing sufficient reaction time for the pilot to evade harm. Even today, Clausewitz' statement, " . . . the defense is the stronger form of warfare . . . "[129] is a truth for urban combat. Considering the migration of people to cities and the resultant urban growth, Clausewitz' statement about the defense of cities should be given even greater emphasis. Today's military must find a way to breach the impregnable fortress-like advantages of an enemy defending from within a city by employing capabilities that maximize information, situational understanding, and strike capability.

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[127] Joe Burlas, "Comanche Project Grounded," *Army News Service*, 23 February 2004, online: http://www.dix.army.mil/PAO/Post04/post022704/ComancheProjectGrounded.htm, accessed 26 February 2004.
[128] US Department of the Army, Field Manual 1-100, *Army Aviation Operations*, (Washington D.C.: 21 February 1997), 3-4.
[129] Carl von Clausewitz, *On War*, ed. and trans. by Michael Howard and Peter Paret (New Jersey: Princeton University Press, 1976) 84.

Penetrating a defense network within a city may be easier and less risky for unmanned aircraft than manned aircraft. However, for many years UAVs have only performed reconnaissance at altitudes well above cities, not among their structures. Considering the problems that may occur from urban sprawl, as discussed in chapter one, there is justifiable cause to develop reconnaissance UAVs for tactical operation in the urban environment—combat or peace. While an enemy defending within the city presents great risk to an attack helicopter aircrew, many challenges still exist for UAVs to fully replace attack helicopters in the urban environment. One challenge is the ability to hover while carrying sufficient ordnance to conduct combat. Hovering is an important capability because it allows an aircraft sufficient time to conduct reconnaissance, an ability to quickly seek cover, and the opportunity to ambush a target moving through the city.

Some of the advantages and disadvantages of UAVs are found in FM 3-55.1, *JTTP for Unmanned Aerial Vehicles*. The obvious advantages of UAV systems are that they can collect real time information and provide it to digitally linked systems, air or ground. Army aviation's interest in this regard is the reduced need for manned aircraft to over fly enemy locations, subjecting themselves and the aircraft to small arms fire and RPGs. Depending on the size of the UAV, they are capable of operating from unimproved areas or even small clearings or parking lots. Furthermore, the UAV's small visual and radar signatures can prevent successful enemy engagements, thus aiding in the survivability of the UAV and the accomplishment of its mission. Some of the disadvantages are environmental restrictions to flight, depending upon the size of the UAV, and more significantly, the current digital linkage to ground stations, airborne platforms or satellites is line of sight dependant. In the future, line of sight requirements may be overcome

through technology currently under development. Overall, UAVs provide the Army a marked advantage against the enemy's urban defense.[130]

Progress is being made in UAV weapons development that could be used in urban combat. In March of 2003, the Hunter UAV conducted a weapons test firing at White Sands Missile Range, New Mexico, and validated the concept of Viper Strike munitions integrated with and launched from the Hunter UAV. The Hunter successfully hit seven of nine possible targets, ranging from pickup trucks to tanks. The Viper Strike weapon is ideally suited for use in the urban environment and it employs a measure of safety by requiring a "man in the loop" to laser designate the target, thus mitigating the chances for fratricide.[131]

The Longbow and OH-58D could surely operate within the urban environment in no-threat or low-threat conditions with only minor difficulties imposed by numerous wires, confined areas, and avoidance of buildings or other aircraft. However, as seen in the previous case studies, the risk to an aircrew and helicopter is enormous when in proximity to hostile armed forces that are concealed from attack by buildings or even noncombatant masses. Although the Longbow is the world's premier attack helicopter, even with its digitized cockpit, the plethora of information from environmental complexity may be too much for a two-man attack crew to receive, process, and act upon in a timely manner in urban combat without first being engaged by an enemy with an asymmetrical advantage, the defense provided by the urban environment.

The Longbow or Kiowa Warrior by itself is no sure answer to urban combat. Yet, there is no doubt that technology must continue to improve before UAVs can fully replace the capabilities that the Longbow and Kiowa Warrior bring to the fight. Situational awareness and

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[130] JP 3-55.1, *JTTP for Unmanned Aerial Vehicles*, 2-1.
[131] "Viper Strike Munition Released From Hunter UAV Scores Direct Hits In U.S. Army-Northrop Grumman Tests," Northrop Grumman News Release, 9 April 2003, available online: http://www.irconnect.com/noc/pages/news_printer.mhtml?d=38843&print=1, accessed 5 September 2003.

judgment gained by having a pilot in the cockpit during urban attack and reconnaissance must be weighed against the risk involved.

A technique that could allow the Longbow and Kiowa Warrior to maximize weapons stand-off range yet still accurately engage targets from the city's periphery is using a manned-unmanned teaming effort by employing UAVs forward in the urban area with a full suite of electro-optical/infrared (EO/IR) sensors, connected digitally to manned aircraft. In this manner, UAVs can conduct reconnaissance and limited attacks within the urban area and provide targeting data or laser designation for the heavier weaponized Longbows and Kiowa Warriors, which may opt to maneuver around the periphery of the urban area and dash into the city, using routes and firing positions already cleared by UAVs, to strike targets at the best time and place possible to accomplish the mission and ensure the safety of the aircrew.

Reviewing the criteria defined in chapter one (capability, feasibility, acceptability, sustainability, and suitability), and applying them to information presented in chapters two and three, which discussed urban case studies, challenges to Army aviation, and current UAV programs, 23 possible sub-criterion are evaluated against manned, unmanned and a combination of each in Figure one below. The results indicate that MUM teams work best in the future, as defined in chapter one as the years spanning 2010-2025. The teaming concept satisfies the evaluation criteria (capable, feasible, acceptable, sustainable and suitable) better than UAVs or manned aircraft alone. UAVs in the urban environment can lessen the load on the manned crew by removing the aircrew from harm's way while better preparing them with intelligence and targeting assistance. The research provided justifiably tips the scale in favor of UAV integration with manned aircraft for urban attack and reconnaissance missions.

Figure 1: EVALUATION CRITERIA ANALYSIS CHART

***Each sub-criterion is evaluated against manned (M), unmanned (U), and a combination (C) of each.**
***Manned=AH-64D, Unmanned=current and concept UAV/SUAV/Micro-UAV/UCAR**
***The abbreviations, M-C-U, are annotated with 'X' if the criterion is achieved and 'NO' if they are not achieved..**
***Each column reflects (current/future) effectiveness using a slash to separate the timeframes.**

M	**U**	**C**	
			1. Capability: The capacity to be used for a specific purpose.
X / X	X / X	X / X	a. Conduct RSTA in and around the urban area.
X / X	X / X	X / X	b. Destroy tanks or other armored vehicles in and around the urban area.
X / X	X / X	X / X	c. Destroy unarmored vehicles and kill personnel in and around the urban area.
X / X	NO / NO	X / X	d. Conduct show of force.
			2. Feasibility: The determination that a specific task can be successfully accomplished.
X / X	X / X	X / X	a. Can reliably and successfully conduct RSTA around the urban area.
NO/NO	X / X	X / X	b. Can reliably and successfully conduct RSTA in the urban area.
X / X	X / X	X / X	c. Can reliably and successfully destroy armor around an urban area.
NO/NO	NO / X	X / X	d. Can reliably and successfully destroy armor from within an urban area.
X / X	X / X	X / X	e. Reliably / successfully destroy unarmored vehicles / kill personnel around urban area.
NO/NO	NO / X	X / X	f. Reliably / successfully destroy unarmored vehicles / kill personnel in urban area.
			3. Acceptability: Adequate to satisfy the military and political need.
X / X	X / X	X / X	a. Friendly forces have trust in the system.
NO/NO	NO / X	X / X	b. Performs required missions in the urban area.
X / X	X / X	X / X	c. Performs required missions around the urban area.
NO/NO	X / X	X / X	d. Urban combat casualties are accepted by the public.
			4. Sustainability: Providing for and maintaining a required level of materiel readiness.
NO/NO	X / X	X / X	a. Improves readiness by evading air defense threats within an urban area.
NO/NO	X / X	X / X	b. Improves readiness by infrequent and minor maintenance.
NO/NO	X / X	NO/NO	c. Improves readiness by incurring a low level of logistical support.
			5. Suitability: Possesses the qualities that are appropriate for the purpose.
NO/NO	X / X	X / X	a. Small profile size prevents successful enemy engagement.
X / X	NO / X	X / X	b. Hover behind cover.
NO/NO	X / X	X / X	c. Long loiter times to support RSTA.
X / X	X / X	X / X	d. Can carry weapons.
X / X	X / X	X / X	e. Digitally integrated with other aircraft or ground systems.
NO/NO	NO / X	X / X	f. Maintains sufficient situational awareness during combat in an urban area.
12 / 12	**17 / 22**	**22 / 22**	**Manned/Unmanned Teaming Achieves Highest Number of Current/Future Criteria.**

Recommendations

The US Army would benefit greatly by the employment of UAVs in the urban environment, particularly the Raven Small UAV, UCAR, A160 Hummingbird Warrior, and the X-50 model UAVs. However, the solutions which exist now and in the near future for the application of Army attack and reconnaissance helicopters in the urban environment extend beyond the service component and into the joint world. Therefore, doctrine, both joint and Army, should be updated to include urban combat operations by UAVs, attack and reconnaissance helicopters from all service components, helicopters teamed with UAVs, and the employment of lethal as well as non-lethal means. Joint UAVs and doctrinal development should be maximized to retain the economic advantages gained from the original savings that UAVs provide in terms of both risk mitigation and logistical benefits. Joint use UAVs should share the same classes of supply, thus streamlining the support of and benefit from the versatility of land or ship-borne UAVs.

A joint working group, with Fort Rucker as lead agency, should be initiated to develop doctrine for the employment of UAVs in urban operations. Focus areas should include the employment of joint UAVs (and variants) in an independent role, team role with attack and reconnaissance helicopters, and a support role to Army and other service components' aircraft. The support role could include future logistics support, ISR functions, and teamed-strike capabilities that incorporate joint aircraft (fixed and rotary wing). The doctrine, regardless of service component, should maximize the capabilities of each aircraft and align tasks and functions accordingly. The challenge lays partially in the inclusion of multiple UAVs still in development and the growing and still unidentified capabilities provided by technologically advanced UAVs. Logistics must be a common thread in all applications exemplified in future doctrine as well as a common command and control system for UAVs that is tailorable to meet

the requirements of various land, sea, and air equipment that requires UAV support or communication feeds.

Attacks by UAVs are limited only by current enabling technology and will surely have an evolving doctrinal role for urban attack missions once the weapon-carrying capacity, hovering capabilities, and situational awareness are suitable to replace Army attack and reconnaissance helicopters in urban operations.

However, in the years out to 2025, the most effective method for Army aviation to conduct urban operations while mitigating risk for its aircrews is to team manned and unmanned aviation assets. In summary, after exploring the trend and likely results of urban sprawl in chapter one, examining four case studies of urban operations that demonstrated the risk to aircrews, civilians and destruction of property in chapter two, and a discussion of modern manned and unmanned aviation assets in chapter three, analysis confirms that UAVs can not supplant Army attack and reconnaissance aircraft.

Figure 2: APACHE LONGBOW (AH-64D)

Mission: Attack and armed reconnaissance.

Characteristics:

- Day, night and adverse weather capable
- Length 58 feet
- Height 15 feet
- Weight 15000 pounds
- Cruise Speed 150 knots
- Range 240 miles or 1100 miles with auxiliary tanks
- Weapons:
    - 70mm (2.75 inch) Hydra-70 Folding-Fin Aerial Rockets
    - AGM-114 Hellfire semi-active laser anti-tank missiles
    - AGM-122 Sidearm anti-radar missile
    - AIM-9 Sidewinder Air-to-Air missiles
    - M230 30mm Chain Gun

Source: www.fas.org, s.v. "AH-64D"

Figure 3: KIOWA WARRIOR (OH-58D)

Mission: Armed reconnaissance. Also may be called to conduct joint air attack (JAAT) operations, air combat, limited attack operations, and artillery target designation.

Characteristics:

- Mast Mounted Sight (MMS)
- Day and night capable
- Acquire, identify, and derive the coordinate locations of potential targets
- Weapons
    - AGM-114 Hellfire semi-active laser anti-tank missiles
    - Air-to-Air Stinger (ATAS) missile
    - 2.75" Folding Fin Aerial Rocket (FFAR) pods
    - 0.50 caliber machine gun
- Height 12 feet
- Length 41 feet
- Cruise Speed 80 knots
- Endurance 2 hours
- Less survivable than Apache Longbow

Source: www.fas.org, s.v. "OH-58D"

Figure 4: SHADOW 200 TUAV

Mission: Army tactical level reconnaissance, surveillance, target acquisition, and battle damage assessment.

Characteristics:

- Wing Span 13 feet
- Weight 350 lbs
- Range 125 km
- Airspeed (70 kt loiter, 105 kt dash)
- Altitude 14,000 Ft

- Endurance > 4 Hours @ 50 km
- Primary Payload (s) sensors or equipment up to 60 lb
- Launch / Recovery 100m x 50m Area

Capabilities:
- Automatic Landing and Takeoff
- System and Maintenance Section transportable on 3 C-130s
- Early entry capability with 1 C-130
- Compatible with digital command and control (FCS)
- EO / IR Sensor (electro-optical/infrared)

Unit Composition:
- Platoon Set = a System:
  - Soldiers (2 Officers, 20 Enlisted)
  - 4 - Air Vehicles
  - 6 - HMMWVs (Ground Control Station, air vehicle transport, troop transports, maintenance shelter)
  - 3 - Trailers (equipment, launcher)
  - 4 - Remote Video Terminals

Sources:
www.fas.org, s.v. "Shadow 200."
Burke, John D. "Army UAVs—A Systems Update." *Army Aviation*, 29 February 2004. 26-32.
Burke, John D. "US Army Overview of UAV Systems." PowerPoint Presentation, 17 October 2003. Received via e-mail on 12 November 2003.

Figure 5: HUNTER UAV

Mission: Division and Corps Level reconnaissance, surveillance, target acquisition, and battle damage assessment

Characteristics:
- Wing Span 29 Feet
- Weight 1600 Lbs
- Range > 200KM
- Airspeed 90 Kts cruise (106 Kts Dash)
- Altitude 15,000 Ft

- Endurance 8-12 Hours
- Primary Payload(s) EO / IR sensors
- Launch / Recovery Unimproved runway

Capabilities:
- Fully Qualified System
- Versatile Payload Platform
- Multiple Mission Configurations
- Only Army Extended Range / Endurance UAV
- Stellar Overseas / NTC / JRTC Performance (National Training Center/Joint Readiness Training Center)

Notes:
- Supporting OIF/OEF
- Operational deployments to Macedonia in support of KFOR, 1999-2002.
- Systems in place at III CORPS (Ft Hood), XVIII ABN Corps (Ft Polk), Training Base (Ft Huachuca); and V Corps.
- 22 Payload / Sensor Demonstrations
- 31 Joint Readiness Training Center Exercises (JRTC)
- 4 NTC Rotations
- Lowest mishap rate of any US owned UAV
- Demonstrated extended center wing with hard points to drop BAT submunition. 100 percent hit rate against moving armed target array at White Sands Missile Range (WSMR) – Oct 02

Sources:
www.fas.org, s.v. "Hunter."
Burke, John D. "US Army Overview of UAV Systems." PowerPoint Presentation, 17 October 2003. Received via e-mail on 12 November 2003.

Figure 6: RAVEN SMALL UAV

Mission: Army tactical level reconnaissance, surveillance, target acquisition, and battle damage assessment
Characteristics:
- Wing Span 4.5 feet
- Weight 3.8 lbs (w/carrying case, 12 lbs)

- GCS Weight 17 lbs
- Range 10-15 km (LOS)
- Endurance 80 Minutes (Lithium)
- Payload(s) Approx. 2 lbs., 4 x 4 in. (High Resolution, Day/Night Camera, Thermal Imager, etc.)
- Launch / Recovery 100m x 50m Area

Capabilities:

- Hand Launched
- Auto Landing Recovery
- Military P(y)-Code GPS
- AutoNavigation
- Quick Assembly (< 3 min)
- Man Portable / Backpackable
- Quiet
- Reusable (200+ flights)

Configuration:

- Two (2) Air Vehicles
- One (1) Ground Control Station
- Repair and Spare Parts
- Program Funded for Five (5) Systems

Sources:

Burke, John D. "Army UAVs—A Systems Update." *Army Aviation*, 29 February 2004. 26-32.
Burke, John D. "US Army Overview of UAV Systems." PowerPoint Presentation, 17 October 2003. Received via e-mail on 12 November 2003.

Figure 7: UNMANNED COMBAT ARMED ROTORCRAFT

Mission: Armed escort, mobile strike and reconnaissance.

Command and Control:

- Top-level mission planning
- Dynamic retasking
- Autonomous operation
- Collaborative mission execution
- Low altitude autonomous flight

Capabilities:

- Day / Night & Adverse weather
- Similar capability to manned system
- Range, speed, endurance
- Modular payload
- Survivable and will enhance team survivability
- Compatible w/manned system

Sensors/Weapons:

- Multi Spectral
- High Reliability
- Day / Night/Adverse Weather
- Standoff target ID
- Multi-type missiles, 2.75 inch Hydra rockets, Gun

Sources:

Burke, John D. "Army UAVs—A Systems Update." *Army Aviation*, 29 February 2004. 26-32.
Burke, John D. "US Army Overview of UAV Systems." PowerPoint Presentation, 17 October 2003. Received via e-mail on 12 November 2003.
DARPA, "UCAR Overview," online: http://www.darpa.mil/tto/programs/UCAR_overview.pdf, accessed 6 February 2004.

Figure 8: A160 HUMMINGBIRD WARRIOR

Characteristics:

- Rotor Diameter 36 ft
- Fuselage Length 35 ft
- Gross Weight 4,000 to 5,000 lb
- Internal Payload 300 to 500 lb

Capabilities (Anticipated):

- Range 2000+ nm
- Endurance 24-48 hr
- Speed 140 kt
- Hover Ceiling 15,000 ft
- Operating Ceiling 30,000+ ft

Features:

- Patented Optimum Speed Rotor (OSR): Varies RPM from 50% to 100% to Maximize Rotor Performance

- Low Disk Loading
- Advanced Airfoils, High Lift / Drag
- Hingeless Rigid Rotor, Hub Moment Feedback Control
- Autonomous Flight Management

Sources:

Burke, John D. "Army UAVs—A Systems Update." *Army Aviation*, 29 February 2004. 26-32.
Burke, John D. "US Army Overview of UAV Systems." PowerPoint Presentation, 17 October 2003. Received via e-mail on 12 November 2003.
Olinger, Van. "A160 Hummingbird Warrior." 29 March 2004. <http://www.darpa.mil/tto/programs/hum_war.html, (2 April) 2004.

Figure 9: X-50 DRAGONFLY

Mission:

Possible missions include armed escort, reconnaissance, communications relay, and logistical support

Characteristics:

- Fixed or rotational canard wing provides lift
- Wing rotation or air jet provided by turbo fans through diverter valves, thus reducing need for heavy and complex mechanical drive, transmission and anti-torque system.

Capabilities:

- Vertical takeoff and landing (VTOL)
- 500 knots airspeed
- Potential use for attack or lift missions depending on scaled size of aircraft.

Features:

- Weight reduction due to absence of mechanical drive (air thrust)
- Low disk-loading hover efficiency and low-speed flight characteristics of a helicopter with the high subsonic cruise speed of a fixed-wing aircraft.
- Length 17.7 feet
- Height 6.5 feet
- Blade diameter 12 feet
- Lower cost to operate and support than conventional helicopters

Source:

Burke, John D. "US Army Overview of UAV Systems." PowerPoint Presentation, 17 October 2003. Received via e-mail on 12 November 2003.

BIBLIOGRAPHY

Books

Barnet, Sylvan and Hugo Bedau. *Critical Thinking Reading and Writing: A Brief Guide to Argument*. Boston: Bedford/St. Martin's Press, 2002.

Clausewitz, Carl Von. *On War*, ed. and trans. by Michael Howard and Peter Paret. New Jersey: Princeton University Press, 1976.

Craig, William. *Enemy at the Gates: the Battle for Stalingrad*. New York: Ballantine Books, 1974.

Edwards, Sean J. *Mars Unmasked: The Changing Face of Urban Operations.* Santa Monica: Rand, 2000.

Glenn, Russell W., ed. *The City's Many Faces: Proceedings of the Rand Arroyo Urban Operations Conference, April 13-14, 1999*. Santa Monica: Rand, 2000.

Glenn, Russell W. Combat *inHell: A Consideration of Constrained Urban Warfare*. Santa Monica: Rand, 1996.

Glenn, Russell W., et al. *Corralling the Trojan Horse: A Proposal for Improving US Urban Operations Preparedness in the Period 2000-2025*. Santa Monica: Rand, 2001.

Glenn, Russell W, et al. *Denying the Widow-Maker: Summary of Proceedings*. Rand-DBBL Conference on Military Operations in Urbanized Terrain. Santa Monica: Rand, 1998.

Glenn, Russell W. *Marching Under Darkening Skies: The American Military and the Impending Urban Operations Threat*. Santa Monica: Rand, 1998.

Lunsford, Andrea A. *Easy Writer: A Pocket Guide, S*econd Edition. Boston: Bedford/St. Martin's, 2002.

Oliker, Olga. *Russia's Chechen Wars, 1994-2000: Lessons From Urban Combat*. Santa Monica: Rand, 2001.

Strunk, William, Jr. and E. B. White, *The Elements of Style*, (3rd and 4th Ed), New York: MacMillian Publishing Co. Inc., 1979, 2000.

Sun Tzu, *The Art of War*, Translated and with an introduction by Samuel B. Griffith and foreword by B.H. Liddell Hart. Oxford: Oxford University Press, 1963.

Turabian, Kate L., *A Manual for Writers of Term Papers, Theses and Dissertations*, (6th Ed), Chicago: The University of Chicago Press, 1996.

US Department of the Army. *Field Manual 1-100, Army Aviation Operations.* Washington D.C.: 21 February 1997.

US Department of the Army. *Field Manual 100-5, Operations*. Washington D.C.: May 1976.

US Department of the Army. *Field Manual 3-06 (90-10), Urban Operations*. Washington D.C., June 2003.

US Department of the Army. *Field Manual 3-06.1, Aviation Urban Operations Multiservice Procedures for Aviation Urban Operations.* Washington D.C.: 2001.

US Department of Defense, *Joint Publication 1-02, Dictionary of Military and Associated Terms*. Washington D.C., 12 April 2001, as amended through 17 December 2003.

US Department of Defense, *Joint Publication 3-06, Doctrine for Joint Urban Operations.* Washington, DC: US Department of the Joint Chiefs of Staff; 2002.

Weidenborner, Stephen and Domenick Caruso. *Writing Research Papers: A Guide to the Process*, sixth edition. Boston: Bedford/St.Martin's, 2001.

Wirtz, James J. *The Tet Offensive: Intelligence Failure in War.* Ithaca: Cornell University Press, 1991.

Unpublished Manuscripts

Barry, Charles L. *UCAVs-- technological, policy, and operational challenges*. Washington, D.C.: National Defense University, 2001.

Desch, Michael C., ed. Soldiers *in Cities: Military Operations on Urban Terrain.* Carlisle Barracks: Strategic Studies Institute, 2001.

Fort Rucker DCD, White paper. "Manned and Unmanned Air Maneuver Teaming in Objective Force Air-Ground Operations." Fort Rucker: Directorate of Combat Developments. 30 July 2002.

Glade, David B. "Unmanned Aerial Vehicles: Implications for Military Operations." Occasional Paper No. 16. Maxwell Air Force Base: Air University, 2000.

Robertson, William G., ed. *Block by Block: The Challenges of Urban Operations*. Fort Leavenworth: CGSC Press, 2003.

Scales, Robert H. America's *Army in Transition: Preparing for War in the Precision Age*. Carlisle Barracks: Strategic Studies Institute, 1999.

Spiller, Roger J. *Sharp Corners: Urban Operations at Century's End.* Fort Leavenworth: CGSC Press, 2001.

Thomas, Timothy. "The Caucasus Conflict and Russian Security: The Russian Armed Forces Confront Chechnya, Part I and II." Fort Leavenworth: CGSC Press, 1995.

Unmanned Aerial Vehicles: Questionable Basis for Revisions to Shadow 200 Acquisition Strategy: "Report to the Chairman, Subcommittee on Military Research and Development, Committee on Armed Services, House of Representatives." Washington: US G.A.O., 2000.

Periodicals

Barry, Charles L., Zimet, Elihu. "UCAVs – Technological, Policy, and Operational Challenges." *Defense Horizons*, October 2001.

Burke, John D. "Army UAVs—A Systems Update." *Army Aviation*, 29 February 2004.

Krulak, Charles C. "The Strategic Corporal: Leadership in the Three Block War." *Marines Magazine*, January 1999.

Peters, Ralph. "Our Soldiers Their Cities." *Parameters*, XXVI, no. 1 (Spring 1996).

Roosevelt, Ann. "Army Chief Approves Major Aviation Restructuring," *Defense Daily*, 30 January 2004.

Thomas, Timothy. "The Caucasus Conflict and Russian Security: The Russian Armed Forces Confront Chechnya, III, The Battle for Grozny, 1-26 January 1995." *Journal of Slavic Military Studies*, Vol. 10, No. 1 (March 1997).

Triggs, Marcia. "3rd ID Reorganizes Into Modular Force." *Fort Leavenworth Lamp*, *Army News Service*, 22 January 2004.

Willis, G.E. "Remembering Mogadishu: Five Years After the Firefight in Somalia, Some Say US Forces Abroad Still Are Reeling from It." *Army Times*, October 1998.

Interviews

Bass, Steve. Interview by author, telephone, 12 December 2003.

MacWillie, Steve. Interview by author, internet instant messaging, 27 February 2004.

Internet/Electronic

Burke, John D. "US Army Overview of UAV Systems." PowerPoint Presentation, 17 October 2003. Received via e-mail on 12 November 2003.

Burlas, Joe. "Comanche Project Grounded." *Army News Service*, 23 February 2004. <http://www.dix.army.mil/PAO/Post04/post022704/ComancheProjectGrounded.htm> (26 February 2004).

Congressional Budget Office. "The Army's Bandwidth Bottleneck: Bandwidth Supply and Demand in 2010," August 2003. <http://www.cbo.gov/showdoc.cfm?index=4500 &sequence=3> (5 September 2003).

DARPA. "UCAR Overview." <http://www.darpa.mil/tto/programs/UCAR_overview.pdf> (6 February 2004).

Dictionary.com, n.d. s.v. "megalopolis." http://dictionary.reference.com/search?q=megalopolis> (6 September 2003).

Federation of American Scientists. s.v. "AH-64 Apache," "OH-58D." <http://www.fas.org/man/ dod101/sys/ac/ah-64.htm> (6 January 2004).

Guardiano, John R. "Manning and Unmanning Army Aviation," *Aviation Today*. <http://www. aviationtoday.com/cgi/rw/show_mag.cgi?pub=rw&mon=1202&file=1202rorep.htm> (10 December 2003).

Lambeth, Benjamin S. "NATO's Air War for Kosovo: A Strategic and Operational Assessment." (RAND, 2001) 94-97. Available online: <http://www.rand.org/publications/MR/ MR1365/> (15 March 2004).

McCoy, John V. "Unmanned Aerial Logistics Vehicle – A Concept Worth Pursuing," *Army Logistician*, (March-April 2004). Available online: http://www.findarticles.com/ cf_dls/m0PAI/2_36/114487531/p1/article.jhtml?term=, accessed 5 April 2004.

Microsoft Encarta Encyclopedia. s.v. "Chechnya," "Panama City," "Grozny," "Mogadishu," "Stalingrad." CD-ROM, 2002.

Northrop-Grumman. "Viper Strike Munition Released From Hunter UAV Scores Direct Hits In U.S. Army-Northrop Grumman Tests." Northrop Grumman News Release, 9 April 2003. <http://www.irconnect.com/noc/pages/news_printer.mhtml?d=38843&print=1> (5 September 2003).

Olinger, Van. "A160 Hummingbird Warrior." 29 March 2004. <http://www.darpa.mil/tto/ programs/hum_war.html, (2 April 2004).

Pike, John. "Unit of Action." 26 March 2004. <http://www.globalsecurity.org/military/ agency/army/ua.htm. (5 April 2004).

Rabinovitch, Jonas. "Practical Approaches to Urban Poverty Reduction." The International Forum on Urban Poverty Governance and Participation held in Florence 10-13 November 1997. <http://magnet.undp.org/Docs/urban/Urbpov.htm> (10 February 2004).

Riebeling, Sandy. "Unmanned Aerial Vehicles." Redstone Rocket, 17 July 2002. <http://www. tuav.redstone.army.mil/rsa_article.htm> (5 September 2003).

Sandra I. Erwin. "Army to Field Four Classes of UAVs." *National Defense Magazine*, April 2003. <http://www.nationaldefensemagazine.org/article.cfm?Id=1077> (6 October 2003).

Sheftick, Gary. "Army to Reset into Modular Brigade-Centric Force," *Army News* Service.

<http://www4.army.mil/ocpa/print.php?story_id_key=5703> (27 February 2004).

Sherman, Jason. "UAVs Can't Replace Innate Abilities, Judgment of Soldiers on the Ground." *Defense News*, 31 March 2003. <http://www.defensenews.com/conferences/0403ftb/ftb_1725774.html> (5 September 2003).

"US Army to Test Smart Munitions on UAVs." *Defense Update*, 8 July 2002. <http://www.systima.com/Bat-Hunter.pdf. (5 September 2003).

US Department of Defense. *Joint Publication 3-55.1, JTTP For Unmanned Aerial Vehicles*. Washington D.C.: 27 August 1993. <http://www.fas.org/irp/doddir/dod/jp3-55_1/index.html> (10 January 2004).

United States Senate Press Release. "The Senate Armed Services Committee Completes Markup of the National Defense Authorization Bill for fiscal year 2001." 10 May 2000. <http://armed-services.senate.gov/press/01mark.pdf> (6 October 2003).