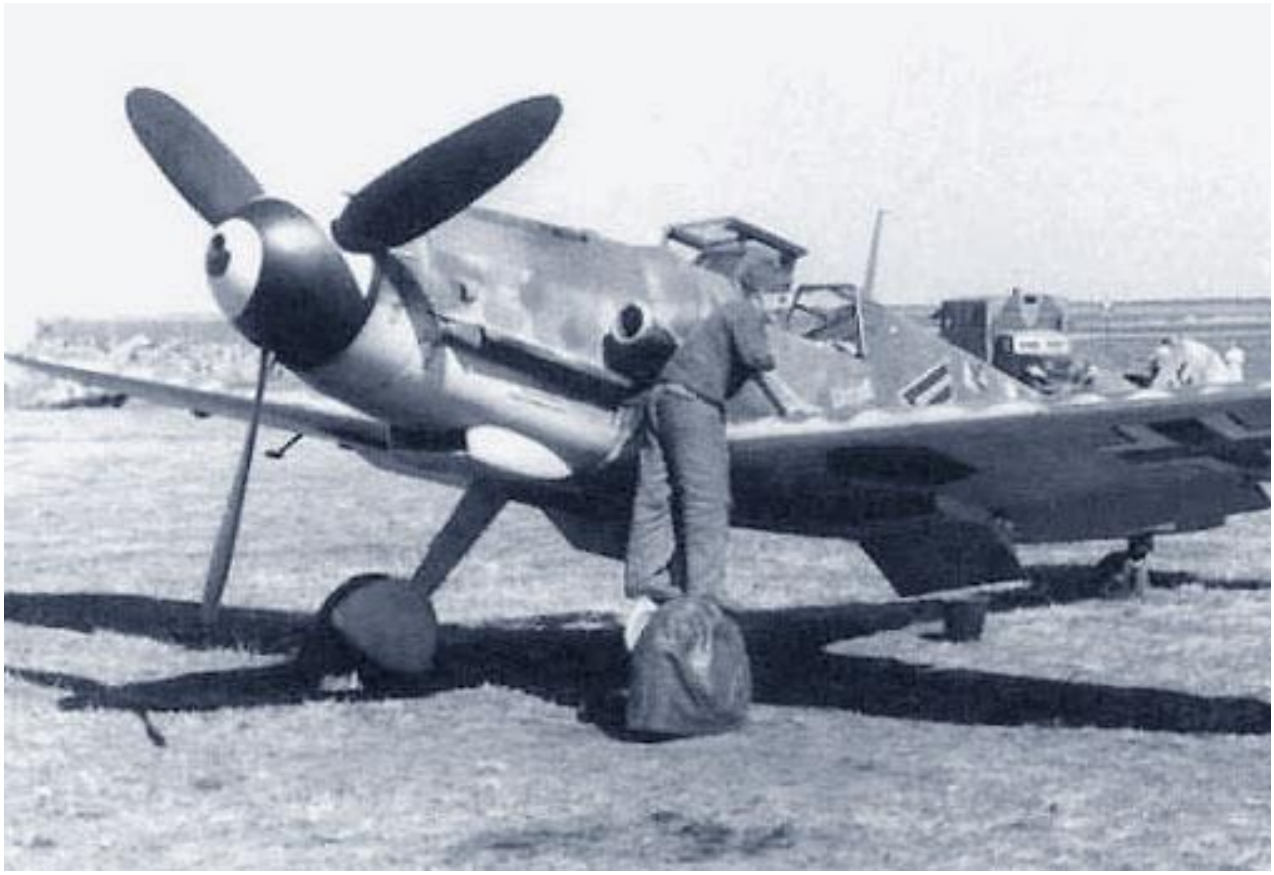
Flying the Messerschmitt Bf-109E - by Rob Erdos, Vintage Wings of Canada

"Achtung Spitfire", I heard in a ridiculous German accent. I smiled. The voice was my own. My head swivelled within the tight confines of the Bf-109 cockpit, looking for the attacker. There it was, above and behind, waiting to pounce upon me from out of the sun! This particular "Spitfire" (pronounced *Schpitfire*) looked like an unassuming summer cumulus cloud, but I turned to meet the attack nonetheless. An intense and terrifying dogfight ensued, as the Bf-109 twisted and turned to pursue the advantage. The enemy was cunning, but within minutes a particular southern Ontario cumulus cloud had been reduced to wispy shreds, and I had gained a much better understanding of the renowned Messerschmitt Bf-109.

May 2008 found me at Niagara South airfield, the base of the Russell Aviation Group, operators of the pristine and lovely Bf-109E, registered C-FEML, and at that time the only "Emil" flying in the world. In addition to the Messerschmitt, Russell Aviation operates a Spitfire Mk IX and Hurricane XII. The air display season was fast approaching, and the Russell folks needed maintenance test flights performed on all of their aeroplanes. As a happy outcome of my work with Vintage Wings of Canada, I was already familiar with the British fighters. The Messerschmitt was new to me, but I understandably relished the opportunity to sample the flying qualities of the "other side" of the Battle of Britain. It's a single-seater. You check yourself out. With the concurrence of the nice folks at Russell Group, I went to work.

The cockpit of the Bf-109 was a tight fit, even in comparison to the snug dimensions of the Spitfire cockpit. The seating position was semi-reclined, indicating either that Dr. Messerschmitt appreciated the importance of g-tolerance, or that he was trying hard to reduce my frontal area. As an outcome of both the reclined seating position and being tightly wrapped by the airframe, the forward field of view was nearly non-existent; a characteristic unfortunately common to this vintage of fighters. In stark comparison to the semi-random layout of British cockpits of this era, the Bf-109 instrument panel was arrayed in a thoughtful, almost modern manner. That was when my eyes caught upon the instruments: the airspeed indicator was labelled in kilometers per hour, oil pressure in "kilograms per square centimetre", power was indicated in "ATA". An apparently important instrument, devoid of other markings read, "Luftschraube Stellungsanzeige". Hmm. This was getting interesting.

Returning to the cockpit with my German-English dictionary and a calculator, I took note of the controls. The small control stick fell comfortably to hand, although full displacement seemed to use most of the space in the cockpit. The pedals, oddly situated more ahead than below me in the reclining cockpit, incorporated a metal strap for negative "g" restraint. The throttle was a small stub mounted on the left cockpit sidewall. A larger throttle would have hit my thigh as I advanced it. I scowled at the tailwheel locking mechanism mounted beneath the canopy rail directly under my left elbow. I had already knocked that lever several times, but I mustn't do it again. Performing a take-off or landing with the tailwheel unlocked was guaranteed to have an unpleasant outcome. Wearing a parachute and helmet, I tried to close the heavy side-hinged canopy, finding that it rested atop my helmet with about two inches to spare before closing. I am 5 feet 9 inches tall. The helmet was reluctantly left behind. Have I mentioned that the cockpit was tight?



Luftwaffe ground crew swarm a Messerschmitt Bf-109 on the ground in Europe during World War Two

Russell Group ground crew swarm a Messerschmitt Bf-109 on the ground in Ontario during the Friendly Foes Above the Falls Air Show. Photo: yerphonebox at Flickr

Notable in their absence were any further engine controls. Mixture was automatic. The propeller control was truly unusual, consisting of a rocker switch mounted on the inside of the throttle lever. The switch manually controlled the pitch of the propeller, via an electric motor mounted on the engine crankcase, and indicated on a clock-like instrument. (Aha! I think I know what ñLuftschraube Stellungsanzeigeò must mean!) I could hardly believe the implications of this installation: the Bf-109E had only a controllable pitch propeller. It did not have a propeller governor! I would have thought automated propeller speed control essential for an aeroplane with a 400 knot speed range. Indeed, such systems were fitted to later Bf-109 variants. I noticed that this particular aeroplane incorporated a small electrical switch on the floor, marked ñProp: Auto/Manualò, but it was wired to the Manual position. I was later told that this aeroplane never flew operationally with the system operative. The lack of propeller governing aroused my suspicions about the workload associated with dogfighting in the aeroplane.

The most innovative and interesting feature in the cockpit were two large concentric wheels situated on the left sidewall, aft of the throttle. The outer wheel actuated the flaps and inner wheel controlled the pitch trim by changing the incidence of the horizontal stabilizer. Since the flaps inevitably affect the pitch trim, the pilot could ostensibly maintain trim during flap deployment by actuating both wheels simultaneously. An ingenious mechanism within the wing allowed the ailerons to droop for further lift as the flaps reached full extension. The wings incorporated roughly half-span leading edge slats. These actuated independently under the influence of aerodynamic and inertial forces. In all, this was a very complicated wing, and one designed to squeeze as much lift as possible from each square foot of area. Thatôs good because another thing became evident about the Bf-109ôs wing: there wasnôt much of it. The wing loading of the Bf-109E was almost 50% higher than the Spitfire. This too would be factor in air combat performance, and I would need to keep it in mind if I were ever attacked by a cumulus cloud.

Once my preparations were complete and all requisite German-English translations were made, it was

time to go flying. Starting the rare Daimler-Benz DB601 engine was relatively straight forward, although the staccato note of the powerplant initially took me by surprise. I have always found something reassuring in the deep sonorous thrum of the Merlin; a sound akin to standing behind a dozen self-satisfied tenors. The Daimler engine, by comparison, struck me as clattering and harsh, more like a barrel full of hammers rolling down a staircase. I flashed a look of concern at the Russell Groupôs Chief Engineer, Gerry Bettridge. His cheerful grin seemed to confirm that this cacophony was not unusual.

The beautifully ugly working end of the Bf-109E, the only flying "Emil" in the world. Noise and stink were not the only things to come out of the Daimler-Benz DB601 engine - it also spewed a thumping heavy stream of 20 mm cannon rounds. The single high-performance cannon (or 'shell-gun', as sometimes referred in the 1930s) fired through the cylinder banks via a blast tube, with the engine buffering the recoil. The brutally simple design concept dealt with protruding bits by letting them hang in the slipstream and just fairing over them. Photo: John Latimer, Velocity Photograhy

Taxiing is the Messerchmittôs opportunity to get you alone and to whisper a warning in your ear. There is a grotesquely high download on the tailwheel in the Bf-109; a situation made evident by the requirement for full rudder, hard braking, forward stick and a blast of power to effect a turn. Try that in a Spitfire and the propeller will chew dirt! While odd, it at least gave reassurance that even aggressive braking would be unlikely to result in a nose-over. Unfortunately it also meant that the center of gravity was very far aft of the main wheels. That is not a good thing. Recalling my misadventures in once trying to steer a shopping cart backwards down a hill, I made a mental note that the tail might try to pass me during the landing.

The geometry of the undercarriage is perhaps the most unusual feature of the Bf-109. A digression is in order to appreciate how its characteristics would manifest themselves during take-off or landing. Some sources claim that between 15-25% of the Bf-109s ever built were damaged or destroyed during take-off or landing accidents. I find this a remarkable figure for a combat aeroplane ï especially one that served on the losing side of the war! Most contemporary histories of the Bf-109 attribute this to the narrow undercarriage track, however this misses the point. (The Spitfireôs undercarriage is just as narrow, and it doesnôt have any of the Bf-109ôs quirks. It has its own quirks ï but thatôs another story.) Dr. Messerschmitt faced a challenge in the design of his first fighter. In the interest of simplifying transport and repair of the aeroplane, it was designed with the undercarriage attached to the fuselage, such that the wings could be completely removed with the aeroplane resting on its wheels. The undercarriage

struts were attached to a complicated forging at the firewall aft of the engine mount. The narrow width of the fuselage structure necessitated installing the undercarriage legs splayed outwards. This feature became the aeroplaneôs Achilles heel.

Another advantage of main gear design was that because landing gear, retracting through roughly an 85º angle, was attached to the fuselage, it was possible to completely remove the wings of the aircraft for major servicing without the need for additional equipment to support the fuselage. It also meant that the wing structure was able to be simplified through not having to carry the weight of the aircraft and not having to bear the loads imposed during takeoff or landing. However, this had one major drawback - the wheels had to be splayed outwards and this created an extreme tendancy to ground loop and/or collapse. Photo via Rob Erdos

Imagine that you have a bicycle wheel in your hands. Roll the wheel with the axle parallel to the ground. It goes straight. Now roll the wheel such that the axle is not parallel to the ground. The wheel turns. Letôs return to the Bf-109. Both of the tires are mounted ñcrookedò, rolling with a camber angle of about 25°. Consequently both wheels want to turn inwards under the aeroplane. When the aeroplane is rolling with an equal download on both wheels, symmetry prevails; both wheels fight to a stand-off, and the aeroplane rolls straight. Now imagine that something causes the download on the wheels to momentarily become unequal. In that case the rolling friction of the tires becomes uneven and the turning tendency of the ñheavyò tire asserts itself. What might do this? Well, crosswinds. Or torque from engine power. However, the most dangerous culprit is turning. With the aeroplaneôs center of gravity situated high above the tires, a swerve will set loose large centrifugal forces that cause the

aeroplane to try to roll over the tires. This is true of any aeroplane, but in this scenario the unusual camber of the Bf-109ôs tires creates strong directional instability, requiring a different type of control strategy for take-offs and landings. Tight heading control or aggressive tracking of the runway centerline can set off abrupt directional divergence. Better for the pilot to relax, merely dampen heading changes, and accept small heading errors. Funny, I didnôt feel relaxed.

On a sunny day in the Niagara region, the Russell Group Bf-109 awaits her pilot. Photo: John Latimer, Velocity Photograhy

These thoughts ran through my mind as I taxied for take-off at the Niagara South airfield. ñDonôt fight with the aeroplane. Accept any heading you get and roll straightò, I told myself as I took position for take-off. The Daimler engine responded by growling at me, as I applied a final stab of power to turn onto the runway centerline. Okay, pause. I checked that the flaps were set to 20°, set the trim to one degree UP, set the propeller pitch to ñ11:30ò on the weird clock indicator, and then locked the tailwheel. Then I checked the tailwheel lock. Then I double checked. Looking straight ahead I took note of the 3-point attitude: completely blind, save for two small strips of horizon visible at the edges of the windscreen. Mentally noting the 3-point attitude wasnôt enough. I would need to quickly re-establish this view when it came time to land, so I took out my secret weapon. Using a black grease pencil I drew the meagre horizon line on the inside of the windscreen.

I opened the throttle slowly. Directional control authority quickly felt quite positive, although I recalled my commitment to use it judiciously. A fairly strong push on the stick was required to gently lift the tail as the airspeed passed 60 km/hr; an act that was further destabilizing, however things were quickly improving as the airspeed increased. With a gentle skip, the Bf-109 became airborne around 110 km/hr. I retracted the undercarriage and immediately turned into a climbing orbit overhead the airfield while I confirmed that the engine indications were stable.

The Russell Group Bf-109E climbs out. Photo: John Latimer, Velocity Photograhy

The Messerschmitt is a rare bird indeed in a wolrd of rare vintage fighters. Photo: yerphonebox at Flickr

Power was set at 1.15 ATA (atmospheres of manifold pressure) at the recommended climb speed of 250 km/hr. Propeller speed was sensitive to airspeed changes, so a slight pitch reduction was required to stabilize at 2300 RPM. The Daimler engine sounded much smoother in flight. My initial impressions of the aeroplane were mixed. The field of view was poor, necessitating continuous clearing turns in the climb. The greenhouse canopy structure seemed to be slightly obtrusive no matter where I looked. Control response in the climb was satisfyingly light and crisp, with good harmony between pitch and roll control forces. Directional stability was clearly inadequate. Every roll input required conscious pedal coordination. The absence of rudder trim proved a considerable annoyance during the protracted climb. In the interest of ñcalibratingòmy aileron-rudder coordination, I tried a few aggressive roll reversals in the climb and received an unpleasant surprise. The application of full aileron caused the aeroplane to shudder and buffet in a manner that, to my overactive imagination, seemed like I was receiving machine gun fire. I rolled level and breathed. Subsequent investigation showed that the onset of buffet occurred at large aileron displacements, and was associated with a very slight lightening of the aileron control forces and a distinct high-frequency ñhammeringòin the stick. I had seen that before. Aileron stall! It was becoming clear to me. Dr. Messerschmitt kindly provided me with powerful mechanical leverage to actuate the ailerons against the aerodynamic forces, and that explained why the stick forces were so pleasantly light. That is certainly not the case in the Spitfire, where the ailerons stiffen terribly at high speeds. In the Bf-109 I unfortunately had enough leverage under some conditions to deflect the aileron to the point of airflow separation. The results were a bit disappointing. In spite of the light control feel, the roll rate achievable in the Bf-109 was no better than the Spitfire.

I levelled off above the airfield and went to work. My test card began with an investigation of the slow flight and stall characteristics, in order to prepare myself early for the eventual landing.

The power was reduced to just above idle, and the aeroplane decelerated for a clean stall. I was fascinated to watch as the leading edge slats automatically extended themselves into the airflow. The effect was smooth and transparent, however I noted that the rate of deceleration increased as the slats extended. I made note of this effect, intending further investigation during air combat scenarios. The clean stall occurred at 125 km/hr indicated airspeed, preceded by a 3-5 knot band of mild buffeting. Thatôs 68 knots. I wasnôt sure if I was impressed or sceptical. The stall was marked by a mild pitch and right roll break; cues so mild that they were hardly inhibiting. I continued to explore increasing angles of attack until I was happily flying along with full aft stick. No sweat. In the clean configuration, the Bf-109

retained its lateral control effectiveness without any tendency to depart - even tolerating mild sideslips at full aft stick.

Next I investigated the stall characteristics in the landing configuration. The undercarriage and flaps were extended, the power reduced to idle, and a gradual deceleration was performed. Roll control response became sluggish once the ailerons drooped with full flap selection, and it exhibited considerably more adverse yaw. Again a mild buffet preceded a gentle pitch break, this time at 88 km/hr. 88 km/hr!? Thatôs 47 knots indicated airspeed. Now I was definitely sceptical. There was simply no way that this modest wing area was holding this mass of aeroplane aloft at 47 knots. I recalled the location of the pitot-static probe, mounted close under the left wing, and knew with certainty that it was lying. Nevertheless, the low-airspeed and stalling characteristics of the Bf-109 were extremely benign and forgiving; a highly desirable characteristic in a fighter.

While the undercarriage and flaps were extended, I took the opportunity to do a few landings ï in the clear air at 6000 feet above the airfield. I did a simulated final turn to parallel the runway and flared to the 3-point attitude, with the objective of ñlandingò my altimeter exactly at the 6000 foot mark. The final turn in a fighter typically involves a gradual turning deceleration to the runway. I found that controlling speed and descent gradient during the turn were hardly demanding, however the forward field of view was gradually disappearing. No surprise there. Elevator response was suitably precise to capture the 3-point attitude without difficulty. Overshoot from the pseudo-landing was easy ï at least for a high-performance fighter. The Bf-109E is powerful, however propeller effects were easily managed. Chalk up one advantage of having low directional stability.

Now that I felt I could land it, I was eager to pursue my curiosity about the Bf-109ôs qualities as a fighter. I set cruise power setting (1.0 ATA manifold pressure, 2300 RPM), stabilizing at 415 km/hr at 5500 feet. That equates to a modest 225 knots indicated airspeed, but it wasnôt my engine. The aeroplane felt comfortable in cruise, exhibiting weak but positive speed stability, as evidenced by the gentle, progressive elevator forces required to maintain off-trim speeds. A gentle sustained sideslip gave evidence of both weak directional stability and weak lateral stability, at least by modern standards. The rudder forces seemed very light. The sideslip also induced a gentle nose-down pitch response, indicative of possible elevator blanking. All this talk about weak stability doesnôt imply criticism of its qualities as a fighter. The flip side of low stability is often high agility. Nevertheless this wouldnôt be my first choice of an aeroplane for instrument flying.

The next order of business was to become familiar with maneuvering the machine. I performed a wing-over and was immediately reminded of the benefits of propeller speed governing. Lacking such amenities, the propeller speed on the Bf-109 decayed terribly as the speed reduced, reaching as low as 1600 RPM at the top of the maneuver. The result was a slightly laboured sound from the engine, as it struggled with high torque at low speed. The effect was not unlike taking your foot off your carôs clutch from a standstill in fifth gear. Ouch. Not good for the engine, and not good for performance. I noted that the peak of the wing-over had been about 1700 feet above my starting altitude. I repeated the maneuver, this time maintaining a constant propeller speed using the rocker switch on the throttle. The engine sounded happier, if the growling Daimler could be described as ñhappyò, and this time the top of the maneuver managed to achieve 2300 feet of altitude gain. Clearly any pilot wishing to obtain maximum performance from the Bf-109E would need to carefully regulate propeller speed. Unfortunately, this draws the pilotôs attention into the cockpit, rather than allowing him to focus outside where the dangers lurk. I was left wondering whether the young lads who flew the Bf-109E in combat really applied that degree of finesse, or whether the circumstances of combat necessitated cruder engine handling.

Once familiar with coordination of propeller pitch with speed changes, the Bf-109 and I performed some gentle aerobatics together ï strictly for technical investigation, you understand. Loops were enlightening. The low directional stability could result in comically large heading variations unless careful rudder coordination was applied. I was reminded of a long-ago instructor of mine, who remarked upon seeing my aerobatics, ñNice loop. Now do one to the right.ò It was easily mastered with practice. Multiple maneuvers seemed to result in a notable decay in speed, particularly whenever the leading edge slats deployed; a stark contrast to the Spitfire, whose elliptical wings retain energy nicely under sustained ógô The Messerschmitt was paying the price for its high wing loading.

It was at this point that I was pounced upon by that dastardly cumulus. ñFineò, I thought, ñletôs see what this aeroplane can doò I climbed steeply and turned to bring the guns to bear upon the target. Field of view through the greenhouse canopy was again a hindrance as I looked over my shoulder to gauge the turn. The cumulus turned and dove steeply to flee (bear with me for a momenté). A deflection shot would be required to engage from long range, however the limited field of view down over the nose would make this difficult. The Bf-109 built speed rapidly in a dive, however the necessity to attend to propeller speed proved a distraction as I closed quickly upon the target. Pulling out of the dive, I discovered that the Bf-109ôs elevators became distressingly heavy at high speed. I had read wartime

accounts of Spitfire pilots taking Bf-109s into steep high-speed dives, knowing that the Bf-109 would be unable to pull out. This was a convincing demonstration, requiring a two-handed pull to achieve a 3.5 g recovery at 450 km/hour. I flashed past my adversary like it was standing still. With a gallant salute, I disengaged. After less than an hour, the fuel gauges were telling me that it was time to return to Niagara South.

The circuit procedures were familiar from my rehearsals at altitude, but this time it was for keeps. A standard overhead break was performed, but delayed until well past the upwind end of the runway. Extension of the flaps required about 30 quarter-turns of the flap wheel; a time-consuming process. The downwind leg was entered at 200 km/hour, decreasing to 150 km/hour as the undercarriage and flaps were extended. The numbers on the airspeed indicator seemed high, and I had to keep telling myself that they were "only kilometers". From abeam the touchdown point on downwind, a continuous decelerating turn was performed to the flare. With virtually no forward field of view, a straight-in final approach leg was definitely to be avoided. I entered the flare at 125 km/hour, maintaining a trickle of power. I can't claim to have been completely at ease, but within seconds the wheels began to gently rumble across the grass. The Bf-109 was home from another mission.

Ron and Emil after landing. Photo via Rob Erdos

Enemies no more. The Russell Group Spitfire closes in on the right wing of their Bf-109E. In a story coming out this winter, Rob relates his impressions after flying both the Spitfire and the Messerschmitt back to back, hopping from one cockpit right into the next - something which has been rarely done if at all. Photo: yerphonebox at Flickr.