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UAV Employment in Kosovo: Lessons for the Operational Commander

by

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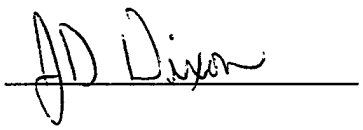
A paper submitted to the Faculty of the Naval War College in partial satisfaction of the requirements of the Department of Joint Military Operations.

The contents of this paper reflect my own personal views and are not necessarily endorsed by the Naval War College or the Department of the Navy

Signature: 

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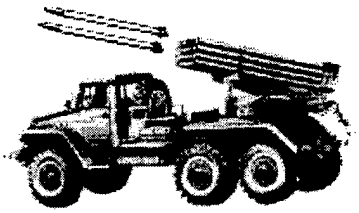
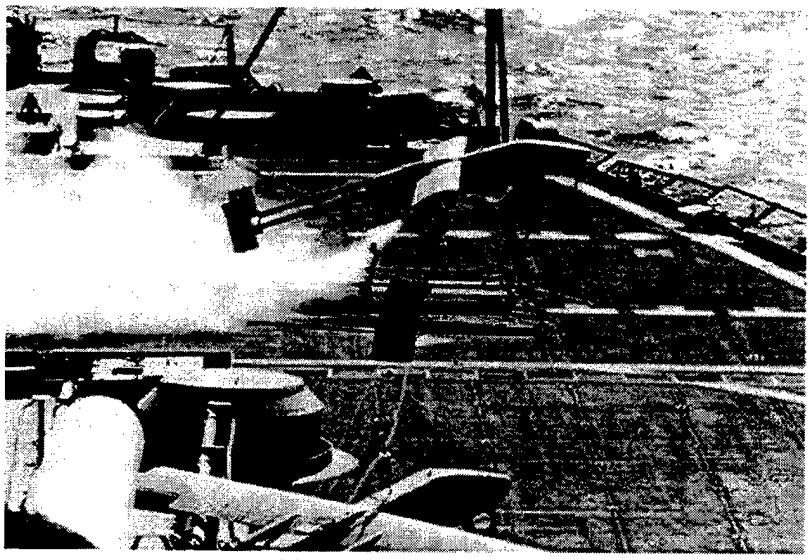


The Katyusha Rocket "Multiple Rocket Launcher" BM-21 pictured here could be easily taken apart and smuggled into a "demilitarized" Palestinian state. Individual Katyushas can be launched from a pipe using just a car battery.

INTRODUCTION

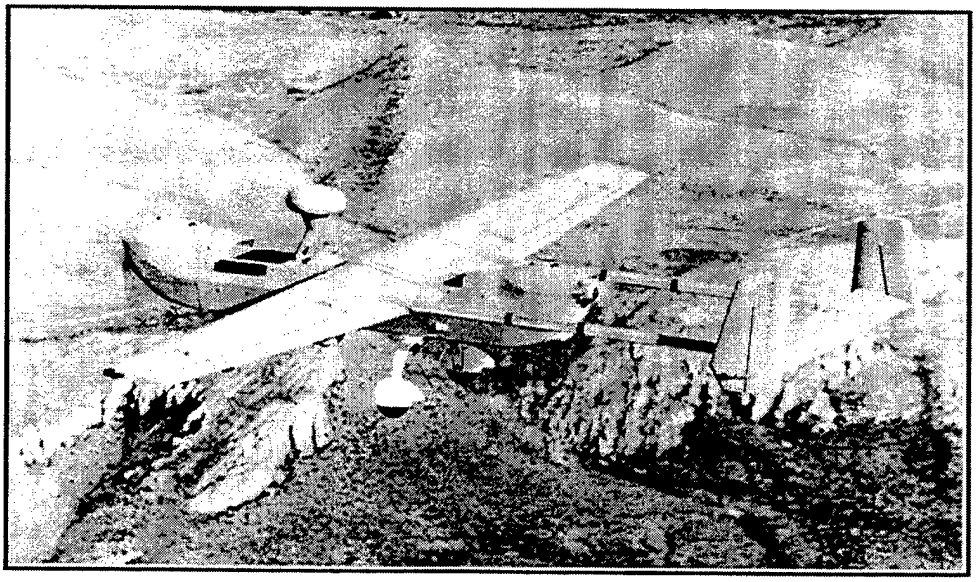
> There is no audio on the tape, but the impact of footage is stunning. In the headquarters of the Israel Defense Forces/Air Force (IDF/AF) in Tel-Aviv, a video recorder is showing a bird's eye video view of four men standing around a white pick-up truck in the middle of a cemetery. Mounted on the truck is a Katyusha rocket launcher. One after the other, rockets are viewed leaving their tubes and streaking out toward their target, over 10Km away, in the North of Israel. "We couldn't do anything about them (the four men), at this point because they were standing on sacred ground," says the IDF/AF officer in the room. The Hizbullah fighters on the television screen complete their firing mission, get back into the truck and drive off. The airborne camera stays on the pick-up truck until the vehicle enters a driveway and disappears inside a garage in the basement of a villa in Southern Lebanon. Within a minute, the building explodes as two 2000lb (908Kg) laser-guided bombs strike home. "The terrorists died in there. And we were right about the house being empty otherwise, because we didn't see it the next day on CNN (Cable News Network)," said the Israeli officer.[1]

This event occurred in April 1996 during Operation "Grapes of Wrath."[2] It illustrates what can be achieved using Unmanned Aerial Vehicles (UAVs)[3] in a counter terrorism role of Military Operations Other Than War (MOOTW). Unprecedented numbers of UAV assets were recently employed against Serbian forces during *Operation Allied Force*. This writer's hypothesis is that *UAV doctrine and contingency operations must evolve in order for the operational commander to fully integrate UAVs into the joint force, and UAV intelligence and targeting, combined with reduced risk to U.S. pilots, significantly enhance the warfighting capability of the operational commander.* This paper will first analyze the history of UAVs, then discuss their types and capabilities. Next, it will examine UAV employment in Kosovo, and analyze their effectiveness using operational factors as a tool. Finally, the paper will examine their losses, discuss potential roles in peace operations, and deduce lessons learned.



Navy Pioneer

Lightning Bug drone being recovered by CH-53 during Vietnam War



Army Hunter UAV

HISTORY

During the 1991 Persian Gulf War, UAV video feeds helped Navy Commanders direct operational fires from the battleship's 16-inch guns to Faylakah Island. It was here that Pioneer UAV was credited with the famed surrender of Iraqi soldiers waving handkerchiefs, undershirts, and sheets to signal submission to this strange airplane, that so often was followed by a rain of destruction.[4]

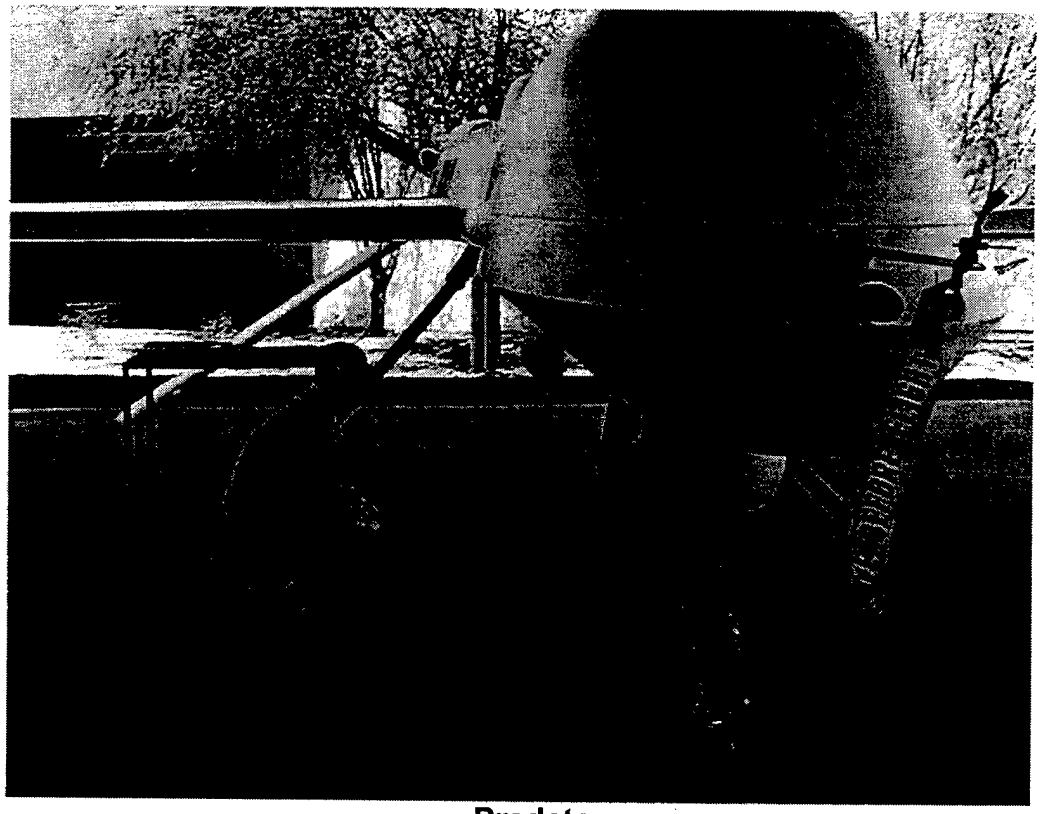
The previous example is part of a long history for U.S. military UAVs ranging from Lightning Bug reconnaissance drones first used by the Air Force during the Vietnam War to Predator, Pioneer, and Hunter used by U.S. Forces in the recent Kosovo operation. It is only in the last 20 years that UAVs have taken on the status as operational force multipliers. [5]

. This paper will now discuss current operational UAVs in the U.S. Military and their capabilities.

TYPES AND CAPABILITIES

There are two classes of UAVs: tactical and endurance. Tactical UAVs (TUAV), such as Pioneer and Hunter, support air, land, and sea forces with a reconnaissance, surveillance, and target acquisition capability during day, night, and limited bad weather. TUAVs operate at altitudes below 15,000 feet using line of sight or relay links for control of Air Vehicle, payload, and Electro Optical (EO)/Infrared (IR) sensor imagery products.[6]

Endurance UAVs (EUAV) provide selected near real time, synthetic aperture radar, EO, and IR imagery for extended periods of time via command and control nodes. This capability enables the ability for near real time intelligence and targeting. EUAVs



Predator

B-52 with cruise missiles

are used to support near real time planning for current operations, surveillance of enemy centers of gravity, conventional attack capabilities, offensive and defensive positions, deception postures, and combat assessment.[7] The Preditor EUAV system is designed to fly for approximately 20 hours, out to 400 nautical miles, at an altitude below 25,000 feet, normally 16,000 to 18,000 feet.[8] There are four sensors on the Preditor. A synthetic aperture radar, day camera (variable from 16 to 160 millimeters), spotter camera (955millimeters), and infrared camera occupy the Versitron Skyball. Additionally, there is a fixed nose-mounted daylight color television camera to aid the remote pilot.[9] The preliminary draft of Joint Publication 3-55.1 for UAVs lists the following UAV applications for the operational commander's toolbox:

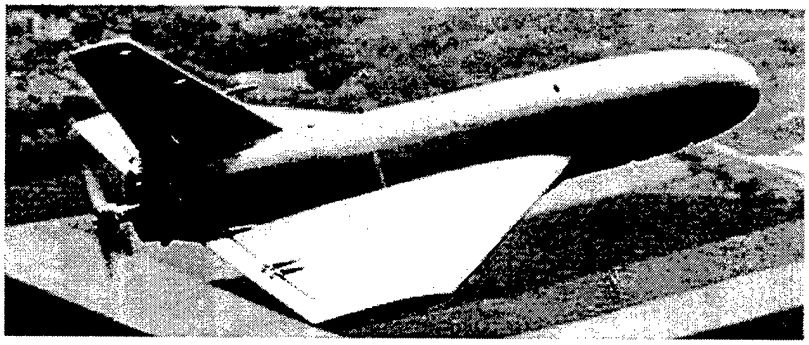
- Indications and Warnings
- Combat Assessment
- Target Acquisitions
- Enemy order of Battle
- Treaty Monitoring
- Treaty Verification
- Peace Operations
- Special Operations
- Blockade Enforcement
- Counter Drug and Humanitarian Aid
- Personnel Recovery/Combat Search & Rescue
- Theater Ballistic Missile[10]

The author will next cover how UAVs in Kosovo were employed with emphasis on applications not included in the preliminary draft of UAV Joint Publication 3-55.1.

UAV EMPLOYMENT IN KOSOVO

This paper will focus on the period of UAV employment between 24 March 1999 at 1900 Greenwich Mean Time, when a B-52 from RAF Fairfield fired its payload of cruise missiles in the opening salvo of *Operation Allied Force*, through 9 August 1999,

British Phoenix



French Crecerelle

CL-289

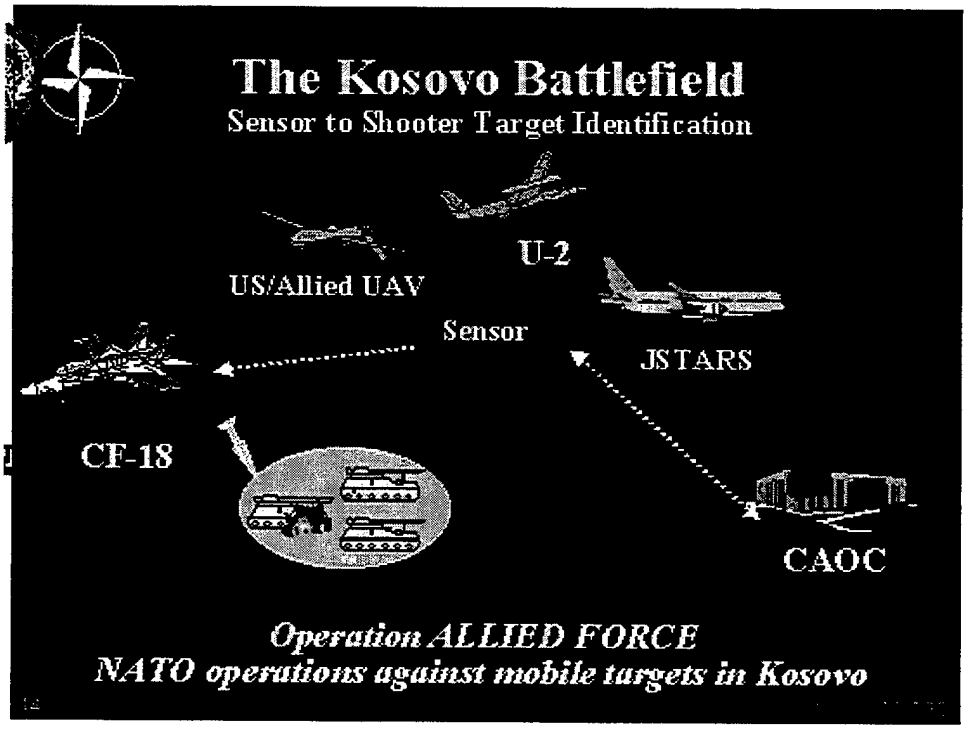
which is two months past the end (9 June 1999) of the 78-day air operation against Yugoslavia.[11]

Operation Allied Force marked the largest deployment and use of UAVs in military history. Five Predators from the Air Force's 11th Reconnaissance Squadron in Indian Springs, Nevada, and eight Army Hunters from the 15th Military Intelligence Battalion in Fort Hood, Texas, were mobilized in late March, 1999, to support *Operation Allied Force*. Hunter and Predator units were ready for operations approximately seven days after mobilization at Skopje, Macedonia and Tuzla, Bosnia respectively. German turbojet CL-289 UAVs were in country and immediately ready in Tetevo, Macedonia. French CL-289 and Crecerelle UAVs arrived in Kumanovo, Macedonia 6 days after mobilization. British Phoenix UAVs joined the campaign two months later in Macedonia as did Navy Pioneers on board *USS Ponce* (LPD 15) in the Adriatic Sea.

Before moving on, it is important to have some background information. NATO forces had been doing business out of the Combined Air Operations Center (CAOC) at Dal Molin AB, Vicenza, Italy, since 1994. The Preditor, Pioneer, and German CL-289 were routinely used in intelligence and surveillance roles over Bosnia via the Air Tasking Order (ATO). This image intelligence was sent to the Joint Analysis Center in Molesworth, England, for routine intelligence review. Contingency Operations (CONOPS) and doctrine focused on these roles.

When *Operation Allied Force* air operations began in Kosovo, there was a change in mindset for how the operational commander employed UAVs. CONOPS for UAVs varied from the familiar surveillance and intelligence roles to direct coordination into current operations. The new challenge for commanders was to effectively target and


Mobile Targets
Armored Personnel Carriers (APCs)
Tanks
Self-propelled Artillery
Mortars
Military Vehicles
Artillery

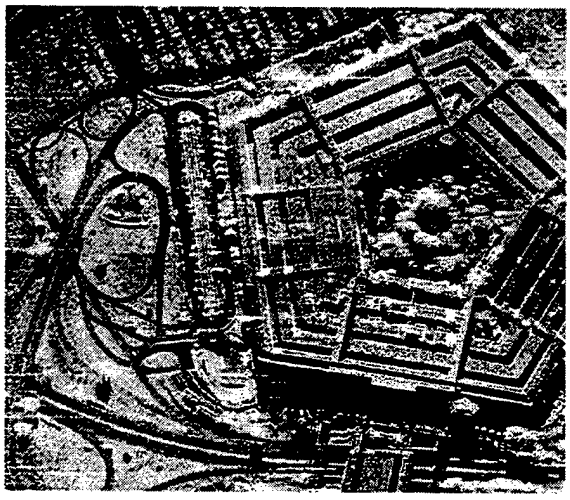

The Kosovo Battlefield
Sensor to Shooter Target Identification
U-2
US/Allied UAV
Sensor
JSTARS
CF-18
CAOC
Operation ALLIED FORCE
NATO operations against mobile targets in Kosovo

attack the operational center of gravity, Serbian Army and Special Police.[12] The lack of significant ground threat allowed the highly mobile Serbian forces to spread out and hide their equipment, (e.g. tanks, trucks, and armored personnel carriers) in and among houses, barns, sheds, and foliage.[13] Additionally, the Serbian forces mixed in with local populace and used their vehicles in many cases. This problem required NATO commanders to develop a "hunter-killer" strategy using all assets available, including UAVs.[14] Serbian air defenses were passive, non-cooperative, dispersed, and well sheltered. This problem, coupled with public opinion's growing intolerance for casualties, forced NATO commanders to set a 15,000 foot minimum altitude for all manned aircraft. Tactical aircraft sensor capabilities were limited at altitude, and loitering over enemy territory became risky for aircrews because their heads were down looking at sensors. The only near real time UAV assets available to the CAOC were Predator, and Hunter. It is important to note at this point that available satellite data rate and bandwidth for the area was saturated with three video feeds. These three channels were Cable News Network (CNN), Predator and Hunter.

Commanders would "catch the pulse of the country to see what was happening on the ground,"[15] using Hunter UAVs for indications and warnings. Army Colonel Mike Howell, the program manager for the Joint Tactical UAV, said "They (the Hunters) look to see if children are playing or wash is on the clothes lines because that is an indication of whether or not the bad guys are bothering people in that particular village on a given day."[16] Hunters and Predators sent near real time video to the CAOC and other desired locations via the Global Broadcast Service, (GBS).[17]

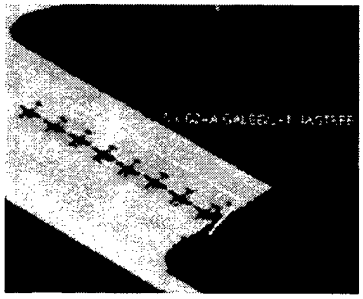
Inside the CAOC

Predator products:



SAR example

Electro Optic



IR

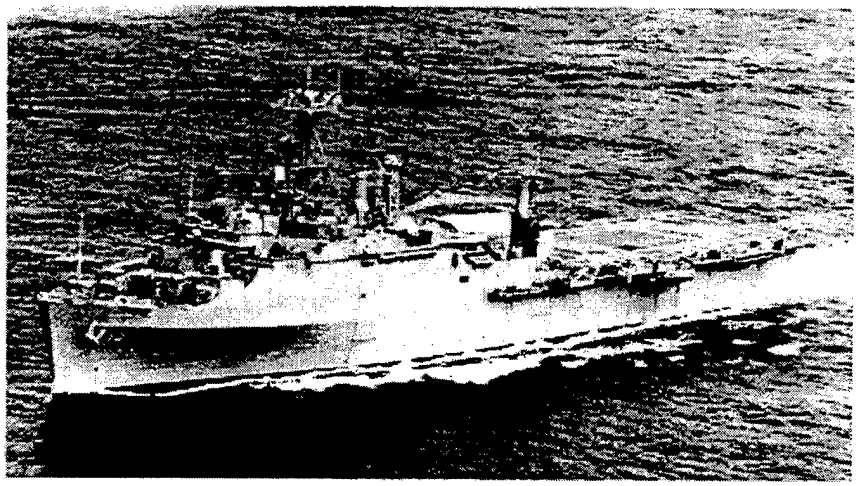
Following the accidental civilian bombings by aircraft, NATO directed tighter rules of engagement for air strikes in Kosovo. Aircraft were required to have two sets of eyes to confirm target identification. The second pair of eyes could be an Airborne Forward Air Controller (AFAC) or UAV imagery relayed back to the CAOC, where commanders could approve the attack.

Tim Ripley, a correspondent for Jane's Defence Weekly, would argue that many NATO pilots felt second-guessed by the commanders in the CAOC. In many cases, it could take considerable time for a UAV to get to a target to confirm identity. During this time the target may have moved or the aircraft may have returned to base due to limited fuel. This problem continued until sufficient numbers of AFACS were available.[18]

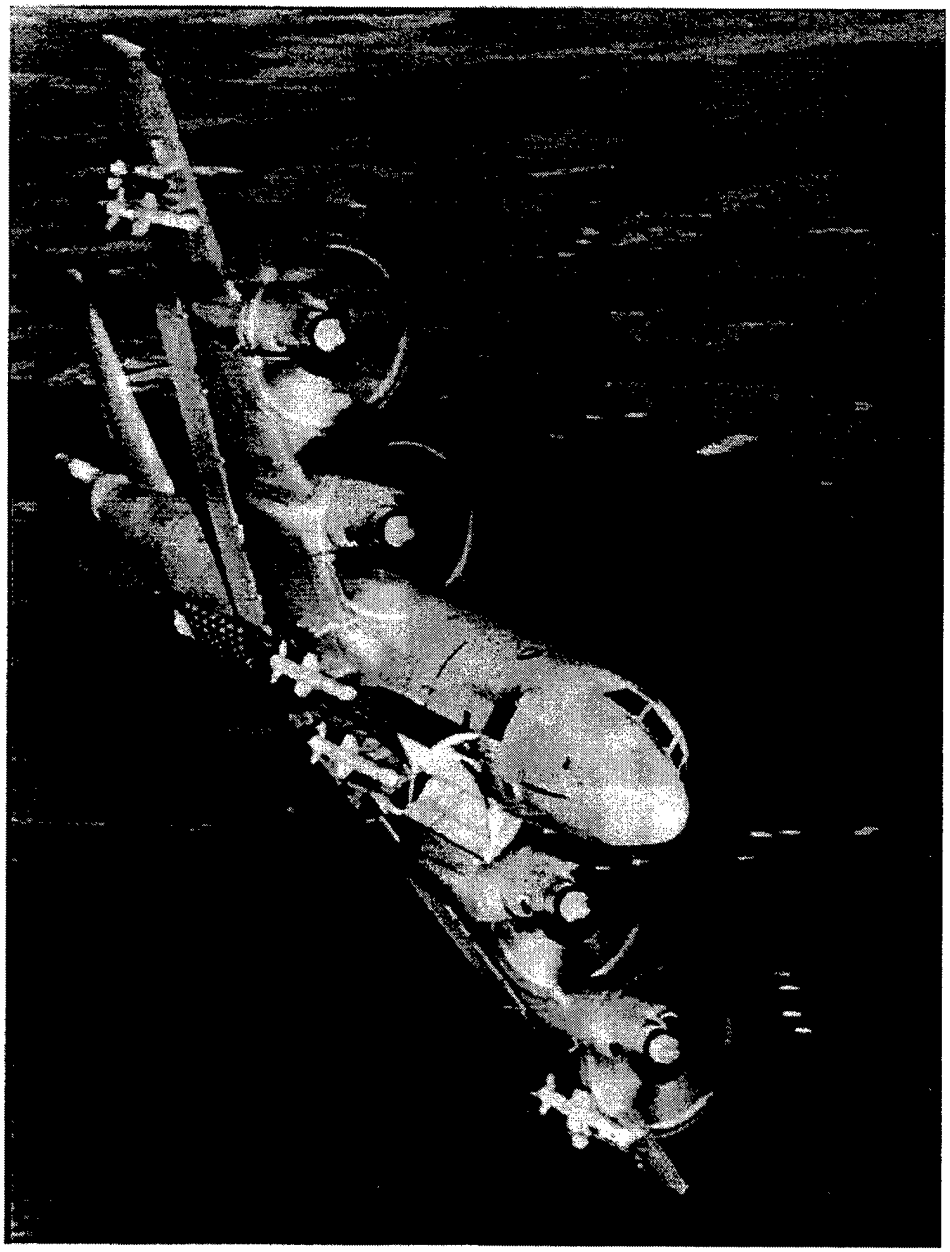
Another possible problem for NATO commanders in the CAOC was the availability of video via GBS to senior officers in Washington D.C. and Europe such as NATO's Supreme Allied Commander Europe (SACEUR), located in Mons, Belgium. This access to near real time video sometimes encouraged phone calls and created a potential for UAV micromanagement.[19]

OPERATIONAL FACTORS

When analyzing UAV employment in Kosovo using Operational Art as a tool, factor space presented two significant challenges for all six NATO UAVs. One element was weather. UAVs have a slow rate of climb and are susceptible to problems when passing the average icing level of 6,000 to 8,000 feet mean sea level. A second factor is terrain. Severe turbulence caused by mountainous terrain was a constant threat to UAVs. The mountains also required Hunter units to use two UAVs, one for the mission and one



USS Ponce (LPD-15)



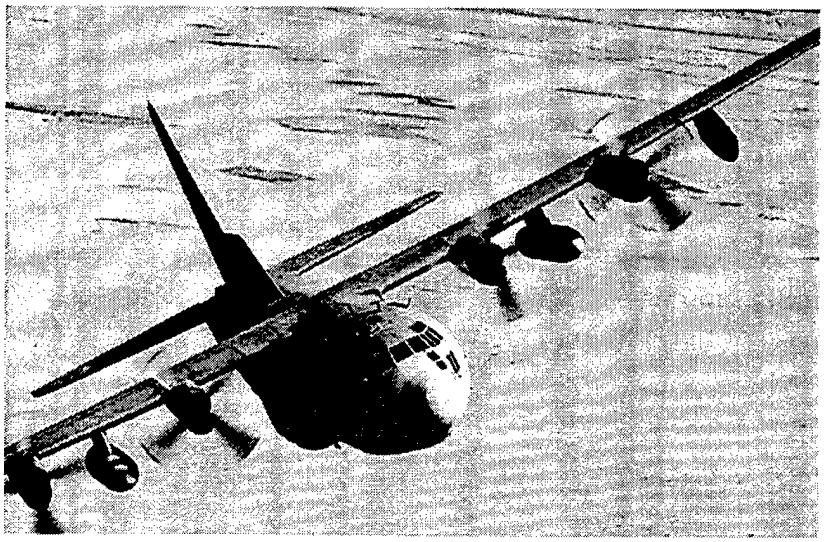
P-3C Orion with SLAM

for relay. This allowed them to maintain line of sight communications, thus extending their range.

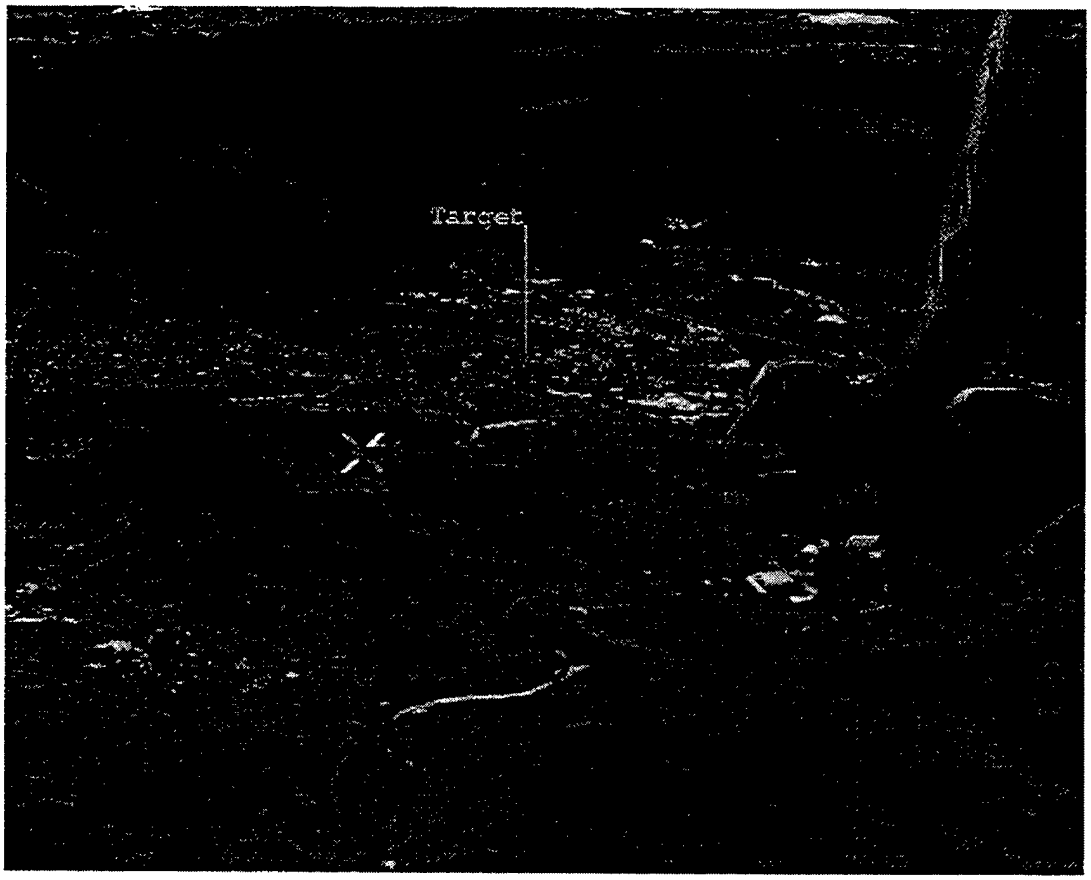
Moving on to the more important operational factor of time. Milan Vego concluded, "The factor of time is the most critical and precious factor in the conduct of warfare. It is one of those rare commodities that once lost cannot be retrieved."[20]

Commanders employed UAVs in a dynamic role to shorten reaction time from target identification by reconnaissance assets to target prosecution and attack with combat forces. In one case, Pioneer UAV imagery was relayed to a control station on the *USS Ponce* (LPD 15), where an operator talked a strike aircraft onto the target.[21] Pioneer also found and pinpointed early warning and Command/Control (C2) targets that Yugoslavian forces constantly moved near Montenegrin Ports. This timely data was passed to Navy P-3C Orions, who then fired AGM-84 Stand off Land Attack Missiles at the important targets. The Pioneer was then able to confirm target destruction with Bomb Damage Assessment (BDA) video, making the targeting cycle more efficient.

In another Kosovo example, a large number of Serbian soldiers took control of a bridge, blocked it with an armored truck, and began harassing local civilians attempting to cross. Undetected at 20,000 feet above them was a Predator. The image of the Serb checkpoint, with an approximate location, was beamed to the CAOC in Italy. Commanders immediately dispatched an American strike aircraft to bomb the checkpoint.[22] There were also some difficulties integrating the C2 of UAVs and air assets. Once the UAV found and relayed a hostile target to the CAOC, qualified personnel would use a PowerScene[23] computer program to locate the target. Commanders would then pass coordinates or landmark descriptions via the Airborne



EC-130 ABCCC

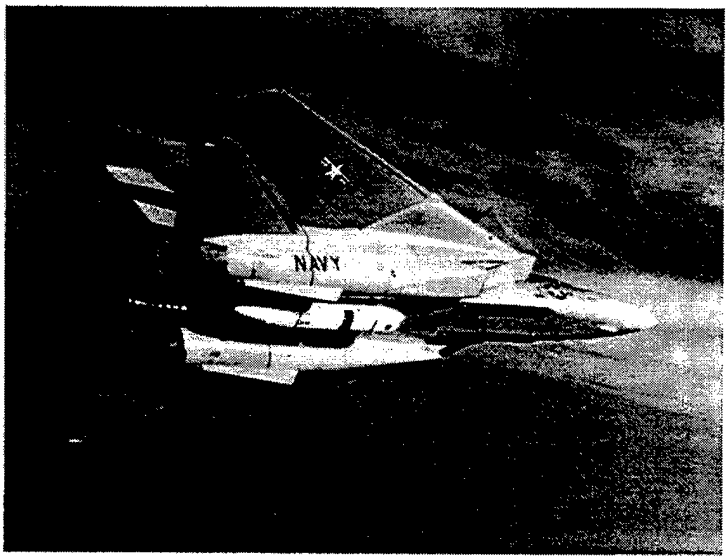


PowerScene Display

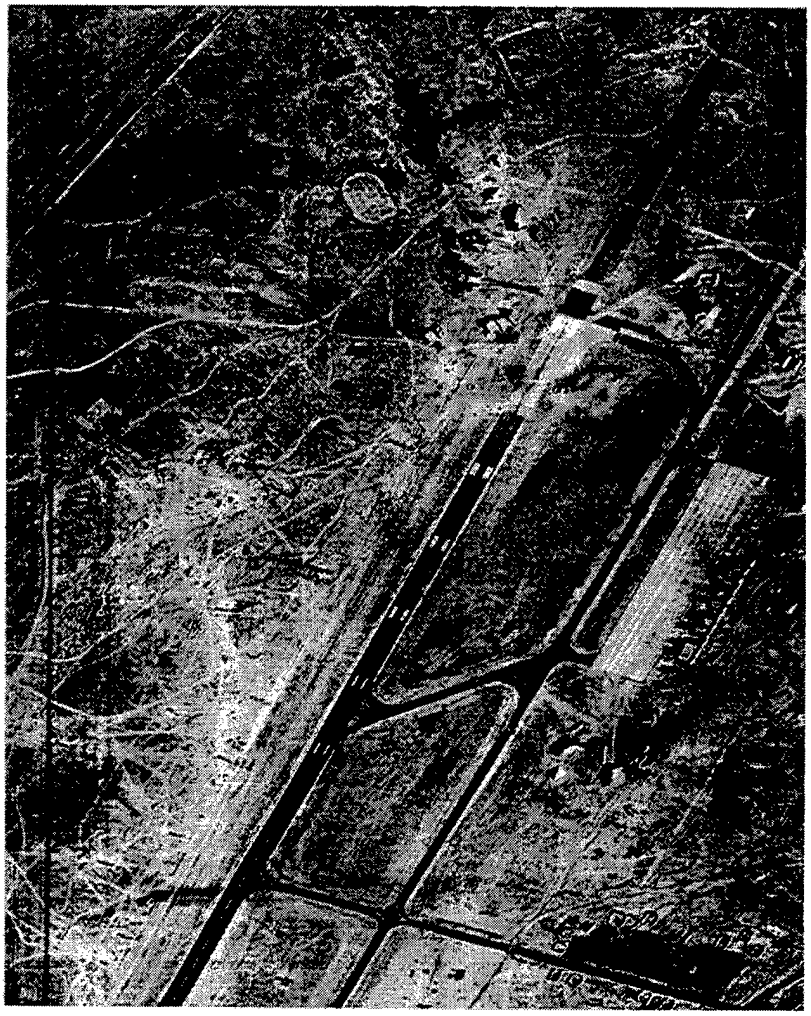
Command, Control and Communication (ABCCC) platform to the AFAC or strike aircraft. The inability of the UAV to provide exact coordinates directly to the strike aircraft required additional time and coordination for the targeting process. Additionally, this error prone communication relay would increase the probability of incorrect target coordinates. CONOPS for UAVs in this role had not been planned or practiced.

Commanders in *Operation Allied Force* wisely considered the importance of public support as another element of operational factor forces. With this in mind, commanders used the economy of force principle to employ UAVs and avoid casualties. UAVs were expendable and avoided the risk of sending aircrew into dangerous spots. This advantage enabled commanders to receive critical information by risking UAVs at lower altitudes too dangerous for manned aircraft.[24] By sending UAVs instead of aircrew, NATO commanders did not have to deal with aircrew becoming Prisoners Of War, who could be paraded on streets in Belgrade and made into a significant CNN story.[25] Very little publicity and headlines were generated when UAVs were lost over Kosovo. One source concluded, "Each UAV lost on a reconnaissance patrol may represent a pilot's life that was saved by not having to undertake the same mission."[26]

UAV employment by operational commanders in place of manned aircraft also alleviated the need for Combat Search and Rescue (CSAR) forces to recover downed aircrew. Additionally, the cost of any single American UAV is significantly less than an F-14 Tactical Airborne Reconnaissance Pod System (TARPS) by a factor of ten as depicted in Table 1 on the next page.



F-14 TARPS



VF-2 TARPS Imagery taken during Desert Storm of Shuaibah Airfield

Table 1

American UAVs versus F-14 TARPS Costs[27]

Predator	3.2 million dollars
Hunter	1.2 million dollars
Pioneer	750,000 dollars
F-14 TARPS	40 million dollars

In order to understand the operational value of UAVs, this paper will examine losses during *Operation Allied Force.*

UAV LOSSES

The 24 NATO UAVs lost in Kosovo made it apparent to commanders that Serbian soldiers were using developed tactics to counter the UAV threat. At first, some soldiers would wave at the UAVs, but this changed quickly when a devastating strike would follow. In one case, a Hunter UAV tracked a mobile target for 100 minutes and watched the missile go right into it.[28] The word got out quickly and Serbian troops would scatter at the first sight of any UAV, creating an effective psychological tool for the Operation Commander.[29]

Serbian air defense forces had learned many lessons from NATO's use of UAVs in Bosnia. The remains of a Predator shot down in 1995 are currently displayed at the Yugoslav Air Museum in Belgrade.[30] During *Operation Allied Force*, the Yugoslavs captured a wide collection of downed UAVs including Predator, Pioneer, Hunter, German CL-289, French CL-289, and British Phoenix, as the air operation progressed.

Four of the six NATO UAV units were based in Macedonia and their UAVs were launched from sites well known by Serbian Intelligence. This allowed guns and heat

Remains of Hunter in Kosovo

Warranty plate off Hunter UAV shot down 28 May 1999 by Yugoslav Naval forces over Boka bay

Yugoslavia MI-8 HIP

seeking missiles to be placed under likely UAV flight paths. The geography of Kosovo also helped the Serbian defenders concentrate on limited approaches. One innovative Serbian anti-UAV tactic was to launch a Military Mi-8 HIP helicopter to fly alongside a Hunter UAV and then have the Door Gunner blast the UAV with his 7.62mm machine gun.[31] This tactic was popular until allied fighters made it dangerous for the helicopters.[32] UAV attrition rates were subsequently reduced by taking advantage of the UAV's ability to fly at night. Table 2, collated from several research sources, depicts the approximate losses of UAVs in Kosovo:

Table 2

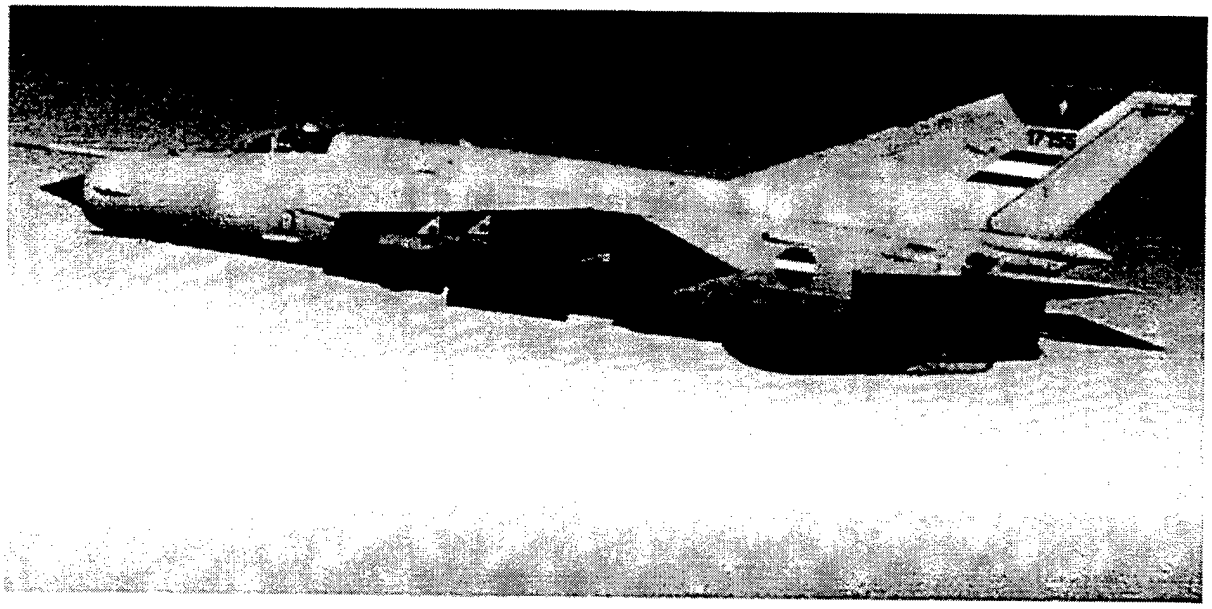
NATO UAV Losses in Kosovo[33]

	Enemy Fire	Other
Predator	3	1 (Unknown)
Hunter	4	2 (Engine failure/operator error)
Pioneer	3	1 (Unknown)
German CL-289	Unknown	6 (Geo. data/jamming/enemy Fire)
French CL-289	Unknown	1 (Possible friendly or enemy jamming)
French Crecerelle	2	
British Phoenix	Unknown	2 (Unknown)

Next, this writer will discuss how the operation commander used UAVs in a peacekeeping role.

PEACE OPERATIONS

Following the end of the 78-day air operation on 9 June 1999, UAVs were used for treaty verification to monitor Serbian withdrawal from Kosovo. British Phoenix UAVs found 11 Serbian Mig-21 fighters that survived the NATO air operation at Pristina Airport and filmed them taking off for Belgrade.[34] Predator and Hunter ensured Serbian troops exited the province of Kosovo and took all their equipment with them. The



Yugoslavia MIG-21

Serbian Army's lack of trucks made getting all of their military equipment withdrawn an issue for NATO to monitor. UAVs also flew above and forward of United Nations Kosovo Forces (UNKFOR), providing force protection and reconnaissance for every convoy of troops. Additionally, NATO engineers used UAVs to assess the requirements needed to rebuild roads and bridges throughout Kosovo.[35] Once UNKFOR arrived in their area of responsibility, Army Hunters and Canadian CH-146 helicopters, equipped with Forward Looking Infrared (FLIR), provided force protection and nighttime surveillance.[36]

KOSOVO UAV LESSONS LEARNED

This writer from his research and study has deduced the following list of lessons. These are useful for changing and supplementing doctrine so the operational commander can advance toward fully integrating UAVs into the joint or combined force. There is no order of priority:

- *Operational commanders must know the capabilities and limitations of all UAV assets (e.g. dwell time, profiles, survivability and procedures for when they lose navigational capability).*
- *Joint training exercises must include UAVs. Doctrine must continually evolve during these training exercises, as it should during actual operations.*[37]
- *UAVs are only one part of the synergistic effect created by air, space, land, and sea forces systems providing superior command, control, communications, intelligence, surveillance and reconnaissance.*[38] *Joint publication 3-33 reminds us that Operational commanders "must integrate and synchronize operations in such a*

manner as to shock, disrupt, and defeat opponents. Selecting the right mix of forces to attain the desired end state is more challenging today than ever before. This is a result of three factors: reduction in forces, rapid advances in technology, and a wide range of potential missions." [39]

- *The primary military value of UAVs is real time data.* This data translates into video of what enemy forces are doing, where they are located and bomb damage assessment. *This data must be provided to the operational commander who can use it to make a real time contribution with available weapon systems inside the enemy's decision cycle.*[40]
- *The availability of real time surveillance video to senior leaders may significantly help the operational commander. However, senior leaders must resist the temptation to use this video access to micromanage the operation.* Tim Ripley's UAV report argues this micromanagement lesson in the following example:

  > "According to CAOC staffers, the General (SACEUR) would on occasions telephone the CAOC demanding that UAVs break off from their tasking and go and look at things of interest to him. Clark was in daily telephone contact with Kosovo Liberation Army chief, Hashim Thaci, and immediately after these conversations would dispatch a UAV to look at what often turned out to be spurious targets."[41]

- *Manned aircraft and UAVs must train together more with emphasis on the UAV filling a Forward Air Controller (FAC) role.* This training will improve the process for communicating UAV sensor information (target location) to the shooter.

- *Engage allies to participate in joint initiatives to explore the use of UAVs on future battlefields.* Activities would include harmonization of national requirements, doctrine and research effort.[42]
- *UAVs can be used as vital Measure of Effectiveness (MOE).* An MOE example of this application was the live video shot by Predator of Serbian troops retreating. This film footage gave the evidence needed by NATO commanders to stop the bombing campaign.[43]
- *The operational commander must employ risk calculated trial and error processes when employing forces in new roles.* The lack of UAV CONOPS for the "hunter-killer" strategy in Kosovo required this operational trial and error process and enabled new doctrine to evolve.
- *Air Force, Army, and Naval services must have common UAV C2 and Command, Control, Communication, Computers, and Intelligence (C4I) connectivity that will enable joint operational and tactical UAV control flexibility (interoperability).*[44] Although not available for *Operation Allied Force*, a Tactical Control System (TCS) will provide military services with a single command, control, data receipt, data processing, data export and dissemination system that is interoperable with the family of all present and future tactical unmanned aerial vehicles (UAVs).[45] Furthermore, the Commander in Chief Joint Forces Command (CINCJFCOM), Admiral Gehman said, "*TCS is a life or death joint issue.*"[46] He should know.
- Finally, according to Anthony Cordesman, UAVs and other systems are needed to gather targeting and intelligence data *at low altitudes, under poor weather conditions, and at night.*[47] Under these circumstances, current higher altitude and space-based

sensors were unable to provide the operational commander with the near real time intelligence needed to attack targets and minimize collateral damage.

This ends the major lessons learned for UAV employment in Kosovo. Next, the author will make some final conclusions and recommendations.

CONCLUSIONS AND RECOMMENDATIONS

UAV doctrine, tactics, techniques, procedures, and contingency operations must evolve to support joint integration of UAVs and strike weapon systems. Furthermore, the operational commander's integration and use of UAVs were critical in the engagement of time critical Serbian targets in Kosovo. The combination of enhanced intelligence/targeting results and reduced risk to U.S. pilots makes the use of UAVs extraordinarily attractive to today's operational commander. Future operations will benefit from improved joint force integration and interoperability of UAVs.

The writer offers the following recommendations:

- *Aggressively continue UAV research and development.*
- *Continue to integrate UAVs in all joint and service wargames and exercises.*
- *Teach UAV doctrine at all service schools and incorporate into each syllabus.*

A quick review of the proceeding 13 pages should make it apparently clear that UAVs significantly enhance the warfighting capability of today's operational commander. Therefore, U.S. military services should continue to look for new and better ways to integrate this phenomenal capability as a combat multiplier.

NOTES

[1] Joris J. Lok, "Sky-High Surveillance Realigns the Battlefield," *Jane's International Defense Review*, 1 September 1997, 65.

[2] Ibid., 65.

[3] U.S. Joint Chiefs of Staff, *Department of Defense Dictionary of Military and Associated Terms as amended through June 29, 1999* (Joint Pub 1-02) (Washington D.C.: March 23, 1994), 724. Unmanned Aerial Vehicle is defined by Joint Pub 1-02 as " A powered, aerial vehicle that does not carry a human operator, uses aerodynamic forces to provide vehicle lift, can fly autonomously or be piloted remotely, can be expendable or recoverable, and can carry a lethal or nonlethal payload. Ballistic or semiballistic vehicles, cruise missiles, and artillery projectiles are not considered unmanned aerial vehicles."

[4] Michael E. Ruane, "Setbacks Leave Pilotless Plane with an Uncharted Course," *Philadelphia Inquirer*, 28 August 1995, 2.

[5] Christian M. Cupp, *The DTIC Review, Unmanned Aerial Vehicles, Vol. 4, No. 2,* (Fort Belvoir, VA: Defense Technical Information Center, 1998), 1.

[6] U.S. Joint Chiefs of Staff, *Joint Tactics, Techniques, and Procedures for Unmanned Aerial Vehicles (UAVs), Preliminary Coordination, 24 September 1999* (Joint Pub 3-55.1), (Washington D.C.), I-3.

[7] Ibid., I-4.

[8] Ibid., I-5.

[9] Kenneth Munson, *Jane's Unmanned Aerial Vehicles and Targets, Issue Eleven,* (Alexandria, VA.: Jane's Information Group, 1999), 217.

[10] Joint Pub 3-55.1 (draft), I-4.

[11] John P. Jumper, "Statement of: General John P. Jumper, Commander, United States Air Forces in Europe, United States Air Force," 26 October 1999. <http://www.house.gov/hasc/tistimony/106th congress/99-10-26jumper.htm> (22 December 1999).

[12] Major General Trexler of Washington D.C. He was former Commander Fifth Allied Tactical Air Force during Operation Allied Force. Phone interview by author, 28 January 2000.

[13] Ibid.

[14] Ibid.

[15] Colonel Mike Howell quoted in Jessica Drake, "UAV Programs Learn Lessons from New Equipment," *Aerospace Daily*, Vol.190, No.58, 435, <http://www.mcgraw-hill.com> (21 December 1999).

[16] Colonel Mike Howell, quoted in Jessica Drake, 435.

[17] J.M. Delphino, C.L. Leonard and A.D. Yarbrough, "The Global Broadcast Service: A System Overview and Acquisition Summary," n.d.<http://www.laabfb.af.mil/SMC/MC/gbs.html> (27 January 2000).

[18] Tim Ripley, "UAV's Over Kosovo – Did the Earth Move?" 1 December 1999, <http://www.defence-data.com/fpage34.htm> (12 January 2000).

[19] Ibid., 4.

[20] Milan Vego, "On Operation Art, 4th Draft," (Unpublished Paper, U.S. Naval War College, Newport, RI: 1998), 83.

[21] Colonel Mike Howell quoted in Jessica Drake.

[22] Thomas Ricks and Anne Squeo, "High Potential, Low Priority: UAV's and the Military," *The Wall Street Journal*, 7 November 1999, <http://www.messenger-inquirer.com/perspective/697814.htm> (20 December 1999).

[23] "Commercial Terrain Visualization Software Product Information," n.d., <http://www.tec.army.mil/TD/tvd/survey/PowerScene_aka_CVPS.html>(28 January 2000). PowerScene is software developed by Cambridge Research Associates in McLean, VA. It uses digital maps, imagery, and digital terrain elevation data from the Defense Mapping Agency and other sources to generate high fidelity pictures and perspective scenes for tactical simulations to support situational awareness. UAV video received in the CAOC could be placed over digitized imagery using PowerScene. The operator could then determine precise coordinates and surrounding topography information for relay to strike aircraft or airborne forward air controllers.

[24] John A. Tirpak, Senior Editor, "The NATO Way of War," *Air Force Magazine*, "December 1999, <http://ca.dtic.mil/cgi-bin/ebird?doc_url=/Dec1999/s19991202way.htm>(2 December 1999).

[25] Dave Mayfield, "Pilotless Planes' Combat Success Could Mean an Expanded Role," *The Virginian Pilot*, 12 July 1999, <http://www.pilotonline.com/military/ml0712uav.html>(8 December 1999).

[26] Charles Perkins, "Unmanned Israeli Drones Made the Difference in Kosovo Operation," AIPAC Near East Report, 12 July 1999, <http://www.AIPAC.com> (8 December 1999).

[27] Kenneth Munson, 41,62,72,149,217.

[28] Perkins, Charles, 1.

[29] Ibid., 1.

[30] Tim Ripley, 6.

[31] Ibid., 6.

[32] Ibid., 6.

[33] This writer discovered a number of discrepancies and contradictions in the figures found in various sources. The figures in Table 2 come from lessons learned and accounts from allied liaison officers. All source documents are held in the bibliography.

[34] Tim Ripley, 7.

[35] Ripley, Tim, "Hunters Switch to Support NATO Peacekeeping," *Jane's Defence Weekly*, vol.32, Issue: 5, 4 August 1999, <http://www.janes.com> (14 January 1999).

[36] Tim Ripley, "UAV's Over Kosovo – Did the Earth Move?" 1 December 1999, <http://www.defence-data.com/fpage34.htm> (12 January 2000).

[37] Major General Trexler.

[38] Major General Trexler.

[39] U.S. Joint Chiefs of Staff, *Joint Force Capabilities* (Joint Pub 3-33), (Washington D.C.: 13 October 1999), I-3.

[40] Patrick Kirk and Steve Endacott, "UAV Initiatives," Naval Strike Air Warfare Center Command presentation at Naval Air Station Fallon, NV, n.d. (21 December 1999).

[41] Tim Ripley, 4.

[42] "US, UK Agree on Tactical Unmanned Aerial Vehicle (TUAV) Explorations," U.S. Army News Release, 12 October 1999, <http://www.dtic.mil/armylink/news/Oct1999/r19991012usuktuav.html> (30 January 2000).

[43] Dave Mayfield, 1.

[44] Commander Stan Stefansky, "UAVs, The Joint Warfighter View," U.S. Joint Forces Command presentation at UAV conference in Fort Huachuca, AZ, 23 September 1999.

[45]"Tactical Control System/ Joint Program Office UAV Home Page," 4 October 1999, <http://www.nswc.navy.mil/tcs/> (25 January 2000).

[46] Admiral Harold W. Gehman quoted by Stan Stefansky.

[47] Anthony H. Cordesman, "The Lessons and Non-Lessons of the Air and Missile War in Kosovo," 29 September 1999, <http://www.csis.org/kosovo/lessons.html>(19 January 1999).

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APPENDIX A

Balkins Map