Dogfight

A **dogfight** or **dog fight** is a common term used to describe close-range aerial combat between military aircraft. The term originated during World War I, and probably derives from the preferred fighter tactic of positioning one's aircraft behind the enemy aircraft. From this position, a pilot could fire his guns on the enemy without having to lead the target, and the enemy aircraft could not effectively fire back. The term came into existence because two women fighting is called a *catfight*, and all early fighter pilots were men, hence *dogfight*. This subsequently obtained its revised folk etymology about two dogs chasing each other's tails.[*citation needed*]

Modern terminology for aerial combat between aircraft is **air-to-air combat** and **air combat maneuvering**, or ACM.

F-22 Raptors over Utah in their first official deployment, Oct. 2005, simulating a dogfight.

History

World War I

Dogfighting emerged in World War I. Aircraft were initially used as mobile observation vehicles and early pilots gave little thought to aerial combat—enemy pilots at first simply exchanged waves. Intrepid pilots decided to interfere with enemy reconnaissance by improvised means, including throwing bricks, grenades and sometimes rope, which they hoped would entangle the enemy plane's propeller. This progressed to pilots firing hand-held guns at enemy planes. Once machine guns were mounted to the plane, either in a turret or higher on the wings of early biplanes, the era of air combat began. The Germans acquired an early air superiority due to the invention of synchronization gear in 1915.

During the first part of the war there was no established tactical doctrine for air-to-air combat. Oswald Boelcke was the first to analyze the tactics of aerial warfare, resulting in a set of rules known as the

Dicta Boelcke. Many of Boelcke's concepts, conceived in 1916, are still applicable today, including use of sun and altitude, surprise attack, and turning to meet a threat.

World War II

During the first part of World War II, the basic ideas behind dogfighting changed little. However, the aircraft were improved drastically over their World War I counterparts. Aircraft like the Messerschmitt Bf 109 and the Mitsubishi Zero surprised the Allies with their superior maneuverability and speed. Allied fighters, such as the Supermarine Spitfire, would continually "bunny hop" with Axis planes, going through numerous variants in the continuing effort to gain technological superiority.

The Battle of Britain was largely determined by dogfighting between British and German fighters.

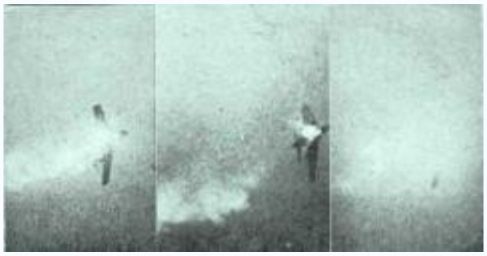
The American Volunteer Group (AVG), which was later better known by its nickname the Flying Tigers, led by Claire Chennault, was among the first to successfully counter the highly maneuverable Japanese fighters. Chennault interviewed Chinese pilots carefully and learned all he could about Japanese fighter performance characteristics, tactics and methods. He realized that the Japanese fighters were extremely maneuverable and classic tactics would not work against them, so he advised pilots to work in teams rather than alone and devised tactics to take advantage of the strengths of the P-40 and avoid fighting on Japanese terms.

The P-40 Warhawk had pilot armor, self-sealing fuel tanks, sturdy construction, powerful machine guns, and a much faster diving speed. It could defeat the more maneuverable Japanese fighters by remaining out of range and using diving attacks and reattacks after a zoom climb, or "vertically". This was important, because their opponents could outmaneuver the Warhawk in a horizontal turning contest. Chennault also created a relatively primitive, but effective early warning network to enable his fighters to take off in time to gain an altitude advantage before the Japanese arrived. By using speed and resisting the deadly error of trying to out-turn the Zero, eventually the .50 caliber machine guns could be brought to bear and a single burst of fire was usually enough to shoot down the Japanese fighters, which did not have self-sealing fuel tanks or armor. In a time when most of the news was of defeats, the AVG was officially credited with 297 enemy aircraft destroyed (although author Daniel Ford discounts the total to 115). Even at Ford's lower figure, the AVG was a notable success in the first few months of 1942, when the Allies were being thrown back throughout the Pacific theater.

Another pilot who realized that new tactics had to devised was then-Lieutenant Commander John S. "Jimmy" Thach, commander of Fighting Three in San Diego. He read the early reports coming out of China and wrestled with the problem of his F4F Wildcats being relatively slower and much less maneuverable. He devised a defensive maneuver, called the "Thach Weave" by LtCdr James H. Flatley, another fighter tactician and contemporary of Thach. Thach reasoned that two planes, a leader and his wingman, could fly about 200 feet apart, and adopt a weaving formation when under attack by Japanese fighters. He later faced the A6M Zero during the Battle of Midway in June 1942 for the acid test of his theory. Although outnumbered, he found that a Zero would lock onto the tail of one of the fighters. In response, the two planes would turn toward each other. When the Zero followed its original target through the turn, it would come into a position to be fired on by the target's wingman, and the predator would become the prey. His tactic proved to be effective and was soon adopted by other squadrons. The Thach weave helped make up for the inferiority of the US planes in technology and numbers, until new aircraft could be brought into service. Its usefulness survives until today.

The Lufbery circle was another defensive maneuver used when faced with attack by superior numbers or less maneuverable opponents. The Lufbery is executed by several aircraft turning horizontally in same direction which forces an opponent to get down into the same circle where an attack cannot be made without coming under attack by the following fighter. When the allies fielded the Hellcat and Corsair in the Solomon Islands, the Zero could not outrun the faster Navy fighters and resorted to the Lufbery in an attempt to draw their opponents into a horizontal turning contest they could win. Likewise, the North Vietnamese MiG-17 resorted to use of the Lufbery on occasion when cornered by faster F-4 Phantom fighters. Whereas the Thach Weave is used as aircraft move towards a point in space, the Lufbery is fixed over a point.†

Modern air combat



Gun camera stills released by the Indian Air Force show FLTLT M.A. Ganapathy's Gnat scoring hits on FLGOFF Khalil Ahmed's F-86 Sabre over Boyra during the Battle of Boyra in the 1971 Indo-Pak war

Even in the jet age, modern air-to-air combat often develops into dog fights. A fighter can evade a supersonic missile by turning and outrunning a missile under certain circumstances, employing countermeasures (like chaff and flares), or "beaming" an incoming missile - potentially escaping its field of view - if the pilot has excellent situational awareness and a good anticipation of the attacker's moves. Supersonic head-on closure with the enemy while evading further missile flights may eventually achieve a visual dogfight with Gatling guns at a range of less than one kilometer.

Superiority in a dog fight can depend on a pilot's experience and skill, and the agility of his fighter when flown at minimum air speeds approaching loss of control (causing a danger of stalling); the winner typically plays to the strengths of his own aircraft while forcing his adversary to fly at a design disadvantage. Dogfights are generally contests fought at low airspeeds, while maintaining enough energy for violent acrobatic maneuvering, as pilots attempt to remain within air speeds with a maximum turn rate and minimum turn radius: the so-called "corner speed" that often lies between 300 and 400 knots, depending on conditions. Therefore a dogfight has nothing to do with supersonic speed, but much to do with the engine power that makes supersonic flight possible. The F-22 Raptor can stand on its steerable nozzles at less than 100 knots airspeed, yet quickly maneuver to bring its M61 Vulcan cannon to bear on a nearby evasive target, while an F-15 Eagle is more likely to use its thrust to maintain its relatively high corner speed, working to counter the drag caused by tight turns.

The continued importance of maintaining dogfighting proficiency was demonstrated during the Vietnam War. American pilots flew aircraft such as the F-4 Phantom II, equipped with long-range AIM-7 Sparrow missiles, and AIM-9 Sidewinder missiles. However, air crews were required not to fire any missiles without having visually identified the target first, to make absolutely sure they were not an ally, thus losing this technological advantage. The AIM-7 missile was also not very reliable, making heavy use of delicate components such as vacuum tubes which had to endure the SE Asia climate, carrier takeoffs, and high stress maneuvers. Also, they had semi-active radar homing, meaning that they used the carrier plane's radar signals to home in on the target. The missiles themselves did not have a radar system, but "listened" to the pings of the attacker's radar and used the reflection of the prey aircraft to home in on it. AIM-9 missile were heat-seeking fire-and-forget missiles, meaning that once they had a lock on a heat source, they would attempt to hit it. They were only useful in short range, and in many cases fail due to a number of factors including delicate instruments and false heat sources such as the sun. Additionally, early versions of the F-4 (prior to the E model) relied solely on missiles, having no guns nor lead-computing Gyro gunsight, and were therefore very vulnerable in the gun-range combat that could ensue.


IAF's Sukhoi Su-30MKI during a dogfight maneuver.

Lightweight, short-endurance, point-defense fighters such as the MiG-17 and MiG-21 are typically far more agile than heavy, long-range, fighter-bombers (see the F-105 Thunderchief). Still, using superior tactics, the AIM-9 Sidewinder short range missiles, and cannon fire, American pilots were able to gain significant victories in the air over North Vietnam, especially after the establishment of the US Navy's Fighter Weapons School (TOPGUN) to restore dogfighting ability to its pilots.

With modern air-to-air AMRAAM guided missiles greatly extending the general engagement range of jet fighters, some experts hypothesize that dogfighting may be headed toward extinction, but others cite the occurrences in Vietnam as evidence otherwise. However, it is worth noting that there have been a great number of Beyond Visual Range (BVR) kills occurring during and after the Persian Gulf War. This was due to the improved reliability of BVR missiles, radars, and most importantly, the integration of C3I assets such as AWACS aircraft into the realm of aerial warfare. This provided Coalition forces with a superior picture of the battlefield, and in conjunction with airspace management allowed utilization of BVR weaponry.

Despite this, the improvement of all-aspect IR missiles coupled with helmet-mounted sights has mitigated the necessity of tail-chase attacks. In addition, Russian development of tail-mounted radar and rear-firing missiles has reduced the vulnerability to tail-chase attacks.

Yet because this feature is only present on the most modern jets, and missiles are a finite resource, The US Navy (TOPGUN) and Air Force (Red Flag) continue to teach postgraduate level classes in air combat maneuvering engagements. Russian aircraft manufacturers heavily emphasize superagility and dogfight capabilities in fighter design, with aircraft such as the Su-37 or the Su-30MKI demonstrating advanced thrust vectoring systems to achieve these goals, pushing the aircraft to its limits to give it an advantage in combat. USAF fighters such as the F-15 and F-16 tend to favor higher speeds because of their emphasis on high power-to-weight ratio and low wing-loading, although the F-22 does appear to have some level of superagility with its own vectored thrust.

Fictional depictions in space

Although combat in space involves different considerations due to the lack of drag and gravity, science fiction films and space simulations often invoke analogies to aeronautical dogfighting to better relate to the audience's experience. Some films and games, such as *Babylon 5*, *Battlestar Galactica*, *Escape Velocity*, and *I-War* have tried to accurately model Newtonian physics and tactics in such an environment. For example, since a body will remain in motion without additional thrust, a fighter could orient itself to face directions other than its direction of travel, i.e. if being chased, a space fighter can make a 180 degree spin on its axis to shoot its forward guns at its pursuer, while still moving in its original direction.

Wikisource has several original texts related to:
Audio recordings and transcripts with comments of actual Wild Weasel missions flown during the Vietnam War, including air combat with MiG-17s.

- Thach Weave
- The Scissors
- Immelmann turn
- Split S
- Lufbery
- Aerial warfare
- List of aircraft shootdowns

References

- Shaw, Robert L. (1985). *Fighter Combat: Tactics and Maneuvering*. Annapolis, MD: Naval Institute Press. ISBN 0-87021-059-9.

Interrupter gear

Damaged propeller from a Sopwith Baby aircraft circa 1916/17 with evidence of bulletholes from a machine gun fired behind the propeller without an Interruptor. The propeller required immediate replacement after the aircraft landed.

Interrupter gear is a term that covers two related technologies.

The first is **Synchronization gear**, which is often incorrectly referred to as "interrupter gear"; this is a triggering device attached to the machine gun armament of a tractor-type fighter aircraft so that it would fire only at certain times. This allows the gun to fire through the arc of a spinning propeller without the bullets striking the blades. Introduced during the First World War, the gun synchronizer was a significant development in the history of air combat and remained in operational use until the Korean War when the widespread adoption of Jet aircraft rendered them obsolete.

A true interrupter gear stops the firing of the machine gun when some part of the aircraft was in the way. For much of the early history of the fighter aircraft this was limited to the propeller. This would change with the introduction of the turret mounted armament firstly to the bomber aircraft and briefly to the fighter.

Though their effects were the same, there was a subtle difference between the concept of the interrupter and the synchronizer. A machine gun fitted with interrupter gear had the trigger normally enabled and the interrupter mechanism would disable the trigger when a propeller blade was in the way. A machine gun fitted with synchronization gear had the trigger normally disabled and the synchronizer mechanism would enable the trigger when the propeller was clear. In reality, the technical difficulties associated with reliably halting the firing of a Maxim-type machine gun meant that no working interrupter system was ever developed — all successful implementations used the concept of synchronization.

Origins

Experimentation with gun synchronization had been underway in France and Germany before the First World War but the engineers involved received little support or encouragement from the military who disregarded the need for armed aircraft, believing them solely useful for reconnaissance. Swiss engineer Franz Schneider, working for LVG, designed and patented a synchronizer in 1913. French aircraft designer Raymond Saulnier built and patented a practical gun synchronizer in April 1914, having borrowed a machine gun from the army for testing. No design was developed to the point of being operational in the field, one significant problem being the inconsistency of ammunition propellant resulting in hang fire rounds.

Saulnier pursued a simpler method using armoured propeller blades. In December 1914, French pilot Roland Garros approached Saulnier to arrange for this device to be installed on his aeroplane but it was not until March 1915 that he took to the air with a forward-firing Hotchkiss 8 mm (.323 in) machine gun mounted on his Morane-Saulnier Type L. In addition to the armoured blades, Garros's mechanic, Jules Hue, attached deflector wedges to the blades. While this reduced the chance of a dangerous ricochet, the wedges diminished the propeller's efficiency. On 18 April 1915, having shot down three German aircraft, Garros' plane was forced down in German territory. Before he could burn his aircraft, he was captured and the gun and propeller were sent for evaluation by the *Inspektion der Fliegertruppen* (*Idflieg*) at Döberitz near Berlin.

Fokker's synchronizer

Popular accounts claim that Dutch aircraft designer Anthony Fokker was then asked to reproduce Saulnier's deflectors and proceeded to invent the synchronization system in a matter of days — according to some accounts,[*attribution needed*] Fokker was given the problem on a Tuesday evening and presented a working system on Friday. However, Fokker's team, including engineer Heinrich Lübbe, had been working on a synchronization mechanism since late 1914, probably based on Schneider's patent. Indeed in 1916 LVG and Schneider sued Fokker for patent infringement — the battle continued until 1933 and though the courts repeatedly found in Schneider's favour, Fokker refused to acknowledge the rulings.

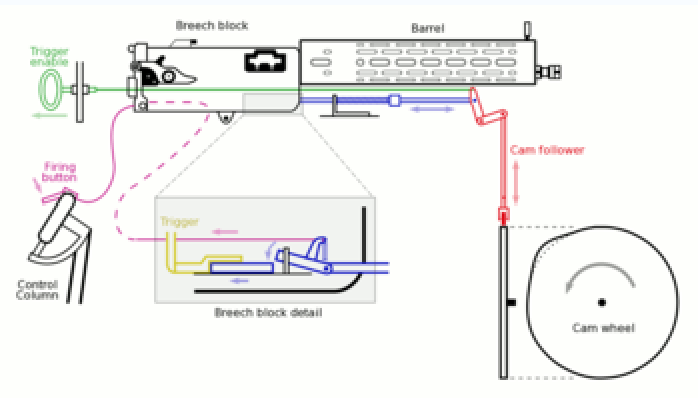


Diagram of Fokker's "Zentralsteuerung" synchronization mechanism. Pulling the green handle lowers the red cam follower onto the cam wheel attached to the propeller shaft. When the cam raises the follower, the blue rod is depressed against the spring, enabling the yellow trigger plate to be reached when the purple firing button is pressed. This image shows a side view of one of the original Spandau LMG 08 guns, somewhat different in appearance from the LMG 08/15 that later German fighters used

Fokker's team adapted their system to work with the new Parabellum lMG 14 machine gun fitted to a Fokker A.III unarmed single-seat monoplane (a military version of the Fokker M.5K) usually flown by Leutnant Otto Parschau. This aircraft — the first example of the five M.5K/MG production prototypes for the Fokker E.I — was demonstrated on 19–20 May 1915 and shipped to the Western Front on 30 May 1915.

The solution used a cam attached to the propeller shaft that pressed on a long rod running to the trigger of the guns. The cam was set such that the propeller was horizontal when it pushed on the rod, and the rod in turn pressed the trigger to fire a bullet. The trigger operated by the pilot pulled the rod into position over the cam.

The first victory using a synchronized gun-equipped fighter is believed to have occurred on 1 July 1915 when Lieutenant Kurt Wintgens of *Feldflieger Abteilung 67*, flying the Fokker M.5K/MG serial number 'E.5/15', forced down a French Morane-Saulnier Type L east of Lunéville. However the plane landed in French territory and the victory could not be confirmed. The first confirmed victory went to Max Immelmann flying a Fokker E.I on 1 August 1915, forcing down a Royal Flying Corps B.E.2c.

Sole possession of a working synchronizer enabled Germany to dominate the Western Front skies in a period known as the Fokker Scourge. Initially lacking a synchronizer, the Royal Flying Corps relied on pusher aircraft such as the Vickers F.B.5 Gunbus and the Airco D.H.2 which did not have the problem of firing forwards through the propeller. Germany was protective of the synchronizer system, instructing pilots not to venture over enemy territory in case they were forced down and the secret revealed, but by 1916 the Allies had developed various synchronizer mechanisms of their own, usually based on cams and links, like the Fokker mechanism.

Further development

The first British aircraft to use a synchronizer gear was the Sopwith 1½ Strutter which arrived in April 1916 equipped with the Ross synchronizer, although some other service types were retrofitted with synchronised guns about this time, including the Nieuport 12 and the Bristol Scout. The main problem with early mechanical synchronizers was that the rate of fire of the machine gun was dependent on the engine revolutions, and was slowed, especially when the engine was throttled back. The mechanical linkages were also very liable to failure, resulting in the unfortunate pilot shooting away his own propeller.

Eventually all British aircraft were equipped with the superior hydraulic Constantinesco synchronization gear (or "CC" gear), invented by Romanian engineer George Constantinesco) which used impulses transmitted by a column of liquid instead of a mechanical system of linkages. This was not only inherently more reliable, but delivered firing impulses at a much higher rate, so that a synchronised gun now fired at more or less the same rate as a normal machine gun, regardless of engine revolutions. The gear could also be easily fitted to any type of aircraft instead of having to have type-specific linkages designed. The Constantinesco gear remained in use with the Royal Air Force until the Second World War, the Gloster Gladiator being the last British fighter to be equipped with it.

A pilot would usually only have the target in his sights for a fleeting moment so a concentration of bullets was vital for achieving a kill. The obvious solution was to increase the number of guns. The final version of the Fokker Eindecker, the Fokker E.IV, came with two Spandau machine guns and this became the standard armament for all the German D-type scouts starting with the Albatros D.I. Fokker experimented with mounting three machine guns on the E.IV but the extra weight rendered the aircraft virtually unflyable. The Allies did not field an aircraft with twin synchronized guns until the Sopwith Camel and the SPAD S.XIII came into service (mid 1917).

Turrets

With the introduction of the "high speed" bomber came a need to protect the gunner from the elements and to give protection but retain the wide firing arcs and so the power driven multi-gun turret evolved. One of the first instances was the single nose mounted turret of the Boulton Paul Overstrand that served with the RAF, and the almost simultaneous introduction of the much more advanced Martin B-10 with the US Army Air Corps.

For maximum efficiency the bomber turret needed to be able to rotate in all directions and cover as wide a range of elevation as possible - this meant that there would be some combinations of elevation and direction where the turret was aiming at some part of the aircraft itself. To prevent the guns firing an electrical system was used. The guns were fired by solenoids and by introducing a break in the electrical power to the guns that coincided with the forbidden arcs of fire the aircraft would be safe from its own guns. The Boulton Paul design used a brass drum and brush contacts that corresponded to the direction of the turret and angle of the guns. Where the brass was removed and replaced with insulating material the electrical circuit would be broken and the guns prevented from firing.

The End of Synchronization

Synchronization gears finally became totally redundant when jets replaced propeller-driven fighters - but their use, even in piston engined aircraft, had already declined - especially after 1940. It was no longer practicable to mount guns with their firing mechanisms within the cockpit, which eliminated one of the reasons for having guns mounted in the fuselage in the first place. The importance of locating the guns in front of the pilot also diminished, as aircraft gunsight technology improved and the requirement for heavier armament increased. Cantilever monoplane wings provided much more space than the fuselage to mount armament - and being much more rigid than the old cable braced wings they provided a much steadier mounting. The result was that many fighters of the World War II era had all their guns mounted in the wings outside the propeller disc - their direction of fire "harmonised" to converge at a preset distance. Nevertheless, German and Soviet fighter types in particular were slow to abandon fuselage-mounted guns, usually in addition to wing mounted guns.

The last synchronizer-equipped aircraft to see combat action were the Lavochkin La-11 and the Yakovlev Yak-9 during the Korean War.

References

- Woodman, Harry, "CC Gun Synchronisation Gear", *Aeroplane Monthly*, September 2005
- Jarrett, Phillip, "The Fokker Eindeckers", *Aeroplane Monthly*, December 2004
- "The Electro-Hydraulic Turret", *The Aeroplane* No: 1654, February 1943