The Best of the Breed

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Anyone who believes that he can satisfactorily demonstrate which WWII fighter was the "best" out of the whole bag that appeared from 1940 to 1945 is incredibly naive. There are so many performance variables and kinds of missions, that arguing them to all to a bedrock conclusion that would convince everyone is virtually impossible. There were a few generally acknowledged leaders, however, fighters which became household words the world over: the Spitfire, Mustang, Thunderbolt, Focke-Wulf 190 all proved themselves in the crucible of war. The Me 262 was the first operational jet fighter and a dazzling achievement, years ahead of anything we had. But another household work, the highly propagandized Me 109G, was obsolete when it was built and was aerodynamically the most inefficient fighter of its time. It was a hopeless collection of lumps, bumps, stiff controls, and placed its pilot in a cramped, squarish cockpit with poor visibility.

Putting aside the relative merits of one fighter versus another, there was a simple truth that quickly emerged from your first engagement with the enemy: whichever one of you saw the other one first had the winning advantage.

The most subjective variable is the experience and ability of the pilots. Their state of training was certainly an essential factor. Thus Clair Chennault was able to recruit experienced Army and Navy reserve pilots and civilians with a solid log book into the AVG "Flying Tigers", who flew for China in 1941, and chalked up a 12 to 1 victory loss ratio with P-40s. However, he warned new arrivals, "You've got to be good out here; when you tackle a Zero in a P-40 you are already outnumbered 3 to 1." He despaired of the P-40 as a weapon, but it was all he could get. The ultimate measure of combat effectiveness in fighter operations is the victory-to-loss ratio and there are several factors in the equation that one can juggle if necessary, but you deal yourself all the high cards that you can. Chennault's low cards were the P-40 and rotten logistic support; his high cards were experienced pilots, tactical genius, and dogged determination. That's another way of saying that unless you were willing to close with the enemy in decisive combat, using all the advantages that you have, and carve your initials on him, then your government made a mistake in pinning those wings on you.

So I must leave it to the reader to conjecture about pilots and crews while we talk about airplanes. What follows is intended to give the average aviation enthusiast some idea of how the fighters in Europe compared with each other in performance and maneuverability. The data on British and German aircraft come from the Royal Aircraft Establishment, Farnborough. Data on the American fighters come from the National Advisory Committee for Aeronautics test reports and, in addition, figures on the Mustang have been verified by data from North American Aviation flight test reports where it was possible to do so.

The first German aircraft that was shot down over England and which landed intact was a Heinkel 111 brought down on 28 October 1939. Two of the four crew were dead but the airplane survived in one piece except for a few bullet holes. A Ju 88 was shot down a few days before, but it crashed into the sea, a total loss. As the war went on into 1940 and the Battle of Britain was engaged, German aircraft fell all over England. Different types were quickly recovered in various stages of disrepair and subsequently arrive at experimental stations for analysis and to be made flyable again, if possible. Those that were brought down by fighters or antiaircraft guns were usually basket cases. The more favored carcasses were those that landed because of engine failure, exhausted fuel or bad navigation. Abundantly provided by thes sources, the British soon had a "flying circus" of captured

German aircraft with RAF markings that toured the air bases in Britain to allow familiarization of new crews with the armament, performance and weaknesses of the opposition.
The idea of building a fighter to meet every performance requirement is out of the question. At best, each design is a compromise with priority emphasis on one or two qualities. Thus the Spitfire was a true interceptor designed primarily for the defense of the British Isle, a sprint climber with a small turning radius. The Mustang, after its conversion to the Merlin engine in 1942, was a fast, long-range, strategic escort fighter with an easy 8-hour endurance. Like the T-bolt it would dive like a banshee, well ahead of the Spit and all German craft. However, in rate of climb the Me 109G was 200-500 feet per minute ahead of the Mustang upto 20,000 feet, then the '51 pulled ahead on up to 40,000 feet, while the Spit 14 would climb faster than any of them at any altitude from sea level up.
Generalizations in narrative form are difficult to make and by the time you get to the end, the conclusions are so fogged up the reader can't tell where he's at. We will, therefore, deal primarily in numbers of two kinds -- One group is those that are measured against time: speed, endurance, rate of climb and acceleration in a dive. The second kind is those that are measured by distance: range and turning radius. Speed, most emphatically, is not everything.
Before we get into the performance comparison competition, some acquaintance with the features of the aircraft that we're talking about is necessary for understanding of why things turned out as they did. If you're handy with a slide rule you can do your own mission profiles and performance variations.

Me 109

General Characteristics:

The characteristics of two Me-109 models are of historical interest, the "E" and the "G". The "E" formed the backbone of the German fighter strength during the Battle of Britain, its opposition being the Spitfire I and the Hurricane I. The "G" was the prevailing type in 1944 during the Battle of Europe and its main opponents were the Spit 14, the Thunderbolt, and the Mustang. So it is worthwhile to explore more fully the characteristics of the Me-109 because it was the longest-lived of the fighters produced in Germany. It was a most worthy opponent in 1939, but it was outclassed by 1942 and by 1944 was manifestly obsolete.
An intact Me-109E with wing cannon was captured by the French in the summer of 1940 and was flown to England for flight test and evaluation. There were three stages of development prior to the "G". First was an early version of 109 flying in 1938 with a 670hp Jumo 210 engine, a fixed pitch wooden prop and two synchronized guns. Second was the variable-pitch two-bladed prop model and the addition of two wing guns. Third was the "E" model, with a far more powerful engine, the DB 601, which was an inverted V-12 of 1100hp with direct fuel injection driving a 3-bladed variable-pitch prop. Its wing structure was beefed up, but in the process of "designing" in the additonal engine and structural weight, the engineers screwed up the center of gravity, and 60 pounds of permanent ballast had to be added to the rear of the fuselage to get the C.G. back. As a pilot and an engineer I can only be sympathetic with 109 pilots. Who needs that kind of milstone around his neck in a fighter? Pilots had nothing to say about the design faults of airplanes in Germany. They had damn little to say about them in England or in this country, at that time. Designers didn't have to fly their mistakes; they just produced them. Most of them didn't know how to fly and didn't want to learn, but more about that later.
In size the Me 109, all models, was the smallest fighter produced by Germany or the Allies. That gave it a high wing loading for that time, about 32 lb./sq. ft. for the "E". The Spit I and the Hurricane I were about 25 lb./sq. ft. at their normal combat weight. The 109-G was about 38 lb./sq. ft. as compared to 35 lb./sq. ft. for the P-51B.

	Me-109E	Me-109G
Mean weight, lbs.	5580	6450
Engine	DB 601	DB 605A
Horsepower	1100/15,000 ft.	1475/22,000 ft.
Power loading, lbs./HP	5.07	4.37
Wing loading, lbs./sq. ft.	32.1	37.5
Prop. diameter, ft.	10.2	9.83
Gear Ratio	14/9	16.85/10
Wing Geometry:		
Area sq. ft.	174	172
Span, ft.	32.4	32.6
Mean Chord, ft.	5.36	5.38
Aspect Ratio	6.05	6.10
Dihedral, degrees	5.75	5.75
Sweepback, degrees	1.0	1.0
Root chord, ft.	7.03	7.0
Tip chord, ft.	3.42	3.42
Root thickness, percent chord	14.8	14.2
Tip thickness, percent chord	10.5	11.3
Slat length/span, percent	46.2	Approx. same
Slat Chord/local chord, percent	11.8	Approx. same
Wing Twist, Root to tip	0	0
Speed, mph	354/12,500 ft.	387/23,000 ft.

The fastest "G" subtype was the G-10 capable of 344 mph at SL or 428 mph at 24,000 ft. with a meager range of 350 miles and an endurance of 55 minutes, but it wasn't introduced until the spring of 1944. Too little, too late, and still lacking in range and endurance.

Engine and Propellor:

In principle the DB 601 and 605 series engines were the same as the Allison or Merlin, except they were inverted and had direct fuel injection; otherwise they were 12-cylinder, 60 degree Vee, glycol-cooled engines. The prop was a 10.2 foot, 3 blade variable pitch mechanism of VDM design. Here is another major difference between their design approach and ours. The pitch on the Me-109 prop could be set at any value between 22.5 and 90 degrees, a visual pitch indicator being provided for the pilot. There was no provision for automatically governing the rpm. We did just the opposite, using a constant speed governor and flying by a constant tachometer indication of rpm. For any flight condition the rpm remained constant. We didn't know, or care, what the blade angle was.

Wings and Controls:

The wings had straight leading and trailing edge taper and no geometric twist from root to tip. The airfoil section had a 2 percent camber with the maximum thickness at the 30% chord position. The "E" thickness ratio was 14.8 percent at the root and 10.5 percent at the tip. All that was standard design practice of the mid-1930s. What was new for fighter design was the leading edge slats which ran 46% of the span. There was no damping device fitted to the slat mechanism, they'd bang open at 120 mph with the airplane clean or at 100 mph with the gear and flaps down. Each control surface was mass-balanced. Another unusual feature was that as the flaps were lowered, the ailerons automatically drooped, coming down 11 degrees for the full flap movement of 42 degrees.

There were no movable trim tab controls on the ailerons or rudder, although both had fixed tabs that could be bent on the ground. Pitch trim was affected by changing the stabilizer incidence through a range of 12 degrees. The design scheme was that both the flaps and the stabilizer were coordinated mechanically from two 12-inch wheels mounted concentrically on the left side of the pilot's seat. By twirling both wheels in the same direction the pilot could automatically compensate for the change of pitch trim due to lowering or raising the flaps. Differential coordination could be set by moving one wheel relative to the other.

Performance Evaluation:

The first surprise you get in planning a test hop in the Me-109 is that you're limited to about an hour with some aerobatics at combat power, because the internal fuel capacity is only 88 gallons; with the drop tank, the "G" carried a total of 154 gallons. I'll never understand why the fuel capacity designed in Luftwaffe fighters was so limited. It was a major design deficiency that contributed to the loss of the air war, but even more puzzling is the fact that it could have been quickly changed anytime after 1940 onward, but it wasn't.

Takeoff was best done with 30 degrees of flaps. The throttle could be opened quickly without loading or choking up the engine. In fact, the Daimler-Benz engine was the best thing about that airplane. The stick had to be held hard forward to get the tail up, and it was advisable to let the airplane fly itself off. If it was pulled off at low speed the left wing would not respond and on applying aileron the wing would lift and fall again with the aileron snatching a little. If no attempt was made to pull it off quickly, the takeoff run was short and the initial climb good.

The absence of a rudder trim control in the cockpit was a bad feature at speeds above cruise or in dives. Above 300 mph the pilot needed a very heavy foot on the port rudder pedal for trimmed flight with no sideslip which is absolutely essential for gunnery. The pilot's left leg quickly tired while keeping this load on, and this affected his ability to put on more left rudder for a turn at 300 mph or above. Consequently, at high speeds the 109 could turn far more readily to the right than to the left.

Fighting Qualities:

A series of mock dogfights were conducted by the British in addition to the flight test and the following was revealed:

If the airplane was trimmed for level flight, a heavy push on the stick was needed to hold it in a dive at 400 mph. If it was trimmed into the dive, recovery was difficult unless the trim wheel was wound back, due to the excessive heaviness of the elevator forces.

Ailerons:

At low speeds, the ailerons control was good, response brisk. As speed increased the ailerons became too heavy but the response was good up to 200 mph. At 300 mph they became "unpleasant". Over 300 mph they became impossible. At 400 mph the stick felt like it was set in a bucket of cement. A pilot exerting all his strength could not apply more than one fifth aileron at 400 mph; that's 5 degrees up and 3 degrees down. The aileron situation at high combat speeds might be summarized in the following way:

(1) Due to the cramped cockpit a pilot could only apply about 40 pounds side force on the stick as compared to 60 pounds or more possible if he had more elbow room.

(2) Messerschmitt also penalized the pilot by designing in an unusually small stick top travel of plus or minus 4 inches, giving very poor mechanical advantage between pilot and aileron.

(3) At 400 mph with 40 pounds side force and only one fifth aileron displaced, it required 4 seconds to get into a 45 degree roll or bank. That immediately classifies the airplane as being unmaneuverable and unacceptable as a fighter.

Elevator:

This was a good control at slow speeds but became too heavy above 250 mph and at 400 mph it became so heavy that maneurverability became seriously restricted. When diving at 400 mph a pilot, pulling very hard could not pull enough "g" force to black himself out. The stick force per "g" was an excess of 20 pounds in a high speed dive. To black out, as a limit to the human factor in high speed maneuvers, would require over 100 pounds pull on the stick.

Rudder:

At low speeds the rudder was light, but sluggish in response. At 200 mph the sluggishness disappears, at 300 mph the absense of trim control in the cockpit became an acute problem. The pilot's leg force on the port rudder above 300 mph to prevent sideslip became excessive and unacceptable.

Control Harmony:

At low speed, below 250 mph, control harmony was good, only a little spoiled by the sluggishness of the rudder. At higher speeds the aileron and elevator forces were so high that the word "harmony" is inappropriate.

Aerobatics

Not easy to do. Loops had to be started from about 280 mph when the elevator forces were getting unduly heavy; there was also a tendency for the wing slats to bang open the top of the loop, resulting in aileron snatch and loss of direction.

Below 250 mph the airplane would roll quickly, but there was a strong tendency for the nose to fall through the horizon in the last half of the roll and the stick had to be moved well back to keep the nose up.

Upward rolls were difficult, again because of elevator heaviness at the required starting speed. Due to this, only a moderate pull out from a dive to build up speed was possible and considerable speed was lost before the upward roll could be started.

The very bad maneuverability at high speed of the Me 109 quickly became known to the RAF pilots in 1940. On many occasions 109 pilots were led to self-destruction when on the tail of a Hurricane or Spitfire at moderate or low altitudes. The RAF pilot would do a snappy half roll and "split ess" pull out, from say 3,000 feet. In the heat and confusion of the moment the 109 pilot would follow, only to discover that he didn't have enough altitude to recover due to his heavy elevator forces and go straight into the ground or the Channel without a shot being fired.

Turning Radius:

At full throttle, at 12,000 feet, the minimum turning radius without loss of altitude was about 890 feet for the Me 109E with its wing loading of 32 pounds per square foot. The corresponding figure for the Spit I or Hurricane was about 690 feet with a wing loading of 25 pounds.

Summary:

Good points:

(1) Reasonable top speed and good rate of climb.

(2) Engine did not cut out under negative "g," also reliable.

(3) Good control response at low speeds.

(4) Easy stall, not precipitous.

Bad Points:

(1) Ailerons and elevator far too heavy at high speed.

(2) Poor turning radius.

(3) Absence of rudder trim control in cockpit.

(4) Aileron snatch (grabbing -- uneven airflow) when slats opened.

(5) Cockpit too cramped.

(6) Visibility poor from cockpit.

(7) Range and endurance inadequate.

While the 109 may have been a worthy opponent in the Spanish Civil War or during the Battle of France in early 1940, it became a marginal airplane against the Spits during the attack on Britain in September of that year. By 1942, even with the appearance of the "G," it was definitely obsolete. However, the Germans continued to produce it as the backbone of the Luftwaffe fighter forces. The attitude of Nazi high command was that this was going to be a quick "blitz" war and if they lost three 109s for every Spitfire shot down, that was acceptable. In fact, in 1940 the official policy was laid down that the development of all other aircraft types requiring more than 6 months for completion was prohibited. They'd turn out the existing designs like hot cakes and swamp the RAF with production.

That doesn't say much for any charitable concern they should have had for the unnecessary loss of pilots caused by going into combat with a sub-standard airplane. But, after all, no one has ever said that the Führer and Göring had any anxiety about their pilots or troops. Quite the contrary, the record of history shows that they had none.

Furthermore, no designer in that period would pretend that he could stretch the combat effectiveness of a fighter for 7 years, 1935 to 1942, without major changes in power plant or aerodynamics, or, better yet, going to a new design. Technology in design in that era was changing too fast. The reader might well say, "The Spitfire was certainly a long line of fighters, about 10 years, how come?"

The Spitfire was an aerodynamically clean airplane to start with, having a total drag coefficient of .021 at cruise. The Me-109 had a coefficient of .036; drag coefficiency and of the horsepower required to haul 'em around. Like golf scores, the lower the better, and no fudging.

The British, in particular the staff at Vickers Supermarine, had done their homework in aerodynamics and put out a clean airplane that had the potential of longevity and increased performance. They had only to wait for Rolls-Royce to pump up the horsepower on the Merlin, which they did by going from 790 hp in 1934 to well over 2,000 by 1945. The Merlin, in my (Col. Carson's) opinion, was the best achievement in mechanical engineering in the first half of the century.

Messerschmitt practically ignored the subject of low-drag aerodynamics and one can tell that by an inspection of the 109E or G. The fact is evident even in close-up photographs. It was aerodynamically the most inefficient fighter of its time. That's a puzzling thing when one realizes that much of the original work on high speed drag and turbulent surface friction was done in Germany in the '20s and '30s. Messerschmitt was surrounded by it. Further, the work in England and the U.S. in this field was in the open literature, at least until 1938.

I also suspect, again from the record of history, that Willy Messerschmitt was too busy becoming a Director of Messerschmitt A.G. to concentrate on improving his status as an ingenious.

Having gone this far, let me carry this affront to Messerschmitt's engineering reputation one step further.

An airplane factory can get things done awfully fast, in any country and in any language, once the engineers and sheet metal benders understand what is wanted. Every factory has a "development shop" or its equivalent, which is a full scale model or prototype shop with 100 or 200 old pros in every skill. Having that many coffee drinkers, pipe smokers and "yarn spinners" around on the payroll, let's clobber 'em with a bundle of shop drawings on a clean up of the Me 109. Object: to make it a 400 mph plus airplane. Time... 30 days. The information and techniques required are currently available as of 1940. It's all written up in unclassifed reports.

(1) Cancel the camouflage paint and go to smooth bare metal. Besides the weight, about 50 pounds, the grain size is too large when it dries and it causes turbulent friction over the entire airplane surface. That may take a phone call to the brass. They're emotional about paint jobs. "Image," you know.

(2) Modify the cockpit canopy. Remove the inverted bathtub that's on there now and modify as necessary to fit the Me 209V-1 canopy. That's the airplane that set the world speed record in 1939.

(3) Get rid of the wing slats. Lock them closed and hand-fit a strip, upper and lower surface, that will close the sheet metal gaps between the slat and wing structure. That gap causes the outboard 15 feet of each wing to be totally turbulent.

(4) As aerodynamic compensation for locking the slats, setup jigs and fixtures on the assembly line to put in 2 degrees of geometric twist from the root to tip, known as "washout."

(5) Modify coolant scoop inlet fairings. The square corners that are there now induce an unnecessary amount of drag. Also lower the inlet 1 to 2 inches below wing surface to get it out of the turbulence of the wing surface.

(6) Install complete wheel well farings that cover the openings after the gear is retracted.

(7) Retract tail wheel.

All of the above could have been done in 30 days but it wasn't. I don't know why. Someone would have to ask Willy...it's for him to say.

Fw 190A

General Characteristics:

A superb airplane, every inch a fighter. It could do a half roll at cruising speed in one second. Taking this in conjunction with the airplane's high top speed and rate of climb one expected its pilots to exploit its high speed qualities to the fullest without staying in there to "mix it up" in a low speed, flaps down full throttle, gut-wrenching dog fight.

They did. The 190 pilots had a good airplane and some good advice. Nearly all of my encounters with the 190 were at high speeds. On at least two occasions when I met them, my Mustang started porposing, which means I was into compressibility, probably around 550 mph. I don't know what my air speed indicator was reading, I wasn't watching it.

On another occasion, I jumped one directly over the city of Paris and fired all my ammo, but he was only smoking heavily after a long chase over the town. Assuming I was getting 10 percent hits, that airplane must have had 200 holes in it. It was a rugged machine.

Mean weight	8580
Engine	BMW 801D
Horsepower	1600
Power loading, lbs./HP	5.36
Wing loading, lbs./sq.ft.	41.7
Prop diameter, ft.	10.86
Wing Geometry:	
Area, sq.ft.	205
Span, ft.	34.5
Mean chord, ft.	5.95
Aspect Ratio	5.8
Dihedral, degrees	5
Sweepback, degrees	5.5
Root chord, ft.	7.45
Tip chord, ft.	4.05
Thickness Ratio, percent	12
Maximum thickness location	Between 25 and 30 percent
Top speed, mph	408/20,600 ft.

Engine and Propeller:

The BMW 801D was a 14 cylinder, twin-row radial with direct fuel injection. A 10.9 foot diameter, 3-bladed VDM prop was used and was provided with hand lever or automatic pitch control. The 801D radial air-cooled engine first appeared on the Dornier Do 217 and the Fw 190. Its most novel feature was the oil cooler system which was a number of finned tubes shaped into a ring of tubes a little larger in diameter than the cooling fan. This ring was fitted into the rounded front portion of the cowling just aft of the fan.

I don't think this was a good idea. For example, my principal aiming point was always the forward portion of an enemy ship; the engine, cockpit, wing root section. If you get any hits at all, even only a few, you're bound to put one or two slugs into the engine compartment. Having a couple of bullets riccochet off the engine block and tear up some ignition harness is not too bad at all, at least not fatal. But to have all those thin-walled oil cooling tubes ahead of the engine is bad news. Any hits or riccochets in the engine section are bound to puncture the oil tubes. Then the whole engine is immersed in oil spray, and sometimes it would flash over into a fire. All of the 12 Focke-Wulfs that I shot down sent off a trail of dense, boiling oil smoke heavy enough to fog up my gun camera lens and

windshield if I were so close.
Wings and Controls:
Again, as in the case of the Me 109, no trim tabs adjustable in flight from the cockpit were provided for the aileron and rudder. European designers seem to have acquired the notion that this was a nuisance or unnecessary. Not at all; when going into a dive, it's very easy for the pilot to reach down with his left hand and flick in a couple of half turns of rudder trim. It's not only desireable, but necessary to eliminate side slip for good gunnery. The Fw 190, however, did have electric trim tabs for the elevators.
Performance Evaluation:
The Fw 190's handling qualities were generally excellent. The most impressive feature was the aileron control at high speeds. Stick force per "g" was about 9 pounds upto 300 mph rising to 12 pounds at 400 mph as compared to over 20 pounds for the Me-109.
High speed stalls under "g" load were a little vicious and could be a fatal handicap in combat. If the airplane was pulled in tight and stalled at high speed at 2 "gs" or more with the power on, turning right or left, the left wing would drop violently without warning and the airplane would flick onto its back from a left turn. I scored against a 190 under such circumstances. The message was clear, don't stall it. Our own Bell P-39 Aircobra would do the same thing.
Fighting Qualities:
Excellent high speed, with exceptional maneuverability at those speeds. Range and endurance were markedly improved over the 109. The Focke-Wulf would go 3 hours plus. Visibility with the full view canopy was superb, as it was in the Mustang.

Summary:

Bad points:

(1) Oil cooling tubes at the front of the engines was a poor choice of location. A puncture due to combat damage, or to simple failure covered the engine section with an oil spray.

(2) Lack of aileron and rudder trim controls in the cockpit.

(3) Vicious high speed snap rolls if stalled under significant "g" load.

(4) Poor turning radius due to high wing loading.

Good points:

Everything else was good. In the hands of a competent pilot the 190 was a formidable opponent. The landing approach speed was high and this shakes some pilots up a bit, but I don't think it's anything it's anything to complain about.