Side-Firing Weapon Systems

A New Application of an old concept *by Lieutenent Colonel Ross E. Hamlin*

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In the early stages of air warfare, vintage 1914, an enterprising aviator dropped hand grenades over the side of his flying machine; another airman took along a rifle & shot at enemy troops on the ground. Since that time, quantum steps have occurred in the development of bomb-navigation & gun systems. One facet of the evolution of gun systems is of particular interest—the side-firing mode. Yet this concept had lain dormant for a number of years. During World War II flexible side-firing weapons were used almost exclusively on bomber aircraft as a defensive system in the air-to-air role. Occasionally, a low- flying bomber would strafe, using its flexible mounted side guns or turrets. The emphasis for air-to-ground gunnery was placed on fixed forward-firing systems in the wings or nose sections of fighters & light attack bombers. With the advent of jet bombers (e.g., B-47 & B-52), the side-firing system passed out of existence. These high-speed bombers relied on a tail turret for defense against enemy fighters. Thus, it appeared that the mounting of guns in the sides of aircraft was doomed to antiquity.

This was not to be, however, for nearly everyone who has served a tour in Vietnam, & many who have not, has been awed by the tremendous firepower of the AC-47 gunships, or 'Spookies' as they are often called. The enemy was also impressed, for after a few nocturnal encounters with a 'Spooky' he named it 'Puff the Magic Dragon.' This name is derived from the long tongues of flame stretching nearly to the ground: the muzzle blast & tracer action from the three fixed side-firing 7.62-mm miniguns. They are of the Gatling variety & together fire 18,000 rounds per minute. The 'Spooky' was the first in a new family of Air Force aircraft, the side-firing gunships. Now we also have the 'Shadow' or AC-119G & K 'Stinger' models &, in the vernacular of Ed Sullivan, 'the really big' AC-130 or 'Spectre.' Some wag at the Pentagon took a picture of the new giant C-5 transport, faked in 48 Gatling guns along one side, & speculated that the enemy might well dub it with the acronym BUF (big ugly friend). One should not scoff at this apparently outlandish concept, for strange things have occurred in the development of gunships. Consideration was given to bringing some of the C-97s & C-121s out of mothballs & using them as gunships. The other end of the scale of aircraft was looked at, too, for some favorable tests were run with the small 0-2 equipped with a side-firing minigun. The present force structure calls for, in addition to the AC-47, the AC-119G equipped with four 7.62-mm miniguns, & we also have the jet-engine-augmented AC-119K with its four miniguns plus two 20-mm M-61 Gatling guns. Of course, the AC-130 with its eight side-firing guns—four 7.62-mm & four 20-mm gatling guns—is truly an impressive weapon system.

How did this all come about? And why all the sudden interest in using old & slow transports? First, we had not been in Vietnam very long before it became apparent that we had a problem in trying to support the 'strategic hamlet' concept. We found that during the day the Viet Cong would seldom venture forth, & if they did our fighter aircraft tore them up. So like any smart guerrillas, they turned to night operations. This created a major problem since there were many, many hamlets but not enough fighter aircraft to provide protection. Besides, the jet jocks were having their problems finding the black pajama crowd & then hanging around all night. At the risk of alienating many friends with 'the big wristwatch &—,' they just did not have the staying power. Tooling over the rice paddies at 400-plus at night was not conducive to pinpoint target acquisition. We needed something that could circle over a village or an outpost while we picked out which rubber tree the bad guys were leaning against. We needed an aircraft that could carry its own flares or spotlight, & we needed room for some pretty exotic sensors which were vastly improved over the 20/20 (?) vision of the tired fighter pilot. So people around the Air Force started looking for a solution.

One who dug into the problem thoroughly was Captain (now Retired Colonel) Ronald W. Terry, who was assigned to the Flight Test Section of the Aeronautical Systems Division of AFSC, at Wright-Patterson AFB, Ohio. In the course of analyzing the close air support problem, he reviewed an old study that addressed lateral sighting techniques. This paper was based on some observations by an Air Force officer in a remote jungle village in South America. He had watched medical supplies & mail being lowered on a rope from an aircraft to the ground. The aircraft was flying in a modified pylon turn so that the end of the rope remained nearly stationary over a point on the ground. This technique was the basis for follow-on studies that led to the development of the current side-firing gun systems.

Advantages of the gunship To carry on with the evolution of the gun-ship, let us look at some of the advantages of this 'new' system. First, the pylon turn geometry of the side-firing delivery mode allows the guns to be aimed at a ground target for extended periods of time while the aircraft maintains a constant altitude & slant range. This permits almost continuous target surveillance & suppressive fire from all sides. Further, a high degree of accuracy from extended slant ranges is obtained while reducing the exposure of the aircraft to enemy small-arms & automatic-weapons fire. Furthermore, the air- crew has ample time to operate the sensors & remain target-oriented, while devoting maximum attention to the firing problem. A corollary advantage is that the high angle of bullet trajectory increases the accuracy & effectiveness of the gun system. Finally, targets can be acquired, identified, & fired upon without descending to a lower altitude or overflying the target (See Fig 1). These advantages are extremely attractive, particularly when air operations are conducted in an environment where hostile fire is limited to small arms & light automatic weapons.

The progress made in sensor technology has enhanced the capability of gunships to assist in conducting tactical air operations on a 24-hour basis, weather permitting. This has always been a goal to which we have aspired but one that has not been easily attainable. The ability to acquire, identify, & then destroy fleeting targets during darkness or periods of low visibility has eluded us in the past. Now, however, we appear to be solving this troublesome problem.

The gunship development has been aided materially in this area because of its unique side-firing capability & its large load-carrying capacity. It can carry a large internal load of ordnance, including parachute flares & other devices for illumination of night targets. In addition, it can handle considerably more sensors & operators than can be accommodated by fighter aircraft. Another important asset of these converted transports is their ability to fly for extended time periods over the target. For example, a current application of the gunship concept includes airborne alert with the subsequent ability to proceed to numerous targets, spending considerable time in each area. Mission durations of five to eight hours are common for these flights. Operator/technicians aboard can make in-flight repairs or adjustments, thus improving the overall weapons effectiveness.

Target acquisition & identification With the AC-47, the first in the series of combat gunships in Southeast Asia, the principal method of detecting & acquiring a target was by use of the human eyeball. Dense foliage & camouflage made target detection difficult in the daytime, & daytime operations did give the enemy the advantage of easily tracking & firing at the large, slow gunship. This he did with disconcerting frequency & accuracy. To lessen vulnerability from ground fire, the modus opera ridi was changed to night operations. This was a compatible change, for the fighters, though capable of good daytime close air support, were having problems at night. With the changeover, the problem of target acquisition arose, so the AC-47s carried parachute flares, to aid the crew in making positive identification.

The AC-130 was the next gunship developed, & it had numerous more sophisticated improvements in target-acquisition capability. It relied on complex electronics systems to do this job. In addition, it too carried flares plus a large spotlight for battlefield illumination. These systems gave the aircraft a self-contained night attack capability. The AC-119 series had variants of these systems.

Gun geometry Once the target has been acquired & identified, the next step is to place the aircraft in the proper position for firing. This is the genesis of the gun geometry problem. The pilot must approach the target from the side, & the distance for offset depends on the desired slant range. Slant range is the product of two factors: absolute altitude (actual distance above the ground) & lateral distance from the target. To maintain the advantage of a high angle of attack in relation to the target, the guns are depressed in relation to the late a axis of the aircraft. The depression angle required at a given airspeed is a factor of altitude & turn radius. For example, with a 15-degree gun declination & a 30-degree angle of bank, there is a 45-degree angle of attack on the target. Whenever possible, the guns are depressed at an angle that allows some degree of flight deviation without diminishing firing accuracy.

Another aspect of the gun geometry problem is the effect of projectile motion. The usual ballistic factors associated with any airborne gun are considered, e.g., wind effect, gun angle, slant range, bullet drop, etc. The side-firing gun introduced another problem, since the bullet leaves the muzzle at a 90 degree angle from the path of the aircraft. This induces a condition known as velocity jump. When the projectile leaves the gun, it will have two components of velocity with respect to air mass. These components are the muzzle velocity along the gun line & the true airspeed. The angle in mils between the muzzle velocity line & the projectile total velocity is called velocity jump (See Fig 2).

All these factors make for a sizable ‘Kentucky windage’ problem. In the AC-47 the pilot has to solve these problems as well as position the aircraft properly in relation to the target. In the follow-on aircraft, the AC-130 & AC-119, the solution to the gun geometry problem is made much easier & more effective through the use of a fire-control system containing a computer that provides aiming & steering information to the pilot. The computer interprets the inputs from any one of the sensors to establish a line of sight to a designated point. The computer receives values of aerodynamic wind, true airspeed, & altitude; compares the line of sight with the corrected gun line; & provides position & altitude guidance information visually to the pilot through an instrument landing system (us) indicator & a gunsight (See Fig 3). Certainly this is a vast improvement over the earlier system, & current plans call for retrofitting the AC-47s with a modified fire-control system similar to this one.

While considering these improvements, let us further compare gunships. The AC-47 carries three 7.62-mm miniguns, each of which can fire either 3000 or 6000 rounds per minute. The pilot has a gunsight by his left shoulder & a trigger on the control column. Gunners are crewmembers on all gunship missions, & they reload & clear jammed weapons; however, they cannot fire the guns.

The AC-130 has much greater firepower. It carries four 20-mm M -61 Gatling guns & four 7.62-mm miniguns. The 20-mm weapons are very effective against trucks, small boats, & light structures.

The AC-119G armament consists of four 7.62 miniguns, & its sister ship the AC-119K carries, in addition, two of the 20-mm Gatling guns. The ‘K’ model differs from the ‘G’ in the addition of two J-85 jet pods, which give it approximately 25 percent greater load- carrying capacity & a significant increase in single-engine performance. Aircrews operating at night off small airfields & in narrow mountain valleys greatly appreciate this factor.

Employment of gunships Examination of gunships to this point has concentrated on their evolution & how they work. Let us look now at how they are employed, what specific missions they perform. The versatility of the side-firing gunship has made it possible to adapt the system to a variety of missions, including close air support, interdiction, aerial blockade, & base defense. A close look at some gunship missions will highlight the special flexibility of this new ‘machine.’

• *Close air support*. An essential requirement of close air support is that it be readily available & effective when & where needed. It must be responsive to ground needs, easily obtainable, reliable, & suitably armed; above all, it must be able to strike targets in close proximity to friendly ground units during any condition of ground maneuver & fire. Presently no single Army or Air Force system is capable of doing these things economically during darkness & adverse weather. Yet the gunship in the close air support role has achieved a reputation for its responsiveness, fire support, battlefield illumination & surveillance, convoy escort, air- mobile operations, & search & rescue operations.

• *Responsiveness*, among other things, is the capability to react quickly to requests for fire support to meet unexpected contingencies in ground operations. For aircraft on strip alert, responsiveness is a factor of basing distance, cruise speed, command & control procedures, & the time to acquire & strike the target. The gunship cannot compete with other systems in response time, unless it is on airborne alert over or near the maneuvering forces. Yet from this posture, it can proceed to the area of engagement in a matter of minutes & deliver automatic-weapons fire on a target in minimum time.

Gunships should be airborne over the forward edge of the battle area (FEBA) or over maneuvering forces when it is believed that contact with the enemy is probable. With its large payload & fuel capacity, the gunship can remain in the battle area for extended periods. In addition to being available for automatic-weapons fire, the constant presence of a fire support aircraft with appropriate sensors provides strong suppressive & deterrent effects on the enemy & puts him at a distinct disadvantage in initiating offensive actions.

To reduce delays inherent in command & control procedures, the gunship on airborne alert will have prior clearances from the Tactical Air Control System (TAGS) to respond to any request from the maneuver force commander or the fire support director. If necessary, a forward air controller (FAC) will be aboard the gunship, or a crewmember of the gunship will be qualified as a FAG. Common communications equipment, maps, & procedures will ensure effective coordination between the maneuvering unit & the gunship. As they are only a short time on station, gun- ship crewmembers must be familiar with the situation on the ground & the locations of friendly & enemy forces. Constant monitoring of ground radio frequencies will keep them up to date with the ongoing actions, even in a rapidly changing combat situation, thereby providing immediate response to the ground commander.

• The mix of 7.62-mm & 20-mm high- explosive (HE) automatic weapons & the system accuracy make its *fire support* very effective against enemy personnel & many other targets normally encountered along the FEBA or in close proximity to friendly forces in combat. When necessary, flash fires (direct fire on friendly troops when covered by bunkers) can be used. This technique is effective when defending fortifications against overrunning troops in the open. Against enemy troops in foxholes, trenches, or under light cover, the gunship's high angle of bullet trajectory, pius the high rate of cannon & machine-gun fire, enhances its effectiveness in delivering enfilading automatic-weapons fire. The AC-130, for example, can fire one or any combination of its eight guns. When all eight are placed on rapid fire, the effect is devastating.
• In its *battlefield surveillance & illumination role*, the gunship with its sensors can detect targets in the battle area which cannot otherwise be observed in real time from the ground or air, particularly at night. The gun-ship can respond to ground requests to investigate suspected areas & suspicious activity. In this way the ground commander can be informed via secure communications of enemy activity in the area.
In conjunction with battlefield surveillance, the gunship can provide the ground commander with on-call battlefield illumination by flare or spotlight. Enemy troops can be pinned down, & hard point targets can be detected & illuminated for fighter attack. (See Figure 4.) Thus, a gunship's usefulness in close air support can extend beyond the time its ammunition is expended. Instead of returning to base immediately, it can continue to search for targets & illuminate & mark them for fighter strikes until it is relieved by another gunship.
• *Convoy escort* is the protection of ground forces that are in movement. The aircraft must maneuver ahead & to the flanks of the column, search for & neutralize threatening targets, & warn the convoy of impending danger. While escorting, the gunship circles over & ahead of the convoy, scanning the area along the route with its sensors. It can observe suspicious conditions & road blocks & detect ambushes, particularly at night. The gunship has an advantage over light aircraft for convoy escort because it is able to scan a larger area with greater thoroughness & bring automatic-weapons fire on enemy threats to the convoy.
• The gunship can assist fighters & armed helicopters in providing security to forces engaged in *airmobile operations*, especially in jungle or sparsely populated terrain. The gunship plays a role in each phase of air-mobile operations the preassault, assault, & withdrawal phases.
In the *preassault phase*, after the primary & alternate landing zones (LZ) have been selected, a large aircraft capable of carrying the required number of real-time readout sensors can survey the surrounding area for signs of enemy activity & pinpoint the locations of enemy units. With long-range sensors, this can be done at higher altitudes & over larger areas; such intelligence is invaluable to the airmobile commander. Just prior to the assault, & as part of the LZ preparation, definitive airborne sensors should be employed to determine if enemy troops are waiting in ambush or are in the vicinity.
During the *assault phase*, a gunship can cover the helicopter landings & disembarkment of troops. Using its communications & ability to survey & fire from an orbit high above the operations, a gunship could possibly serve as an airborne command post, radio relay unit, & forward air controller. It can also maintain security for helicopter resupply & medical evacuation for the forces on the ground & protect base camps at night.
Gunship support during the *withdrawal phase* is similar to that during preassault & assault phases & depends upon the circumstances under which the withdrawal is made.
• The gunship offers unique capabilities for supporting *search & rescue operations*. With its numerous sensors, it can aid in locating downed airmen, especially at night. It can provide illumination, should it be desired for a night extraction, & it can also provide suppressive fire to allow a helicopter or other rescue forces a chance to effect the rescue. As in airmobile operations, the gunship can perform a multitude of roles. Probably its most singular advantage is its ability to operate effectively under poor weather conditions & darkness.
Interdiction & armed reconnaissance. For the gunship, interdiction & armed reconnaissance operations are synonymous because the gunship employs armed reconnaissance in its interdiction mission. To be effective, interdiction must be a well-planned & well-executed continuous round-the-clock operation against all routes of transportation, including railroads & waterways. No one aircraft or system now in-being is capable of conducting an effective interdiction campaign in every situation. The capabilities of fighter aircraft attacking enemy rail & highway bridges, ferry ships, harbor facilities, marshaling yards, supply depots, & other hard point or area targets are thoroughly recognized. However, a weakness of fighter aircraft is their relative

ineffectiveness at night against individual vehicles, boats, & troops. Gunships can seek out these small, scattered targets with their sensors & inflict aggregating attrition on the enemy.
In low-threat environments, the gunship operates alone at night. It can fly relatively long distances to an area & still have sufficient endurance to search along the line of communication (LOC) for trucks, POL dumps, supply areas, truck parks, & vehicle repair shops. In higher-threat areas, an optimum concept for night interdiction is to have several gunships search for targets in conjunction with fighter aircraft. Either the fighter can be directed on a target, or it can provide flak suppression for the gunship. This joint effort is very effective for attacking enemy LOCs.
Aerial blockade. Closely allied to the interdiction mission is the concept of aerial blockade where the object is to reduce enemy infiltration & resupply by inflicting casualties & destroying supplies & transport. The political developments in Southeast Asia have brought about increased emphasis on the use of the aerial blockade. The Free World forces in South Vietnam are now faced with trying to choke off the enemy flow of men & materiel from several politically protected sanctuaries. The provisions of any truce arrangement could be enforced by an effective aerial blockade.
The gunships offer excellent capabilities for this mission with their sensors, firepower, & extended flight duration. They can team up with other methods of surveillance to apply continuous coverage of points of entry along enemy borders. If border violations arise that require immediate use of firepower, gunships can provide instant & accurate response.
Base defense. Active base defense, other than normal security measures against saboteurs, entails protecting the base from ground attack & mortar, rocket, & artillery fire. Although the type of defense used depends upon the demographic environment of the base, the mission can be considered as preventing or stopping attacks. Prevention of attacks is the most desirable course if it can be accomplished without undue consumption of resources. The use of ground forces for the sole purpose of preventing mortar or rocket attack is wasteful & not too reliable. Airborne visual surveillance in conjunction with ground patrols is slightly more effective. Airborne sensor surveillance, along with the other efforts, is still more effective. In many instances the gunship sensors can detect enemy positions at night while they are being prepared or emplaced. In the event an enemy attack is already in progress, the gunship can again be employed to good advantage.
Silencing mortar or rocket positions quickly is imperative to minimize damage to base facilities, personnel, & parked aircraft. The ability to do this is a function of target acquisition, time to engage, & effectiveness of suppressive fires. The gunship, on airborne alert over the base, offers a good solution. With its sensors, long loiter time, & excellent firepower, both in terms of accuracy & volume, it provides effective & rapid response. This kind of reaction degrades mortar & rocket crew performances & serves as an excellent deterrent for subsequent attacks.
Target detection & tracking will continue to be a major problem in the interdiction mission, particularly under the weather, terrain, & foliage conditions commonly found in Southeast Asia. Impressive advances in sensor technology have been made since the gunship prototype was first introduced in SEA. System effectiveness can be improved by utilization of sensors that can operate during inclement weather & by the use of improved weaponry (i.e., improved ammunition & larger-caliber guns with an improved fire-control system). Flexible turrets for sensors & weapons are also a possibility. Who knows—perhaps we saved some of the ball turrets from the B-17s & B-24s of World War II!
The improved weaponry & new sensors will make the gunship less vulnerable in that more lucrative targets can be destroyed from greater standoff ranges & during inclement weather. At the same time, new & refined employment tactics will evolve that will confirm the role of the gunship along with that of the tactical fighter. Because of their different characteristics & capabilities, the gunship & tactical fighter complement each other. Gunships are primarily for night operations, tactical fighters for day operations. Working together, gunships can operate in more hostile areas with fighter protection or increase fighter effectiveness at night by being the eyes, ears, & pointer for fighter operations.
Finally, by placing gunships in strategic areas, we will have the capacity to provide a rapid response to developing crises. The gunship's long-distance ferry range reduces its dependence on base & overflight rights for deployment to distant places in the world. Once there, it can operate on austere civilian fields if necessary. Its automatic-weapons fire presents a considerable military capability without being provocative.
Hq United States Air Force