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Aviation Urban Operations

Are We Training Like We Fight?

TODD G. KEMPER
Lieutenant Colonel, USMC

Air War College
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Air War College

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Please send inquiries or comments to
Editor
The Maxwell Papers
Air War College
325 Chennault Circle, Bldg. 1401
Maxwell AFB AL 36112-6427
Tel: (334) 953-7074
Fax: (334) 953-1988
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Foreword

Doctrine for joint urban operations, which include aviation urban operations, combined with revised tactics, techniques, and procedures for joint close air support, offers the combined/joint force air component commander a set of best practices for conducting counterland operations on urban terrain. In this study, Lt Col Todd Kemper, USMC, argues that aviation urban operations, particularly urban close air support, are no longer high-risk, low-probability missions left to academic discussions, but are proving to be high-risk, high-probability missions, as witnessed during Operation Iraqi Freedom. Furthermore, the author contends that urban terrain has become the preferred battlespace of US adversaries in the early twenty-first century. This environment poses unique challenges, especially to air and space warfare. The difficulty of sorting friendlies from enemy combatants, the latter intermingled with large numbers of noncombatants in very confined spaces, creates serious dilemmas for maneuver and aviation forces. Colonel Kemper believes that this mission, though well documented, has received neither the priority nor the resources necessary to ensure operational excellence and success on the modern battlefield. Thus, he not only inquires about whether we are training like we fight, but also seeks to determine what makes aviation urban operations so complicated and unique that they require stand-alone doctrine, tactics, techniques, and procedures.

Colonel Kemper examines aviation urban operations during Operations Allied Force, Enduring Freedom, and Iraqi Freedom, demonstrating the use of airpower and space power as a force multiplier and enabler in the urban environment. During those operations, tactical jets, bombers, AC-130 gunships, and unmanned aerial vehicles provided precision fires as well as command, control, communications, computers, intelligence, surveillance, and reconnaissance (C4ISR) support to the joint fight. Although each conflict is different, recent combat in Iraqi cities such as Fallujah and An Najaf indicates the enemy's willingness to drag US and coalition forces into urban warfare. In view of the possibility of collateral damage and with the world

media watching, air and space forces can ill afford to get it wrong in urban fights. Colonel Kemper believes that the US Air Force, Navy, Special Operations Command, and Marine Corps should redouble their efforts from a doctrinal, organizational, training, material, leadership, personnel, and facilities perspective on the important mission area of aviation urban operations. His study concludes with recommendations for US Joint Forces Command and the military services.

As with all Maxwell Papers, this study is provided in the spirit of academic freedom, open debate, and the serious consideration of issues. We encourage your responses.

ROBERT J. ELDER JR.
Major General, USAF
Commandant, Air War College

About the Author

Lt Col Todd G. Kemper, USMC, is on the faculty of the Department of Warfighting at Air War College (AWC), Maxwell AFB, Alabama. He entered the Marine Corps from Indiana University in 1984 and has served as commanding officer of Marine Fighter Attack Squadron 242, Marine Aircraft Group 12, at Marine Corps Air Station (MCAS) Iwakuni, Japan, and as aviation safety officer for the 3rd Marine Aircraft Wing, MCAS Miramar, California. He has completed tours at MCAS Yuma, Arizona; MCAS El Toro, California; Marine Corps Base Camp Hansen, Okinawa, Japan; and Marine Corps Air Ground Combat Center, Twentynine Palms, California. A naval flight officer with over 2,800 hours in the F-4, RF-4, OA-4, and FA-18D aircraft, Colonel Kemper was a forward air controller (FAC) assigned to Task Force Grizzly, 3rd Battalion, 7th Marines, during Operations Desert Shield and Desert Storm. After graduating from Marine Aviation Weapons and Tactics Squadron 1's (MAWTS-1) Weapons and Tactics Instructor Course, he served as a MAWTS-1 FA-18 instructor from 1995 to 1998 and as a FAC airborne instructor. A distinguished graduate of Air Command and Staff College (ACSC), Maxwell AFB, and a graduate with academic distinction from AWC, Colonel Kemper holds a master of military operational art and science degree from ACSC and a master of strategic studies degree from AWC.

Aviation Urban Operations

Are We Training Like We Fight?

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 two warring tribes apart—conducting peacekeeping operations. Finally, they will be fighting a highly lethal mid-intensity battle. All in the same day, all within three city blocks. It will be called the three-block war.

—Gen Charles C. Krulak, USMC, 10 October 1997

The battle for the bridges of An Nasiriyah, Iraq, was one of the most important engagements of Operation Iraqi Freedom and a baptism by fire for joint urban operations (JUO) doctrine. At 0400 local time on 23 March 2003, tanks and a combined antiarmor team from the 1st Battalion, 2nd Marines, entered the city as lead elements for the battalion. The unit had as its objective three key bridges north of the city. Terrain of questionable trafficability kept the advancing vehicles predominantly road-bound. Three brigades of Iraqi fighters defended the city, and units from the Republican Guard, Saddam Fedayeen, Al Quds, and regular army lay in wait in an area that marines had already named "ambush alley."[1]

On this day, combat would take place both in and around An Nasiriyah. Before the lead units entered the city, they came under intense machine gun and mortar fire from positions inside the city. Once inside, the marines found themselves taking fire from rooftops and around the corners of buildings. Interspersed between the marines and Iraqi fighters, most of whom wore no uniforms, were numerous noncombatants. Close air support (CAS) and indirect fires aided the advance of the battalion, which encountered remnants and survivors from the US Army's 507th Maintenance Company. Using a combined-arms approach, the marines slugged their way through the town, fighting street to street and even house to house. The enemy, bolstered by a successful ambush of the 507th, brought T-55 tanks into the fight.

By 1430 all three companies of the Marine battalion were engaged in different locations across the city. Man-made structures created line-of-sight (LOS) communication problems, negating lateral communication between the companies and the battalion's command operations center. Charlie Company, which had set up its defensive position north of the Saddam Canal, found itself in a fight for survival. Enemy units used bracketing artillery fire, rocket-propelled grenades, and strafing fire to keep the company pinned down as other enemy forces maneuvered behind protective terrain. The company dispersed into squad-sized defensive positions. Casualties mounted, not only in Charlie Company, but also in Alpha and Bravo Companies.

Then, in the middle of this chaotic and confusing firefight, a single American A-10 Warthog engaged the Charlie Company marines and their vehicles with 30 mm cannon fire.[2] US Central Command (CENTCOM) later investigated this suspected "blue on blue" instance of fratricide, acknowledging that it constituted friendly fire.[3] Tragically, following the combat 18 marines lay dead, and 14 others had sustained wounds in some of the most intense urban combat observed since the battle for Hue City, South Vietnam. How could this have happened? Did it result from lack of training, procedural error, or human error (usually caused by a lack of knowledge)? The CENTCOM investigation report focuses on human error. We may never know all the facts about the incident, but we do know for certain that no aviation setting is as complex or confusing as the urban environment.

This study uses the terms *JUO* and *aviation urban operation* to reflect the most current, joint perspective. The key concepts associated with these terms include (1) military operations/actions on or near man-made construction and (2) the density of noncombatants. The importance of aviation urban operations will continue to grow as long as trends in demographics and conflict remain on their present course. The urban environment poses unique challenges to warfare, especially when it involves air and space. The difficulty of sorting friendlies from enemy combatants, the latter intermingled with large numbers of noncombatants in very confined spaces, creates serious dilemmas for maneuver and aviation forces.

The Department of Defense (DOD) finds itself inadequately prepared to solve this strategic, operational, and tactical problem because a lack of emphasis in flying-training syllabi and a shortfall in dedicated ranges have hampered US forces' ability to conduct effective aviation urban operations with fixed-wing aircraft. Thus, this paper emphasizes the fire support conducted by these aircraft in such operations, as well as the subset of urban CAS, finding that joint and service doctrine on the subject, although adequate, remains incompletely implemented into fixed-wing training syllabi. Consequently, aircrews receive improper education or training in the conduct of aviation urban operations and/or urban CAS. Additionally, a lack of complexes designed to provide training in these operations and authorized for air-delivered ordnance has further complicated the development and evaluation of tactics.

Specifically, the paper discusses emerging urban-operations doctrine, both service and joint; examines the nature and complexity of the urban environment, the constraints it places on combined-arms operations, and the potential sanctuary it provides enemy forces; and addresses the requirements for effective aviation urban operations. After summarizing recent combat experience in the form of lessons learned from Operations Allied Force, Enduring Freedom, and Iraqi Freedom, it then provides a synopsis of training in aviation urban operations within the services and among specialists. Acknowledging the validity of the multiservice tactics, techniques, and procedures (TTP) outlined in the Air Land Sea Application (ALSA) Center's publication *Aviation Urban Operations*, April 2001, and the TTPs outlined in Joint Publication (JP) 3-09.3, *Joint Tactics, Techniques, and Procedures for Close Air Support*, 3 September 2003, the study considers whether the US military has sufficient training to execute multiservice TTPs. Finally, the paper formulates conclusions and recommendations for planners who work in the area of fixed-wing aviation. These suggestions outline better organizing, training, and equipping that would promote effective aviation urban operations with an emphasis on urban CAS.

The Evolution of Doctrine for Aviation Urban Operations

The battlefields of the future will be highly complex urban terrains. If our soldiers cannot fight and kill at close range, our status as a superpower is in question.

—Robert D. Kaplan, 2002

Coordinating and executing CAS is difficult under most combat conditions; it becomes even more problematic over urban terrain—a scenario labeled "urban CAS" by analysts such as Gen Thomas McInerney, USAF, retired.[4] As early as 1982, the United States Marine Corps began investigating how to employ combined arms on urban terrain, publishing its findings in the study *Close Air Support in an Urban Environment*. In "Urban Offensive Air Support: Is the United States Military Prepared and Equipped?" Maj Jon M. Davis, USMC, highlights the global trend toward urbanization and challenges air and space planners to focus on the training, procurement, and doctrine of what he calls urban offensive air support.[5] Since 1995 several military professional journals have published articles addressing the role of airpower and space power in urban warfare, leading the Marine Corps and the Air Force to undertake two separate studies of urban CAS. The Air Force launched its *Urban Close Air Support Tactics Development and Evaluation Test Plan* in 1996, and the Marines followed suit in 1997 with *Marine Aviation Weapons and Tactics Squadron One (MAWTS-1) Urban CAS Study*, later changed to *MAWTS-1 Urban Close Air Support Assessment*.[6]

In early 1998, recommendations and data presented at a Joint Doctrine Working Party hosted by the Joint Warfighting Center at US Atlantic Command (now US Joint Forces Command) convinced members from nine unified commands, four services, and the Joint Staff to vote 12–2 to develop doctrine for military operations on urban terrain (MOUT).[7] In May 1998, the Joint Staff's J-8 directorate stood up a Joint Urban Working Group to begin the difficult task of drafting joint MOUT doctrine. On 17 May 2000, the group published the *Handbook for Joint Urban Operations*, designed to provide joint force commanders and

their staffs a perspective on the fundamental principles and operational-level considerations for conducting JUOs.[8]

Out of that body of work have come two new joint doctrinal publications: The ALSA Center's *Aviation Urban Operations*, mentioned previously, and JP 3-06, *Doctrine for Joint Urban Operations*, 16 September 2002. Written for commanders, planners, aircrews, and ground personnel, the ALSA Center publication provides tactical understanding of the complexities of urban terrain, incorporating lessons learned from real-world operations and training exercises, as well as TTPs from various sources. JP 3-06 not only discusses the planning and conduct of JUOs, explaining how they differ from other operations, but also examines the special considerations and unique challenges posed by JUOs at the operational level of warfare. With the publication of both documents, military planners and aircrews finally had doctrine to apply to the complex task of planning and executing *aviation urban operations*, a term that raises a relevant point about lexicon.

Urban combat, *urban fights*, *urban operations*, *MOUTs*, *JUOs*, *urban offensive air support*, and *aviation urban operations* are all terms used to describe military actions in the urban environment. According to JP 3-06, JUOs are

> all joint operations planned and conducted across the range of military operations on, or against objectives within, a topographical complex and its adjacent natural terrain, where manmade construction or the density of noncombatants are the dominant features. This definition is similar to that of [MOUT], which is used by the Army and Marine Corps, but MOUT has strong connotations of urban ground combat at the tactical level. The term "joint urban operations," on the other hand, connotes an operational-level approach that considers the use of joint forces across the range of military operations.[9]

The Army defines urban operations as "operations planned and conducted in an area of operations . . . that includes one or more urban areas. An urban area consists of a topographical complex where man-made construction or high population density is the dominant feature."[10]

The Marine Corps defines MOUTs as "all military actions planned and conducted on a topographical complex and its adjacent natural terrain where man-made construction is the dominant feature. It includes combat-in-cities, which is that portion of MOUT involving house-to-house and

street-by-street fighting in towns and cities."[11] Because the new ALSA Center publication does not offer a definition for aviation urban operations, this paper regards them as aviation operations on, or against objectives within, a topographical complex and its adjacent natural terrain, where either man-made construction or the density of noncombatants is the dominant feature.

The Emerging Urban Battlefield

And the worst policy is to attack cities. Attack cities only when there is no alternative. . . . The General unable to control his impatience, will order his troops to swarm up the wall like ants, with the end result that one-third of them will be killed without taking the city. Such is the calamity of attacking cities.

—Sun Tzu
The Art of War

Since World War II, the world's population has become larger and more urban. Demographic trends note the movement of large populations from rural areas to cities, which are becoming centers of finance, politics, transportation, communication, industry, society, and culture.[12] Globalization has accelerated urbanization. Relocating from rural areas makes the products and services created by globalization more accessible. According to the Central Intelligence Agency, "the world population in 2015 will be 7.2 billion people, up from 6.1 billion in the year 2000." The report also observes that "the ratio of urban to rural dwellers is steadily increasing. By 2015 more than half of the world's population will be urban."[13] Additionally, the Marine Corps publication *Expeditionary Operations* notes that "some 60 percent of the world's population lives within 100 kilometers of the ocean. Some 70 percent lives within 320 kilometers. By far the most cities with populations of more than one million are located in the littorals. Coastal cities—that is, cities directly adjacent to the sea—are home to almost a billion people worldwide and experiencing unprecedented growth."[14]

Overcrowding in the cities pushes competition for resources, which, in turn, increases stress and the potential for violence. Functioning governments struggle to provide basic services, jobs, and security. In the world's megacities—those containing more than 10 million people—huge

slums and shantytowns sprout up to house newcomers. But cities cannot support the burgeoning populations. Movement of more of the world's people into urban areas enhances the military significance of cities, thereby increasing the likelihood that US forces will operate on urban terrain.[15] Indeed, the United States fought in such areas some 30 times during the twentieth century (table 1) and has done so twice already in the twenty-first (Enduring Freedom and Iraqi Freedom).

Table 1. Twentieth-century urban operations

Location	*Date*	*Location*	*Date*
Ebroin	1938	Warsaw	1939
Rotterdam	1940	Moscow	1942
Stalingrad	1942	Leningrad	1942
Warsaw	1943	**Palmero**	**1944**
Tokyo	**1944**	Dresden	1944
Brest	**1944**	Warsaw	1944
Aachen	**1944**	Ortona	1944
Cherbourg	**1944**	Breslau	1945
Weissenfels	**1945**	Berlin	1945
Manila	**1945**	**San Manuel**	**1945**
Berlin airlift	**1948–49**	**Seoul**	**1950**
Budapest	1956	**Beirut**	**1958**
Santo Domingo	**1965**	**Saigon**	**1968**
Kontum	**1968**	**Hue**	**1968**
Belfast	1972	Montevideo	1972
Quangtri City	**1972**	**An Loc**	**1972**
Xuan Loc	**1975**	**Saigon**	**1975**
Beirut	**1975–78**	Managua	1978
Sidon	1982	Kabul	1978–87
Tyre	1982	**Panama City**	**1989**
Khafji	**1991**	**Baghdad**	**1991–98**
Mogadishu	**1992–94**	**Port-au-Prince**	**1994**
Sarajevo	**1994–98**	Grozny	1994–95
Monrovia	**1996**	**Freetown**	**1997**
Belgrade	**1999**	**Pristina**	**1999**

Reprinted from ALSA Center, *Aviation Urban Operations*, April 2001, I-3, http://www.globalsecurity.org/military/library/policy/army/fm/3-06-1/fm3-06-1.pdf.

Note: Boldface denotes direct US involvement.

Nevertheless, both Army and Marine Corps doctrine recommends isolating and bypassing urban areas whenever possible due to potential risks. Despite our military's preference for fighting opponents in open terrain, where it

can take full advantage of superior firepower and maneuver, our enemies are not playing along. As a matter of fact, in both Enduring Freedom and Iraqi Freedom, adversaries attempted to draw American and coalition forces into urban terrain to deny maneuver elements freedom of action. According to Maj Jon Davis, "given the [US] doctrinal aversion to urban combat, a competent defender will do everything in his power to draw the fight into the city."[16]

Characteristics of Urban Terrain

Three interrelated and complex characteristics distinguish the urban battlespace: man-made construction, high population density, and restrictive rules of engagement (ROE) (table 2). Understanding the characteristics of urban terrain and their interrelationship requires a radical change in how military planners and aircrews view terrain. It also demands critical thinking about the multidimensional aspects of that terrain (i.e., size, pattern, and density).

Table 2. Comparison of operations in urban terrain and in other types of environments

Characteristic	*Urban*	*Desert*	*Jungle*	*Mountain*
Number of noncombatants	High	Low	Low	Low
Amount of valuable infrastructure	High	Low	Low	Low
Multidimensional battlespace	Yes	No	Some	Yes
Restrictive rules of engagement	Yes	No	No	No
Detection, observation, engagement ranges	Short	Long	Short	Medium
Avenues of approach	Many	Many	Few	Few
Freedom of vehicular movement and maneuver	Low	High	Low	Medium
Communications functionality	Degraded	Fully capable	Degraded	Degraded
Logistics requirements	High	High	High	Medium

Reprinted from Joint Publication 3-06, *Doctrine for Joint Urban Operations*, 16 September 2002, I-7, http://www.dtic.mil/doctrine/jel/new_pubs/jp3_06.pdf.

Man-made construction is the most recognizable characteristic that makes urban terrain unique. Buildings and other structures contain more than double or even triple the number of significant areas of interest than does a similarly sized piece of natural terrain. The complex blend of horizontal, vertical, interior, exterior, and subterranean forms and structures creates additional battlespace for both attackers and defenders. Urban battlespace consists of the familiar dimensions of airspace and land-surface areas, as well as man-made spaces known as "supersurface" and "subsurface" areas (fig. 1).[17]

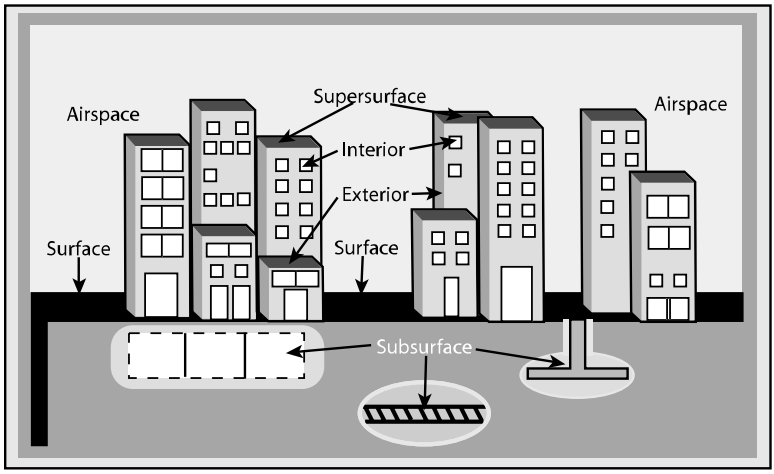

Figure 1. Urban terrain. (Reprinted from Joint Publication 3-06, *Doctrine for Joint Urban Operations*, 16 September 2002, I-5, http://www.dtic.mil/doctrine/jel/new_ pubs/jp3_06.pdf.)

Capt Troy S. Thomas, USAF, comments that

> the urban battlespace is a system. . . . The urban system is unique in that it consists of five dimensions or spaces. First, the airspace above the ground is usable to aircraft and aerial munitions. Second, the supersurface space consists of structures above the ground that can be used for movement, maneuver, cover and concealment, and firing positions. For airmen, the supersurface warrants special consideration since the enemy can locate weapons such as surface-

> to-air missiles or antiaircraft artillery there. Structures also channel or restrict movement at the surface. Third, the surface space consists of exterior areas at ground level, including streets, alleys, open lots, parks, and so forth. Fourth, the subsurface or subterranean level consists of subsystems such as sewers, utility structures, and subways. Although often overlooked, the subsurface space is more exploitable than one realizes because these elements exist as part of a city's planned infrastructure; therefore they have known relationships and nodes. The fifth domain is the information space.[18]

Potential adversaries understand the military significance of urban terrain and will exploit all five areas to their advantage. Natural terrain—unless complicated by underground facilities, caves, or tunnel systems—lacks the complexity of urban terrain.

The size and geolocation of an urban area can also affect the type of man-made construction. Construction materials, techniques, and designs vary throughout the world, but as urban populations rise, so does the use of multiple-story buildings. Depending on the region, the presence or absence of urban planning has created variable sizes and patterns of urban construction. In the Middle East and South Asia, for example, the practice of armies rebuilding over the old foundations of conquered cities has created urban areas that resist classification. In Europe, older cities typically display two distinct patterns: the "old" and "new" sections of the city.

Urban patterns reflect the spatial relationship between surrounding terrain and man-made construction. The ALSA Center identifies 11 distinct patterns: hub, satellite, network, linear, segment/pie slice, rectangular, radial, concentric, contour conforming, irregular, and planned irregular.[19] Each pattern affects navigation, target acquisition, and application of joint terminal control procedures. The success of aviation urban operations depends upon early recognition and identification of the pattern type.[20] Failure to understand and account for street patterns adds friction to the execution of these operations, especially CAS. For example, understanding street patterns can improve LOS communication, the ability of CAS aircraft to acquire marks, and the ability of joint terminal attack controllers (JTAC) to acquire CAS aircraft and provide "cleared hot" status during their weapons deliveries. During their Weapons and

Tactics Course 2-02, urban CAS instructors from MAWTS-1 made the following observations about run-in geometry: "the use of small final attack cones, low altitude releases, and single rocket/short gun burst proved successful for [fixed-wing] aircraft."[21]

Factors other than size and pattern—structural density, for example—influence man-made construction. Accordingly, the compressed battlespace of the urban environment creates unique considerations for aviation urban operations. In the view of the ALSA Center, "structural density is proportional to the population density."[22] In layman's terms, structural density is nothing more than the spatial relationships between buildings. The ALSA Center uses five categories to classify this feature: dense random, close orderly block, dispersed residential, high-rise, or industrial/transportation construction.[23]

One finds dense random construction (the ALSA Center's "type A") in lesser-developed and nondeveloped nations. It consists of groupings of older buildings separated by very narrow streets, located in the center of an urban area. Buildings are closely spaced and in some cases adjoining; the older sections of European cities feature this type of construction.

Close orderly block (type B) represents more modern construction, including rectangular or square residential and commercial buildings located on wide streets and possibly containing inner courtyards. One sees this type of density in almost all medium-sized and large cities in the United States.

The outskirts or peripheries of towns or cities often contain dispersed residential area construction (type C), with street widths much narrower than those associated with type B construction and houses typically closely spaced and arranged in rows. One finds such one-to-two-story houses with backyards in the residential areas of any large European or American city.

Multistory business and residential developments reflect high-rise construction (type D). The downtown areas of most medium and large cities—Chicago, Ankara, and Seoul, for example—contain this type of structural density. Elevated skylines and urban canyons give type D construction a distinctive flavor.

One finds the most open and dispersed appearance of all the structural-density types in industrial/transportation construction (type E). In this type of density, large single- or two-story, flat-roofed buildings and warehouses with large dirt or paved parking lots populate large industrial parks, railroad yards, or large manufacturing facilities, usually located on the outskirts or peripheries of cities.

Size, pattern, and structural density are related to the materials, design, and type of man-made construction within a given urban area. Building construction is an important factor in planning and executing aviation urban operations, particularly in terms of estimating collateral damage; therefore, it has become part of the joint intelligence preparation of the battlespace.[24]

Closely related to man-made construction is the second unique characteristic of urban terrain: the presence of large numbers of people in a confined area, many of them noncombatants. Many features, both physical and socioeconomic, influence urban population density: land resources, roadways, public transportation, utilities, building construction, employment opportunities, economic resources, education, access to international aid and charity, and political unrest. The numbers of refugees and displaced civilians created by this last feature will vary, based on the ferocity, length, and type of conflict.[25]

Concerns about population and structural density almost inevitably lead to the imposition of restrictive ROEs during urban operations, one of whose greatest risks involves noncombatant casualties. In many situations, the possibility of causing collateral damage inhibits the use of armor, artillery, multiple rocket launchers, and mortars, leaving aviation-delivered fires as the only option.

However, ROEs, as well as concerns about fratricide, may similarly restrict many types of aviation-delivered ordnance—the use of cluster munitions in the urban environment, for example. Accordingly, matching weapons to target becomes another important consideration for aviation-delivered fires. Exacerbating the problem, structural density restricts maneuver and makes direct-fire engagements during ground combat occur at very close ranges (25–100 meters), in contrast to similar engagements in open terrain, which occur at much greater distances (300–800 meters).[26]

Consequently, the majority of urban CAS missions will fall into the category of "troops in contact" or "danger close."[27] Because of the close range of urban direct-fire engagements, target identification (ID) and combat ID of friendly positions become extremely difficult for fixed-wing CAS platforms. A ruthless and reactive adversary can further compound the problem by using noncombatants as shields, as the Serbs did in Allied Force. In the words of an Albanian refugee, "Tanks, heavy artillery, and anti-aircraft guns were reported hidden in civilian houses and barns. During NATO air strikes . . . Yugoslav troops move as close as they can to populated areas, where they can seek protection."[28]

In summary, myriad characteristics and planning considerations complicate the conduct of aviation urban operations. The presence of man-made structures, their corresponding supersurfaces and subsurfaces, and the proximity of friendly forces and large numbers of noncombatants differentiate urban from natural terrain, making this environment both unique and difficult.

Considerations for Planning Aviation Urban Operations and Urban CAS

The ALSA Center identifies several considerations that make the planning and execution of aviation urban operations unique: "(1) operations in urban canyons [artificial canyons created by multistory buildings], (2) deconfliction in confined airspace, (3) restrictive [ROEs], (4) difficulty in threat analysis, (5) an overload of visual cues, (6) the presence of noncombatants, (7) the potential for collateral damage, and (8) the increased risk of fratricide."[29] These items suggest two broad tactical problems: the difficulties of properly identifying (1) potential targets (target ID) and (2) friendly vehicles and positions (combat ID), both of which are especially critical for urban CAS.

For example, tall buildings particularly confound target ID for urban CAS by reducing the ability of aircrews to maintain LOS with their targets. If LOS becomes a problem, then they might need to use specific attack headings. However, in a cascading manner, such headings could increase either the risk to aircrews or the requirement for the

suppression of enemy air defenses (SEAD) or similar measures, as discussed below. LOS difficulties also might require marking of the target by smoke, white phosphorus, laser, infrared, or other methods, which, in turn, could alert an adversary to our presence, creating more demand for SEAD. JP 3-09.3 also makes reference to a need for detailed, gridded maps or photos to aid in the description and location of targets. The numbering of significant man-made objects such as roads, intersections, and buildings could speed up the acquisition process or provide situational awareness. Moreover, all units, whether air or ground, should have in their possession identical maps or gridded photos.[30]

JP 3-09.3 outlines the conditions for effective CAS: "thoroughly trained personnel with well developed skills, effective planning and integration, effective command, control, communications, and computers systems, air superiority (especially . . . [SEAD]), target marking and/or acquisition, streamlined and flexible procedures and appropriate ordnance. Although not a requirement for CAS employment, favorable weather improves CAS effectiveness."[31] All personnel involved in CAS—including aircrews, JTACs, maneuver forces, and fire-support elements—need rigorous and realistic training. Because skill sets and competencies acquired in initial CAS training are perishable, personnel need refresher training in order to maintain their proficiency.[32] The unique nature of aviation urban operations makes this requirement even more imperative. Because of its structural and population density, urban terrain can change drastically after attacks by high-explosive ordnance, which can create "rubbling" of man-made structures, thus continually changing the battlespace and creating additional cover and concealment for the enemy. Furthermore, explosive fires can panic noncombatants, causing them to run into the streets or adjacent buildings seeking shelter—a situation that could abruptly change the conditions of the battlespace.

Planning and integration involve the detailed synchronization of air support with both fire support and the ground scheme of maneuver. As discussed above, the requirement for special products for navigation and targeting, such as gridded maps, photos, and numbering systems for buildings,

exemplifies the kind of detailed integration demanded by operating in the urban environment. Timely dissemination of those products to all participants is crucial.

Command, control, communications, and computers (C4), require an "integrated, flexible [C4] structure to identify requirements, request support, prioritize competing requirements, task units, move CAS forces to the target area, provide threat warning updates, enhance CID [combat ID] procedures, etc."[33] Without an effective command and control (C2) system, a tactical air control party's (TACP) chances of requesting immediate CAS become questionable at best. The physical characteristics of urban terrain magnify the problems that accompany the C2 of aviation operations and accentuate some of the greatest challenges associated with CAS in general: airspace deconfliction, dissemination of fire-support coordination measures, and LOS communication, for example.

Effective CAS absolutely requires air superiority and its subset—SEAD. One only has to experience engagement by enemy fighters or ground based air defense (GBAD) while trying to provide bombs on time and on target to realize what prohibitive interference is all about. However, concerns about collateral damage and civilian casualties may restrict or even prohibit the use of ground-based and airborne assets to suppress GBADs during aviation urban operations. In any case, the location of GBAD systems and shoulder-fired surface-to-air missiles may prove hard to pinpoint because of LOS and the availability of hiding places in urban terrain. All of these factors increase the risk to both aircrews and mission accomplishment.

Target marking and acquisition are both integral tasks in conducting CAS. Accurate and timely marks increase the probability of getting bombs off on the first pass and help reduce the potential for fratricide. LOS problems and dust associated with urban terrain may cause difficulties with laser and infrared marks, and indirect marks such as white phosphorus may encounter restrictions or prohibitions. Thus, visual talk-on procedures (verbally describing the target until the attack aircraft has positive identification or "contact") conducted by a forward air controller airborne (FAC [A]) or strike coordination and reconnaissance platform become the default mark in the urban environ-

ment. Exacerbating the problem, aircrews can easily lose sight of targets because of the busy and repetitive scene (e.g., different blocks look alike). The visual clutter, combined with visual talk-on marks, makes target acquisition difficult, thereby lengthening the time to get bombs on target in the urban environment and increasing the aircrew's exposure to the threat and overall risk.

Streamlined, flexible procedures allow C2 agencies to retask CAS assets dynamically across the battlespace to provide air support. Techniques used to improve responsiveness for preplanned or immediate CAS over natural terrain will work just as well for urban terrain. Selecting the appropriate ordnance or matching the correct weapon to the target needs to begin in the planning process for aviation urban operations. Specific ordnance, such as cluster bombs or napalm, may be restricted or prohibited, and certain subsurface targets may require very specific bomb and fuse combinations to produce the desired effects. Concerns about collateral damage also may preclude the use of heavyweight precision-guided bombs or unguided general-purpose bombs. In some situations, inert ordnance will become the weapon of choice. According to one report, "if there is a ground fight for Baghdad, the new air strategy will involve smaller bombs to reduce the threat of civilian casualties; more laser-guided weapons, which are more accurate than satellite-steered munitions; and even concrete bombs that can disable a target but can't cause a blast that could kill civilians or damage buildings."[34] With the advent of the 1,000- and 500-pound versions of the Joint Direct Attack Munition (JDAM) and an even smaller 250-pound (small-diameter bomb) variant to follow, planners now have a choice of desired blast effects, provided JTACs and targeteers can supply precise target coordinates.[35] Additionally, nonlethal-weapons technology holds promise as a realistic and developing capability for aviation urban operations.[36]

We neglect any of these myriad, unique planning considerations, conditions, and factors at our peril. Any of them can compromise the effectiveness of aviation urban operations, urban CAS in particular, producing unacceptable risk and unintended consequences. After all, the uniqueness and complexity of the urban environment make it far less forgiving than natural terrain.

The Legacy of Recent Combat

Some of the most limiting constraints on future U.S. military actions in urban environments are not going to be technological or operational; they are going to be legal and political.

—Matthew C. Waxman
International Law and the Politics of Urban Operations

Since 1999 the DOD has conducted aviation urban operations in Operations Allied Force, Enduring Freedom, and Iraqi Freedom. We would do well to examine whether aircrews were sufficiently well organized, trained, and equipped to succeed in those operations.

Operation Allied Force

Beginning on 24 March 1999, US-led aircraft of the North Atlantic Treaty Organization (NATO) flew over 38,000 sorties in a 78-day campaign against the forces of the former Republic of Yugoslavia and their leader, Slobodan Milosevic. The first part of the three-phase NATO air campaign concentrated on the Serbian integrated air defense system—in particular, the C2 bunkers located in Kosovo. The second phase targeted fielded forces south of the 44th parallel in Kosovo, and the third phase went after military facilities and infrastructure north of the 44th parallel, including Belgrade.[37] Allied planners targeted bridges, airfields, tunnels, bunkers, electrical power, petroleum/fuel facilities, and other fixed, aboveground structures, many in complicated urban terrain. Serbia's mobile targets—tanks, armored personnel carriers, towed artillery, and mobile surface-to-air missiles—proved more difficult to locate and validate their destruction.[38]

Of the many lessons learned from Allied Force, two of the most relevant to aviation urban operations include the impact of international legal restraints and the political constraints on operations. A RAND study notes that

> urban environments pose enormous difficulties for those planning and conducting military operations within the boundaries of international law and self-imposed political constraints. The speed and agility of air power, combined with its ability to deliver firepower precisely and with relatively low risk to U.S. personnel across the spectrum of conflict, often make it the military instrument of choice for policymakers. However, the heightened risk of collateral damage

> when operating in urban environments partially offsets U.S. technological superiority. The features of urban environments also provide adversaries with expanded opportunities to exploit U.S. adherence to certain norms by using human shields and propagandizing civilian injuries. As a result, the urban combat operations available to planners and decisionmakers are generally far narrower than the domain of the feasible.[39]

Air operations over Kosovo raised a number of international legal concerns over the discrimination between combatants and noncombatants and between military assets and civilian property. The international law of armed conflict mandates that combatants on both sides reduce the risk of collateral damage and/or noncombatant injuries. NATO made every effort to minimize collateral damage during Allied Force. Postwar assessment of 38 targeted sites revealed that only one experienced significant collateral damage. Damage at the other sites was limited to broken windows, displaced roof tiles, and detached ceiling tiles.[40] During the conflict, however, Serbian leaders and the media used collateral damage and noncombatant casualties as propaganda designed to sway international public opinion against the use of airpower by the United States and NATO. Because of the legal concerns, military lawyers played as large a role in targeting decisions as did the targeteers. According to analyst William Arkin, the total number of noncombatant casualties attributed to Allied Force amounted to 500 killed and 900 wounded.[41] Serbian propaganda had the numbers in the thousands, attempting to exploit Allied Force's status as the first "information war," during which the media and the 24-hour news cycle created greater strategic effects in some cases than did kinetic operations. Although the loss of a single noncombatant is a tragedy, by twentieth-century standards the operation stands as a benchmark for limiting collateral damage and the loss of innocent lives.

Political considerations also affected operational decisions, including the choice of forces, weapons, and ROEs. Again, according to RAND, "political constraints derive from the need to maintain minimum levels of support for military operations among three audiences: the domestic public, the international community (most notably major and regional U.S. allies), and the local population in the conflict area."[42] The nature of the conflict and the level of US na-

tional interest determine which audience will have the most influence over US policy. Political constraints drove the decision to make Allied Force an air-only operation. The establishment of the initial 15,000-foot floor for ordnance delivery serves as another example. This restriction on altitude created problems with target acquisition and combat ID for aircrews, preventing them from striking certain enemy targets because they could not solve ROEs for ordnance delivery. Other factors such as camouflage, concealment, and deception (CCD) and poor weather also complicated target acquisition and combat ID.

Forces of the former Republic of Yugoslavia used CCD extensively to complicate allied targeting and combat assessment. The Serbs were experts at using both high-tech and low-tech decoys, the latter including tanks made out of milk cartons and wood-burning stoves with their exhaust pipes angled upwards to simulate both the visual and infrared signatures of artillery tubes.[43] Another CCD technique heavily employed by the Serbs called for dispersing or hiding armor and artillery in populated areas, in some cases backing tanks into barns, churches, or other buildings.[44]

Adverse weather also complicated aviation operations: Kosovo was obscured for almost 70 percent of Allied Force by at least 50 percent cloud cover.[45] This obscuration reduced visibility, making target ID difficult and complicating weapons employment. Moreover, high absolute humidity degraded precision-strike operations by affecting aircraft infrared sensors and the employment of laser-guided weapons.

NATO flew 23,300 strike sorties against both fixed and mobile targets, employing the full spectrum of aviation ordnance—from 500-pound general-purpose bombs to air-launched cruise missiles—and striking over 7,600 of the desired mean impact points. In the final tally, 35 percent of the weapons dropped were precision-guided munitions (PGM), more than three times the number used during the first Gulf War.[46] The United States expended 6,778 PGMs during Allied Force, the majority of them laser-guided. In Operation Desert Storm, only 10 percent of US strike aircraft could deliver and direct laser-guided bombs, compared to nearly 90 percent during Allied Force.[47] Kosovo saw the first combat use of the satellite-guided JDAM and

the Joint Standoff Weapon. The precision demonstrated throughout Allied Force stands as a benchmark for assessing all subsequent air operations and continues to shape public opinion on the effectiveness of airpower. Nevertheless, noncombatant casualties remain a cause for concern in densely crowded urban terrain.

Operation Enduring Freedom

Beginning in Afghanistan on 7 October 2001, Enduring Freedom concluded its first phase 70 days later. During this time, US and coalition aircraft flew over 55,150 sorties and dropped a total of 24,000 bombs, of which 13,000—approximately 54 percent—were precision-guided.[48] Bombing operations on the first night targeted the Taliban's air defenses and C2 infrastructure, switching to the enemy's fielded forces after establishing air superiority. By early December 2001, air strikes had declined and then ceased on the 17th of that month, signaling the end of the 16-day battle for Tora Bora. The strikes, most of them either air interdiction or CAS, resumed in March 2002 in conjunction with Operation Anaconda. Although most engagements took place on natural terrain, air attacks also cleared Taliban and al-Qaeda fighters from villages. One highly publicized aviation urban operation suppressed the Qala-e-Gangi fortress uprising on 25 November 2001. Al-Qaeda and Taliban fighters taken prisoner during the battle for Mazar-e-Sharif were transported to the makeshift prison west of the city. During the two-day revolt, coalition forces supported by urban CAS from allied airpower drove the fighters into a series of small, underground chambers inside the fortress. Stephen Biddle comments that "entire ammunition payloads of multiple AC-130 gunships and no fewer than seven 2,000-pound JDAMs were expended in this tiny area."[49] At best, one finds only fleeting references to aviation urban operations or urban CAS during Enduring Freedom. However, two considerations show up in almost every set of lessons learned: the use of precision weapons and collateral damage.

First, Enduring Freedom made unprecedented use of precision technology. By the end of February, US aircraft had dropped more than 18,000 bombs, about 10,000 of

them precision weapons (roughly 56 percent, compared to 35 percent in Allied Force; as of June 2002, this figure may have reached 60 percent).[50]

Second, according to two civilian studies, Enduring Freedom had a higher number of noncombatant bombing casualties than did Allied Force. Dr. Marc Herold, an economics professor at the University of New Hampshire, has compiled a database of hundreds of press releases claiming 4,000 noncombatant deaths during Enduring Freedom. A study by Carl Conetta, however, refutes Herold's numbers, estimating 1,000–1,300 noncombatant deaths attributable to the bombing campaign. According to Conetta, "the high likelihood that 1000–1300 civilians were killed in the OEF bombing campaign directly contradicts the notion that the campaign was 'cleaner' than other, recent ones. Instead, in terms of the rate of civilian deaths per bomb or missile expended, there seems to have been a distinct deterioration from the standard set in Operation Allied Force (1999), in which fewer civilians were killed and more munitions used."[51] The report claims that during Enduring Freedom one noncombatant was killed for every 12 bombs or missiles expended, compared to one for every 46 bombs delivered during Allied Force. Conetta argues that Enduring Freedom's emphasis on weapons directed by the global positioning system rather than on the laser-guided variety contributed to the lack of accuracy and increased collateral damage.[52]

We have no unclassified government report to confirm or dispute the findings of these studies. It may be years, if ever, before the US government publishes precise numbers of noncombatant casualties. Left unanswered, questions raised by studies such as these can shape political thinking, degrade public support for air operations, and instigate additional political constraints on air operations by future political leaders.

Operation Iraqi Freedom

On 19 March 2003, coalition aircraft began to shape the battlespace for Iraqi Freedom. F-117 stealth fighters attacked Iraqi leadership targets on 20 March, and A-day commenced the following day, signaling full-scale air oper-

ations. Exactly 26 days later, CENTCOM declared an end to major combat action. Airpower and space power played a major role in bringing down the regime of Saddam Hussein. According to the Assessment and Analysis Division of US Central Command Air Forces (CENTAF), aircraft expended 19,948 PGMs (68%) and 9,251 unguided munitions (32%) during the operation.[53] Unlike the situation in Allied Force and Enduring Freedom, coalition ground forces in Iraqi Freedom found themselves drawn into the cities and engaged in JUOs. In anticipation of urban combat, aviation planners prepared gridded photos and developed airspace-deconfliction plans to facilitate aviation urban operations.

Because phase-four operations are ongoing in Iraqi Freedom—the first major test of JUOs—we have only limited unclassified information that specifically addresses aviation urban operations or urban CAS. However, the available data suggests the effectiveness of those operations and the soundness of JUO doctrine. For example, according to an after-action report for the US 3rd Infantry Division (Mechanized), CAS played an important role in the success of urban operations, particularly in terms of limiting collateral damage. Coalition aircraft used PGMs, especially JDAMs, against artillery, surface-to-surface missiles, special operations forces, and time-sensitive targets. In the cities of An Najaf and Karbala, urban CAS successfully engaged artillery and surface-to-surface missiles, causing little damage to surrounding property and buildings. Indirect-fire assets such as the Army Tactical Missile System and Multiple Launch Rocket System also suppressed the same targets but caused heavy collateral damage. PGMs destroyed buildings deemed hostile by the ground commander, and the division employed "bunker busting" munitions with delayed fusing, which allowed for the destruction of specific buildings without harming adjacent structures. Urban CAS also proved effective in support of troops in heavy contact. Fixed-wing aircraft assisted the move by the division's 2nd Brigade Combat Team into Baghdad by using guns and JDAMs on targets along Highway 8 with devastating results. Current TTPs for CAS effectively controlled collateral damage in the urban environment; indeed, "throughout [Iraqi Freedom], CAS played a significant role in the success of Third Infantry Division (Mechanized) on the battle-

field," flying 925 sorties and destroying 656 enemy combat systems as well as 89 enemy facilities.[54]

Additionally, the after-action report for Task Force Tarawa notes that "the City [An Nasiriyah] was divided into colored zones to aid in targeting and coordination. For CAS in a built-up area the city was divided up into colored and numbered sections for coordination."[55] The report goes on to discuss the enemy's attempts at concealment, such as eschewing uniforms; mingling with noncombatants; and using hospitals, schools, and other restricted structures as fighting positions or ammo-storage facilities. Furthermore, it highlights the Iraqis' use of decoys and dummies: "TF Tarawa estimates there were in excess of 50 T-55 hulks in and around Nasiriyah placed prior to the TF's arrival. Iraqis also placed immobile T-55s in hospitals, buildings, schools etc. to create pillboxes."[56]

The legacy from recent combat as it applies to aviation urban operations is fairly clear. Enemies without uniforms will attempt to draw US forces into urban terrain; unhesitatingly use noncombatants as shields; fight from prohibited structures; move armor, artillery, and other battlefield systems into urban areas to conceal them; use decoys to the maximum extent possible; and exploit potential collateral damage for propaganda purposes. On the US side, we will do everything we can to prevent collateral damage and the deaths of noncombatants. Concerned about international legal restraints, our political leadership may impose political constraints on operations when appropriate even though they may complicate aviation urban operations in the future. Lastly, it appears that our JUO doctrine survived its first contact with the enemy and remains tactically viable.

Training and Education

A B-1 bomber dropped four satellite assisted 2000-pound bunker buster bombs in a commercial section of Baghdad where a reported senior leadership meeting of the Iraqi regime was taking place. This illustrates how far the air, ground, and intelligence team has come in the last several years as well as the value of the new concept of Urban Close Air Support.

—Rear Adm Stephen H. Baker, USN, Retired, 8 April 2003

The 1997–2000 time frame laid the groundwork for the doctrine of aviation urban operations and training in that area. However, all US military services have struggled with the task's complexity and with resource shortfalls in trying to develop TTPs for this evolving mission. The Marine Corps took the lead by developing an urban training complex—"Yodaville"—in Restricted Area R2301 West, Yuma, Arizona. Specifically designed for urban CAS, the target complex provides "realistic simulation of urban or built up areas for Marine aviation to train."[57] Authorized for the aerial delivery of both light and heavy inert ordnance as well as ground-based light ordnance, Yodaville remains the only dedicated DOD complex for training in urban CAS. Without additional ranges, aviators across the services have had to use innovative, opportunistic means of developing training for aviation urban operations.

For example, one of the most pervasive scenarios in the DOD today is what aircrews call "urban targeting drills," which may simply entail using off-the-shelf imagery products to locate and identify specific urban targets and then proceeding to either a military operating area or restricted area to practice acquiring these targets by visual means or other onboard sensors. Once on the range, one aircraft frequently assumes the role of either strike coordination and reconnaissance (SCAR) or FAC (A), locates specific urban targets, and, using procedures outlined in JP 3-09.3, provides a visual talk-on. At a minimum, the SCAR or FAC (A) must reveal the target location, elevation, and description. The strike aircraft then has the option of utilizing either onboard sensors (e.g., radar/forward-looking infrared) or visual means to acquire the target. Once the aircrew makes a positive identification, the strike aircraft will receive instructions to "continue dry" (continue to maneuver but not release ordnance) or to execute a simulated ordnance delivery.

Urban targeting drills, although very good for refining mission-planning skills, target-acquisition techniques, and sensor-employment procedures, provide only the first step in the weapons-delivery process. Without ordnance coming off the aircraft, aircrews never have to make tough decisions or face the consequences of pushing the weapons-release ("pickle") button, as they would in real combat. Thus, aircrews can be-

come complacent and develop a training mind-set, routinely pressing the pickle button without complete assurance that they have the correct target in sight. The crews do their best to assess target acquisition, either in real time or through extensive review of the cockpit tape during the postflight debriefing. If urban targeting drills remain aircrews' only exposure to aviation urban operations, then we run the risk of acquiring the wrong habits, which could lead to fratricide/collateral damage in combat or failure to push the pickle button when it's appropriate and necessary to do so.

Conversely, without feedback from realistic training and positive reinforcement, aircrews may become timid in combat, refusing to drop ordnance following the solution of ROEs because they lack confidence and fear repercussions. Furthermore, urban targeting drills do not provide for interfacing with the ground commander and terminal controllers. As in CAS drills, the ground-force commander's perspective in prioritizing and authorizing the delivery of ordnance is of paramount importance to realistic training.

Air Force

The United States Air Force began examining aviation urban operations after completing tactics, development, and evaluation (TD&E) for urban CAS in 1999. Although lessons learned from TD&E generally remain classified, at the unclassified level, they point out a need for joint/combined-arms training and continued study. In addition to developing TD&E for CAS, the Air Force funded a RAND study that addresses tasks and concepts for improving the effectiveness of airpower and space power in the urban environment.[58]

Air Combat Command (ACC), which has initiated several technology projects, participates in Joint Forces Command's TD&E for JUOs. As of this writing, ACC has neither drafted any specific operational-level doctrine for aviation urban operations nor funded additional TD&E on the subject. At the squadron level, training officers have begun to compile local-level TTPs for these operations.[59]

The A-10 squadron at the US Air Force Weapons School at Nellis AFB, Nevada, has begun teaching "trial academics" on the subject of urban CAS and has produced several

student papers. The F-16 squadron, however, currently does not include aviation urban operations in its syllabus.[60] Neither division provides dedicated airborne instruction on the subject. Both of them want to expose their students to these operations, but without a realistic urban-training complex at their disposal, the instructors feel that the potential for students to learn the wrong lessons is too great. Moreover, despite the existence of opportunities for urban training at Yuma and Fort Irwin, California, issues with scheduling and resources prevent the weapons school from incorporating either range into its flying syllabi. The Air Force's Air Warfare Center at Nellis is in the process of constructing an urban training complex in its "60 series" ranges that will allow for aviation-delivered ordnance and offer aircrews much-needed training opportunities.

Although the B-52 Weapons School at Nellis now covers counterland operations, with students flying a single CAS sortie over natural terrain, it does not address sorties for aviation urban operations. Instead, instructors use the lecture on urban CAS from the Air Ground Operations School's (AGOS) Joint Firepower Course. In the future, the weapons school plans to incorporate possible urban CAS scenarios and utilize the facilities at Yodaville; the Shugart-Gordon MOUT site at Fort Polk, Louisiana; or Fort Pickett, Virginia.[61] Similarly, the B-1 Weapons School at Nellis conducts three CAS sorties but does not include aviation urban operations in its syllabus. B-1 students receive the same Joint Firepower Course materials as do their B-52 counterparts. Like the B-52 school, the B-1 school seeks to teach urban CAS in the future.[62]

As for individual Air Force units, F-16s from Hill AFB, Utah, participated in urban CAS training at Yodaville—but for the purpose of supporting TACPs of the 82nd Airborne and 101st Air Assault Divisions.[63] Air Force units around the world, such as the 36th and 25th Fighter Squadrons from Osan AB, Korea, and the 90th Fighter Squadron from Elmendorf AFB, Alaska, are also conducting urban targeting drills. The Osan squadrons routinely drill in prohibited area P-518, and the 90th does so in restricted area R-2202.

We find another example of how the Air Force is developing and improving its urban CAS capability in the Combat Air Force Tactics Review Board/Weapons and Tactics Con-

ference Close Air Support Working Group, which is tasked with reviewing tactics and training as well as identifying needs in critical combat capabilities. In its draft final report of 2004, the working group found aircrews deficient in urban CAS, attributing the problem to training shortfalls; recognized a desire by Air Force TACPs to increase training in the urban environment; identified the small number of urban CAS live-fire ranges as a limitation to training; and acknowledged that most training in urban CAS must be conducted dry in a military operations area. The group also validated the need for an improved point-and-shoot, accurate, low-risk-estimate, low-collateral-damage weapon for "danger-close" and urban CAS.[64] This recommendation supports ACC's current strategy for tackling the complexities of aviation urban operations by focusing on intelligence preparation of the battlefield—specifically, new sensor technologies that would increase the reliability of target coordinates and selectable-yield precision weapons.

Marine Corps

The Marines have expended substantial time, energy, and resources to explore concepts and technologies for improving JUOs. Since the mid-1990s, the Marine Corps Warfighting Laboratory, in conjunction with the US Navy's Fleet Battle Experiment, has directed a series of advanced war-fighting experiments—Hunter Warrior, Urban Warrior, and Project Metropolis—to investigate the urban environment and explore emerging technologies useful to urban operations. As part of this program, the lab funded the construction of Yodaville, which saw extensive use during the experiments and continues to provide TD&E support to the MAWTS-1 urban aviation initiative. In addition to Yodaville, the Marine Corps is studying the construction of a large-scale urban-training facility at Marine Corps Air Ground Combat Center (MCAGCC), Twentynine Palms, California.[65]

MAWTS-1 publishes the lessons learned in aviation urban operations from each Weapons and Tactics Instructor Course, as well as the Air Combat Element MOUT manual.[66] Updated annually, this predominantly rotary-wing-based manual is an excellent source of information and TTPs for aviation urban operations. MAWTS-1 also offers a classi-

fied lecture on urban offensive air support during the common academic portion of the Weapons and Tactics Instructor Course syllabus. Every student qualified to fly the FA-18, AV-8B, EA-6B, KC-130, and F-14 receives this instruction. Based on joint and service doctrine, the course explores considerations unique to the urban environment and TTPs for conducting aviation urban operations. As part of the flying syllabus for offensive air support, students then test the concepts and TTPs they learn in the classroom, each student having two opportunities to conduct urban CAS during the course. The first sortie, which uses Yodaville, involves low- and medium-threat urban CAS, ground as well as airborne terminal controllers, and rotary-wing CAS assets. The final sortie, a simulated urban CAS scenario with the same terminal-control support, is flown over the town of Ajo, Arizona.

The Marine Corps became the first service to require a dedicated urban CAS sortie as part of its process for combat-capable (300-level) training and readiness qualification. Specifically, Marine policy directs all AV-8 and FA-18 aircrews to be current and qualified in executing urban CAS.[67] The goal of the sortie entails conducting low-threat urban CAS, day or night, under FAC or FAC (A) control, with emphasis on CAS procedures, mission planning, attack parameters, delivery modes, designation techniques, and information flow through the C3 system.[68] The fact that the service mandates the sortie, however, does not solve Marine aviation's shortfall in training for urban operations. The location of the service's only live-fire urban CAS range on the US West Coast creates a huge burden on East Coast units and does not begin to address the requirements of the 3rd Marine Expeditionary Force in the western Pacific. Even though most East Coast Hornet and Harrier squadrons deploy once a year to Yuma, for a heavy-weapons detachment this is another example of a training requirement levied against the Fleet Marine Force without applying the proper resources. The bottom line is that the existence of Yodaville and the inclusion of urban CAS in the combat-qualification process constitute steps in the right direction for the Marine Corps. However, it will be years, if ever, before this type of training achieves the requisite level of servicewide proficiency.

Navy

The Navy is working to improve its JUO capabilities. As of this writing, it has not produced any service-specific doctrine covering aviation urban operations, relying on Marine Corps and joint doctrine for its TTPs. Naval aviators gain exposure to these operations through carrier-air-wing training conducted at Naval Air Station Fallon, Nevada. Instructors at the Naval Strike and Air Warfare Center (NSAWC) teach an urban CAS class based on joint doctrine as part of the air wing's training syllabus. Students then apply what they have learned in the classroom as part of a multiship sortie launched from Fallon designed to expose them to JP 3-09.3 visual talk-on procedures in an urban environment. NSAWC-qualified JTACs call in CAS aircraft over the city of Fallon and execute simulated talk-on urban CAS.[69]

As many as four crews of F-14 Tomcat students attend the Weapons and Tactics Instructor Course held twice a year in Yuma. The training, which exposes them to aviation urban operations, is important for two reasons: (1) it provides a baseline understanding of the complexity and uniqueness of such operations and (2), more importantly, the concepts and TTPs migrate back to Strike Fighter Weapon School Atlantic through their augment instructors—witness the addition of urban CAS TTPs to that school's and the Pacific Strike Fighter Advanced Readiness Program ground-school's curricula. Other than the opportunities listed above, naval aviators get no additional formal training in urban operations. Squadron-level training depends upon the initiative of the commanding officer and training officers. The Navy's strike-fighter community has no dedicated aviation urban operations sortie in its current training-and-readiness syllabus and no plans to include one.

Neither does the Navy currently have any dedicated aviation urban target complexes on either coast, although Naval Air Station Fallon plans to construct an urban complex on its ranges in the next two years, using a design similar to Yodaville as a potential model.[70] Moreover, the Navy has conducted no aviation urban TD&E to date. In 1999 the service conducted Fleet Battle Experiment Echo, designed by the Maritime Battle Center at Naval Warfare Development Command, to test the effectiveness of naval forces facing

unconventional, nonmilitary threats in shallow coastal waters. During the experiment, conducted simultaneously with the Marine Corps Warfighting Lab's Urban Warrior exercise, unmanned aerial vehicles, after launching from Navy vessels, provided intelligence, surveillance, and reconnaissance for marines engaged in urban operations.

Special Operations Forces

The AC-130 gunship community specializes in precision fires and CAS. Because of their precision, under certain conditions the gunships become the platforms of choice in the urban environment. Because of their experience in conducting aviation urban operations in Just Cause, Desert Storm, Deliberate Force, Allied Force, Enduring Freedom, and Iraqi Freedom, AC-130s were among the first platforms to develop aviation urban TTPs, many of which are now found in the aircraft's classified tactics manuals. The AC-130 Weapons School at Nellis offers two lectures, one unclassified and the other classified, based on joint doctrine for aviation urban operations. As opportunities become available, students perform urban operations at the MOUT facilities at both Fort Polk and Fort Campbell, Kentucky, the latter providing training in support of Task Force 160. According to Maj Craig Walker, USAF, a former AC-130 weapons instructor, Fort Campbell is the only MOUT facility east of the Mississippi River authorized for aviation-delivered ordnance.[71] Gunships routinely fire both 40 mm and 105 mm systems on those ranges, and they regularly support quarterly Ranger training exercises at Fort Polk on the Sugar-Gordon MOUT facility. Furthermore, both the weapons school and the two active AC-130 squadrons stationed at Hurlburt Field, Florida, perform urban targeting drills at undisclosed locations all over the Gulf coast and eastern seaboard. The weapons school is aware of the training opportunities at Fort Irwin and Yodaville, but operational constraints have prevented any utilization of those complexes. Because the AC-130 community specializes in CAS, the combat-qualification syllabus contains no dedicated sortie for urban CAS; however, AC-130 weapons instructors must complete the urban-CAS instructor syllabus to meet qualification requirements. At present the AC-130

community has no plans to develop any TD&E for aviation urban operations.

Joint Terminal Attack Controllers

Today the Air Force, Marine Corps, and Navy all operate schools that train TACPs and terminal air controllers. The Air Force trains both officer and enlisted terminal controllers at its AGOS at Nellis AFB. The Marine Corps trains officer terminal controllers at both the Expeditionary Warfare Training Center Pacific (EWTCPAC) and the Expeditionary Warfare Training Center Atlantic (EWTCLANT). The Navy trains special operations personnel (SEALs) as terminal controllers at the NSAWC in Fallon, Nevada.

The training syllabi at all the schools are based on JP 3-09.3 and Standard NATO Agreement 3797, a long-standing capstone document that outlines the basic requirements and standardization for certifying terminal controllers. Each service has approached TACP training (which covers both classroom and "hands on" experience) differently, as evidenced by the multitude of names used by the services to describe terminal controllers: *air liaison officers* and *enlisted terminal controllers* (Air Force); *FACs* (Marine Corps and Navy); *FAC (A's)* (terminal controllers in aircraft) (Marine Corps); and *air FACs* (terminal controllers in aircraft) (Air Force). In an effort to reduce confusion and increase standardization, the Joint Close Air Support Executive Steering Committee established a new joint term for personnel who conduct terminal control of aircraft: *JTAC*, defined by JP 3-09.3 as "a qualified (certified) service member who, from a forward position, directs the action of combat aircraft engaged in CAS and other air operations. A qualified and current JTAC will be recognized across the Department of Defense as capable and authorized to perform terminal attack control."[72] The JTAC memorandum of agreement, which awaits final approval, will standardize JTAC training across the services.

As part of their curricula, the AGOS, EWTCPAC, and EWTCLANT teach standardized characteristics of and considerations for conducting aviation urban CAS. EWTCLANT, the only school with access to an urban CAS facility, uses the Gulf-10 target-complex MOUT site located at Camp

Lejeune, North Carolina. The MOUT facility is not authorized for aviation-ordnance delivery, so all urban CAS training is conducted dry. The AGOS and EWTCPAC will have to wait until the completion of proposed urban-training complexes on the Nellis ranges and at the MCAGCC at Twentynine Palms to begin such training.

The NSAWC trains JTACs as part of its Terminal Controller Course, based on JP 3-09.3 and very much focused on special operations. The SEALs conduct seven field events (two days/five nights) in the Bravo-17 target complex, working special-operations CAS scenarios. They also participate in air-wing CAS events, including urban operations over the city of Fallon.

In sum, JTACs remain an integral part of urban CAS. To fully appreciate the complexities associated with controlling aircraft in an urban environment, one would have to initiate an in-depth discussion of doctrine, organization, training, materiel, leadership, education, personnel, and facilities. Such an undertaking, however, lies outside the scope of this paper.

Conclusions and Recommendations

Failure to bring the advantages inherent in joint aerospace power to bear against our adversaries in the urban environment puts operational success seriously at risk. A full complement of joint military power—including aerospace in all its forms—is the key to achieving our national objectives in this most challenging of all operational environments. To sum it up, "Don't go downtown without us!"

—Lt Gen Norton A. Schwartz, USAF, 2000

Since 1998 the Defense Department has come a long way in its understanding of the complexities and uniqueness of JUOs through the development of joint doctrine. But it is not enough: aviation urban operations pose an ever-increasing operational risk to US and coalition forces as they perform their assigned missions. The lack of formal training requirements, education and training syllabi, realistic aviation urban-target complexes, and dedicated resources, together with highly complex and uncertain urban environments, creates significant operational risk. Potential enemies realize the value of conducting combat

operations in urban terrain in order to counter the United States' overwhelming advantage in firepower, especially airpower and space power. These adversaries have demonstrated a willingness to draw American and coalition forces into urban combat. Countering such efforts and learning how to operate effectively in an urban environment require renewed emphasis on aviation urban operations, as well as dedicated resources and training, to ensure that aircrews, JTACs, and military planners are properly organized, trained, and equipped to perform at a high level.

The US military must accept the inevitability of urban combat and the role that airpower and space power will play in those operations. Furthermore, it must overcome the cultural inertia surrounding joint urban operations. Nowhere else on the modern battlefield is there greater risk of a tactical-level event creating a strategic-level effect than in aviation urban operations—recall, for example, the Al Firdos bunker incident during Desert Storm, the bombing of the Chinese Embassy during Allied Force, and the attack on the wedding party during Enduring Freedom. The US military needs to make aviation urban operations a core competency, as well as reprioritize funding and provide sufficient resources to develop joint aviation urban exercises and target complexes to ensure that joint aircrews truly "train like they fight and fight like they train."

The combined effects of changing global demographics, the strategic-threat environment, and the willingness of potential adversaries to draw US and coalition forces into urban areas are now obvious. However, current land-warfare doctrine espouses avoiding, bypassing, and isolating urban areas whenever possible. But will potential adversaries allow us that advantage?

Noncombatant casualties remain a strategic concern for the United States.[73] US leaders believe that our military has a moral obligation to reduce fratricide, noncombatant casualties, collateral damage, and even the death and wounding of enemy combatants. The presence of local and international media in the urban environment is a fact of life. In the event of collateral damage, adversaries can make exaggerated claims of death and destruction, as they did in Kosovo and Iraq, and seek to manipulate the media for propagandistic purposes. This moral obligation to pro-

tect noncombatants and curb collateral damage drives US forces to exercise high degrees of discrimination in the conduct of joint urban operations. But such an approach comes at a cost, and until technology advances in the world of fire support, aviation-delivered fires will remain the weapons of choice. As we wait for technology and information superiority to help us solve the problems associated with aviation urban operations, what can the DOD do to prepare US forces in the near term? A number of suggestions come to mind.

First and foremost, US Joint Forces Command should add aviation urban operations to the Joint Tactical Task List. Without a DOD-wide emphasis on doctrine, the mission will never receive the attention, priority, and resources required to change institutional mind-sets. For example, most aircrews at the squadron level consider aviation urban operations, together with its subset of urban CAS, as a high-risk, low-probability area of mission execution. In reality, the mission has evolved over the last five years into a high-risk, high-probability operation. Without a top-down approach that reemphasizes and prioritizes the mission, nothing will change at the squadron level, and aircrews will continue to deploy with inadequate training.

Second, US Joint Forces Command and the services must fully integrate aviation urban operations into the syllabi at each of the service centers of excellence within the next fiscal year. For purposes of this paper, centers of excellence include all of the services' weapons schools, the Joint National Training Center, the Joint Reserve Training Center, and the MCAGCC at Twentynine Palms. Additionally, each service should look for opportunities to modify such exercises as Red Flag, Green Flag, and Cope Thunder, as well as the Strike Fighter Advanced Readiness Program, air-wing training, and combined-arms exercises to include aviation urban operations without adversely affecting the existing learning objectives.

Third, each service must develop and integrate aviation urban operations into the training-and-readiness/combat-qualification syllabi for all types, models, and series of aircraft. Without mandated training requirements, commanding officers and training officers at the squadron level will

continue to put their emphasis and resources on the more established missions at the expense of urban operations.

Fourth, JTAC training should include aviation urban operations. US Joint Forces Command and the services must establish requirements for JTACs to receive CAS training for these operations and establish criteria for the number and types of terminal controls in the urban environment necessary for initial qualification and currency requirements.

Fifth, US Joint Forces Command needs to establish two JTAC centers of excellence, one on the East Coast and one on the West Coast, for the consolidation and conduct of all JTAC training. The current system of four centers of excellence requires substantial effort to maintain the level of jointness required to train JTACs properly.

Sixth, the services must also identify additional ordnance training required for both aircrews and JTACs to conduct aviation urban operations properly. Furthermore, they should increase existing noncombat expenditure allocations as appropriate.

Seventh, US Joint Forces Command, the Joint Staff (J-8), and the services must continue to explore new technologies. They should also develop mission-planning tools, tactical data links, sensors, unmanned aerial vehicles, and selectable-yield precision weapons that support aviation urban operations.

Finally, with help from the Joint Staff (J-8), the armed services must reprioritize funding and expedite the development of complexes for aviation urban training. Without them, our training will remain at current levels. Despite the utility of our current facilities, they provide only an interim capability to train and evaluate TTPs for JUOs. The DOD needs realistic urban complexes that expose personnel to all five categories of structural density outlined in the ALSA Center's publication. They should feature multistory buildings that create the urban-canyon effect, instrumentation and clearance for utilizing all aviation inert ordnance, and multiple observation posts interspersed throughout to integrate and facilitate JTAC training.

Today the US military finds itself in a situation analogous to the early years of the Vietnam War when we should have recorded much higher kill ratios in the air-to-air arena against a less sophisticated, poorly trained adver-

sary. Critical thinkers at the time assessed the situation and concluded that our aircrews lacked proper training and understood neither the threat nor the new air-to-air environment. This assessment led to the establishment of the Naval Fighter Weapons School and helped produce a 10-to-1 kill ratio by the end of the Vietnam conflict. Today the joint team must understand that, whether we want to or not, future adversaries will make us fight in urban terrain—a unique environment that requires stand-alone doctrine, TTPs, and training. Aviation urban operations are the most complex, challenging, and high-risk missions assigned to the air-ground team today. Like air-to-air combat over Vietnam, today's aviation urban operations require a dedicated, systematic, joint approach to doctrine, organization, training, materiel, leadership, personnel, and facilities. If the US military adopts a cavalier approach toward these operations, it invites future mission failure as well as increased risk of fratricide and collateral damage that can have strategic consequences. We need to act now.

Notes

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16. Davis, "Urban Offensive Air Support," 13.

17. JP 3-06, *Doctrine for Joint Urban Operations*, I-5.

18. Capt Troy S. Thomas, "Slumlords: Aerospace Power in Urban Fights," *Aerospace Power Journal* 16, no. 1 (Spring 2002): 60, 61, http://www.airpower.maxwell.af.mil/airchronicles/apj/apj02/spr02/spr02.pdf.

19. ALSA Center, *Aviation Urban Operations*, II-2 through II-5.

20. For a thorough discussion of the classification of different street patterns, see ibid., II-3 through II-5.

21. Maj David Bussel, USMC; Maj Rich Jordan, USMC; and Maj Mark Palmer, USMC, "CAS in the Urban Environment," *Eagle One Newsletter*, 16 May 2002, 6, http://www.tecom.usmc.mil/mawts1/expirament/My%20Webs/eagle%20one/EAGLE%20ONE%202-02.pdf.

22. ALSA Center, *Aviation Urban Operations*, II-6.

23. For a detailed discussion of the five categories of structural density, see ibid., II-6 through II-9.

24. A complete discussion of that process lies beyond the scope of this paper. For information about building construction as part of the joint preparation of the battlespace, see ibid., appendix B, as well as the *Joint*

Munitions Effectiveness Manual: Air to Surface: Weaponeering Guide (Tinker AFB, OK: Joint Technical Coordinating Group for Munitions Effectiveness, Air to Surface Methodology Working Group, 31 January 2002).

25. ALSA Center, *Aviation Urban Operations*, II-6. Unlike their treatment of natural terrain, experts tend to add measures of population size for their classification of urban terrain. For example, the ALSA Center identifies the following categories: (1) villages (population less than 3,000), (2) towns and small cities (population 3,000 to 100,000), (3) large cities with associated urban sprawl (population 100,000 to the millions), and (4) strip areas (urban areas built along roads connecting towns or cities). Ibid., II-1. The center also notes that the movement of refugees and displaced personnel in and out of urban areas is a point of great concern. Ibid., II-6.

26. Davis, "Urban Offensive Air Support," 8.

27. "Friendlies within 1 km [represent] a 'troops in contact' situation. . . . Ordnance delivery inside the 0.1 percent PI [probability of incapacitation] distance will be considered 'danger close.'" JP 3-09.3, *Joint Tactics, Techniques, and Procedures for Close Air Support*, 3 September 2003, V-14, http://www.dtic.mil/doctrine/jel/new_pubs/jp3_09_3.pdf. Risk-estimate distances are based on specific conditions. Ibid., appendix D.

28. John Matsumura et al., *Exploring Advanced Technologies for the Future Combat Systems Program* (Santa Monica, CA: RAND, 2001), 65, http://www.rand.org/publications/MR/MR1332.

29. ALSA Center, *Aviation Urban Operations*, I-1 through I-2.

30. JP 3-09.3, *Joint Tactics, Techniques, and Procedures for Close Air Support*, III-18.

31. Ibid., I-6.

32. Ibid.

33. Ibid., I-7.

34. Eric Schmitt, "Urban Battle Transforms Air Strategy," *Post and Courier* [Charleston, SC], 6 April 2003, http://charleston.net/stories/040603/ter_06airwar.shtml (accessed 15 October 2003).

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38. Department of Defense, *Kosovo/Operation Allied Force After-Action Report: Report to Congress* (Washington, DC: Department of Defense, 31

January 2000), 80, http://www.defenselink.mil/pubs/kaar02072000.pdf. For an analysis of these attacks, see pages 80–96 of the after-action report.

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43. Lambeth, *Transformation of American Air Power*, 197.

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45. Department of Defense, *Kosovo/Operation Allied Force*, 86.

46. Bacevich and Cohen, *War over Kosovo*, 21.

47. Department of Defense, *Kosovo/Operation Allied Force*, 88.

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50. Cordesman, *Ongoing Lessons of Afghanistan*, 10.

51. Carl Conetta, "Operation Enduring Freedom: Why a Higher Rate of Civilian Bombing Casualties?" *Project on Defense Alternatives*, Briefing Report no. 11, 18 January 2002, http://www.comw.org/pda/0201oef.html.

52. Ibid., 4.

53. USCENTAF Assessment and Analysis Division, *Operation Iraqi Freedom—By the Numbers* (Shaw AFB, SC: USCENTAF Assessment and Analysis Division, 30 April 2003), 11, http://www.au.af.mil/au/awc/awcgate/af/oifcentaf.pdf.

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55. "Operation Iraqi Freedom: Quick-Look Tactical Observations (Task Force Tarawa)," *Urban Operations Journal*, April 2003, 3, http://www.urbanoperations.com/ifaar2.htm (accessed October 2003).

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58. See Alan Vick et al., *Aerospace Operations in Urban Environments: Exploring New Concepts* (Santa Monica, CA: RAND, 2000), http://www.rand.org/publications/MR/MR1187.

59. Lt Col Eddie Kostelnik, USAF, commanding officer, 66th Weapons Squadron, Nellis AFB, NV, interview by the author, 16 January 2004.

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61. Capt Todd Schrim, B-52 Weapons School instructor, 340th Weapons Squadron, Barksdale AFB, LA, interview by the author, 25 February 2004.

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64. Maj Scott Kniep, "2004 CAF [Combat Air Force] Tactics Review Board/Weapons and Tactics Conference Final Report," draft (Nellis AFB, NV: 6th Combat Training Squadron, 27 January 2004), https://do.acc.af.mil/DOT/DOTW/WEPTAC/Archives/2004/FinalReports/2004CASFinalReport.doc.

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66. See MAWTS-1 *Eagle One* newsletters at http://www.tecom.usmc.mil/mawts1/eagle%20one/publications.cfm.

67. Marine Corps Order (MCO) 3500.44, *AV-8B Pilot*, 2 June 2004, 76, http://www.tecom.usmc.mil/atb/Volumes/AV-8B/AV-8B%20MAY%2004%203500.pdf, directs AV-8B Harrier aircrews to conduct 300-level combat-qualification training; MCO 3500.46, *FA-18A/C/D Pilot and WSO*, 2 June 2004, 59, http://www.tecom.usmc.mil/atb/Volumes/FA-18/FA-18%20MAY%2004%203500.pdf, does so for FA-18 Hornet aircrews.

68. Mission-performance standards include (1) accurate copying of the CAS brief from the terminal controller; (2) delivery of weapons with effects on target within 15 seconds of time on target; (3) delivery of weapons only when cleared by the terminal controller; (4) accurate correction from the mark or lead's hit; and (5) adherence to tactical abort parameters, when applicable. Ordnance requirements include six Mk-76 25-pound practice bombs; two laser-guided training rounds; 250 rounds of 20 mm, 4X LUU-2 airborne paraflares; 10 chaff; and 20 flares. External syllabus support includes an urban CAS target array, FAC or FAC (A), WP/RP/ ILLUM/smoke marks or laser-designation platform and illumination rounds. MCO 3500.44, *AV-8B Pilot*; and MCO 3500.46, *FA-18A/C/D Pilot and WSO*.

69. In many cases, aircraft returning from simulated armed-reconnaissance missions in Dixie Valley, NV, have neither the fuel nor the interest to complete the additional urban-CAS learning objectives. Consequently, they elect to return to base without checking in with the JTACs located on the observation point overlooking Fallon, NV, for the urban CAS training.

70. The planned urban facility will be constructed in the Bravo-20 target complex.

71. Maj Craig Walker, USAF, interview by the author, 11 February 2004.

72. JP 3-09.3, *Joint Tactics, Techniques, and Procedures for Close Air Support*, ix.

73. See "Noncombatant Casualties as a Result of Allied Engagements," appendix, in Matsumura et al., *Exploring Advanced Technologies*, http://www.rand.org/publications/MR/MR1332/MR1332.app.pdf.

Abbreviations

ACC	Air Combat Command
AGOS	Air Ground Operations School
ALSA Center	Air Land Sea Application Center
C2	command and control
C3	command, control, and communications
C4	command, control, communications, and computers
CAS	close air support
CCD	camouflage, concealment, and deception
CENTAF	US Central Command Air Forces
CENTCOM	US Central Command
DOD	Department of Defense
EWTCLANT	Expeditionary Warfare Training Center Atlantic
EWTCPAC	Expeditionary Warfare Training Center Pacific
FAC (A)	forward air controller airborne
GBAD	ground based air defense
ID	identification
JDAM	Joint Direct Attack Munition
JP	joint publication
JTAC	joint terminal attack controller
JUO	joint urban operation
LOS	line of sight
MAWTS-1	Marine Aviation Weapons and Tactics Squadron 1
MCAGCC	Marine Corps Air Ground Combat Center
MOUT	military operations on urban terrain
NATO	North Atlantic Treaty Organization
NSAWC	Naval Strike and Air Warfare Center
PGM	precision-guided munition
ROE	rules of engagement

SCAR	strike coordination and reconnaissance
SEAD	suppression of enemy air defenses
TACP	tactical air control party
TD&E	tactics, development, and evaluation
TTP	tactics, techniques, and procedures