

THE BATTLE OF BRITAIN



By Joseph Miranda

The summer and autumn of 1940 saw a unique occurrence in the history of warfare, the first full-scale air campaign between opposing air forces in which no ground forces were involved. This was the Battle of Britain, fought in the skies over the British Isles. Until that battle—actually a campaign lasting several months—no one had much of an idea of how an actual “air war” would go. While aerial warfare had been a feature of conflict since World War I, the Battle of Britain was the first full-fledged aerial conflict. Its outcome proved to be a surprise to the combatants and the world.

In World War I, aircraft were initially used only for reconnaissance, but missions were soon expanded to include interception, ground support, interdiction, aerial re-supply, and air

superiority. There were also experiments with strategic bombing. Starting in 1915 the Germans launched a series of airship raids against Britain, but they proved to be a failure. While the

Zeppelins initially caused some panic among civilians, the British quickly developed an air defense system, based on the fighters of the Royal Naval Air Service (the Royal Navy was historically charged with the responsibility of defending the British Isles, so they kept that responsibility even as the threat moved from the water into the sky.) The fighters worked because they were part of a much larger system that included centralized command-control, ground based observers, and anti-aircraft weapons. Those air defenses were

effective in making the Zeppelin raids too expensive to continue.

In 1917 the Germans tried again, this time using twin-engine *Gotha* and *Riesen* (giant) bombers in daylight raids. Those aircraft proved more effective, penetrating British defenses and dropping bombs within proximity of their targets. Again there was some panic as civilians saw the raiders as effectively negating the Royal Navy's control of the sea. Again, a revamped British air defense made the raids too expensive for the Germans to continue.

An outcome of those bomber raids, one the Germans didn't anticipate, was the creation of the Royal Air Force (RAF). By April 1918 the British public had turned from panic to outrage, which gave the advocates of airpower the support they needed to create an organizationally independent air force. One of the first missions of the RAF was to launch its own strategic bombing campaign against German industry in the Ruhr. While those attacks did little physical damage, they managed to disrupt war production to a small degree as factories were shut down during the raids and fighter squadrons were redeployed for homeland protection.

The end of World War I gave further impetus to the advocates of airpower. Italian Gen. Giulio Douhet called for the creation of strategic bombing forces that would directly attack enemy cities. The idea was, since the fighting in 1914–18 had shown land operations could easily be deadlocked into static trench warfare, a quick victory could be found only in the air. In that interpretation of World War I, Germany, Austria-Hungary and Russia all collapsed internally owing to revolutions on the home front, while the French army came close to dissolving in mutiny. Attacking enemy civilians with bombers could hasten and magnify those kinds of collapses and thereby shorten any future war.

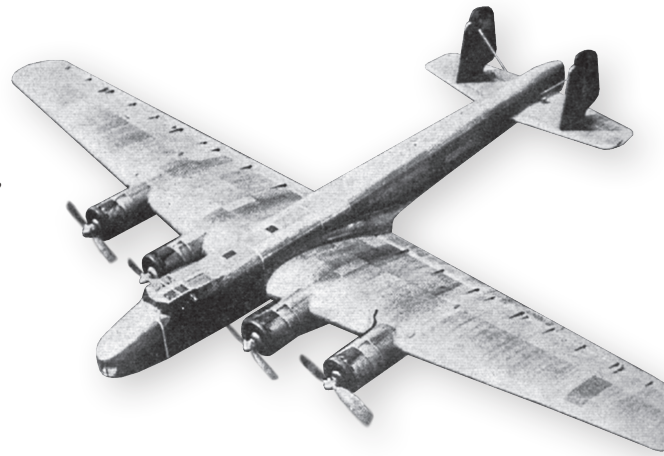
Of course, while one side's air force was attacking the other side's cities, that side's air force would be attacking the other side's cities in return. Consequently, the side that delivered the hardest aerial blows at the earliest opportunity would triumph. A nation should therefore concentrate its industrial production on manufacturing

the maximum number of heavy bombers. Other aircraft types, along with ground and naval forces, were to be relegated to secondary status in the race for the biggest and hardest-hitting bomber force. Meanwhile, civilian populations would have to be psychologically prepared to survive the expected mass air raids of future wars, raids that would probably involve poison gas as well as explosives.

All that should be understood within the context of the prevailing theories of "total war" put forward in the 1920s and 1930s. According to those theories, a nation's industrial infrastructure and its civilian workers were both considered as much a part of the war machine as the forces fighting at the front. Attacks on civilians would, in that view, cause fewer casualties in the long run, at least compared to another four years of trench warfare.

Air defense against bombers was considered impractical. "*The bombers will always get through*" was the prevailing wisdom. Given the technologies of the 1920s and early '30s, there was reason to believe that was the case. During most of the interwar years, multi-engine bombers could fly as fast or faster than single-engine fighters. The all-metal monoplane, which had the speed to intercept bombers, didn't come into its own until the late 1930s. More, until the invention of radio direction finding (later called RADAR, short for "RADio Direction And Ranging"), there was no reliable means of detecting aerial intruders at a distance.

To be sure, there was the experience of the RNAS in World War I, which showed that air defense *sans* radar could work. Still, while the bomber raids of 1917–18 never involved more than 35 aircraft at one time, they proved effective in not only penetrating British air defenses, but also at initially generating chaos out of all proportion to their size. It was feasible large formations of hundreds of heavy bombers could accomplish much more. British and American advocates of airpower, such as Hugh Trenchard and William Mitchell, believed heavy bombers could fight their way through air defenses to put decisive amounts of ordnance on their targets.



ABOVE: The Dornier 19 strategic bomber. *Flight magazine archive from Flightglobal.*

CENTER: *Luftwaffe Gen. Walther Wever.*

RIGHT: *Ruins of Guernica (1937).*

Rise of the Luftwaffe

The Treaty of Versailles that ended World War I mandated the destruction of the German air force. Nonetheless, in the 1920s the *Reichswehr* (the interwar German armed forces), under the leadership of Hans von Seeckt, promoted air mindedness. Seeckt and others realized airpower would be a vital component of any future conflict. Consequently they supported civilian airlines, aviation clubs, and clandestine pilot training in an often forgotten alliance with the Soviet Union, which endured until the accession to power of the Nazis in 1933.

The Nazis tore up the Versailles Treaty and created the new *Wehrmacht*, which included the army (*Heer*), the navy (*Kriegsmarine*), and an independent air force, the *Luftwaffe*. While both Adolf Hitler and Herman Goering are often criticized for their later mismanagement of strategy in World War II, both were instrumental in creating the new air force, with Goering, a former World War I fighter pilot, becoming air minister.

One of the first questions for the new air force's high command to answer was: what kind of future war would the *Luftwaffe* prepare to fight? The *Luftwaffe's* first chief of staff, Gen. Walther Wever, was an advocate of *Risikoflotte* (risk fleet). The idea was to create an armada of strategic bombers that could threaten Germany's foes with certain destruction, thereby forcing them to concede to the Reich's demands without war. Such an air



force would also be useful in deterring enemies from launching the expected Douhet-style terror attacks against German cities. Wever promoted the building of strategic bombers such as the Dornier 19. That plane had four engines and a relatively large range and payload for the 1930s. Several prototypes of the Do-19 were built, but problems emerged that rendered impractical the creation of a strategic bomber force.

One problem came from the simple fact German industry couldn't produce engines of sufficient power for the bombers. Indeed, the Germans were never able to build engines fully suitable for heavy bombers, and that would plague the *Luftwaffe* all through World War II. The one German strategic bomber to be produced in any numbers, the Heinkel 177, which came into service in late 1942, still had inadequate engines.

Another shortfall was in the allocation of resources. The metal and engines required to build one strategic bomber could be used instead to produce two or three medium bombers. The production of large numbers of medium bombers was seen as more important than a smaller number of heavier aircraft, especially when the latter, because of the engine shortfall, couldn't perform efficiently anyway. Since at least a part of the *Luftwaffe's* mission was to be a psychological weapon to force the Reich's enemies to back down without a fight, numbers of airframes seemingly counted more than bomb tonnage delivered. At any

rate, Wever's death in a plane crash in 1936 ended the Do-19 program, and Germany thereafter concentrated on medium bomber production.

When the Spanish Civil War broke out in 1936, pitting left-wing Republicans against the right-wing Nationalists, Hitler supported Nationalist leader Francisco Franco with the *Condor Legion*, which included *Luftwaffe* units. The Heinkel-111 bomber proved its worth, being a fast and modern aircraft, capable of both close air support and long range attacks. The new Me-109 monoplane fighter was instrumental in establishing Nationalist air superiority. One experiment that was tried and proved ineffective was terror bombing civilians, the most infamous *Condor Legion* operation being the air raid against the Basque town of Guernica. German intelligence reported attacks on civilian targets not only failed to break morale, but actually caused outrage that worked to stiffen the enemy's will to fight.

The *Luftwaffe* did find tactical combat support could work, though a major challenge was the lack of suitable bomb aiming technologies. Bombsites available in the 1930s couldn't dependably place bombs on target. One alternative was developed by Wolfram von Richtofen, cousin of the famous World War I German aviator and later commander of the *Condor Legion*. That alternative was the dive bomber, in this case the Ju-87, popularly known as the Stuka. The Stuka proved successful

both as a military and psychological weapon, engendering terror among ground troops who came under its attack. German medium bombers were also adapted for dive bombing missions, though usually in the form of shallow dives so pilots could line up the glide paths of their bombs on targets.

There was more to tactical support than dropping bombs. In order for tactical air support to be effective, the bombers had to be part of a bigger system that included liaison officers accompanying ground units, centralized communication systems to coordinate operations, and well trained aircrews. The Spanish Civil War was the proving ground not only for the *Luftwaffe's* aircraft, but for its entire system of operation.

Still, it would be a mistake to see the *Luftwaffe* as simply a tactical force. Its planners emphasized the operational use of airpower—conducting missions throughout the entire theater of operations, concentrating combat power for a full range of missions from close support to deep strikes in enemy rear areas. *Luftwaffe* missions came to include gaining air superiority, attacking command-control, long-range and short-range interdiction of ground forces, and long range reconnaissance. Thus the *Luftwaffe* was intended to be an instrument of decision on both the operational and tactical levels, but—and this is the critical part—not for the strategic air war that everyone had previously anticipated.



The rapid growth of the *Luftwaffe*, and the reputation it gained in the Spanish Civil War, made it a potent psychological weapon when Hitler confronted the Western powers during the Austrian and Czechoslovakian crises of 1938–39. Opposing governments and civilian populations, responding more to air war theories and propaganda than to military reality, were demoralized. Fearing aerially delivered destruction, they acquiesced to Nazi demands for concessions during the years of appeasement.

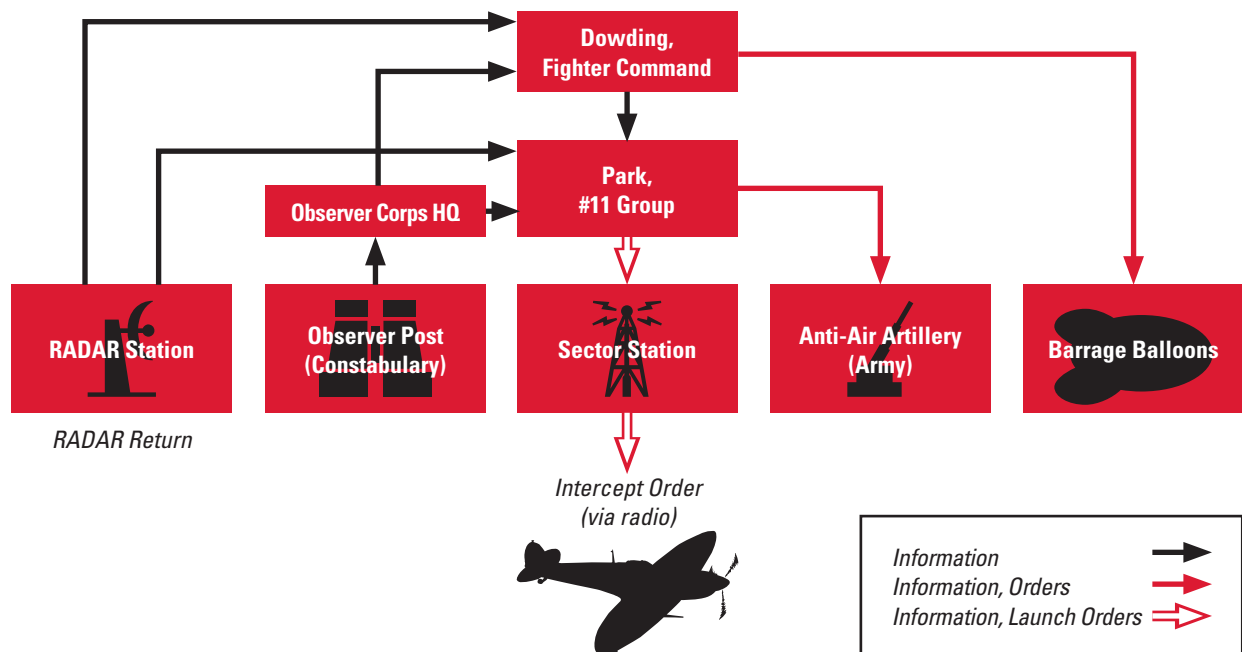
Fighter Command

During the early 1930s the RAF made the creation of Bomber Command its first priority. The RAF had to concentrate on one type of air mission, because civilian anti-war sentiment, and the economic effects of the global depression, made across-the-board arms expenditures politically unfeasible. Given the interwar theories of airpower, a large bomber force seemed to make sense since it would provide a deterrent to aggressive powers by threatening destruction of their cities.

Also, the bombers were also useful for the air defense of the British Empire since they could fly long distances and concentrate combat power rapidly against any foe, whether local rebels or aggressive major powers. Even so, like the *Luftwaffe*, Bomber Command was also limited by the technology of the day to being equipped mostly with medium bombers.

Despite the general belief in the supremacy of the heavy bomber, there were some who refused to abandon other aspects of airpower. One such

BRITISH COMMAND & CONTROL SYSTEM, 1940





LEFT: RAF Air Marshal Hugh Dowding.

CENTER: Flight Officer P M Wright supervises (right) as Sergeant K F Sperrin and WAAF operators Joan Lancaster, Elaine Miley, Gwen Arnold and Joyce Hollyoak work on the plotting map in the Receiver Room at Bawdsey CH, Suffolk.

ABOVE: The 360ft transmitter towers at Bawdsey Chain Home radar station, Suffolk, May 1945.

was Air Marshal Sir Hugh Dowding, the first head of RAF Fighter Command. He believed a well trained and well organized fighter force, backed by an effective ground organization, could stop bombers from getting through. Throughout the late 1930s he organized the air defense of Britain. Much was made of the lessons of British air defense practice during World War I: air defense consisted not simply of fighters, but of integrated systems, including anti-aircraft guns, ground-based observers, and centralized command-control facilities. Fighters were purpose-designed for interception, including (for the time) revolutionary monoplanes such as the Hurricane and Spitfire. Those aircraft could quickly climb to altitude, and had both the speed and the firepower to take on bombers.

The air war was also seen as a technological war, and the British promoted the early use of radar.

Squadrons Forward vs. Big Wings

Throughout the Battle of Britain, RAF commanders debated interception tactics. The *11 Group's* commander, Air Vice Marshall Sir Keith Park, utilized "squadrons forward." As soon as intruders were detected, individual squadrons would take to the air and attack them. The objective wasn't so much to destroy enemy aircraft as it was to disrupt bomber formations and force escorts to burn fuel. That would reduce the efficiency of the intruders before they reached their targets.

The *12 Group's* commander, Air Vice Marshal Sir Trafford Leigh-Mallory, instead practiced the "big wing" approach, by which all the intercepting squadrons from each sector would first form into one large mass before attacking the intruders. The objective was to shoot down a maximum number of enemy aircraft as quickly as possible. The downside of the big wing came from the fact it took time to form and, while the squadrons were doing that, the *Luftwaffe* would be hitting targets on the ground.

Both approaches made sense within context. The *11 Group* was in the direct path of the *Luftwaffe*, and its aircraft had to be quickly scrambled before their airfields were attacked. The *12 Group*, north of London, had the luxury of relatively secure airbases. In practice each tactic, when working together, had effects greater than the sum of their parts. Independent squadrons were frequently successful in disrupting bomber formations, to the point those bombers arrived over their objectives straggling and with some planes even unable to find their targets. The big wings caused considerable attrition to intruders and, in the longer run, it was the attrition of aircraft that would cost the Germans the battle. At the same time, the failure of the *Luftwaffe* to knock out British aircraft factories or destroy London was in no small part due to the disruption of its attack formations. And German fighters that had to burn fuel to engage RAF interceptors couldn't be there to protect bombers when the big wings hit. ♦

Their radar system included the Chain Home Line, which could detect aerial formations at up to 120 miles, and Chain Home Low, which could detect low-flying intruders. The latter was necessitated by the ability of aircraft to fly under the altitude of normal radar detection. The British also pioneered many techniques of cryptologic and electronic warfare, all of which would pay off later.

There were still other strategic considerations at work. The British had relatively easy access to all the materials needed to create an air force, either from directly within their own empire or from trade with neutrals such as the United States: fuel, lubricants, aluminum, and rubber. The Germans lacked ready supplies of all those items, having to rely on foreign imports that, once the war broke out, became ever harder for them to get. The Germans began experimenting with synthetic petroleum production in the late

1930s, but there was never enough to meet all the needs of the armed forces.

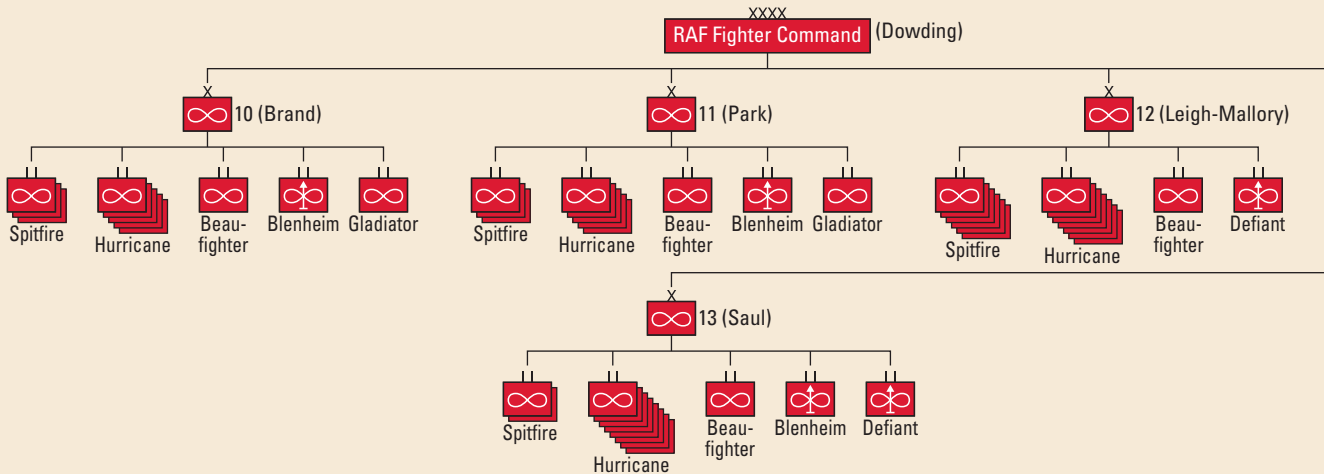
Aside from the British having the advantage of access to petroleum, their aviation fuel was also of better quality with a higher octane rating, giving better performance to their engines. Another area in which the British had a long-term advantage was in pilots. While the Battle of Britain would create a short-term crisis, in the longer run they could rely on a pool of aircrew drawn from their entire empire, as well as flyers from occupied countries who escaped German internment, and volunteers from the US.

War

Germany invaded Poland on 1 September 1939, and Britain and France responded with declarations of war. The Germans quickly overran Poland, then turned their attention

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RAF FIGHTER COMMAND



Royal Air Force (RAF)

In 1940 the RAF was organized into three major commands: Bomber Command, which was intended to take the war to the enemy; Coastal Defence Command, set up to protect British and Allied shipping and deal with the U-Boat threat; and Fighter Command, responsible for the air defense of Britain.

Fighter Command was organized into four groups (equivalent of a USAAF wing or *Luftwaffe Geschwader*), each responsible for the defense of a portion of the British Isles. Thus, *13 Group* was in the north, *12 Group* in the center, *11 Group* in the south-east and *10 Group* in the southwest.

Each group was divided into sectors, each with an aircraft wing of one to four squadrons. (That reversed the USAAF practice of making groups subordinate to wings.) Squadrons each had 12 or so aircraft, plus several spares. The latter were useful in keeping units at full strength when some aircraft had to be written off, though the shortage in pilots still almost cost the RAF the battle.

Aside from the aircraft, groups and sectors each included a complete air defense organization. A central headquarters plotted the locations of intruders, ordered aircraft scrambled, and directed interceptors in the air. There were also ground observers who would report intruders, anti-aircraft guns, searchlights, and barrage balloons for protection of targets. Of course, there was the radar that facilitated all of it.

Backing up Fighter Command was an efficient industrial organization. Lord Beaverbrook, in charge of aircraft production, ensured there was a steady supply of fighters to frontline units. The British would indisputably win the battle of production.

Luftwaffe

The Germans deployed three major *Luftwaffe* formations (*Luftflotte*) during the Battle of Britain: *Air Fleet Three* (northern France), *Air Fleet Two* (Low Countries) and *Air Fleet Five* (Scandinavia). An air fleet was the equivalent of a US numbered air force. It had all the aircraft needed to conduct an aerial campaign on a particular front: fighters, bombers, recon, transport and so on. The air fleet also controlled a number of anti-aircraft units.

The major subordinate unit of the air fleet was the *Fliegerkorps* (air corps), which would consist in turn of *Geschwader* (wings), *Gruppen* (groups), and *Staffeln* (squadrons). Specialized formations included the *Fliegerdivision* (air division) and *Fliegerfuhrer* (air command).

Logistics were provided by a ground organization, the *luftgau* (air district), which had a geographic area of responsibility. One of the major logistical challenges the Germans faced in 1940 was redeploying their air forces to forward fields in recently occupied countries for the assault on Britain. German ground crews at that time in of the war tended to be efficient, but the problem came from the lack of an equally efficient industrial base to back them. Sufficient numbers of spare parts and replacement aircraft weren't being produced, which meant the Germans would eventually lose any battle of attrition. While the *Luftwaffe* survived the Battle of Britain intact, the foundation for its eventual defeat was already present.

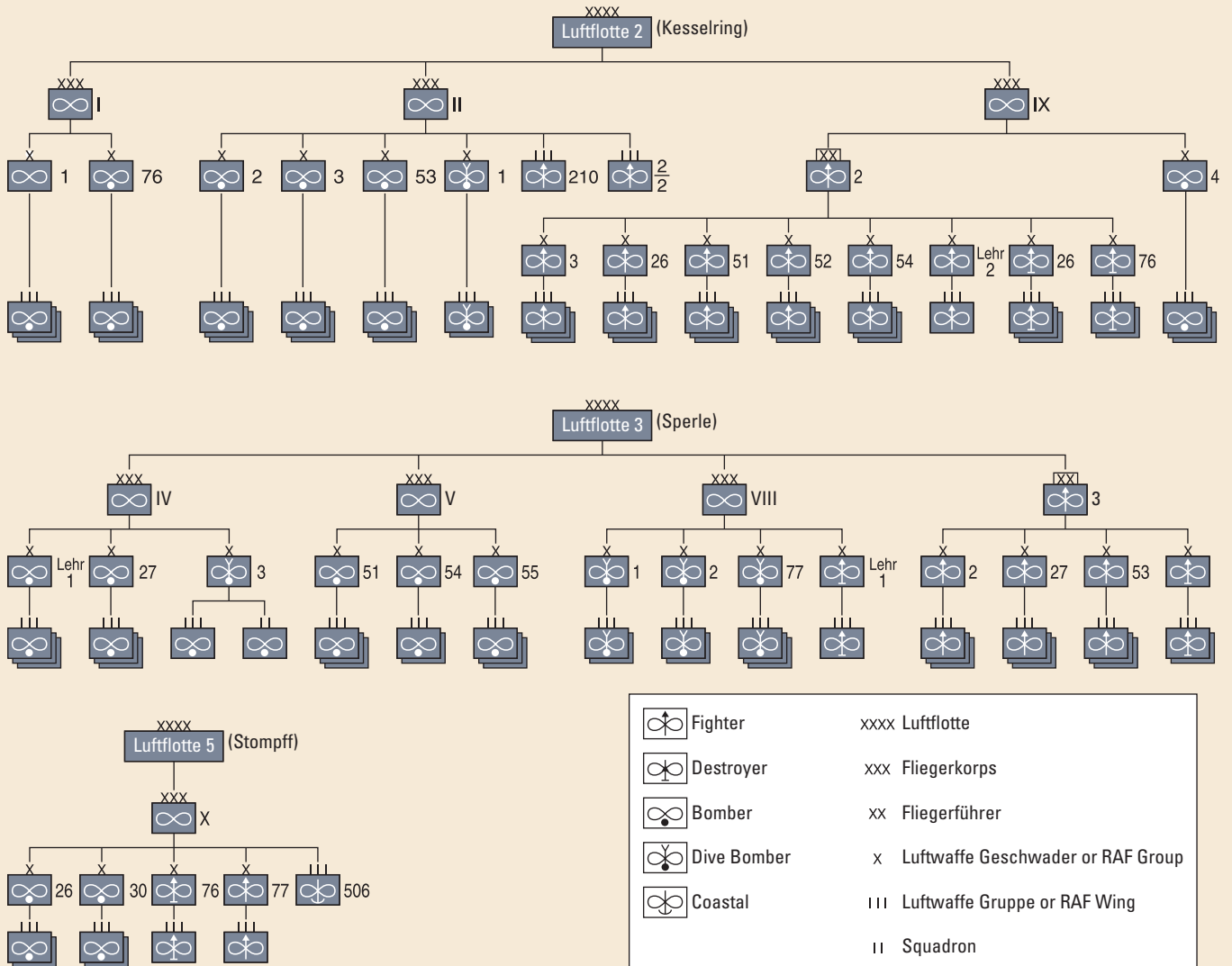
Corpo Aereo Italiano

With the Battle of Britain in full swing, Italian dictator Benito Mussolini decided to send a *Regia Aeronautica* (Italian Air Force) unit to reinforce the Germans, the *Corpo Aereo Italiano* (CAI – Italian Air Corps). The aircraft were flown from Italy to *Luftwaffe* fields in Belgium in late September, though their air operations against Britain didn't actually begin until 24 October, just as the battle was coming to an end.

The CAI's performance was poor. While Italy had been a pioneer in the air during the 1930s (Mussolini himself was a pilot), by 1940 its aircraft technology had fallen behind. During the campaign the *Regia Aeronautica* tried to use bi-planes to take on more modern aircraft. While those bi-planes were maneuverable, they lacked the speed to tackle monoplane fighters. The CAI also suffered from inadequate training and lack of navigational equipment, making aerial operations in the worsening weather difficult. Little was accomplished, and by January 1941 most of the aircraft were sent home. In the end, the main impact of the CAI in the Battle of Britain was providing Mussolini with some propaganda photo opportunities.

Italian air units were organized into *stormo*, which in turn consisted of two *gruppo*, each of two or three *squadriglia* (squadrons). For the battle of Britain the CAI had two bomber and one fighter *stormo*, plus a recon squadron. ♦

LUFTWAFFE ORGANIZATION IN THE WEST, 1940



LUFTWAFFE TOTAL STRENGTH AT SELECTED DATES

| TYPE | 11 MAY 1940 | 29 JUNE 1940 | 21 JUNE 1941 |
|---|-------------|--------------|--------------|
| Single engine fighters | 1,360 | 1,110 | 1,440 |
| Twin engine fighters & bomber destroyers | 350 | 360 | 450 |
| Medium bombers | 1,710 | 1,380 | 1,510 |
| Dive bombers & ground attack | 460 | 430 | 420 |
| Coastal | 240 | 230 | 220 |
| Recon | 660 | 570 | 830 |

to the Western Allies. For the first several months of the war, everyone expected the long anticipated air war against cities to erupt, but it didn't.

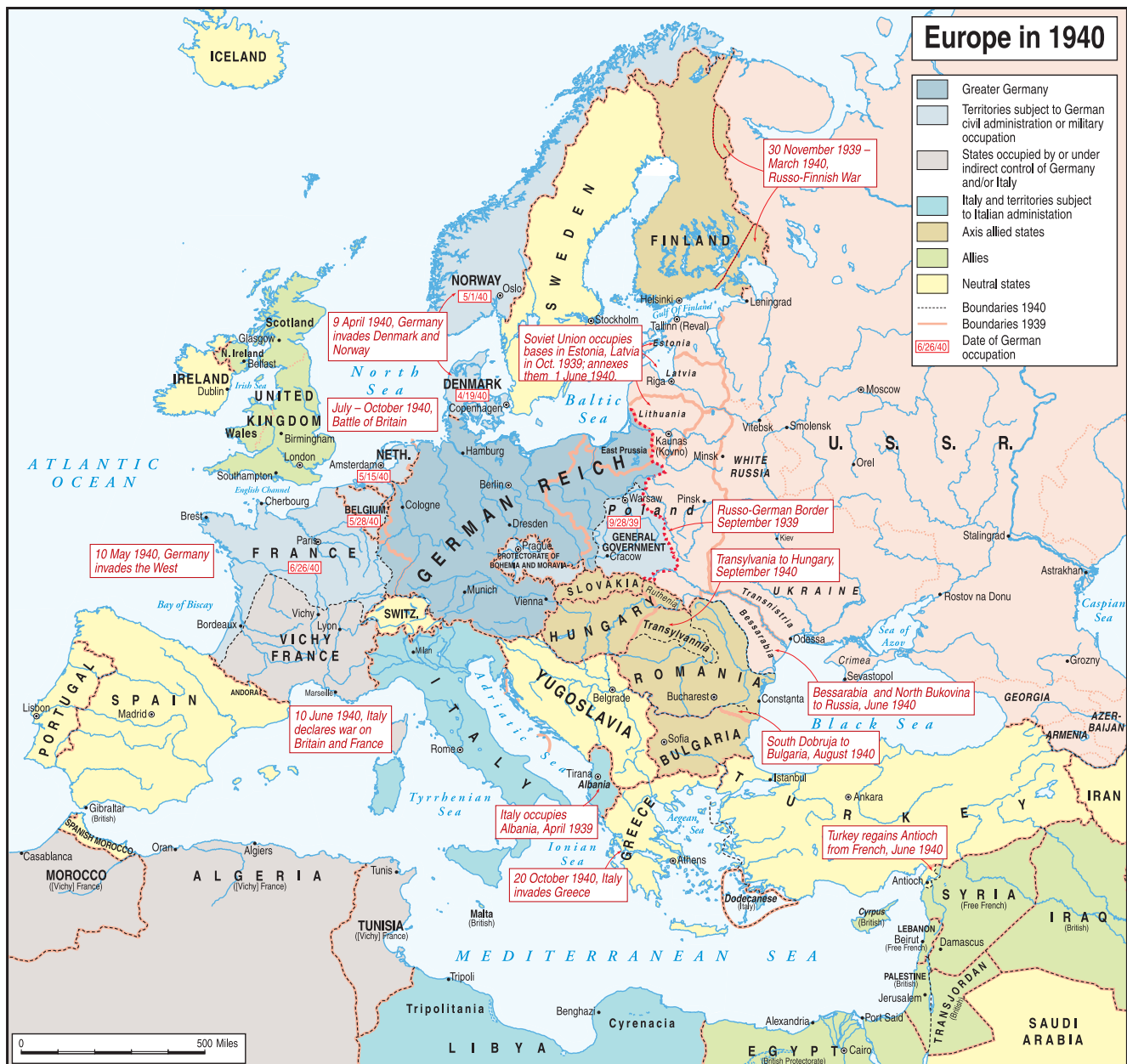
One reason was political. Both the German and British governments were concerned the initiation of such attacks would lead to massive retaliation by the enemy's air force. Another reason was military. No one really had the heavy bombers, as well as the long-range fighter escorts, to conduct such raids. A few British attempts to penetrate German air space with medium bombers led to unsustainably high losses. The French Air Force was poorly organized

(though with good aircraft) and its bomber component was oriented toward ground support. The *Luftwaffe* was conserving its strength for the coming spring ground offensive.

As is well known, the *Wehrmacht* quickly overran Scandinavia, the Low Countries, and France in April, May, and June 1940. The *Luftwaffe* proved decisive in those campaigns. It first established air superiority by attacking airfields, then struck deep against headquarters, troop concentrations, and lines of communication. German air superiority ensured Allied reconnaissance would not detect the panzers as they moved through the Ardennes and crossed the Meuse River to divide the

Allied armies. Close support missions concentrated German combat power at critical points along the front. The overwhelming presence of the *Luftwaffe* in the skies above western Europe also had psychological impact, demoralizing both Allied military forces and civilians.

As German ground forces approached the Dutch city of Rotterdam, the *Luftwaffe* launched an attack against it on 14 May. A thousand or so civilians were killed, and thousands of buildings were gutted. There's still debate over who exactly ordered the raid, along with some claims it had actually been cancelled but with half the bombers not getting the recall message in time. Regardless, in the



RAF & LUFTWAFFE STRENGTH FOR BATTLE OF BRITAIN (circa 1 July 1940)

| | RAF FIGHTER COMMAND | RAF OTHER | LUFTFLOTTE 2 & 3 (France & Low Countries) | LUFTFLOTTE 5 (SCANDINAVIA) | LUFTWAFFE TOTAL |
|--|---------------------|-----------|--|-------------------------------|-----------------|
| Single engine fighters | 754 | - | 760 | 30 | 1,110 |
| Twin engine fighters & bomber destroyers | 149 | - | 220 | 30 | 360 |
| Medium bombers | - | 560 | 1,200 | 130 | 1,380 |
| Dive bombers | - | - | 280 | - | 430 |
| Coastal | - | 500 | - | - | 230 |
| Recon | ? | ? | 140 | 30 | 570 |

As can be seen in the table above, the RAF had a rough equivalency in fighters with the *Luftwaffe*. Still, those numbers have to be looked at critically. Many of the fighters on both sides weren't suited to the conditions of the battle, such as the Me-110, Blenheim, Defiant, and Gladiator.

There's also a difference between total numbers and the number that could actually be deployed. Some of the *Luftwaffe* strength was in *Air Fleet Five* in Scandinavia, and could operate only at ranges too long for its fighters, which then put its bombers at considerable risk. Fighter Command had a third of its strength in *10* and *13 Groups*, which weren't as heavily committed as *11* and *12 Groups*, though they were a source of replacement pilots and aircraft. Aside from Fighter Command, the RAF had its Bomber and Coastal Commands attacking staging areas for Sealion and mining the Channel.

Another thing to consider is the "operational rate." That's the percentage of aircraft available for flying, as opposed to total numbers in the inventory. At the start of the Battle of Britain, *Luftwaffe* operational rates were high. They then fell off, though, often to less than 50 percent in some units. Increasing the number of sorties flown put more aircraft in the air, but at the cost of increasing maintenance requirements on overworked ground crews. Damaged aircraft also had to be repaired. Exacerbating the *Luftwaffe's* situation was the failure of the German aircraft industry to produce sufficient numbers of spare parts. That was due to pre-war *Luftwaffe* planning that had emphasized the creation of a large air force as opposed to one that could be maintained to fight a long war.

BATTLE OF BRITAIN AIRCRAFT LOSSES

| RAF | | LUFTWAFFE | | | | |
|----------|--------|-----------|--------|-------|---------|-------|
| Fighters | Others | Me-109 | Me-110 | Ju-87 | Bombers | Other |
| 1,004 | 61 | 636 | 243 | 80 | 881 | 82 |

Accounts of the Battle of Britain show the *Luftwaffe* taking more aircraft losses than the RAF, but a number of things need to be kept in mind. A certain percentage of German losses were owing to anti-aircraft fire. German pilots were often shot down over enemy territory; so, even if they bailed out, they couldn't return to service, unlike RAF aircrew who were operating over friendly territory. Then there were the intangibles, such as pilot quality. The longer the campaign lasted, the more those intangibles would have an effect as veteran pilots were killed or captured and aircrew fatigue set in. A week of combat operations was usually enough to render a pilot ineffective until rested. Aircraft were also lost to accidents and enemy attacks on airfields.

The more meaningful comparison in losses needs to be made between fighters, since they were ultimately what counted for air superiority. As can be seen, the Germans actually shot down more fighters than did the RAF. That vindicates *Luftwaffe* tactics, though not its overall strategy.

The Germans had an advantage insofar as they held the initiative throughout the battle, being able to select the intensity of operations

depending on the mission and timing in which they committed their aircraft. Fighter Command, despite radar, often lost track of intruders and couldn't efficiently commit its full strength. *Luftwaffe* attacks on RAF airfields disrupted British operations, while *Luftwaffe* airfields weren't usually attacked by Bomber Command because it was kept busy attacking Sealion ports.

One area where the RAF held the advantage was in the British war economy, in that it was geared up for fighter production. RAF squadrons could each maintain several aircraft in reserve; so pilots whose aircraft were damaged or otherwise in need of maintenance could still fly. In comparison, German industry still emphasized bombers at that time in the war and would continue to do so until 1944. The German economy was also still on a partial peacetime basis in 1940. The result was too much of *Luftwaffe* strength was "up front," capable of inflicting telling blows in the short term but inescapably falling off in strength over the course of a long campaign. At the start of Operation Barbarossa, *Luftwaffe* strength wasn't much more than it had been at the start of the Battle of Britain. ♦

ROYAL AIR FORCE AIRCRAFT

| MODEL | TYPE | MAX. SPEED (mph) | CRUISING SPEED (mph) | RANGE (miles) | ARMAMENT (no. of guns & caliber) | PAYLOAD (lbs bombs) | CREW | ENGINES (no. & hp) | WEIGHT (loaded, lbs) | NOTES |
|---------------|------------------|------------------|----------------------|---------------|----------------------------------|---------------------|------|--------------------|----------------------|--|
| Hurricane I | Fighter | 324 | 254 | 425 | 8 x 7.7mm | - | 1 | 1 x 1,030 | 6,158 | |
| Spitfire IA | Fighter | 362 | 280 | 575 | 8 x 7.7mm | - | 1 | 1 x 1,030 | 5,811 | Some models had 2 x 20mm cannon and 4 x 7.7mm machineguns. |
| Beaufighter I | Night fighter | 323 | ? | 1,271 | 4 x 20mm, 6 x 7.8mm | - | 2 | 2 x 1,590 | 20,800 | |
| Blenheim IF | Bomber destroyer | 285 | 200 | 1,125 | 5 x 7.7mm | - | 3 | 2 x 840 | 12,500 | Converted bomber |
| Defiant I | Bomber destroyer | 304 | 259 | 465 | 4 x 7.7mm | - | 2 | 1 x 1,030 | 8,318 | Guns in power turret |
| Gladiator II | Fighter | 253 | 210 | 444 | 4 x 7.7mm | - | 1 | 1 x 840 | 4,750 | Bi-plane |
| B-17G (USAAF) | Heavy bomber | 287 | 182 | 2,000 | 13 x 12.7mm | 17,600 | 10 | 4 x 1,200 | 65,500 | US bomber, included for comparison. |

Notes:

- 1) Figures may vary depending on aircraft model and methods of evaluating performance.
- 2) The range given is the maximum from take off to landing. Actual combat ranges would be less, since fuel would be expended in forming up and in maneuvers while engaging enemy aircraft. Luftwaffe fighters also expended considerable fuel keeping station on the slower bombers they were escorting. Given all that, combat radius—the distance from base to target—might be a third of the maximum range.

ensuing panic the Dutch capitulated. The Rotterdam raid seemed to vindicate the advocates of terror bombing against civilians, since it did lead to the surrender of the Netherlands. What was missed was the fact the attack occurred as part of a successful ground offensive against a largely unprepared foe. The Netherlands had been neutral until the campaign began.

The destruction of Rotterdam had another effect, which was to end the British policy of avoiding city bombing. The day following the attack, the RAF launched a retaliatory raid against the German industrial heartland in the Ruhr. That was the beginning of a pattern to be seen throughout the rest of the war: retaliatory air raids, often conducted more to bolster home front morale than to have any real or lasting effect on the enemy.

Yet another incident marred the performance of the *Luftwaffe*. As Allied forces evacuated the continent through the Channel port of Dunkirk, Herman Goering ordered the *Luftwaffe* to destroy

them from the air. The *panzers* were needed for the drive on Paris to the south, and Goering believed airpower alone could do the job. The British successfully evacuated some 340,000 Allied troops from the beaches, albeit while abandoning most of their heavy equipment. Fighter Command successfully contested control of the air, making it difficult for the *Luftwaffe* simply to get through to the beaches. The RAF could do that because it was fighting the kind of air war for which it had prepared: a battle against enemy aerial intruders.

Dunkirk, though, was a defensive victory at best. The Germans took Paris on 14 June and France capitulated on the 22nd. Germany stood triumphant across western Europe. Airpower had contributed to the stunning victory that, in the course of a few weeks, had achieved what the Kaiser's armies couldn't do in four years—win a decisive victory in the west. With Britain left to stand alone, the greatest air campaign to date would inevitably be fought.

Sealion

With German armed forces on the Channel coast, the question for their high command was: what next? The obvious answer, since London refused to negotiate a separate peace, was that Britain itself would have to be knocked out of the war. Accordingly, the Germans began planning for Operation Sealion, the cross-Channel invasion of the British Isles.

There is still debate over the actual objective of Sealion. It was possibly a serious attempt at invasion. Another interpretation, however, is that it was really nothing more than a gigantic bluff intended to move the British to make peace. Hitler's ultimate objectives were in the east, conquering the vast territory of the Soviet Union with its agricultural and industrial resources. Hitler believed the British would see the advantage of a peace that would guarantee the existence of both the Nazi and British Empires.

The German high command came up with several different Sealion plans.

| LUFTWAFFE AIRCRAFT | | | | | | | | | | |
|--------------------|------------------|------------------|----------------------|---------------|----------------------------------|---------------------|------|--------------------|----------------------|--|
| MODEL | TYPE | MAX. SPEED (mph) | CRUISING SPEED (mph) | RANGE (miles) | ARMAMENT (no. of guns & caliber) | PAYLOAD (lbs bombs) | CREW | ENGINES (no. & hp) | WEIGHT (loaded, lbs) | NOTES |
| Me-109 E | Fighter | 350 | 305 | 410 | 2 x 20mm, 2 x 7.7 mm | 550 (see notes) | 1 | 1 x 1020 | 5,875 | Only E-4B variant carried bombs |
| Me-110 C | Destroyer | 336 | 217 | 680 | 2 x 20mm, 5 x 7.7 mm | 1,100 | 2 | 2 x 1,100 | 40,786 | |
| Do-17 Z | Medium bomber | 265 | 216 | 745 | 4-6 x 7.9mm | 2,200 | 4 | 2 x 940 | 18,931 | |
| FW-200 | Maritime bomber | 224 | 208 | 2,212 | 4 x 13mm, 1 x 20mm | 2,200 | ? | 4 x 1,200 | 50,057 | |
| He-111 H | Medium bomber | 247 | 202 | 1,224 | 3-5 7.9mm | 4,400 | 5 | 2 x 1100 | 29,762 | |
| Ju-87 B | Dive bomber | 238 | 209 | 490 | 3 x 7.9mm | 1,100 | 2 | 1 x 1,100 | 9,560 | |
| Ju-88 A | Medium bomber | 280 | 222 | 1,050 | 5 x 7.9mm | 4,400 | 4 | 2 x 1,200 | 22,840 | |
| He-100 D | Fighter | 416 | ? | 625 | 1 x 20mm, 2 x 7.9mm | - | 1 | 1 x 1,175 | 5,512 | Produced but not deployed |
| Do-19 | Strategic bomber | 217 | 155 | 1,600 | 2 x 20mm, 2 x 7.9mm | 3,527 | 9 | 4 x 715 | 22,125 | Pre-war prototype |
| He-177 A | Strategic bomber | 303 | ? | 3,100 | 2 x 20mm, 3 x 13mm, 3 x 7.9mm | 13,228 | 6 | 2 x 3,100 | 68,342 | Deployed in late 1942; some models carried air-to-surface guided missiles. |

They all would've moved divisions across the Channel via amphibious assault, with airborne units making paradrops in support. The *Luftwaffe* would provide air cover. The real threat to the invaders wasn't so much the British ground forces, which were still in disarray after Dunkirk, but the Royal Navy. The British had naval superiority, made all the more complete by the destruction of much of the *Kriegsmarine* during the recently concluded Norwegian campaign. The *Luftwaffe* would therefore have to guard the invasion flotilla from naval as well as aerial attack. That meant the Germans would have to have air superiority over the Channel and southern England in order to even get the invasion force ashore.

There were also other influences at work. Dusting off some of the prevailing interwar theories about airpower, some German planners hoped, if they could gain air superiority over London and other critical cities, the mere threat of the aerial destruction of those

urban areas would be enough to bring the British to the bargaining table. At the same time, RAF Bomber Command would be deterred from making similar attacks against German cities.

Another strategy was the *Luftwaffe*, in coordination with Germany's U-boats, could interdict the waters surrounding the British Isles. Cut off from its sources of raw materials and food, Britain could be starved into capitulation. That wasn't an unreasonable objective, and the later experience of the U-boat campaign, as well as the *Luftwaffe's* later use of maritime attack aircraft, indicates it might have had some success if the full strength of the *Luftwaffe* could be applied to it.

The Germans didn't have that time. Hitler's ultimate objective remained the Soviet Union, the destruction of Bolshevism, and the seizure of the Eurasian heartland for the creation of an eastern German Empire. More, there was the political situation in Europe to consider. A defiant

Britain would inspire resistance in the occupied countries. Hitler had hoped to bring both Vichy France and Nationalist Spain into the war on his side. A quick blow delivered against Britain would be sure to cement them as continental allies.

Finally, there was the situation on the southern flank. With the entry of Fascist Italy into the war, the entire Mediterranean had been opened as a theater of operations. In the Mediterranean the British had distinct advantages owing to their naval and air bases in Gibraltar, Malta, and Alexandria, coupled with the general Italian unpreparedness for war. Continued British participation in the war could—and in the ensuing years, would—demand the diversion of resources away from the Russian campaign and into peripheral ventures in Africa and the Middle East. With all that in mind, then, the *Luftwaffe* readied its planes and airfields for an aerial assault on Britain.

The Battle of Britain 1940



RAF Fighter Command

- xxxx Stanmore Command Headquarters
- oo Group Headquarters
- x Sector Station
- x Fighter Station
- RAF Command Boundary
- Sector Station Boundary
- ⚡ Low-level Radar Station
- ⚡ High-level Radar Station
- ☀ Cities Bombed

Luftwaffe Command

- oooo Luftflotte
- x Bomber Bases
- x Stuka (Dive-Bomber) Bases
- o Fighter Bases (Bf 109)
- o Twin-Engine Fighter Bases (Bf 110)
- RAF Command Boundary

xxxx
FIVE
(Stompff)
(In Norway & Denmark)

Cover of high-level radar (15,000 ft.)

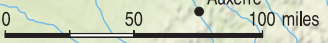
Cover of low-level radar (500 ft.)

Cover of low-level radar (500 ft.)

Cover of high-level radar (15,000 ft.)

xxxx
THREE
(Sperrle)

xxxx
TWO
(Kesselring)



Battle

The Battle of Britain is usually divided into several phases by historians. In general, those phases were as follows.

English Channel Battles: The campaign began on 10 July with the *Luftwaffe* attempting to gain control of the air over the English Channel and attacking coastal shipping. The Germans were generally successful in interdicting British coastal shipping.

Fight for Air Superiority: The Battle of Britain proper officially began on 10 August, designated by Goering as *Adlertag* (Eagle Day), though it was then delayed until the 13th owing to bad weather. This was the *Luftwaffe* assault on the Royal Air Force itself. *Air Fleets Two* and *Three*, based in northern France and the Low Countries, carried the bulk of the aerial battle from the south. *Air Fleet Five*, in Scandinavia, went after targets farther north.

German objectives were to attack airfields and aircraft factories, especially engine production, while luring British interceptors into the air where they could be destroyed by superior numbers of German fighters. The Germans also attacked British radar towers but, after some success, stopped in order to concentrate on airfield attacks.

Things didn't go according to the *Luftwaffe's* plan. Despite German claims of having effectively destroyed Fighter Command, the RAF always remained able to put fighters in the air, and German bombers took heavy losses. The Me-110 long-range "destroyer" proved to be a liability, unable to engage the more nimble British fighters. While the Me-109 was superior to most British aircraft, it lacked the endurance to stay in the air long enough to escort bombers and fight for air superiority. London was the 109s' farthest practical limit of operation. *Air Fleet Five's* targets were all beyond effective fighter range, and its unescorted bombers were badly shot up. Nonetheless, that threat on the northern front forced the British to divert air strength from the battle to the south.

Growing losses caused the *Luftwaffe* to completely withdraw the Stukas. Fighters were ordered to conduct close escort of the medium bombers. That caused ire among the fighter pilots, who wanted to conduct "sweeps" of British airspace in order to be able to most efficiently engage and destroy the RAF. Meanwhile, Bomber Command launched air raids against continental ports and other staging areas for Sealion, while Coastal Command attempted to interdict the Channel via mine laying.

Massed Bomber Assault: This phase began on 24 August. Bombers in close formation, escorted by large numbers of fighters, attacked critical targets, especially Fighter Command airfields. That forced the forward groups of Fighter Command to rise to their own defense or face destruction on the ground. The new *Luftwaffe* tactic proved capable of punching through RAF air defenses and forcing the British to engage on the *Luftwaffe's* terms.

Both sides exaggerated the number of enemy aircraft shot down, but the Germans certainly got the worst of it. Nonetheless, the repeated attacks took a toll on RAF efficiency. Many pilots suffered from fatigue. The British partially solved that problem by rotating in squadrons from the north, but trained pilots couldn't be replaced in sufficient numbers.

Assault on London: This phase began on 7 September, with the *Luftwaffe* making alternating day and night raids against London. The German objective was to force the RAF to come up and fight in massive air battles to defend the capital, where the last of British fighter strength could then be destroyed. The Germans initially attacked military targets, such as the London docks, and inflicted considerable damage. They later shifted to terror attacks, hoping to break British morale.

Both sides continued to prepare for Sealion, with the British at one time even issuing an alert that invasion is "imminent." Bomber Command intensified attacks on

Fighter Formations



The aerial battles of World War I caused debate over the best formation in which fighters could be employed. One answer was in the three-finger "Vic" (it resembled a "V" in the air). The flight leader would go in for the kill while his two wingmen covered him. The RAF still used the Vic at the start of the Battle of Britain since, in theory, it put maximum firepower forward against enemy bombers. The formation was overly rigid, however, and its effectiveness depended entirely on that of the leader.



The *Luftwaffe* pioneered the *Schwarme* (flight), from its experience in the Spanish Civil War. It consisted of two *Rotte* (pair) of two aircraft each. Each *Rotte* consisted of one pilot and one wingman. The *Schwarme* proved in practice to be much more flexible than the Vic. Each *Rotte* could cover the other, or act independently. The *Schwarme* gave a real advantage against enemy fighters flying in Vics, since it put four fighters with two leaders against three fighters with only one leader. The RAF would adopt the *Luftwaffe* tactic in 1941. ♦

invasion staging areas. Hitler, growing ever more pessimistic about the outcome of Sealion, kept postponing its launch date. Bad weather began to limit the extent of German air raids. On 15 September a *Luftwaffe* raid on London was entirely broken up by the RAF's *11* and *12 Groups*. The bombers that reached the city were badly disorganized and inflicted insignificant damage.

Fighter Sweeps: Following the defeat of the 15 September raid, the *Luftwaffe* reverted to fighter sweeps along with hit-and-run attacks by bomb-carrying Me-109s. The Germans gained some success using small bomber formations as “bait,” with Me-109s counterattacking RAF interceptors, but the *Luftwaffe* was exhausted. The Germans concluded Sealion was unfeasible, owing to their inability to gain air superiority and the weather. By the end of October, the Battle of Britain was over with a clear British victory.

Conclusions

The RAF emerged as the victor in the Battle of Britain, first, because Fighter Command had actually been prepared for the kind of war it ended up fighting. The *Luftwaffe* hadn't been so lucky. Fighter Command had the aircraft, the command-control system, and all the rest of the elements of a full-fledged air defense system. The *Luftwaffe* lacked even the doctrine and training needed to fight an independent, protracted aerial campaign over enemy territory.

As one example, the British radar and ground observation systems gave Fighter Command a tremendous advantage in intelligence. The British always had a reasonable picture of

where intruders were over British territory. The Germans, on the other hand, were flying over enemy territory with only a vague idea where British aerial formations were located. The *Luftwaffe*'s usual adeptness at long-range reconnaissance failed in a situation for which it wasn't prepared.

In fairness, the *Luftwaffe* hadn't been intended to fight a strategic air campaign and, given the situation, it performed adequately. It may simply have been that the technology needed to conduct decisive strategic bombing wasn't available—to anyone—in 1940. Most notable was the lack of bombsights that could place ordnance accurately on target.



Aldwych tube station being used as a bomb shelter in 1940.

The Blitz

The “Blitz” was the British term for the *Luftwaffe* bomber attacks on their cities, which continued through to May of 1941. The initial objective of those raids was to destroy aircraft factories and military facilities such as docks, but shifted to terror attacks in the hope of breaking British morale. Later they were downgraded to nuisance raids. The *Luftwaffe* shifted from day to night raids against cities to reduce its losses at the expense of accuracy. At the start of the battle, the RAF lacked an effective night fighter, but the introduction of the Beaufighter in large numbers in 1941, along with the improvement of anti-aircraft and searchlight defenses, made night attacks increasingly expensive for the *Luftwaffe*. Hitler's decision to turn against the Soviet Union with the opening of Operation Barbarossa in June 1941 brought an end to the Blitz. ◆

Royal Air Force

The Battle of Britain was the first independent air campaign in history, and many of the shortfalls on both sides, while clear in retrospect, until then had no precedent. A case in point was the revealed vulnerability of unescorted bombers against interceptors. RAF Bomber Command never developed an effective long-range escort for its intruders over German skies, eventually abandoning daylight bombing for night attack. The US Army Air Force (USAAF) didn't deploy sufficient numbers of long-range fighters to support its own daylight bombing campaign until early 1944, when it seized control of the skies over Germany. Despite having the experience of the Battle of Britain on which to draw, Allied air forces made little use of range-extending drop tanks until late in the war.

Another part of the German dilemma in 1940 was their constantly changing objectives. The shift from airfield attack to city bombing to fighter sweeps meant that, just when results from one approach were starting to pay off, *Luftwaffe* units were switched to something else, and the RAF was given a reprieve. The Germans failed to adhere to one of the basic principles of warfare: maintaining concentration on the objective. Instead they constantly shifted tactics, trying to find some formula that would bring quick victory. The result was that anything accomplished ended up having its effects dissipated, and the RAF was allowed to recover.

All that was one symptom of a larger problem: the Germans never had an overall plan. Theoretically, the *Luftwaffe* was to pave the way for the Sealion operation. Yet Sealion itself was probably impractical, assuming it represented a serious effort to invade Britain. Even had the *Luftwaffe* attained air superiority, it remains uncertain that would have been enough to ensure safe passage for the invasion force across the Channel. The British were ready to sacrifice the Royal Navy to stop the invasion. The lack of a realistic amphibious component meant the aerial battle took on a life of its own, with the *Luftwaffe* having to attempt to defeat the British alone.

Seen in terms of the overall war, the Battle of Britain had considerable effect contributing to the *Luftwaffe's* eventual loss of air superiority over Europe. The losses during the Battle of Britain were part of a long process of attrition, with the *Luftwaffe* losing aircraft during the 1940 campaign in the West, in the Mediterranean, in the Balkan campaign of 1941, as well as in various actions along the aerial periphery of the Reich, such as the maritime attacks on Allied convoys. As for the shortfalls in petroleum, pilot training and spare parts, they were never adequately addressed and eventually led to the collapse of the *Luftwaffe*.

The Battle of Britain was Hitler's first real defeat, after his long run of victories both before the war and during its opening year. The outcome of the air battle contributed to Franco's decision to keep Spain neutral, while encouraging resistance against the Nazis throughout occupied Europe. Fighter Command had demonstrated that the much anticipated aerial apocalypse could be averted and defeated. ❖

Hurricane: The Hurricane was the RAF's first monoplane fighter, entering service in 1937. By 1940 it was outclassed by the Me-109, though it could still hold its own in an aerial fight. Fighter command ended up using Spitfires to engage German fighters while the Hurricanes went after the bombers.



Spitfire: The Spitfire was a purpose-built interceptor. It was an overall match for the Me-109, and had a much tighter turning radius. While the range of the Spitfire wasn't much more than that of the Me-109, the British were operating over friendly territory where they could land and refuel—unlike the *Luftwaffe*, which was operating at the limits of its planes' endurance.



Beaufighter: This was a twin engine interceptor that gave good service during the latter phases of the Battle of Britain as a night fighter. It was equipped with radar.



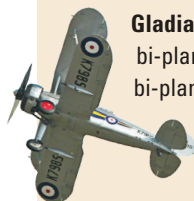
Blenheim: The Blenheim was a fighter version of the British light bomber. It was supposed to be used to intercept and destroy enemy bombers that had no fighter escorts, and to provide protection for British intruders in enemy air space. But the Blenheim lacked the speed and the guns to perform either mission, as well as being vulnerable to enemy fighters. It ended up a night-fighter.



Defiant: This peculiar aircraft was the result of a 1930s Air Ministry directive to build a fighter equipped with a turret to the rear of the pilot's position. The idea was the turret guns would have a wider field of fire than the usual fighter armament of fixed forward firing guns. In the air in 1940 the Defiant proved to be something of a liability. If attacked directly from the rear, it could throw up a hail of lead; otherwise, it was vulnerable and the turret created drag. It ended up as a night-fighter and air-sea rescue plane.



Gladiator: Britain, like most of the major powers, still had bi-planes in its inventory when World War II began. The bi-plane configuration was supposed to give the aircraft more maneuverability; however, by 1940 the Gladiator was thoroughly outclassed by single-engine aircraft.

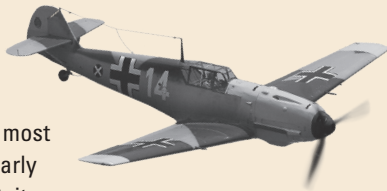


USAAF B-17: The Boeing B-17G "Flying Fortress" is included for comparison, being one of the mainstays of the strategic bombing campaign against Nazi Germany later in the war. Despite having several times the firepower of the *Luftwaffe's* medium bombers, the B-17 still had difficulty in fighting its way through to targets without escorting fighters. In 1940 the German aircraft industry wasn't capable of producing a similar aircraft. ❖

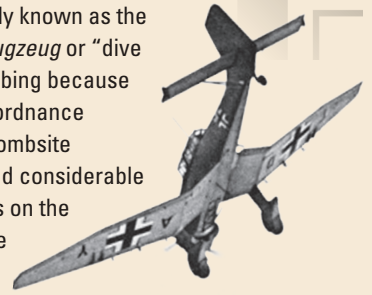




Messerschmitt-109: This was Germany's premier fighter when World War II opened. It was superior to most Allied fighters during the early war, and the equal of the Spitfire. One advantage of the Me-109 was its fuel injection system, which gave it the capability to go into steep dives that would lose most pursuers. Designed as an interceptor and air superiority aircraft, it lacked the range to support strategic bombing missions. Ironically, fuel drop tanks were developed for the 109 during the Spanish Civil War, but they weren't used in the Battle of Britain. The aircraft is often referred to as the Bf-109, "Bf" standing for *Bayerische Flugzeugwerke* (Bavarian Aircraft Manufacturers).



Junkers-87: The Ju-87 was more commonly known as the "Stuka" (an abbreviation for *Sturzkampfflugzeug* or "dive bomber"). The *Luftwaffe* favored dive bombing because it was a more accurate way of delivering ordnance to the target, given the primitive state of bombsight technology in the 1930s. The Stuka also had considerable psychological effect on unprepared troops on the ground. It proved to be a liability during the Battle of Britain, however, being vulnerable to interception.



Junkers-88: The Ju-88 was one of the mainstays of the *Luftwaffe*, and was flown as a bomber, maritime attack, recon, transport and night fighter. It had good speed and maneuverability. One design decision was to have all the crew members together in the same compartment, the idea being to make for good communication and cohesion.



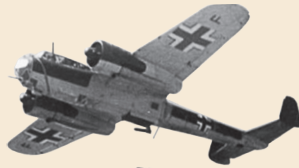
Messerschmitt -110: The *Luftwaffe* intended the Me-110 as a *Zerstroyer* (destroyer) aircraft. It was to penetrate into enemy territory and use its heavy armament to shoot down fighters in the air and strafe them on their airfields. In practice, the 110 lacked the maneuverability to deal with modern fighters. It was used in the Battle of Britain because its range gave it some capability to escort bombers, though it took heavy losses when doing so. It later saw successful use as a bomber destroyer.



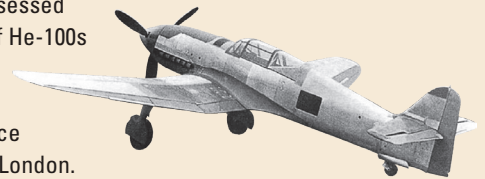
Dornier 19: The Do-19 was the brainchild of the *Luftwaffe's* first chief of staff, Walther Wever, back in the 1930s. It was to have been a four-engine heavy bomber, capable of conducting strategic missions. Three prototypes were completed, but Wever's death in 1936 ended the program.



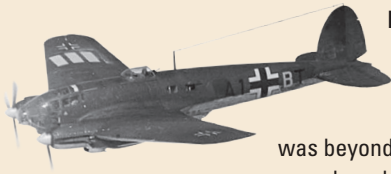
Dornier-17: The Do-17 was a fast, light bomber that proved useful for hit-and-run attacks on airfields.



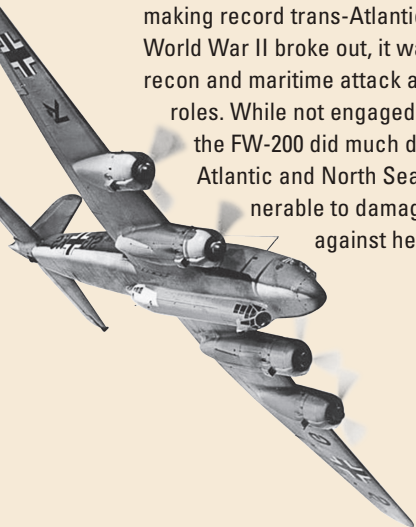
Heinkel 100: The He-100 was designed as a high speed fighter and was produced in limited numbers in the late 1930s, with some attempts to sell them overseas. What makes the aircraft of interest was its long range compared to the Me-109. Had the Germans possessed significant numbers of He-100s in the summer of 1940, they might have tipped the balance in the air battles over London.



Heinkel-111: The He-111's operational history went back to the Spanish Civil War, but by the time of the Battle of Britain it was beyond its prime. Among other things, it was vulnerable to interceptors. Still, it remained in service throughout the war, owing to the inability of the *Luftwaffe* to produce an adequate replacement.



Focke Wolf-200: The "Condor" started as a civilian airliner, making record trans-Atlantic flights during the late 1930s. When World War II broke out, it was adapted to service as a long-range recon and maritime attack aircraft, and proved successful in both roles. While not engaged in targets on the British mainland, the FW-200 did much damage to Allied shipping in the North Atlantic and North Sea. Its main drawback was it was vulnerable to damage, making it impractical for air raids against heavily defended targets.



Heinkel 177: The He-177 *Greff* (Griffin) was the one operational heavy bomber the Germans managed to produce during the war, and it's included here for comparison. The He-177 had a flawed development history, much of which revolved around the inability of German industry to provide an engine of sufficient power. To make up for that shortfall, the design incorporated four engines, each coupled to two propellers. That led to all kinds of maintenance and operational problems, chief of which was the habit of the engines to catch fire. Hitler referred to the He-177 as the "worst junk ever," a remark that could have hardly endeared the aircraft to its crews. ♦

