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Freedom's "Flying Snake"

The AIM-9 Sidewinder in the Cold War

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Abstract: During the Cold War, the simplicity of the Air Intercept Missile (AIM)-9 Sidewinder, as well as its potential for growth, allowed it to continually adapt to the changing times. Whether destroying Communist aircraft to facilitate U.S. national security interests, deterring potential Eastern Bloc aggression in Europe, or allowing U.S. allies to seize air superiority during combat operations, the Sidewinder represents a ubiquitous element of airpower for Western interests. As such, it deserves to be recognized as a key component of the U.S. Cold War-era military technology and one of the nation's greatest military investments.

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On 22 September 1958, during the height of the 1958 Formosa Crisis, a group of 20 Communist Chinese Mikoyan-Gurevich MiG-17 fighter aircraft engaged in a sweep into Nationalist Chinese airspace. As had been the case since the start of the conflict over Quemoy and the Matsu Islands, located just off the coast of mainland China, the MiG-17s were seeking to provoke a response by Nationalist Chinese North American F-86 Sabre fighters. Able to fly faster and higher than the F-86s, the MiG-17 pilots believed that the initiative rested solely in their hands, based on several weeks of previous experience. Loitering at high altitude until they assumed the F-86s to be low on fuel, the MiG-17s descended to a couple thousand feet above their prey. Rather than diving away toward home in an attempt to disengage, however, the F-86s pitched upward toward the MiG-17s that had just passed overhead. From a little more than a mile away, several F-86s began firing what appeared to be rockets from under their wings at a group of MiG-17s. To what was likely the Communist pilots' horror, these rockets immediately began to curve and pursue several MiG-17s with unerring accuracy. At least four and possibly as many as six MiG-17s were quickly dispatched, with the remainder diving away back toward the Chinese mainland.[1]

In what was fundamentally its first operational test, the Air Intercept Missile (AIM)-9 Sidewinder began what would be a long, distinguished career serving the West during the Cold War, waged between the Soviet Union-led

Eastern Bloc and the United States-led Western Bloc. Whether hanging from North Atlantic Treaty Organization (NATO) allies' aircraft as part of the alliance's deterrence posture or being employed in direct military action, the Sidewinder greatly enhanced the West's ability to apply airpower as a counterpoint to the Communist Bloc's numerical advantages from 1958 to 1991.[2] Given this, the AIM-9 deserves to be as respected as the United Kingdom's ubiquitous Royal Ordnance L7 105mm tank cannon, the U.S. Navy's supercarriers, and the venerable Boeing B-52 Stratofortress bomber as a vital component of American military power and ultimate victory during the "long twilight struggle" of 1947–91.[3]

From Lab to Battlefield

Like so many aerial weapons of the 1950s, the impetus for the AIM-9 Sidewinder stemmed from the threat of the atomic bomb. This fear was further exacerbated by the events of the Korean War (1950–53). In that conflict, the U.S. Navy's primary fighter, the Grumman F9F Panther, had been completely outclassed by North Korea's MiG-15. The U.S. pilots' training had allowed them to survive and also claim several kills in a handful of encounters, but the Navy was under no illusion as to the airframes' relative abilities. In addition, perceived advancements in Russian bomber technology prompted U.S. naval leaders to believe that the era of the cannon-armed fighter was rapidly drawing to a close. It was clear to the Bureaus of Ordnance and Aeronautics that if aircraft carriers were to survive, something had to be done.[4]

What neither bureau desired was a heat-seeking missile. Continuing with technology development that had begun in the late 1940s, the Navy

focused instead on a large, radar-guided weapon. Infrared technology was considered, but after a very brief flirtation with the concept it was discarded for several reasons. First, the need for visual acquisition seemed to provide only limited benefits when compared to cannons. Second, tests in the 1940s had shown that infrared technology had difficulty tracking airborne targets due to issues with lens optics and reflection. Finally, in initial design projects, physical limitations on electronics and control surfaces made any proposed infrared weapon just as heavy as its radar-guided counterpart. The Bureau of Aeronautics believed that if the Navy's fighters were going to be burdened with a large missile, it needed to be able to hit a large, nonmaneuvering bomber from as far away as possible. It was in this manner that the Sidewinder's erstwhile stablemate, the AIM-7 Sparrow, was developed in the 1940s and 50s.[5]

Fortunately for the U.S. military, the Navy maintained a number of Naval Ordnance Test Stations (NOTS). At NOTS China Lake in California, the primary focus was on aerial ordnance, with the scientists and engineers there adopting an attitude of disciplined, orderly tinkerers in addition to conducting their directed work. Despite the focus of the Bureaus of Ordnance and Aeronautics on large, bomber-killing missiles, the China Lake team took a different tack. The station's assistant technical director, Dr. William B. McLean, believed that most of the Navy's desired options were overly complex and would not address the full range of possible targets. Moreover, radar guidance required complex electronics on carrying aircraft, which would greatly increase airframe size and decrease performance given the state of jet engine technology. Combined, this appeared to be setting

the Navy on a path of increasingly large, underpowered, and clumsy bomber killers.[6]

In contrast to the evolutions that would eventually lead to the AIM-7 Sparrow, McLean directed several design constraints for the experimental weapon.[7] First, it would be no larger than the already existent 5-inch air-to-ground rocket. This was a proven, reliable system already capable of being carried by most naval fighter and attack aircraft. Second, the warhead would remain small, with most of its killing capacity coming from proximity fusing, which eliminated the need for a direct hit. Finally, the guidance system would be based on infrared technology to take advantage of contemporary jet engines' high heat signatures. If adopted, such simplicity would make the proposed missile quick to develop and also facilitate its wide adaptation across the fleet.[8]

The China Lake team's efforts benefited both from the relative cheapness of their project and the Navy's experience in the Korean War. In the case of the former, the majority of McLean's materials were what today would be considered "off the shelf," already existing either in the Navy's inventory or modified to work in new ways. Concurrently, the F9F Panther's inferiority to the existing MiG-15 and the unexpected immersion of the Navy in a conventional conflict highlighted the need for carrier capabilities beyond bomber interception. Taken together, these factors meant the Navy's ideal missile might be a cheap, easy-to-use weapon that both markedly increased fighter capability and required minimal technology for employment in conventional conflicts. Despite various attempts to end the program by the Bureaus of Ordnance and Aeronautics, the AIM-9 completed its first successful firing on 4 September 1953. Earning its moniker due to its

unique initial flight pattern, the Sidewinder was found to have some initial issues with its guidance system. The China Lake team swiftly corrected these, and the Navy approved the missile for production in March 1955. After another series of shipboard tests, full deployment aboard Navy carriers followed in July 1956.[9]

With the U.S. Navy continuing its vigorous testing regimen and the success of the Nationalist Chinese Air Force over the Taiwan Strait in 1958, by 1960, the Sidewinder seemed to have radically changed the state of air-to-air combat. Testing and operational employment indicated a kill rate of around 60 percent. In almost any scenario the Navy saw itself involved in, the Sidewinder-Sparrow combination seemed to make gun armament superfluous, with aerial warfare becoming almost an automatic process with the right blend of technology and aerodynamics. Enamored with the missile's success, both the U.S. Air Force and several Western nations' air arms began to adopt the new wonder missile. By 1965, many NATO nations had not only adopted the Sidewinder and many of the "Century Series" fighters that carried it but also started their own production lines.[10] If airpower was the shield that protected the so-called "free world" from Communist aggression, the Sidewinder was perceived as the striking *gladius* that allowed that shield to be employed most effectively.[11]

Snake in the Jungle: The Crucible of Southeast Asia

Unfortunately for the U.S. Navy and Air Force, the Sidewinder's early successes in combat and testing masked several major shortcomings with the original AIM-9B model. First, during the 1958 Formosa Crisis, the Nationalist Chinese fighter pilots had benefited from shock effect and the

Communist Chinese pilots' utter ignorance of the Sidewinder's potential. The rapid conclusion of the conflict precluded the People's Liberation Army Air Force (PLAAF) from developing a response in the form of tactical or technological countermeasures. Furthermore, the high altitudes of the fighters' engagements maximized the contrast between the MiG-17s' jet engines and surrounding atmosphere. Lastly, happenstance prevented any of the missiles from being launched in suboptimal conditions, such as with cloudy backgrounds or at an angle that allowed the Sidewinders' seeker to inadvertently track onto the sun.[12]

Figure 1.

A U.S. Air Force AIM-9 Sidewinder. Source: Official U.S. Air Force photo

It would take the United States entering into its own major conflict to fully expose the AIM-9B's myriad shortcomings and the need for further development. While space precludes a full recounting of the U.S. air campaign against North Vietnam during the Vietnam War (1955–75), a short summary is necessary to frame the Sidewinder's central role in the Navy and

Air Force's application of airpower in Vietnam. During Operation Rolling Thunder (2 March 1965–2 November 1968) and Operations Linebacker I and II (9 May–23 October 1972 and 18–29 December 1972), the United States committed almost every type of aircraft in its arsenal against North Vietnam. In return, the North Vietnamese Integrated Air Defense System (NV-IADS) countered with surface-to-air missiles (SAMs), antiaircraft artillery (AAA), and defensive interceptor aircraft (MiGs).[13]

While SAMs were arguably the most troublesome element of the NV-IADS, difficulties when countering enemy MiGs proved to be the most unpleasant surprise for American forces. Unlike the PLAAF in the 1958 Formosa Crisis, the North Vietnamese Air Force (NVAF) was not only aware of the Sidewinder but also possessed full knowledge of its specifications due to Russian espionage.[14] Furthermore, the high-altitude SA-2 "Guideline" (NATO reporting name) SAM system forced U.S. aviators to ingress and egress to the target at medium or low altitudes, where Sidewinder performance was not optimal. Finally, believing in the effectiveness of missiles and focusing on the "massive retaliation" nuclear mission of U.S. president Dwight D. Eisenhower's administration (1953–61), neither the Navy or Air Force had regularly practiced air combat maneuvering against smaller, dissimilar aircraft.[15]

These deficiencies combined to present a wholly different outcome for the AIM-9 than testing and combat in the Taiwan Strait had seemed to presage. American flight crews who were unfamiliar with the weapon's capabilities, oversold on its effectiveness, and subjected to unfamiliar combat conditions regularly launched the Sidewinder outside its effective envelope. Even within the envelope, the higher temperatures encountered

in the humid climate of Southeast Asia as well as from a myriad of ground-based heat sources often caused Sidewinders to track after something other than the intended MiG. NVAF fighter pilots, upon sighting the distinctive signature of an AIM-9 launch, regularly used the MiG-17's nimbleness to maneuver outside of the Sidewinder's guidance envelope. Finally, poor ordnance handling and loading practices brought about from the need to generate as many sorties as possible damaged Sidewinders and led to their malfunction in combat. By the end of Operation Rolling Thunder, the Sidewinder's kill rate had dropped precipitously to roughly 10–15 percent. Far from a wonder weapon, the Sidewinder had both Navy and Air Force pilots clamoring for a return of gun armament on their McDonnell Douglas F-4 Phantom II fighters due to the Vought F-8 Crusader and Republic F-105 Thunderchief communities' cannon kills.[16]

Fixing the Sidewinder

At the conclusion of Operation Rolling Thunder, it was clear that the AIM-9 was in need of major upgrades. The Air Force, in part due to its continued focus on the strategic bomber mission coupled with the limitations of its Vietnam rotation policy, chose primarily to focus on fixing the AIM-9's guidance and maneuverability problems. At Nellis and Eglin Air Force Bases in Nevada and Florida, respectively, engineers focused on developing a gimbal-mounted seeker that was quicker to acquire a target and send transmissions to the Sidewinder's control surfaces.[17] Propulsion was also upgraded to allow quicker acceleration, while steps were taken to reduce the missile's launch signature compared to earlier AIM-9 models. Unfortunately, despite evidence that there were warhead deficiencies, the

Air Force took no steps to improve this aspect of the Sidewinder, nor did it conduct more than a handful of tests in 1969 of its new AIM-9J against maneuvering targets at low altitude. In large part, both these decisions were made due to the Air Force's Tactical Air Command (TAC) believing the air war over North Vietnam to be largely over after Rolling Thunder's conclusion. Therefore, the thinking at TAC senior levels was that the Sidewinder's improvement or replacement could largely be done at a much slower pace as part of the Service's larger examination of its roles and missions.[18]

Unlike the Air Force, the Navy set about fixing both the weapon and training the aircrews employing it. The relative success of the F-8 Crusader compared to the F-4 Phantom II as well as the famous Ault Report led to the development of the U.S. Navy Fighter Weapons School ("Top Gun") at Naval Air Station Miramar in San Diego, California.[19] The Navy also began work on the Sidewinder itself, opting to introduce solid-state electronics across the entire airframe to solve launch reliability, maneuverability, target acquisition, and warhead fusing issues. The resultant AIM-9H was considered a vast improvement over not only the Navy's models but also the prototype of the Air Force's AIM-9J. Despite encouragement from the Navy for the Air Force to adopt its missile, Service parochialism and differences in weapons compatibility prevented the Air Force from doing so before Operation Linebacker I began.[20]

A Mixed Outcome: The Sidewinder in Operations Linebacker II and II

The decision of U.S. president Richard M. Nixon's administration (1969–74) to execute a sustained interdiction campaign against North Vietnam's Easter Offensive in 1972 once more pitted U.S. Navy and Air Force fighter pilots

against NVAF MiGs. For the Air Force, the Sidewinder's performance continued to be frustrating, as many were launched out of envelope by inexperienced, ill-trained aircrews. Even with the rushed introduction of the AIM-9J model in June 1972, Air Force aviators struggled to obtain a kill rate greater than 10 percent against NVAF MiGs when employing the Sidewinder.[21]

In direct contrast to their Air Force counterparts, the Navy's F-4 Phantom II contingent proceeded to maul NVAF's MiGs during Operation Linebacker I. Equipped with the more reliable AIM-9Hs and all but eschewing attempts to use the AIM-7 Sparrow due to its clumsiness, aggressive and well-trained Navy fighter pilots actively sought out dogfights with the enemy while performing escort missions. With the distribution of Top Gun alumni to many of the carrier squadrons off the coast of North Vietnam, Navy aircrews were well aware of the F-4's capabilities versus the MiG-17s and MiG-19s they faced. This led to consistent maneuvers to gain a firing position within the Sidewinder's envelope and, more often than not, the destruction of a NVAF fighter shortly thereafter. While not approaching the 60-percent kill rate obtained by the Nationalist Chinese pilots over the Taiwan Strait, the Navy's Phantom II-Sidewinder combination became so deadly that NVAF MiGs began circumventing combat.[22]

These dissimilar outcomes of success between the Navy and Air Force created questions about whether the Sidewinder had reached the end of its useful life. For the Air Force, the AIM-9J had not met expectations despite a great investment in further refinement. In contrast, the Navy believed that its adaptation of solid-state technology in the AIM-9H model provided a path that would allow the Sidewinder to continue as one of the Western Bloc's

primary aerial weapons. As these discussions were ongoing, results from another conflict would provide further evidence of the Sidewinder's importance in the Cold War.

Under Middle Eastern Skies

By the conclusion of Operation Linebacker II in December 1972, the State of Israel had fought four major conflicts against its larger, more numerous Arab neighbors. In 1948, the nascent state had established its independence. In 1956, in conjunction with France and the United Kingdom, Israeli forces had attacked Egypt and precipitated the Suez Crisis. Eleven years later, facing threats of annihilation, Israel had struck first and bested most of its neighbors during the June 1967 Six-Day War. This humiliation, in turn, had led to the War of Attrition, a series of clashes between 1967 and 1970 that were designed to eventually bleed Israel's population to the point of exhaustion.[23]

In every case, the Israeli Air Force (IAF) had been seen as the primary bulwark of national defense. The IAF's strength had rested largely on its better training and perceived better equipment. Through 1967, its aircraft had been mainly British and French manufacture, with the Dassault Mirage III fighter gaining an especially outsized reputation. In the aftermath of the Six-Day War and subsequent British and French embargoes, Israel became an American client state. For the IAF, this meant transitioning to the F-4 Phantom II, which initially complemented and then supplanted the Mirage III as its primary air-to-air weapons system. By the start of the Yom Kippur War on 6 October 1973, the IAF's Mirage IIIs and Phantom IIs were equipped with

a combination of Sidewinders and Israeli-made Shafrir heat-seeking missiles.[24]

As with the Vietnam War, a full recounting of the Yom Kippur War lies outside the scope of this article. However, with regard to the Sidewinder and its role in U.S. military efforts during the Cold War, the war was an inflection point that matched Vietnam's. First, the IAF's employment and success with heat-seeking weapons seemed to replicate the U.S. Navy's experience in Vietnam more than that of the U.S. Air Force, since pilot training and adherence to the envelope resulted in high lethality. Second, the prevalence of electronic countermeasures, chaotic command and control for both sides, and a high number of targets prevented the employment of beyond-visual-range (BVR) missiles. Third, air combat maneuvering continued to be important for modern air combat. Finally, the increased lethality of advanced SAMs, such as the Soviet-made SA-6 "Gainful" (NATO reporting name) and the ZSU-23-4 Shilka antiaircraft gun system, seemed to indicate that large formations of aircraft could not operate without extensive support. Military and civilian policy makers, shaken by Israeli losses, believed that future air combat would involve a series of sudden, sharp meeting engagements between small roving bands of four to eight aircraft operating at low levels.[25]

The Deadliest Snakes

In light of these lessons and changes to U.S. Navy and Air Force doctrine after 1972, both Services determined that the Sidewinder was the best option for continued development.[26] Furthermore, after negative experiences with the AIM-9J model and with a shifting focus toward BVR-

missile funding, the Air Force deferred to the Navy for further Sidewinder modernizations.[27] This meant that the engineers and scientists at China Lake were tasked with developing a missile that would not only equip the Navy's new Grumman F-14 Tomcat fighter but also the Air Force's McDonnell Douglas F-15 Eagle and General Dynamics F-16 Fighting Falcon fighters. As such, the weapon would have to operate across the width and breadth of possible future conflicts, from Navy carrier battle groups operating in the frigid Arctic to Air Force fighter wings dealing with multiple targets in a potential Central European conflict. Furthermore, to optimize the new maneuverability of the so-called "Teen Series" fighters, the new missile's envelope would have to include the ability to launch while in a high-G turn and against similarly agile targets.[28]

All these requirements made for a tall order, but the China Lake team set on it with great professionalism. First, happy with the solid-state circuitry of the AIM-9H model, the naval engineers established it as the baseline for any future Sidewinder variant. Second, taking advantage of new developments in propulsion, they found a way to improve the AIM-9's range and acceleration while once again reducing its signature. Simultaneously, changes to the infrared seeker and fusing decreased the missile's minimum range. Finally, changes to the control system made the new missile far more agile than even the AIM-9H. Going through various designations, China Lake finally settled on calling the production model of the new missile the AIM-9L, or "Lima."[29]

Entering production in 1976, the AIM-9L was almost as large a technological leap as the initial AIM-9B had been. For the first time, heat-seeking missiles could be used against any target angle, to include head-on

engagements, as long as the target heat signature was high enough. Second, unlike the AIM-9 models used during Vietnam, the AIM-9L was hard to distract even with purpose-designed countermeasures. Third, its rapid acquisition and firing capabilities allowed fighter pilots to rapidly engage a target, meaning that in the midst of a complex dogfight a pilot could more quickly transition to attacking or defending against other adversaries. Finally, the missile's maneuverability was so great that it was considered highly unlikely that any existent aircraft, belonging to either the Western or Eastern Blocs, could escape the missile once employed in its envelope.[30]

These capabilities inspired some fighter pilots to hyperbolically compare the AIM-9L to a point-and-shoot "death ray." Even those who were not that optimistic considered the new Sidewinder to be a major advancement for both the Air Force and Navy. For the former, the F-16 community believed that the AIM-9L plus the Fighting Falcon's maneuverability made it the equal of any Soviet platform despite the lack of an air-to-air radar. Likewise, the Navy's F-14 and nascent McDonnell Douglas F/A-18 Hornet communities also took it as gospel that the AIM-9L would facilitate the rapid establishment of air superiority during strike escort missions. Along with improvements to command and control, training, and doctrine, the AIM-9L was a crucial part of perceived Western aerial dominance by the conclusion of the 1970s.[31]

The Lima Goes to War

The 1980s provided plenty of opportunity for the new Sidewinder to prove its lethality. Contrary to analysts' planning at the time, the AIM-9L would not be employed in a Central European conflict. First blood came on 19 August

1981, when two Libyan Sukhoi Su-22 attack aircraft engaged a pair of Navy F-14s over the Gulf of Sidra. Demonstrating a poor understanding of their weapons system, the Libyan section leader fired a Vympel K-13 missile, the Soviet-designed copy of the AIM-9B, from a head-on aspect at the lead F-14. The missile missed, and within two minutes both Su-22s were dispatched by two AIM-9Ls without any real threat toward the F-14s. Although far from a validation, given the relative capability disparity between F-14s and Su-22s and the U.S. pilots' superior training, the fact remained that the AIM-9L had functioned as intended.[32]

It was left to a different air arm almost half a world away to cement the AIM-9L's reputation as a decisive weapon. Facing unrest at home, Argentina's ruling military junta chose to seize the Falkland Islands, a British overseas territory in the South Atlantic, on 2 April 1982. Expecting a rapid *coup de main* due to the United Kingdom's announced defense cuts and long supply lines, the Argentinian junta was instead confronted by a relatively large Royal Navy task force. Still, despite the United Kingdom's clear resolve to defend its territory, the junta and most military pundits believed that the Royal Navy's mission was ultimately a fool's errand. First, the Royal Navy lacked a true "full deck" aircraft carrier capable of maintaining constant fighter patrols over the Falklands. Second, the Argentine Air Force and Navy boasted almost 100 fighter and attack aircraft. Their 50 Mirage III and IAI "Dagger" fighters seemed markedly superior to the 20 British Aerospace Sea Harriers based on the carriers HMS *Hermes* (R12) and HMS *Invincible* (R05). Even the Argentine Air Force's obsolescent Douglas A-4 Skyhawk attack aircraft, which was expected to conduct many of its strikes, seemed to be almost as fast as the British Sea Harriers and thus near immune to

interception. While extreme range from mainland bases in Argentina would limit the Argentineans' ability to truly conduct dedicated air superiority operations, with more than twice the number of aircraft, simple attrition appeared to be their best path to victory.[33]

Against the enemy's advantages, the Royal Navy boasted three of its own. First, its small cadre of Sea Harrier pilots were superbly trained, with many of them having trained in air combat maneuvering against dissimilar aircraft such as the Mirage III and its descendant, the Dassault Mirage 2000. Second, the Royal Navy's surface fleet was quite experienced in fighter direction operations, which meant the shipborne controllers could place the Sea Harriers in the optimal position for interception. Finally, and most importantly, the delivery of 200 AIM-9L Sidewinders to the Royal Navy task force shortly before it departed Ascension Island for the Falklands meant that the British had a far superior missile to the Argentineans' AIM-9Bs and Matra Magic heat-seeking weapons.[34]

It did not take long for both sides to realize just how great the disparity was between their air-to-air weapons. On 1 May, the Argentine Air Force made its sole attempt to seize air superiority with its Mirage IIIs. As British Sea Harrier pilot David H. S. Morgan relates in his memoir *Hostile Skies: My Falklands Air War*, this did not go well:

> Later that afternoon it was our turn. Bertie [Anthony] Penfold was airborne with Martin Hale when the long-range radar mounted on *Hermes*' mast picked up another pair of aircraft. The SHARs [Sea Harriers] turned to take the bogeys head on and found them on radar, some 13,000 feet above them. As they closed the range, a missile was fired from one of

the enemy aircraft which headed towards Martin. He immediately carried out the manoeuvre that we had briefed and practised: he rolled on his back and pulled his Sea Harrier into a vertical dive. After a few seconds he pulled back into the fight, dumping his airbrake chaff as he did so. This defeated the missile, which fell away before reaching him.

Bertie, meanwhile, had seen the missile fired and the fighter then turn around right in front of him. This gave him a perfect zero-aspect tail shot but at very long range and on a retreating target. He fired his AIM9-L and called, "Fox two away . . . but it is a bit rangy!" After what seemed a very long pause there was a flash followed immediately by a large explosion and the aircraft was transformed into a cloud of wreckage. The pilot was not seen to eject. As Bertie and Martin were returning to the carrier [HMS *Illustrious* (R06)], John Locke came on the ship's broadcast and let us know what had happened. A huge cheer ran through the ship. At that time we believed that they had achieved the first kill of the war, although we learnt later that 801 [Naval Air Squadron] had beaten us to the draw by a few minutes when Flight Lieutenant Paul Barton and Lieutenant Steve Thomas had engaged a pair of *Mirages* near Pebble Island. Paul had dispatched one with a Sidewinder and Steve had damaged the other, which tried to make an emergency landing at Stanley. This was a bit of a mistake, as the pilot was shot down by the Argentine air defences as he approached the airfield. Luck was not on his side.[35]

In short, three of four Mirage IIIs dispatched on an offensive fighter sweep had been damaged or destroyed by AIM-9Ls. This level of lethality would continue throughout the conflict, as the outnumbered Sea Harriers were able to engage and destroy attacking Argentine aircraft out to the very limits of the Sidewinder's envelope. Rather than having to catch the Skyhawks and Daggers themselves, the British pilots were often able to allow the AIM-9L's marked acceleration and high speed to do much of the work for them. By war's end on 14 June, both Royal Navy task force commander Rear Admiral Sir John Forster Woodward and British prime minister Margaret H. Thatcher would credit the AIM-9L with playing a major role in making the British victory possible. With a lethality rate of more than 80 percent, such praise for the Sidewinder was not simple hyperbole.[36]

Sidewinders in the Bekaa Valley, Lebanon, 1982

At the same time that the Sidewinder was ironically being used to destroy American-built Skyhawks, AIM-9Ls were also being employed against their expected prey in the Middle East. Having taken delivery of the F-15 Eagle and F-16 Fighting Falcon in Israel, the IAF had already employed both fighters in operations against Syria and Iraq. In June 1982, the Israel Defense Forces invaded Lebanon to create a buffer state between Israel's northern communities and Palestine Liberation Organization (PLO) forces. Viewing the invasion as a threat to its national interests, Syria moved SAM batteries into Lebanon to reinforce antiaircraft batteries already present. Having learned the lessons of the 1973 Yom Kippur War, the IAF determined to

eliminate these SAMs to facilitate close air support for advancing Israeli armored units.[37]

Dubbed Operation Mole Cricket 19, the IAF's plan involved an intricate synchronization consisting of three main thrusts. First, unmanned aerial systems (UAS) would be dispatched to stimulate Syrian long-range and SAM radars to begin illumination. Once this occurred, Israeli artillery and defense suppression flights would simultaneously attack detected SAM batteries to neutralize them. This, in turn, was expected to spur Syrian Air Force MiG-21s and MiG-23s to scramble in order to engage the defense suppression aircraft. At this point, the IAF's F-15s and F-16s, controlled by orbiting Northrop Grumman E-2C Hawkeye aircraft, would conduct roving patrols to intercept the Syrian MiGs over the Mediterranean Sea and southern Lebanon.[38]

Unlike the British Royal Navy's efforts in the Falklands War, the AIM-9L was not the linchpin to Israeli success. Instead, its capabilities, including superior range and ease of use when compared to Israeli-manufactured Shafrir and Python heat-seeking missiles, simply made it the preferred weapon for IAF pilots. Once again, the AIM-9L proved just how lethal Dr. McLean's "flying snake" had become. During the air operation, conducted on 9 June 1982, Sidewinder, Shafrir, and Python missiles contributed to the destruction of more than 80 Syrian aircraft. Time and again, Israeli F-15s and F-16s were vectored toward Syrian aircraft, closed to visual range from either beam to avoid detection by radar-warning systems, and dispatched their prey at the limit of visual range with AIM-9Ls. As had occurred in the Falklands, the AIM-9L's capabilities so outclassed the Syrian Air Force's K-13 missiles that the Syrians were helpless to offer resistance. In a little more

than 24 hours, the IAF had provided irrevocable proof of the Sidewinder's technological superiority over most of its peers with a kill rate of 85 percent.[39]

The deadliness of the AIM-9L was not lost on the United States' allies and foes alike. For the Soviets, the Bekaa Valley debacle spurred the development of several new air-to-air missiles and hastened the development of both the Mikoyan MiG-29 and Sukhoi Su-27 fighter aircraft. Within NATO, several allied air forces approached the United States regarding the possible development of an export version of the AIM-9L for widespread use. This resulted in the AIM-9P, or "Papa," version of the Sidewinder for export. Based on an AIM-9J chassis with an AIM-9L equivalent seeker, this new variant of the Sidewinder would serve as the primary heat-seeking missile for all NATO member nations except France by 1989.[40]

Mike Triumphant

The AIM-9L was not the final version of the AIM-9 to be used with the U.S. military. After brief flirtations with multinational projects such as the Advanced Short Range Air-to-Air Missile, the U.S. Air Force and Navy once more decided to upgrade the AIM-9 in 1981. The new AIM-9M, or "Mike," boasted improvements to its internal electronics rather than its airframe. For guidance, the China Lake team once more relied on advances in microchips and computer miniaturization to embed a processor to help the missile sort through infrared interference from countermeasures or natural phenomena. Finally, propulsion was once more tinkered with to further reduce the missile's already low launch signature.[41]

Unfortunately, budget restrictions and the AIM-9L's success made accelerated replacement of AIM-9Ls in the U.S. inventory with AIM-9Ms somewhat superfluous. While examples of the new missile were prioritized for Air Force units in Europe and elements of the Navy's Atlantic Fleet, many organizations were still using the older AIM-9Ls when the Berlin Wall fell in November 1989. With the Soviet withdrawal from Eastern Europe shortly thereafter, it seemed as if the Sidewinder's role in major combat operations was complete.

This illusion was shattered by Iraq's invasion of Kuwait in August 1990, which prompted the Gulf War. Iraqi president Saddam Hussein's intransigence and belief that the United States-led Coalition lacked the collective will to initiate combat operations provided one last opportunity to add to the Sidewinder's laurels. On paper, the Iraqi Air Force seemed a formidable opponent, being equipped with advanced Soviet Mikoyan MiG-29 and French Dassault Mirage F1 fighters. As with the British Royal Navy in the Falklands, however, the Coalition possessed excellent training to complement its vastly superior technological edge. The AIM-9M was no exception, as Coalition Sidewinders achieved a kill rate of more than 80 percent in its operations against the Iraqi Air Force. Again, China Lake's side project had provided sterling service for the United States and its allies.[42]

The Serpent's Legacy

In many ways, the Gulf War (1990–91) offered a fitting bookend to a system's combat career that began in the frigid air over the Taiwan Strait. For five decades, the Sidewinder's simplicity and potential for growth allowed the weapon to adapt with the times. Whether destroying Communist fighter

aircraft to facilitate U.S. national security interests, deterring potential Eastern Bloc aggression in Europe, or allowing the United States' allies to seize air superiority during combat operations, the Sidewinder was a ubiquitous element of airpower for Western interests. As such, it deserves to be recognized as a key component of America's Cold War military technology and one of the nation's greatest military investments.

Figure 2.

An AIM-9M Sidewinder launches from a U.S. Navy F/A-18E Super Hornet during a 2017 missile shoot exercise in the Point Mugu Sea Range. Source: Official U.S. Navy photo by Lt Christopher H. Pagenkopf, USN

[1] Ron Westrum, *Sidewinder: Creative Missile Development at China Lake* (Annapolis, MD: Naval Institute Press, 1999), 207–8.
[2] Edward Luttwak and Stuart Koehl, *The Dictionary of Modern War* (New York: HarperCollins, 1991), 529–31.
[3] The term *long twilight struggle* originally appeared in U.S. president John F. Kennedy's inaugural address on 20 January 1961.

[4] Conrad C. Crane, *American Airpower Strategy in Korea, 1950–1953* (Lawrence: University Press of Kansas, 2000), 84–85; and Dan Hampton, *Lords of the Sky: Fighter Pilots and Air Combat, from the Red Baron to the F-16* (New York: HarperCollins, 2015), 415. So great was the disparity between F9F and MiG-15 performance in the Korean War that the U.S. Seventh Fleet explicitly demurred from participating in operations against MiGs in support of the United Nations' air effort.

[5] Norman Friedman, *Fighters over the Fleet: Naval Air Defence from Biplanes to the Cold War* (Annapolis, MD: Naval Institute Press, 2016), 182–92; Tommy H. Thomason, *U.S. Naval Air Superiority: Development of Shipborne Jet Fighters*, *1943–1962* (North Branch, MN: Specialty Press, 2007), 84–85; and Westrum, *Sidewinder*, 42–45.

[6] Friedman, *Fighters over the Fleet*, 182–92; Thomason, *U.S. Naval Air Superiority*, 84–85; and Westrum, *Sidewinder*, 45–62.

[7] Westrum, *Sidewinder*, 45–62. NOTS China Lake was unofficially given a small budget with which to conduct experiments, provided there were no additional material costs. This was, in effect, a tinkerer's budget, and that only available parts were used explains many of the restrictions listed here.

[8] Carlo Kopp, "The Sidewinder Story: The Evolution of the AIM-9 Missile," *Australian Aviation*, April 1994; and Westrum, *Sidewinder*, 45–62.

[9] Friedman, *Fighters over the Fleet*, 188–89; Thomason, *U.S. Naval Air Superiority*, 125–41; and Westrum, *Sidewinder*, 42–73, 120–32.

[10] The Century Series fighter aircraft were so dubbed by their U.S. Air Force designations. Beginning with the North American F-100 Super Sabre and continuing through the General Dynamics F-111 Aardvark, these aircraft were optimized primarily for speed and a role in either delivering nuclear weapons or intercepting nuclear-capable bombers. The U.S. Navy's McDonnell Douglas F-4 Phantom II was also designed during this era, with the Air Force initially designating it the F-110 Spectre before being overruled by U.S. secretary of defense Robert S. McNamara.

[11] Michael Napier, *In Cold War Skies: NATO and Soviet Air Power, 1949–89* (New York: Osprey, 2020), 62–138; Robert L. Shaw, *Fighter Combat: Tactics and Maneuvering* (Annapolis, MD: Naval Institute Press, 1985), 34–40; Mike Spick, *All-Weather Warriors: The Search for the Ultimate Fighter Aircraft* (London: Arms and Armour Press, 1994), 125–27; Mike Spick, *Fighter Pilot Tactics: The Techniques of Daylight Air Combat* (New York: Stein and Day, 1983), 140–41; Thomason, *U.S. Naval Air Superiority*, 85; and Westrum, *Sidewinder*, 133–61. The U.S. Air Force possessed its own heat-seeking missile, the Hughes AIM-4D Falcon. As was common in this era, Service parochialism clouded an objective discussion of each weapon's relative merits. For Western European nations, the AIM-4D was not seen as an option due to the weapons' specifications and U.S. export laws. On the other hand, the AIM-9 was simple, cheap, and available for license production. Almost as importantly, it could be retrofitted to domestic aircraft, provided their pylons had been previously wired for air-to-ground rockets and missiles.

[12] Kopp, "The Sidewinder Story"; and Westrum, *Sidewinder*, 45–62.

[13] For a more thorough discussion of the air war over North Vietnam, see Craig C. Hannah, *Striving for Air Superiority: The Tactical Air Command in Vietnam* (College Station: Texas A&M University Press, 2002); Michael L. Michel III, *Clashes: Air Combat over Vietnam, 1965–1972* (Annapolis, MD: Naval Institute Press, 1997); and Wayne Thompson, *To Hanoi and Back: The United States Air Force and North Vietnam, 1966–1973* (Washington, DC: Air Force History and

Museums Program, 2000). Although the North Vietnamese Air Force inventory consisted of both Russian MiGs and Chinese unlicensed copies of these aircraft, both the U.S. Air Force and Navy referred to all these fighters as MiGs. To avoid confusion, this article does the same.

[14] The NVAF was also known as the Vietnamese Peoples' Air Force (VPAF). Westrum, *Sidewinder*, 205–6.

[15] Walter J. Boyne, *Aces in Command: Fighter Pilots as Combat Leaders* (Washington, DC: Brassey's, 2001), 191–92; and Hannah, *Striving for Air Superiority*, 74–78.

[16] LtCol J. N. Dick Jr., USAF, interview with BGen Cleo M. Bishop, USAF (Ret), 7–8 July 1976, transcript (U.S. Air Force Oral History Program, Albert F. Simpson Historical Research Center, Maxwell Air Force Base, AL), 84–86, 209–11, hereafter Bishop interview; MajGen Frederick C. Blesse, USAF (Ret), *Check Six: A Fighter Pilot Looks Back* (Mesa, AZ: Champlin Fighter Museum Press, 1987), 120–26; and Maj James E. Whitt, USAF, "F-4 Employment of Air To Air Missiles in Southeast Asia: A Special Report," Albert F. Simpson Historical Research Center, Maxwell Air Force Base, AL, n.d., 18, 27–28, 36.

[17] Mounting the seeker head on a gimbal allowed it to rotate independently of the missile's primary centerline. This greatly increased the permissible acquisition and tracking angles and consequently expanded the missile's firing envelope.

[18] Maj John W. Siemann, USAF, *Combat Snap (AIM-9J Southeast Asia Introduction)* (Hickam Air Force Base, HI: Headquarters Pacific Air Forces, 1974), 15–21; Bishop interview, 206; and Michel, *Clashes*, 181–90.

[19] Formally known as *Report of the Air-to-Air Missile System Capability Review, July–November 1968*, the Ault Report is so named for its chair, U.S. Navy captain Frank W. Ault. As the title suggests, the board was initially convened to study every step of air-to-air missile operations from acquisition to firing in combat. Pursuant to this task, Ault and the board also examined Navy fighter pilot training. The resultant reforms, to include the formation of the Navy Weapons Fighter School, were a watershed moment in Navy and Air Force fighter training.

[20] Kopp, "The Sidewinder Story"; Michel, *Clashes*, 181–90; and Westrum, *Sidewinder*, 170–89.

[21] Michel, *Clashes*, 228–71; and Siemann, *Combat Snap*, 26–31.

[22] Kopp, "The Sidewinder Story"; and Michel, *Clashes*, 181–90, 279–91.

[23] Trevor N. Dupuy, *Elusive Victory: The Arab-Israeli Wars, 1947–1974*, 3d ed. (Dubuque, IA: Kendall Hunt, 1992), 221–340; and Brereton Greenhous, "The Israeli Experience," in *Case Studies in the Achievement of Air Superiority*, ed. Benjamin Franklin Cooling (Washington, DC: Center for Air Force History, 1994), 412–13.

[24] Dupuy, *Elusive Victory*, 221–340; Greenhous, "The Israeli Experience," 412–13; and Luttwak and Koehl, *The Dictionary of Modern War*, 523–24.

[25] Col Eliezer Cohen, IAF (Ret), *Israel's Best Defense: The First Full Story of the Israeli Air Force* (New York: Orion Books, 1993), 314–20; Anthony H. Cordesman and Abraham R. Wagner, *The Lessons of Modern War*, vol. I, *The Arab Israeli Conflicts, 1973–1989* (Boulder, CO: Westview Press, 1990), 18–23; Merav Halperin and Aharon Lapidot, *G-Suit: Combat Reports from Israel's Air War* (London: Sphere Books, 1990), 55–94; BGen Iftach Spector, *Loud and Clear: The Memoir of an Israeli Fighter Pilot* (Minneapolis, MN: Zenith Press, 2009), 286–90; and Dupuy, *Elusive Victory*, 344–83.

[26] For more information on such changes in doctrine, see James Young, "Eagles, Ravens, and other Birds of Prey: A History of USAF Suppression of Enemy Air Defense Doctrine, 1973–1991" (PhD diss., Kansas State University, 2018), 63–110.
[27] LtCol E.J. Griffith, USAF, "Aimval-Aceval," *USAF Fighter Weapons Review* (Fall 1977): 23–27.
[28] Col V. Dubrov, "A Soviet View: Soviet Perception of Air Tactics," *USAF Fighter Weapons Review* (Spring 1981): 23–27; LtCol Joseph E. Merrick, USAF, "Combat Capability," *USAF Fighter Weapons Review* (Spring 1981): 16–22; Kopp, "The Sidewinder Story"; Luttwak and Koehl, *The Dictionary of Modern War*, 529–31; Shaw, *Fighter Combat*, 45–52; Spick, *All-Weather Warriors*, 161–70; and Westrum, *Sidewinder*, 191–96.
[29] Kopp, "The Sidewinder Story"; Shaw, *Fighter Combat*, 45–52; and Westrum, *Sidewinder*, 191–96.
[30] LtCol Mike Press, USAF, "Aggressor Reflections," *USAF Fighter Weapons Review* (Summer 1981): 2–5; and Merrick, "Combat Capability," 16–22.
[31] Griffith, "Aimval-Aceval," 23–27; Westrum, *Sidewinder*, 196; and Young, "Eagles, Ravens, and other Birds of Prey," 83–114. The "death ray" comment has been attributed to numerous personnel of various Services in both primary and secondary sources. Given the science fiction films and television shows that were popular at the time of the AIM-9L's fielding, it is likely that this was a common refrain.
[32] Craig Brown, *Debrief: A Complete History of U.S. Aerial Engagements, 1981 to the Present* (Atglen, PA: Schiffer, 2007), 13–18.
[33] Max Hastings and Simon Jenkins, *The Battle for the Falklands* (London: Pan Books, 1997), 61–136; and Sandy Woodward with Patrick Robinson, *One Hundred Days: The Memoirs of the Falklands Battle Group Commander* (Annapolis, MD: Naval Institute Press, 1997), 68–75.
[34] Nigel D. "Sharkey" MacCartan-Ward, *Sea Harrier over the Falklands: "The Black Death"* (Minneapolis, MN: Publish Green, 2011), loc. 1246–1308 of 5898, Kindle.
[35] David Morgan, *Hostile Skies: My Falklands Air War*, (London: Cassell, 2012), loc. 1105–11 of 5435, Kindle. The British Sea Harrier pilots, well aware that the Mirage III would have advantages at altitude, simply refused to meet the Argentineans on their terms. This forced the Mirage III pilots to descend to medium altitude (roughly 10,000–15,000 feet), where the Sea Harrier was not only more maneuverable but also where the AIM-9Ls were even more lethal across the Mirage IIIs' flight envelope. The ensuing dogfight seemed to present a completely hapless situation to the Argentine Air Force. From the view of the British Royal Navy, the conflict's outcome had been close enough that a sustained series of attacks may have ultimately started to result in Sea Harrier losses. Failing that, combat air patrols constantly having to be on the lookout for attacking Mirage IIIs and Daggers was a consistent fear for RAdm Woodward and his staff throughout the conflict.
[36] Anthony H. Cordesman and Abraham R. Wagner, *The Lessons of Modern War*, vol. III, *The Afghan and Falklands Conflicts* (Boulder, CO: Westview Press, 1991), 260–66, 294–303; Jeffrey Ethell and Alfred Price, *Air War: South Atlantic* (New York: Macmillan, 1983), 214–17, 231–33; and Jenkins, *The Battle for the Falklands*, 61–136.
[37] BGen Amos Amir, *Fire in the Sky: Flying in Defence of Israel*, trans Ruvik Danieli (Barnsley, UK: Pen and Sword Aviation, 2009), 273–80; Lon Nordeen, *Fighters over Israel: The Story of the Israeli Air Force from the War of Independence to the Bekaa Valley* (London: Greenhill Books, 1991), 163–68; and Cohen, *Israel's Best Defense*, 436–65.
[38] Amir, *Fire in the Sky*, 273–80; Nordeen, *Fighters over Israel*, 163–68; and Cohen, *Israel's Best Defense*, 436–65.

[39] Cordesman and Wagner, *The Lessons of Modern War*, vol. I, 193–204; Amir, *Fire in the Sky*, 273–80; Nordeen, *Fighters over Israel*, 163–68; and Cohen, *Israel's Best Defense*, 436–65.
[40] Maj Dick Anderegg, USAF, "Meeting the Threat: Sophistication vs. Simplicity," *USAF Fighter Weapons Review* (Fall 1982), 2–6; Paul Eden, ed., *The Encyclopedia of Modern Military Aircraft* (London: Amber Books, 2004), 312–14, 452–61; Benjamin S. Lambeth, *Russia's Air Power at the Crossroads* (Santa Monica, CA: Rand, 1996), 123–61; Benjamin S. Lambeth, *Moscow's Lessons from the 1982 Lebanon Air War* (Santa Monica, CA: Rand, 1984), 32–33, https://doi.org/10.7249/R3000; Alexander Zuyev with Malcolm McConnell, *Fulcrum: A Top Gun Pilot's Escape from the Soviet Empire* (New York: Warner Books, 1992), 21–32, 112–15, 123–57; and Kopp, "The Sidewinder Story." At this time, France was producing the Matra Magic missile as both an independent weapons system for its own fighter aircraft and a direct sales competitor to the AIM-9.
[41] Capt Mark R. Brightman, USAF, "Air to Air Missile Capabilities," *USAF Fighter Weapons Review* (Fall 1985): 15–17; and Westrum, *Sidewinder*, 197.
[42] Brown, *Debrief*, 23–149.