Man & Machine: A Narrative of the Relationship Between World War II Fighter Advancement and Pilot Skill

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MAN & MACHINE:
A NARRATIVE OF THE RELATIONSHIP BETWEEN WORLD WAR II FIGHTER ADVANCEMENT AND PILOT SKILL

A Thesis submitted in partial fulfillment of the requirements for the degree of
Master of Arts

by

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ABSTRACT


From 1938 until the end of World War II, the Curtiss P-40 fighter participated in the European, North Africa, and Pacific theaters of war. An aircraft’s success depends primarily upon the pilot’s expertise. Without skilled pilots, technology alone cannot win a war. Technological innovation still plays a crucial role in the success of a nation’s air force. Relative to technological developments, how impactful is a pilot’s skill on a fighter plane’s performance?

My thesis structure is a deep look into each pilot’s experience and how victory was achieved with a plane that most military writings say is inferior. I investigate the narrative of the aircraft from development based on a pre-war U.S. air doctrine, its exposure and adaptation against enemy aircraft, and the period when piston-driven aircraft performance reached the pinnacle of performance. My analysis shows that due to the adaptability of tactics by fighter pilots, the Curtiss P-40 met Allied needs and aided in the overall contribution to changes in aerial combat. This write-up goes on to show a pilot’s expertise plays a crucial role in an aircraft’s success, regardless of statistical data or the purpose for which the plane was intended. Technological innovation causes an impact on the success of a nation’s air force, but without skilled pilots, technology alone cannot win a war.
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“Remember, never take no cut-offs. And hurry along as fast as you can”

-Virginia Reed, 1847 Donner Party
INTRODUCTION

The Curtiss P-40 was developed during peacetime and continued to fly throughout the entirety of the war; therefore, this aircraft has been exposed to numerous conditions and encountered many different enemy aircraft. This fact explains why the P-40 is a perfect example of why pilot ability is extremely important. This thesis examines the relationship between the plane’s technological development and the performance of pilots in three different areas of conflict: North Africa, the Pacific, and Europe. This analysis will provide some answers to whether an aircraft’s technological improvements are primarily important or if the pilot is more important in determining a fighter plane’s performance in war.

Section I explains the Inter-War Period from 1920-1935. During this period, a gradual interest in fighter operations took hold. In addition, fighter plane construction changed. Militaries across the world began to experiment with all-metal aircraft, more powerful engines, and more firepower. The United States upgraded the Air Corps’ fighter aircraft with a new streamlined version of the P-36 to the new XP-40. At the same time, we begin to see a military aircraft revolution on a scale the world had not seen before. The Bf-109 first flew in 1937 and became one of the most advanced fighters of the Interwar period. The power-to-weight ratio of the aircraft allowed it to outrun and outclimb the enemy with ease. Japan introduced the highly maneuverable Ki-27 and later Ki-43. These aircraft were built with lightweight duralumin metal and upgraded flaps allowing the plane to maneuver tighter and at lower speeds.

Section II goes into the individual instances of P-40 pilots and how they were able to achieve victories against aircraft of superior statistics. My thesis initially begins with occurrences during the air battle over North Africa between the German *Luftwaffe* and the Royal Australian Air Force from 1940 to 1941. Each combat instance explained tells the experience of the Allied
pilot as well as the Axis pilots to show that both pilots had similar capabilities. The only difference was that one pilot could outthink the other. The beginning passages start with Group Captain Clive Caldwell of Squadron No. 250 who flew the P-40E Kittyhawk Mk. I. He flew for just six months in combat before claiming his first documented victory, an Me-109E. In the following months, he became the top Australian P-40 ace and Allied pilot in the North African campaign. In addition, this chapter touches on Caldwell’s invention of the training technique known as “shadow shooting.” The Desert Air Force adopted the technique as an important training tool which allowed them to gain a small but significant edge over the enemy.

The next part moves to the Pacific Theater of War. From 1941 to 1942, the United States Army Air Force pilots fly the P-40B and C models against experienced Japanese pilots. Group Leader Boyd “Buzz” Wagner used his acrobatic and unpredictable flying to become the United States’ first P-40 Ace. Next, the Flying Tigers often intercepted the Japanese Ki-27 and Ki-43. Major General Claire Lee Chennault discovered the idea to fight the Japanese using the P-40’s strong airframe and diving speed as a tactical advantage. Wagner took on the A6M2 Zero during his time defending the Philippines and became the first USAAF P-40 Ace of World War II.

The last part of section II incorporates the European Theater from 1942 through the fall of 1944 and discusses the usage of the P-40B Tomahawk IIA in the Voyenno-Vozdushnyye Sily¹ and the exploits of the Tuskegee Airmen. The P-40B played a role in battles at Stalingrad, Kursk, and Eastern Prussia.² According to retired Major General Nikolai Golodnikov, “had we flown them how Americans wrote it in the manual, we would all [have been] shot down…on our

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¹ VVS, or Russian Air Force.
regimes we had equal combat with either "ME's" or "FW's." Men such as Lieutenant Ridnyi, flight commander of the 6th IAK PVO, flew nearly 4,000 sorties in ten days and scored twenty-one aerial victories in the P-40B Tomahawk IIA. Lieutenant Aleksey Khlobystov rammed two Me-109s and survived to talk about it. Lieutenants E. Lozov, I.P. Levsha, and S.V. Levin, who all engaged Me-109s, with the odds stacked against them, successfully shot down a number of German fighters. The Soviet defense of their country was unparalleled by any Allied country in the West. The Soviets’ ability to adapt the Western-built P-40 to their own methods of combat in the East proved their success, not the limitations with the aircraft.

Technology is not always the sole determiner of success in the field of battle. Sometimes, a pilot’s skill proves pivotal to an aircraft’s success, despite an enemy fighter being more technologically advanced. In the harsh weather, temperatures froze parts, aircraft constantly broke down, and engines ran scarce. Despite these hardships, the Soviets improved their tactics and adapted German strategies as their own. By 1943, these adaptations of both aircraft and techniques allowed the VVS to push back against the German Luftwaffe.

The last portion of Section II focuses on 1943 to 1945 when the P-40 took part in some of the aircraft’s last air-to-air combat situations before it was transferred to fighter bomber missions, and then retired. By May 1943, the Tuskegee airmen used the P-40L against the Third Reich’s front-line air superiority fighter, the FW-190A. The Army Air Corps believed that by giving these pilots “hand-me-down” aircraft, they would be unable to stand up to these more
powerful and faster enemy aircraft. African American Tuskegee pilots sharpened their skills through unusually extensive combat training before the airmen ever saw active combat.\textsuperscript{6} Colonel Momyer of the 33rd Flight Group stated in a letter to Lieutenant Colonel Benjamin O. Davis Jr. that “the 99th are not of the fighting caliber of any squadron…they have failed to display the desire for combat necessary to a first-class fighting organization.”\textsuperscript{7} On the contrary, Charles B. Hall became the first African American to shoot down an enemy fighter when he defended an escort of B-25 Mitchells against two FW-190A-3.\textsuperscript{8} On January 27, 1944, the 99th recorded the most enemy kills in one day when they intercepted sixteen FW-190A-7s and shot down twelve of them, with no Allied losses.\textsuperscript{9} Their performance showed the public how capable they were of fighting in the war with planes others acknowledged as old and outdated. This respect and showcase of how skilled these pilots were, proved their ability to fight superior German aircraft in a seemingly inferior fighter plane. Their recognition later earned them the right to fly the USAAF premiere fighter after 1943, the North American P-51.

Section III analyzes the training that takes place amongst the pilots of the various nations mentioned in this thesis. Each country listed in the proceeding chapters held similar structures in aviation training. The deciding factor in this section boiled down to the number of flight hours and experience. The Japanese and German pilots held hundreds of flight hours from the First Sino-Japanese War and the Spanish Civil War. As the war progressed, neither power could afford to rotate their pilots back to the home front. This brought death to many of Japan and Germany’s veteran pilots as they continued to fight the war. The Americans and British on the

\textsuperscript{7} Homan, \textit{Black Knights}, 102.
\textsuperscript{8} Homan, \textit{Black Knights}, 92-3.
\textsuperscript{9} Homan, \textit{Black Knights}, 107-8.
other hand required their pilots to undergo service rotations. Doing so, allowed for the retention of larger amounts of experienced pilots in reserve as the war progressed.

Section IV focuses on tactics and how they played a part in the progress of dogfighting during World War II. The P-40 exhibited sufficient maneuverability and speed at low to medium altitudes. At higher altitudes, the performance of the aircraft drops significantly. These disadvantages caused many pilots to adapt and use their knowledge of flying to exploit the advantages of the aircraft in a way that the disadvantages outweighed. This idea of adaptation does not stop with the P-40. Other nations exhibit changes in tactics that allowed individual pilots to utilize their aircraft’s advantages.

Section V explains the technical aspects of the P-40 along with the aircraft it faced throughout the war. The subsequent models were created in order to minimize the number of disadvantages that could be exploited by the aircraft. For the P-40, a more powerful engine and streamlined airframe meant it could fly at higher altitudes with minimal loss in performance. Although the Army made changes, the aircraft’s weight in armor, additional armament, and changes in airframe provided no significant gain. This is the same for all aircraft analyzed in this section.

Bill Colgan, a fighter bomber pilot during the last two years of the war, is one of many pilots who flew P-40s in the last year of its production. His opinion of the aircraft is one of uncertainty. His flight instructor, Captain Chester VanEtten, carried the philosophy of “if you cannot learn to fly a fighter right, it was better to be killed here than have the enemy do it.” Colgan describes the P-40 as disappointing performance-wise but attributed this notion to his uncertainty about whether he was flying the plane, or the plane was flying him.\footnote{Bill Colgan, \textit{World War II Fighter-Bomber Pilot}, (Manhattan: Sunflower University Press, 1985), 21-22.} Despite these
remarks, after 285-300 combined flight school hours, he became confident enough that the pilot just needed to learn how to fly it.\textsuperscript{11}

\textsuperscript{11} Colgan, \textit{World War II Fighter-Bomber Pilot}, 22.
FIGHTER DEVELOPMENT

UNITED STATES ARMY AIR FORCE

Ex-Northrop designer Donovan Berlin jumped at the opportunity to develop the Hawk 75. This aircraft was supposed to fly a year later as a prototype against the Seversky P-35 until the P-35 crashed en route to the competition. The aircraft showcased a superb power-to-weight ratio and excellent maneuverability at high speeds compared to the P-26. Despite the superior performance of the P-36 compared with the experiences of the P-26, the Army Air Force wanted something better. In the same year, Claire Lee Chennault challenged the Army Air Corps. and their idea of bombers being the primary factor in winning future air wars. He emphasized that an organized tactical fighter force with good communication could successfully attack a bomber formation at any time. What that strategy entailed was the construction of a fighter aircraft capable of competing with other countries in intercepting bomber aircraft. Curtiss Wright Corporation employed Berlin to come up with a better aircraft. After many redesigns, the XP-40 emerged as the final product. The frame was narrowed for aerodynamics, more armament was included, and the change from a radial engine to an Allison V1710. At low and medium altitudes, the aircraft proved to be exceptionally agile at low to medium altitudes and it handled high-speed dives just as well. At the same time, America was not the only one developing new fighter aircraft.

GERMAN LUFTWAFFE

In 1933, after Hitler became Chancellor and withdrew Germany from the Treaty of Versailles, development started on an aircraft that would become Germany’s premier fighter, one that would usher in the future of German air power. In March 1934, Willy Messerschmitt, CEO of Messerschmitt Flugzeugbau designed the 108. The following year in May, his design was
taken to Bayerische Flugzeugwerke where the 8-109 prototype was built. Bayerische Flugzeugwerke, Arado, and Heinkel participated in a competition to see who could produce the Luftwaffe’s premier fighter plane from July 23, 1937, to August 1, 1937. At this time, Bayerische Flugzeugwerke had the rights to the aircraft, and it was designated the Bf-109. The Bf-109 prototype swept the competition and when the company saw this, Willy Messerschmitt was named Chairman of the company and Bayerische Flugzeugwerke was retitled as Messerschmitt Aktien Gesellschaft. The Messerschmitt Bf-109 was initially outfitted with the Jumo 210 engine during competition. It climbed faster and was far more maneuverable than the aircraft it flew against such as the Heinkel He 112. When the 109 went into official production before the outbreak of the Spanish Civil War, the Messerschmitt Bf-109 was fitted with the more powerful Daimler-Benz DB 600, the aircraft surpassed the original performance capabilities. After 1938, the redesignation of the aircraft to Messerschmitt Bf-109, or shortly Me-109 occurred.

Kurt Tank was approached by the Reich Air Ministry to produce a fighter that could be an interceptor alongside the Messerschmitt Bf-109. He created the prototype of the Focke-Wulf 190A on September 1, 1939. The aircraft gained so much popularity that by 1941 manufacturing began and the aircraft had its first flight in combat in February 1942. The Fw-190 proved to be highly maneuverable, fast, and packed a punch against the Allied aircraft it went up against. It quickly became an aircraft admired by men such as P-51 ace Flight Officer Chuck Yeager.

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regarded the Fw-190 as the one Axis produced aircraft that could match the performance of the P-51D.\textsuperscript{14}

The combat experience of all the pilots during the Spanish Civil War, in addition to the Messerschmitt Bf-109 and Fw-190’s technology, allowed both aircraft to become two of the primary defensive air superiority fighters of the \textit{Luftwaffe} during World War II. The \textit{Luftwaffe} supported advancing infantry and armored vehicles. Fighter Command’s primary role was to gain aerial superiority to allow the bombers open skies to carry out strategic bombing missions against defensive positions, airfields, depots, and transports.\textsuperscript{15}

\textbf{THE IMPERIAL JAPANESE ARMY}

The Japanese began establishing their air force in the late nineteenth century with the use of dirigibles and reconnaissance balloons in the first Russo-Japanese War. By 1910, Japan achieved its first flight with the Farman III, a 1909 French biplane that took to the skies during the Yoyogi Military Parade Grounds. The Japanese Army Air Force sent over pilots to be trained by France and in 1914 gained combat experience over \textit{Tsingtao} after the city was under siege by German forces. After the Versailles Treaty, Japan’s major aeronautical companies partnered with German engineers. For the next decade, \textit{Kawasaki} and \textit{Mitsubishi} merged with Dornier and Junkers to usher in rapid advancements in both fabrication and engine performance.

The Japanese Navy, on the other hand, favored relations with Britain and the rapid improvement in the country’s naval power. British government missions to Japan allowed for the development of British-influenced aircraft carriers and carrier-based aircraft. With the


experience flying the British Sopwith, Japan went on to create the Mitsubishi Type 10. This aircraft along with the creation of the new carrier Hosho allowed Japan to develop a strong defensive modern naval air force. By 1931, Britain continued to help train Japanese pilots on fighter tactics and dropping ordnance.\(^\text{16}\) Japan also needed help with modernizing the performance of their aircraft. For the next decade, until 1940, the Japanese army held access to American aviation companies and acquire the necessary information and tools to develop the agile Ki-10. After encounters with the Curtiss Hawk II over China from 1937 until 1939, the plane became obsolete as all metal monoplanes rapidly replaced biplanes across other nations. The aircraft was soon replaced by the successful Nakajima Ki-27. The Ki-27 was a monoplane fixed-landing gear aircraft that was just as agile as the A5M Type 00. The fighter was fitted with retractable landing gear and modified ailerons to create the Ki-43.\(^\text{17}\)

By 1940, the American Curtiss P-40 faced off against formidable aircraft like the Me-109E, FW-190A, and Ki-43 in the deserts of North Africa to the shores of New Guinea. Despite how successful the P-40 was, contemporary works still regard the plane as “never an outstanding aircraft, but it was available when more advanced fighters were still being tested.”\(^\text{18}\) In addition, others claim the “performance of the aircraft was less than desirable. Compared to other enemy aircraft, it was for all practical purposes outclassed as soon as it came off the assembly line.”\(^\text{19}\) Despite that notion of inferiority, the aircraft put up a fight against the Axis powers.

The beginning of the air war shows a large number of different Allied nations using the P-40. The flying experience of men such as Levi R. Chase, leading P-40 ace in the Mediterranean, RAF P-40 ace Billy Drake, David Lee “Tex” Hill of the Flying Tigers, and the highest scoring P-40 ace of the Soviet Union, Nikolai Fedorovitch Kuznetsov, are evidence that the P-40 handled combat very well, despite being built prior to the war. The different geographic conditions these pilots fought in most certainly impacted their performance and how they flew, but they continued to wreak havoc across enemy airfields and installations. They also shot down countless fighters and bombers in many areas of combat. These pilots brought the P-40 an image that personified Allied resilience at a time when the Axis seemed unstoppable.

In 1941, the P-40 flew primarily air superiority missions. As a low to medium-altitude pursuit fighter, The United States understood an aircraft capable of maintaining air superiority along the coast would be perfect. A high-altitude interceptor was not needed due to the fact a long-range bombing attack was not feasible during that time. Despite this fact, the allies needed something, and due to the low cost, available parts, and growing demand, the P-40 was the definitive choice to go to war with.

On a performance basis, the fighter proved to be naturally more effective in the Pacific due to the low-altitude combat as opposed to the European theater where the regions were mountainous, and many missions involved the escort and defense of bombers flying at a much higher altitude. With the differences in geography causing a war to be fought two different ways, the experience of the pilot proved the capabilities of the P-40 in both scenarios to be sufficient. By 1943, the P-40 was switched from being an air superiority fighter to purely a ground attack fighter. With mid to late-war air superiority aircraft, air battles were fought higher and faster as well as being able to cover and follow bombers at longer escort missions. The USAAF
developed a series of much faster aircraft that could fly farther or higher. The P-40 was relegated to ground attack operations by the USAAF until 1945 when it was taken out of service. Brazil remained the only nation utilizing the P-40 for reconnaissance operations until the last P-40 in service was officially retired in 1958.
PILOT EXPERIENCES

NORTH AFRICAN CAMPAIGN: 1940-1941

The Royal Australian Air Force’s No. 3 Squadron was comprised mainly of P-40B Tomahawk IIA’s as part of the RAF’s Western Desert Air Force. The No. 3 Squadron was instructed to provide aerial support to Allied ground forces against German and Italian forces. Air Vice-Marshall Arthur Coningham was able to use these Allied air forces to battle the German Luftwaffe for air superiority over the Western part of Africa. The No. 112 and No. 250 squadrons flew the Hurricanes until they switched to the newer P-40B Tomahawk IIA’s. As soon as they transitioned, on June 6, 1941, Group Captain Clive Caldwell, in his P-40B, raced into action and took down an Italian CANT Z.1007 bomber. Unofficially, this was the first ever kill by a Curtiss P-40. Throughout the summer Caldwell earned himself a nickname amongst his peers--Clive “Killer” Caldwell.


21 Arguably, the first aircraft downed by a pair P-40 Tomahawks was a Dewoitine D.520 fighter from the RAAF No. 3 squadron on the same day.
Towards the end of the summer, on August 29, 1941, Caldwell was ambushed by 2 enemy fighters. Caldwell was flying back to his base in Sidi Barrani outside the Northwest region of Egypt when he happened to notice two Me-109 E7’s bearing down on him from both sides. At 1800 hours, Lieutenant Werner Schröer of Jagdgeschwader 27, a young promising Luftwaffe pilot, and his wingman, let loose with their 7.92mm rounds and 20mm cannons from both of Caldwell’s flanks. The sound of rounds puncturing the aircraft’s armor filled the canopy and fragments blew through the cockpit and caught him in the left shoulder, left leg, and back. The aircraft quickly became engulfed in flames. Despite the wounds, Caldwell was able to open the canopy and prepare to bail when suddenly, the fire burned itself out. Wounded and bleeding, Caldwell closed the canopy and turned back, and headed straight for Schröer, his wingman, and the flight group they were going to meet with. He used a series of maneuvers in order to get into

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22 Clive “Killer” Caldwell posing outside the cockpit of his new Supermarine Spitfire. [Image](https://i.pinimg.com/originals/a9/96/9b/a9969b4f0e1ea32374ae669b44c696c6.jpg)

23 Bf-109 in the paper will refer to any variant of the Messerschmitt Bf-109 built prior to 1938 when Bayerische Flugzeugwerke had the rights to the aircraft as it was built at the facility, specifically, the Bf-109B through D models. On July 11, 1938, Bayerische Flugzeugwerke was renamed Messerschmitt Aktien Gesellschaft with Willy Messerschmitt as Chairman. Any 109 built after 1938, is mentioned in the thesis as Me-109, which will be the E through K models. Both terms are correct and can be used, but for consistency, I simply refer to Me-109.
position behind Schröer’s wingman. Caldwell led his target using techniques from “shadow shooting” and opened fire with his twin nose-mounted .50 caliber guns and quad .303 caliber guns in the wing. The Me-109 E7 shuddered, trailed smoke, and fell to the earth. His victory was short-lived, as Schröer was trailing Caldwell’s P-40B the entire time. Caldwell and Schröer both pulled a series of acrobatics in order to get into the firing position and escape one another, with Schröer’s aircraft becoming increasingly riddled with bullets, he managed to ditch the fight and go home.

Fortunately for the P-40B, the rugged airframe allowed Caldwell to accept Schröer and his wingman’s initial attack. The pass made by the German pilots set the P-40B on fire. Caldwell was about to bail when the windspeed quickly brought the fire under control. In addition, Luftwaffe tactics call for a “Split S” maneuver when evasion is needed. At low altitudes, this maneuver cannot often be pulled; therefore, the only options were to pull an Immelmann and gain altitude. This risked losing momentum and airspeed. Otherwise, an attempt to out-turn the P-40 can be used. At altitudes below 15,000 feet, the P-40B can turn as efficiently as the early model Spitfire and the Me-109E with the speed slightly favoring the Me-109E. This lower altitude position allowed Caldwell to utilize the P-40B’s low altitude advantages. The Me-109E’s signature was the astounding power-to-weight ratio. At only 7,000 pounds fully loaded, compared to the P-40B or Tomahawk IIA’s 7,550 pounds, the Me-109E hovers around .16 power to weight at high altitudes versus the P-40B’s .11 ratio above that 15,000-foot barrier.

At lower altitudes, the P-40B has an almost even power-to-weight ratio as the Me-109E. With everything considered, Schröer’s wingman could only attempt to outmaneuver Caldwell. That enabled Caldwell to focus on maneuvering into firing position, utilize his persistent training in shadow shooting, and was able to lead his target and shoot down Schröer’s wingman. Only to
follow, with several hits on Schröer’s aircraft. Within the P-40B’s limitations, it performed very well and met the Me-109E on equal grounds at low to medium altitudes. Caldwell explained his tactic using the aircraft in Carl Molesworth’s *P-40 Warhawk: Long Nosed Tomahawks*, “the Tomahawk’s lack of comparable performance left the initiative with the opposition and it was usual to accept their initial attack in order to engage at our best height.”24 He understood the rigid airframe of the P-40B was his best asset, and allowing Schröer and his partner to make the initial attack, gave him the time to analyze and coordinate his attack after their pass, thus allowing Caldwell to be in the optimal position to exploit the advantages of his aircraft.

Schröer also befriended another skilled and unconventional pilot, Hans Joachim Marseille. Schröer told *Oberleutnant* Franz Stigler that with the JG-27 operating against the Western Desert Air Forces, it is important that “you always watch his back and your own because he will not watch yours. All he does is shoot things down.” Marseille was a rebellious pilot but despite his troublesome nature, Marseille held a sense of situational awareness which was critical for any pilot to have. He never stayed fixated on a target for long. Marseille would maneuver, shoot quickly, then move on to a different target as fast as possible. He managed to outmaneuver and out-fly anybody regardless of the circumstances and carve out a victory despite the odds against him in practice. As many of his peers often said, his downfall was not because he was good, it was because he was too good, and his ego got the best of him. Within his brief career, Marseille racked up 158 kills to his name, with 130 of them being P-40 fighters.

On June 10, 1942, Marseille was successful in shooting down three British P-40D Kittyhawks. A fourth P-40 attempted to make a break for Allied territory by speeding along at a low altitude. Marseille dove his Me-109E down and chased the P-40. With only two meters

separating the ground from the aircraft when he leveled off, Marseille was able to close the gap, then opened fire. Suddenly, with fragments flying in all directions, he shredded the P-40. It flipped over and cartwheeled in a burning mass across the ground as Marseille yanked on the stick, pulling the 109 into a high G climb.25 A week later, in Sidi Rezegh, just north of El Adem, twelve Me-109E’s encountered a squadron P-40D Kittyhawks. The Kittyhawks were flying a defensive circle, when suddenly, undeterred, Marseille leaving his flight group, put his Me-109E into a steep dive through the heart of it. Schröer noticed this and quickly followed as a backup. Instantly, P-40D’s collapsed on them firing wildly. Within five minutes, he scored four victories, with Lt. Schröer close behind, who scored two victories.26 In the end, on September 30, 1942, it was a faulty engine out of the J/G 27’s new Me-109G that was Marseille’s undoing. The engine spontaneously erupted into flames after flying with no enemy contact. He bailed out and struck the tail of his aircraft. Marseille’s parachute never opened.27


Kurowski, *German Fighter Ace*, 166-67.


Marseille explaining his maneuvers during a debriefing.
General Masuhara Homma of the Imperial Japanese Army conducted the landing force off the coast of Luzon at Aparri, Gonzago, and Vigan. Once the airfields were established, the Army Ki-27s were used as a defense against aerial attacks. The defense of the Philippines failed and Japan ultimately captured the southern airfields at Tuguegarao and Loang. On the morning of December 11, 1941, Lieutenant Boyd “Buzz” Wagner, known for his daring acrobatics in his P-40, was flying a reconnaissance mission to Aparri. Due to the low cloud cover of the cool morning mixing with the humidity of the area, Wagner dropped down below the clouds, and suddenly, he found himself above two Japanese destroyers. They quickly opened fire on him. He brought his P-40E right below the deck of the ships to avoid anti-aircraft fire. He

29 https://tse3.mm.bing.net/th?id=OIP.JL9IxLS3byxJf4kvI-BM0gHaJJ&pid=Api&P=0
skillfully avoided the onslaught until he finally made it to the captured airfield at Aparri, only to be caught at a tactical disadvantage.\footnote{Lt. Col. Boyd D. “Buzz” Wagner.” Ace Pilots. \url{http://acepilots.com/pto/wagner.html} June 30, 2022.}

Two Japanese fighters caught up to him from behind. By this time, the sun began to show through the clouds. He pulled an old trick from World War I that many German pilots used. He throttled forward and climbed into a Chandelle maneuver towards the sun. The two Ki-27 pilots chased after him. The Japanese pilots were unable to get a visual on Wagner due to the sun being directly in their line of sight. A moment passed when all of a sudden, Wagner came out of a half roll behind them and let loose with his six .50 caliber guns. Both enemy aircraft were ripped apart and the two aircraft fell to the earth. He continued to strafe the airfield and drop the throttle to return to friendly air space.

The week after, Wagner caught himself in another spectacular display of pilot skill. On December 16, 1941, Flight Commander Wagner was alerted to a new airstrip located at Vigan, on the Northwest coast of the Philippine Island. He understood he could not do this mission alone, so he appointed Lieutenant Allison Strauss as top cover and Lieutenant Russell Church as his wingmen. Their mission was to bomb and strafe the airfield where twenty-five enemy aircraft were stationed. Each aircraft was to hold six 30-pound fragmentation bombs and take off in the early hours of the morning and arrive at the airfield right before dawn.

That morning, Wagner and Church dove into the airfield and caught the Japanese by surprise. Wagner’s pass on the field went without incident and he was able to damage some enemy aircraft still on the ground. At this moment, the anti-aircraft batteries opened fire. In the middle of his dive, Church was hit and the P-40E caught fire. Church leveled out and continued his attack run, despite the aircraft being engulfed in flames. At only hundreds of feet above the
airfield, he dropped his fragmentation bombs and strafed the airstrip, damaging aircraft, and installations while receiving hundreds of hits from small arms fire. The P-40E continued through despite the damage, only for Church to nose into the ground about a mile past the airfield. Wagner was able to make five strafing passes until a Japanese fighter was able to make it airborne. Wagner rolled the P-40E upside down to see him below. As the Japanese fighter attempted to level off, Wagner throttled back. This action caused the Japanese pilot to overshoot him. In a corkscrew maneuver, Wagner leveled off behind the Japanese pilot and shot him down before he could evade, making this his fifth kill. He became the first P-40E American Ace of World War II. Four months later, in Southeastern China, another P-40 squadron called the Hell’s Angels under the American Volunteer Group battled with the Imperial Japanese Army’s upgraded Ki-27, the Ki-43.
David Lee “Tex” Hill, Ace Flying Tigers pilot, described the P-40 as an aircraft “too often belittled by Japanese fighters who did not understand it well enough.” On April 8, 1942, Ki-43 Hayabusas squared off against a squadron of newer P-40E Kittyhawks. At 20,000 feet, the Ki-43s triggered the radar system alert from Lanshio all the way to the Flying Tigers base. Captain Maruo Haruyasu provided top cover while half the squadron went down to 2,000 feet to prepare for the strafing attack. There were no onboard radios, so to stay in contact, Captain Maruo Haruyasu decided to follow the attacking aircraft.

Haruyasu and his wingmen let loose with incendiary rounds, damaging the Blenheim and two P-40E Kittyhawks. What he did not realize, at 22,000 feet, the 3rd fighter squadron “Hell’s Angels” under command of Arvid “Oley” Olson were already airborne and waiting. His squadron, with him leading, pulled a 180 roll and dove down on the group of Hayabusa. The Japanese pilots still unaware of the P-40E’s barrelling down at 400+ mph, pulled up for another

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strafing run when Olson let loose with the six .50 caliber guns. He documented later saying the Hayabusa “rolled over and I passed him, fired a long burst into a third at 3,000 feet and he turned over with pieces coming off, dove down and exploded.”

At the same time, John Donovan was returning with Fritz Wolf when two Japanese Ki-43s turned towards him and began firing. He fired back in a head-on attack and documented the aircraft crashing on the north end of the field. Cliff Groh was caught amid a small formation of Hayabusa’s on the southeast side when he caught one off guard at twenty yards. He opened fire and the Ki-43 dove down, recovered momentarily before it slammed into the earth. On the southwest side simultaneously, Fred Hodges dove down while the Ki-43 pulled up into him, Hodges opened fire and the Hayabusa erupted in smoke and fell back to the earth without the pilot returning fire. Link Laughlin and Fritz Wolf both aided in firing an unsuspecting Hayabusa off the tail of another wingman. Edmund “Eddie” Overend was trailing a Hayabusa when suddenly, it attempted to make a high G turn to avoid his guns when the canopy and upper portion of the fuselage tore off and it crashed. Captain and squadron leader Anma Katsumi, Sergeant Wada Haruto, new replacement pilot Kuroki Tadao, and Lieutenant Muneyuki Okumura were highly decorated veteran fighter pilots with multiple victories under their belts, and “never before, had the 64th Sentai lost so many veteran pilots within a single day.”

On April 10, 9 Ki-43 Hayabusa’s took off to strike Loiwing under the command of Lieutenant Takeshi Endo. Before they reached the destination, the AVG’s early warning radar spotted them, and seven P-40B Tomahawks took off to intercept. At 25,000 feet, four of the six

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36 Ford, *Flying Tigers,* 253
37 Ford, *Flying Tigers,* 254
P-40B’s\textsuperscript{38} went into two pairs of split S’s and dove on the nine Hayabusa’s while the other two provided top cover. Lieutenant Hinoki Yohei spotted them at the last minute and signaled Endo to look up. In a desperate attempt to fight them off, Yohei pulled into and fired at the diving P-40C’s, piloted by R.T. Smith and Bob Brouk. The pair of Tomahawks pulled away to engage a lone Ki-43, with Hinoki and Sergeant Misago Aikichi in pursuit. Bob Brouk noticed Aikichi and pulled up into the clouds to re engages. Brouk was able to do a hit & run three consecutive times. On the fourth attempt, Brouk came down on the Ki-43’s nose and put a volley of .50 caliber ammunition into Aikichi’s wing. Aikichi’s plane banked left at the last second, narrowly missing Brouk, and the left gas tank ignited. Brouk “followed him for several seconds, thousands of feet, while he was in flames.”\textsuperscript{39}

As luck would have it, Yohei was saved at the last second. He pulled into a climb and lost Smith’s P-40B in the clouds. Moments later, Yohei saw a shadow amongst a pair of clouds and shot at it. At the same time, Smith noticed Hinoki through the clouds and began firing. Yohei’s engine sputtered, his cockpit filled with smoke, and his face covered in blood from bullet fragments. Barely able to control the stricken aircraft, Yohei was going to commit suicide when out of the sky, two Ki-43’s piloted by Colonel Kato and Sergeant Yasuda Yoshito screamed down on Smith’s Tomahawk and his wingman. Smith disengaged only for his wingman to stay in the fight. Yoshito’s guns momentarily jammed, when after clearing them, emptied them at the enemy aircraft. The Tomahawk nosed up, rolled over, and dove into the jungle in an explosion. Yohei crash-landed with twenty-one bullet holes in his aircraft, a disintegrated wingtip, a shattered canopy, and another bullet through his back, putting him in the hospital for a month.\textsuperscript{40}

\begin{itemize}
\item \textsuperscript{38} 1 P-40B turned back due to a fuel issue and another followed.
\item \textsuperscript{39} Ford, \textit{Flying Tigers}, 260.
\item \textsuperscript{40} Ford, \textit{Flying Tigers}, 261.
\end{itemize}
On May 4, 1942, Vice Squadron Commander Charles Bond Jr. flew a bomber intercept mission over the city of Kunming in Southern China. Including himself, three upgraded P-40B’s took off with him. Bond pulled a high G climb to 18,000 feet where the Japanese bombers were flying in a tight V formation. He noticed no Japanese fighter aircraft cover which was odd. Regardless, Bond continued his climb and leveled off about 1,000 feet above and to the right of the formation. After that, he jammed the stick forward and headed into a diving left turn until his gunsight was aimed at the rear quarter of the outside bomber in the formation. After three long bursts, Bond’s P-40B ran out of ammunition, and the bomber’s right engine burst into flames. The bomber banked to the side and slowly fell into the clouds and disappeared. On his return flight, leveling off for landing, Bond was hit with a massive explosion. He looked behind and noticed three Japanese Ki-27 fighters closing in on him from above who seemingly appeared out of thin air, firing with all they got. The fuselage tank exploded, and fire erupted inside the P-40B. Moments later, Bond bailed out over a Chinese cemetery about a mile and a half away from the airfield while the P-40 bounced off the ground twice before exploding into a fireball.

The Flying Tigers accounted for 229 JAAF aircraft destroyed. That number came at the cost of 14 casualties. A combat ratio of almost fifty to three. The numbers seem far-fetched, given the fact that the Ki-27 and later Ki-43 were substantially more maneuverable than the P-40B and upgraded C model. The Japanese pilots had a service ceiling almost double the amount and could outclimb it as well. Despite the Ki-27 and Ki-43 having a one-up on performance, the Flying Tigers utilized revolutionary tactics, including the use of the early warning radar system to negate their weaknesses and maximize their strengths. The AVG continued to recruit groups of volunteer pilots with plenty of experience from both serving with the U.S. Military and deadly

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fights over Burma early on in China’s defense. Their experience alone played a crucial role in carrying out revolutionary aerial tactics such as Hit & Run attacks efficiently, which negated the disadvantages of the P-40 against Imperial Japanese Army aircraft and gave the Flying Tigers the notoriety they have today.
The United States enacted a Lend-Lease Program with the Soviet Union four months prior to the German invasion in order to help strengthen their air force in the event of a possible invasion. Germany’s air force production had increased, and the German army pushed closer to Soviet borders. It was within the United States and Soviet Union’s best interest to stop the Third Reich’s expansion into Soviet territory. Sources disagree with the exact number of P-40’s sent to the USSR. Out of the roughly 14,000 aircraft sent to the Soviet Union, between 2,100 and 2,400 were P-40C, E, G, K, L, M, and N variants. The P-40 was the fourth most exported aircraft to the Soviet Union behind the P-39 Airacobra, P-63 King Cobra, and the Hawker Hurricane.

On December 26, 1942, Senior Lieutenant Nikolai Kuznetsov along with a group of P-40 Kittyhawk IIBs were escorting eight Il-2 Sturmoviks of the 768 IAP when they were bounced

twice by Me-109F’s. Flying top cover, in three pairs with one above the other, Kuznetsov and the other flight leader Pavel Shevelyov, were told of a group of German fighters approaching from six kilometers out. When they came into view, Kuznetsov and his wingman, Vasilii Doborovol’skii dove down on the Me-109F’s, and the enemy fighters successfully evaded them. At this moment, both Russian pilots were about 1000 meters above the war zone. After the Sturmoviks dropped their ordnance, and strafed the enemy reserves, the Sturmoviks pulled out and headed home. At this moment, the sun began to set, so Kuznetsov and his other wingmen began to have trouble locating all the Sturmoviks.

During the return, two Kittyhawk IIBs provided escort from the front while the other 4 provided support from the rear. As they escorted them, Kuznetsov noticed a lone Sturmovik puffing black smoke and falling behind. As he winged over, to provide cover, screams erupted over the radio. “Messerschmitts attacking the Sturmoviks!” followed by “enemy fighters!” At this moment, the Sturmoviks were ordered into a defensive circle. A group of four FW-190A’s caught them before they could finish their formation and peeled off individually into a dive. Kuznetsov could only look in horror because he was too far away to provide adequate defense. At the last moment, Shevelyov and his wingman intercepted the fighters diving and managed to score a direct hit on one, causing it to spiral vertically to the ground. At the same time, Kuznetsov defended the damaged Il-2 from a group of Me-109F’s at 300 meters. As they approached it, the Il-2 banked left to close the gap of the defense circle. With deadly intent, a Me-109F banked in as well. To his misfortune, the German pilot turned into the crosshair of Kuznetsov and Kuznetsov released a volley of fire, the Me-109F erupted into a ball of fire as it plunged to the earth below. After many unsuccessful attempts to bring down the rest of the Il-2s, the Luftwaffe called off the attack. The Sturmoviks made it back with the damaged one crash
landing, and Kuznetsov’s victory tally rose to twenty-six. After the war his final count was forty-eight total confirmed victories, and he was awarded the title of “Hero of the Soviet Union.”

The Tuskegee Airmen

“The unit has shown a lack of aggressive spirit that is necessary for a well-organized fighter squadron…It is my opinion that they are not of the fighting caliber of any squadron in the group.” Colonel Moymer, commander of the 33rd Fighter Group, verbally attacked the African American fighter pilots of the 99th Fighter Group, by addressing a letter to General Edwin J. House doubting their ability to operate successfully in combat. Thus, the Tuskegee airmen were outfitted with Curtiss P-40L’s and sent to carry out ground support missions in Italy, while the rest of the Air Corps were given fighters such as the more powerful and faster P-47 and P-51. The NAACP back home fought to get these men the recognition they needed to fly. By the war’s

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end, the Tuskegee Airmen would grow to 417 enlisted pilots and sixty-four officers. In addition, they shot down 112 aircraft and flew collectively 15,000 individual missions.

On January 27, 1944, seven months after their first combat mission, the 99th took off with six P-40L’s from Capodichino, Naples on another assignment. Off the coast of the Ponziane Islands, at 8,000ft, the squadron leader, Clarence Jameson noticed a flight of FW-190A’s attacking Allied ships. The 99th climbed for altitude before diving on their opponents without warning. Five FW-190A’s ended up falling out of the sky. Later that day, while patrolling Peter Beach, Lieutenant Howard Bough and Lieutenant Clarence Allen, who both scored a kill earlier in the day, managed to chase a lone FW-190A down to 5,000 feet. After doing so, the German pilot attempted an array of evasive maneuvers. The two P-40L’s stuck to him before both let loose with 2 bursts each from the .50 caliber mounted wing guns. The FW-190A’s fuselage suddenly erupted into a fire as the plane heads down. At the same time, Lieutenant Willie Ashley found an FW-190A attempting to make it to Allied territory in Rome. With only a few miles, Lieutenant Ashley fired a single burst into the FW-190A. The aircraft began spewing black smoke before it winged over into the ground. Meanwhile, Lieutenant Roberts managed to get behind a German pilot before the pilot suddenly flipped the aircraft over and smashed into the ground. Lieutenant John Rogers and Lieutenant Elwood Driver, during the chaos, found a damaged FW-190A making a break for Rome as well. When they dropped behind him, the pilot flipped over and dove for the ground, passing through the clouds, he was not seen again. Lieutenant Robert Deitz found an FW-190A flying below him and lined up a sixty-degree

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deflection shot as he dove on the FW-190A, tearing apart the engine, and it plummeted to earth. The final tally for the battle was six kills and four damaged.\textsuperscript{50}

Later in the evening, on a return flight through the battle area, twelve P-40Ls under Captain Lemuel Custis’s command encountered four FW-190A’s. One was knocked out as another attempted to circle in on the P-40L’s tail. The FW-190A dived on Lieutenant Erwin Lawrence and unbeknownst to him, Lieutenant Wilson Eagleson intercepted the FW-190A on its flank at 250 yards, pouring his .50 caliber ammunition into the side of the German aircraft. The aircraft was seen continuing in its dive before hitting the ground.\textsuperscript{51}

The day after, the 99th made a returning patrol to the battle area at 5,000 feet and encountered four Me-109G’s and three FW-190A’s at 4,000 feet. As they jettisoned their tanks and dove for the enemy, the German pilots attempted to turn over and dive away. Lieutenant Lewis Smith chased a fleeing FW-190A and made a fifty-degree deflection shot, sending it down just twenty feet above the ground. Lieutenant Charles Hall chased down a Me-109G at 300 yards when he was able to make a fifteen-degree deflection shot and score a kill. He pushed the throttle forward to engage another fighter and claim his second kill, an FW-190A at 200 yards. Lastly, Captain Robert Deiz found an FW-190A at 3000 feet. His deflection shot was at thirty degrees above and slightly off-center. After a few bursts, the FW-190A banked over on fire, the pilot successfully bailed out.\textsuperscript{52} In the course of two days, the 99th scored twelve victories, three probable, and four damaged FW-190’s at the cost of three damaged P-40L’s and the death of one pilot, Lieutenant Bruce.\textsuperscript{53} January 27 through the 28, 1944, is regarded as the most successful

\textsuperscript{50} Homan, \textit{Black Knights}, 107.
\textsuperscript{51} Homan, \textit{Black Knights}, 108-109.
\textsuperscript{52} Homan, \textit{Black Knights}, 109.
\textsuperscript{53} Homan, \textit{Black Knights}, 111.
battle the Tuskegee Airmen encountered with the P-40L and one of the most successful engagements of the United States Army Air Force during World War II.

These P-40 pilots shared two important aspects when it came to flying; their ability to adapt their strengths to specific situations and utilize the advantages of the P-40’s performance to their own benefit. The explanations of these enemy pilots scoring multiple victories against the P-40 show they fought on equal terms with the Allied pilots. The main accomplishment comes when the Allied pilots were able to score large amounts of victories in the P-40 against these enemy aircraft utilizing aircraft knowledge and tactic adaptability alone.
Clive Caldwell of the Royal Australian Air Force started training with the Aero Club of New South Wales in 1938. The Club’s intent to spark interest in aviation helped produce fighter pilots from personnel competing in air races as well as air shows. This club had numerous branches across the Commonwealth with locations in Western Australia, Tasmania, and Victoria to name a few. In 1939, these branches were converted to flight training schools for pilots going into the Royal Australian Air Force. After completing his time with the Aero Club, he was too old for flight school. The RAAF physician altered his birth certificate and Caldwell applied for the Empire Air Training Scheme Program of the RAF in 1940. After completing this training, he went to the Middle East. Caldwell flew with Squadron 75 of the Royal Air Force in January 1941 in a Hawker Hurricane and then to Squadron 250 with the P-40E Kittyhawk Mk1 in February. The Empire Air Training Scheme or EATS program was a way to train pilots from all British territories such as Canada, Australia, the United Kingdom, and New Zealand at one time. The program mimicked the RAF flight school with elementary flight training, and service flying, then specialty flight schools such as bombing, air observation, gunnery, and navigation were in Canada. By doing this, Britain could focus on aircraft production, while pilots could be trained equally from all over and sent back to Britain for service in the RAF.

The EATS program, despite being in other countries, contained the same flight curriculum as other British Commonwealth countries. Their courses held Elementary Flying Training, Service Flying Training, Air Navigation, Air Observer, Bombing and Gunnery, and

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Wireless Air Gunnery. A big step in pilot training occurred with the use of the Link Trainer. Edward Albert Link, a pioneer in underwater archaeology and aviation created a flight simulator for the military. In 1929, this blue box retrofitted as an aircraft simulates onboard flight systems with gauges and responds to pilot input. The Link Trainer contained a hood where the cadet was encased and received information through their headset only.

The Army-Navy T-18 Link Trainer was utilized by the Royal Air Force. The T-18 simulated movement amongst all three axes: longitudinal, vertical, and lateral. The system also enabled blind flying with an opaque canopy, stall simulations, flat spins, and landing malfunctions. The large success of this training system allowed pilots to learn how to tackle flight issues without loss of life and to become confident in their ability to handle spontaneous situations where malfunctions do occur. This system of training became so successful, it was noted that "The Luftwaffe met its Waterloo on all the training fields of the free world where there was a battery of Link Trainers." The practice of teaching young pilots how to operate in the worst conditions on a regular basis helped train them to act under pressure. This simple act possibly saved many lives just because it allowed muscle memory to take over under certain scenarios where most pilots may have panicked, ultimately costing their lives.

Another technique the RAF used was skeet shooting. The primary purpose is to shoot ahead of a moving subject to hit the target. This technique was taught through the RAF by firing off clay pigeons and the subject must lead the target to a certain degree in order to hit it. Clay pigeon shooting also taught cadets how to anticipate targets and to shoot where they thought the enemy would be based on their trajectory. The method of deflection shooting was not a skill.

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55 Van Hoek, Susan; Link, Marion Clayton. From Sky to Sea, A Story of Edwin Link (2nd ed.). (Flagstaff: Best Publishing Co., 1993)
that was successfully taught to everybody. It was either the pilot understood the concept and perfected it or not.\textsuperscript{57}

Caldwell did not successfully carry out the concept of deflection shooting; therefore, in his free moments with his wingmen, he would fire at the shadow of their aircraft on the desert ground and observe how far in front he was supposed to aim.\textsuperscript{58} His success caught the RAF’s attention. Shadow shooting was adopted by the Desert Air Forces and incorporated into their lessons. After training, the RAF pilots held a total of around 150 flying hours before entering service.

A typical RAF pilot completed 10-12 hours on a D.H. Tiger Moth in Primary Flight School before they were accepted into basic training. Any more than twelve flight hours, if a cadet did not understand the concept of flight, the instructors would fail them. After the 12 flight hours, the cadets would complete an additional seventy hours of flight time in Basic Flight Training which involved a BT-9 or a BT-13. After completing this, they were sent off to specialty school back in Britain where cadets were trained for an additional fifty to seventy hours to operate combat aircraft in Britain to become familiar with fighting amongst the terrain and within British weather conditions.\textsuperscript{59} By the time RAF pilots went into service, they already acquired at least 130 to 150 hours of flight time and experience.

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\textsuperscript{57} Insight was given into deflection shooting by a F-4 Phantom Pilot, Officer Rob Hunt, now Volunteer at the National Museum of the United States Air Force. He mentioned, “the practice of deflection shooting is not something many pilots document, but it was taught extensively. It incorporated a flag being trailed by an aircraft. The following aircraft were armed with painted rounds and each pilot took turns shooting at the flag. The hits would be assessed after they landed. This continued through the years with very small deviation. The practice was so well taught, the armed forces did not deviate from it until the advent of BVR combat.


\textsuperscript{59} Fenton, Nick. “RAF Training.” Ken Fenton’s War, \url{https://kenfentonwar.com/raf-training/}. Accessed February 6, 2023
United States Army Air Force Training

During the height of World War II, United States Army Air Force pilots were in demand. To obtain more draftees, the age of applicants was reduced to eighteen years of age from twenty, and the required two years of college could be waived if a general education exam was passed. The devotion to creating a massive fighting force was so overwhelming, spaces in cadet training schools became scarce. It was to the point that the Navy forbade the Army Air Force from advertising on the radio. The Army Reserves began to build up an unprecedented amount of manpower due to the large influx of qualified volunteers who could not yet be accommodated for pilot cadet training. Amongst the many applicants for the USAAF Cadet School, only 193,000 cadets became pilots.

One example of these changes is found in Boyd Wagner’s story. He started college at the University of Pittsburg and pursued a degree in aeronautical engineering. In 1937, he decided to leave the University after three years and join the aviation cadet program out at Randolph Airfield in Texas. During his training, his skill with an aircraft showed immediately. In advanced flight school, Wagner developed a reputation for “buzzing” commercial aircraft without them knowing and flying at extremely low altitudes. The men who knew him said that “he was so good he could take the camouflage off the roof of a hangar.” His knowledge of aeronautics allowed him to operate the P-40 in a way no other pilot could. Lieutenant Wagner’s gift of understanding the aircraft he flew with, as well as the aircraft he flew against, did not come without additional training.

60 Nalty, Winged Shield, Winged Sword, 255.
61 Budiansky, Air Power, 309.
The classrooms and physical training were mediocre at best. It is important to note that it was not just military institutions that taught USAAF cadets. Because of the large influx of volunteers and draftees, universities and smaller colleges also taught preflight training courses. There were eight classes a day for nine weeks to achieve the most information one can give in the least amount of time. These classes included physics, aviation theory, morse code, and introductory courses in meteorology, telegraphy, mathematics, and photography. The civilian teachers who taught them had no prior military background, so the promised promotions for their service never came. The physicals included body weight strengthening, cardio, psychological and aptitude tests. Officer applicants encountered psychomotor evaluations in addition to everything else mentioned. In the end, every pilot was given a machine-scored test to tell whether they became a fighter pilot, navigator, or bombardier. The time spent in ground school was described as “the saddest, poorest, most incomplete courses a student ever had to do.”

Initially, American pilots were greeted with tents set up in the mud, no protection from the elements, and the food was subpar. Despite the conditions, the system developed well. USAAF and RAF pilots together underwent a physical assessment, followed by 175 hours of physical training and classroom work combined.

After 175 hours of ground school, these cadets entered primary flight training through contracted civilian companies for sixty hours over nine weeks. These companies used USAAF-owned trainers such as the Stearman PT-13, Fairchild PT-19, and the Ryan PT -20. In addition to learning to fly, pilots also learned map reading and military aircraft and warship recognition. The cadets who made it out of primary flight school, move on to seventy hours of a nine-week basic flying program where they learned how to utilize the skills learned in preflight for military

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64 Nalty, *Winged Shield, Winged Sword*, 258.
applications. At this point, pilots graduated to the faster North American BT-13 Vultee and BT-14. At this point, students were taught nighttime navigation, formation flying, cross-country navigation, and radio usage. In this phase of training, blind flying was introduced, simulating instances where pilots may experience points where they have to rely on their instrumentation to fly.

Throughout basic training, the emphasis on training constantly switched. In other words, no group of cadets learned basics in the same fashion another group learned. Basic training focused on different criteria every time. Sometimes pilots underwent rigorous formation flying lessons, while others focused heavily on blind navigation or aerobatics. Once a cadet cleared this portion, they move on to another seventy hours over nine weeks of advanced flight school. Fighter pilot cadets flew the AT-6 and were taught how to do advanced flying mechanisms such as aerobatics, aerial gunnery, combat, and maneuvers. They also received further practice formation flying and daylight navigation. During the entire phase, only forty percent of cadets made it through training. The rest of the cadets died in training or encountered academic or physical failures. After the cadets passed advanced flight school, they were able to receive their wings and were told where they were to go. At this point, the pilot enters transitional training before they were deployed. This meant each pilot learned to fly the aircraft they were assigned to before being deployed. In Wagner’s case, it was the P-40.

When it came to the African American cadets outfitted to fly the late model P-40L, Tuskegee, Alabama was the chosen sight for flight school. Not only was Tuskegee Institute the best-known black institution, but it also held enough facilities to hold classroom flight courses, dormitories, and mess facilities. Cadets arrived in an unforgiving world. They slept in tents

65 Nalty, *Winged Shield, Winged Sword*, 258
instead of bunks, overcrowding of facilities was common, and instructing was more dangerous than flying the missions themselves. In one such instance, Louis R. Parnell stated the instructors often shook the control stick to make operating the aircraft difficult. As well, the instructors performed various acrobatic maneuvers and told the cadets to perform the same maneuvers with little to no instruction. In the end, a paper was given with a list of errors, and after three papers, a cadet was barred from the program.66

Very few cadets were able to make it through the program without difficulty. Despite the instructors’ attempts to make the program as difficult as possible, it was not much different from a typical cadet school at that time. The instructors teaching at Tuskegee logged thousands of flight hours throughout their career, held many of the cadets accountable, and took it personally whenever a cadet was to fail. The Tuskegee pilots held great admiration for the program even though the program may not have seemed to be to their benefit. The instructors took it upon themselves to make these cadets as elite and disciplined as possible. In one such case, Maury Reid, a graduate of one of the first classes of Tuskegee cadets, recounted how he failed during navigation troubleshooting because his pencil was dull. As well, when he finished the navigation training, he was two degrees off course, despite making it through the flight. He explained, “that was the type of dedication these people had to make sure we were successful. They worked with us. They pushed us. They made me do things I had no idea I could do.”67

The number of White American cadets who graduated from the flight academy was significantly higher proportionally to that of Black American cadets. Captain Noel F. Parrish mentioned in a letter to the commanding general at Maxwell Field, that Senior pilots are of superior ability due to being trained months earlier than regular cadets. For the Tuskegee

66 Homan, Black Knights, 41.
67 Homan, Black Knights, 44.
Airmen, Senior pilots are simply unavailable and that causes an issue with training and organization. In addition, out of every ten black cadets, five have never flown an airplane, let alone ever been on one. Of the other five cadets who have flown, three of them flew for the first time as civilian pilots in training. So how was it that the USAAF could turn groups of inexperienced men into capable fighter pilots? Parrish concluded that in order to create proper organization and training within the 99th Pursuit Squadron, the selection of candidates should be based on comparative test scores in military aviation adaptability, raised the standards of proficiency, and selected from CPT Advanced Graduates. By doing so, it ensured the right cadets would be considered and are able to perform with superior ability.68

The structure of the Tuskegee Institute’s flight school is similar in structure to that of the typical American flight training: Preflight, Primary, Basic, and Advanced training. It was the caliber of difficulty that differentiated them. After eight hours, students were expected to fly solo. Instructors consistently failed cadets for simple infractions without their right to appeal. They slept outdoors in tents, instead of in barracks like many other USAAF pilots mentioned early on. As well, the pilots utilized the Spearman Kaydets PT-17, Vultee BT-13 Valiant, AT-6 Texans, and lastly, the P-40B. The P-40, to a pilot still in training, was deemed “the man-killer.” This was in part due to the aircraft’s tendency to pull too far to the right under load on take-off, poor maneuverability at low speeds, and the tendency to snap-roll.

Hazing was a part of the flight school culture as well. Cadets were pulled from their sleeping quarters, they were forced to sit against a pole for long periods of time, and cold showers in the middle of the night.69 These acts were intended to raise great discipline. Apart from the growing need for pilots as the war waged on, Tuskegee stuck to their rigged training.

68 Homan, Black Knights, 56-7.  
69 Homan, Black Knights, 61-3.
and in the first graduating class, only five black pilots earned their wings and transferred to the 99th Pursuit Squadron.

**Imperial Japanese Army Air Force Training**

After the 1932 success in creating the puppet state of Manchuria in Northeast China and invading Southeastern China in 1937, the JAAF established airfields and bases along the perimeter of the border and reduced Chinese power in efforts to strengthen the defense of the new Imperial Japanese territories. The construction of airfields across the Empire which stretched from the border outside Northern Australia to the Southern tip of Alaska, all the way to Central China, helped the JAAF quickly shift air power to territories where it is most needed, sometimes at a moment’s notice if it does not hamper the strength of Japanese control elsewhere.

Japanese fighter pilot schools varied between the beginning of the war and post-1942 but held a very similar structure to the schools in the West. In the months leading up to the attack on Pearl Harbor, the Japanese held the ideology of quality over quantity. Before students went to pilot school, they went through the *Yokaren* Examination. The *Yokaren* Examination consisted of high-level Mathematics and Science, Afterwards, they are to read and memorize the “Imperial Rescript to Japanese Soldiers and Sailors.” When it was time to graduate, only a handful out of the thousands ended up passing. Their pilots were drilled hard and the JAAF accumulated almost several years of experience in combat between the Second Sino-Japanese War and the beginning of World War II. By the time the US entered the war, the Japanese held a greater number of veteran pilots. Upon entering fighter pilot training, the JAAF went through 6 months of flight training in a *Kyoiku Hiko-Tai.* Mornings consisted of Physical Training followed by breakfast

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71 Flight Training Unit
and classroom work from civilian teachers till 17:30 in the evening. Lunch was given to anybody who was able to decipher a code the flag waver on top of the mess hall roof was displaying. If they got it wrong, no food was given to them, and they were insulted for their lack of spirit.\textsuperscript{72}

After six months, they relocated to Nagoya where they were taught basic flight characteristics and aerial maneuvers in a Yokosuka K5Y biplane and gliders. These maneuvers consisted of aileron rolls, vertical loops, left and right diagonal loops, hammerhead stalls, and the left oblique spin.

After that, trainees were assigned to a fighter sentai and they were trained for an additional three months in their assigned aircraft. By the time the Japanese pilots were sent into combat, they held at least 300 hours and about 100 hours more flight time and experience than the USAAF before going to war with the United States. On top of the flight hours, these cadets were instilled with a nationalistic spirit of death before dishonor. Trainees were used to fill the gaps whenever a fighter pilot was killed in battle. Yasuo Kuwahara, a flight cadet, explained that “punishment was an integral part of training. He went on to say it served two main purposes, to create unwavering discipline and develop an invincible fighting spirit.”\textsuperscript{73} These acts of punishment and harsh discipline were referred to as Kokutai, or national polity. This philosophy served as the basis behind the equilibrium between a disciplined army, religion, and state. These forced methods of beatings and verbal abuse caused these men to adopt a sense of obedience to their emperor in exchange for corporal punishment if they refuse.\textsuperscript{74} With strong obedience and sense of nationalistic pride, these cadets become an extension of the emperor and thus fully

\textsuperscript{72} Ōdachi, Memoirs of a Kamikaze, 34


\textsuperscript{74} P-40 Warhawk vs. Ki-43, 41.
embodied the belief of *Kokutai*. This philosophy became so strict, that any cadet who did not set up his hammock in under eighteen seconds doomed the entire group to a set of whippings. Crash landing an aircraft brought severe punishment as well. Out of the hundreds of pilots sent to cadet school, only sixty were able to move on to several months of advanced flight training. Towards the end of the war, it was shortened to a little over a month.

Advanced Flight Training took place at Oita Air Base located in Japan. At the base, trainees practiced dogfighting against other pilots and flight formations and drills. At Kasanohara Air Base, they practiced deflection shooting. A 200-meter rope would be attached to the tail of a fighter with a five-meter streamer connected to it. The pilot would be trailed by four attackers armed with color-designated ammunition to tell who was able to hit the streamer.

In the 1930’s, harsh training was highly effective as it provided a powerful fighting spirit and a disciplined Air Force for the Japanese. These pilots were not only mentally strong, but the invasion of China made them battle-hardened as they earned combat experience before America entered the war in 1941. Japan’s quest to obtain the resources needed to prolong a war with the United States came at a cost. Many experienced Japanese pilots by 1944 died because they were left in the field and never rotated out of service. Japan had no reserves and many of their pilots afterwards were inexperienced. *Shotai* leader Saburo Sakai, an ace pilot for the Imperial Japanese Navy credited with shooting down a P-40 in the Philippines on December 8th, 1941, explained in an interview, "There were only a few Japanese experts.' He goes on to say, "the American aces were sent home as instructors, but the top Japanese pilots, because of our shortage of manpower, were left in combat to die."75

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Luftwaffe Training

In comparison, German pilots were already gaining combat experience during the Spanish Civil War before Britain started training their pilots. The Spanish Civil War is also where most pilots gained first-hand knowledge of how to handle their aircraft and think rationally while in combat. On the home front, a cadet would complete six months of recruit training at a Fliegerersatzabteilung. In this phase, recruits encountered heavy physical training, rudimentary map navigation, and radio training. The next step was two months in a Fluganwaerterkompanie where recruits took basic flight courses. A/B Schule came afterward where they learned meteorology, aeronautical engineering, navigation, and flight procedure in aircraft such as the Focke Wulf 44, Klem 35, or the Buecker 131. Once recruits achieved their A license, the B license was the next step. This course included flying higher-performance aircraft like the Arado 66, Gotha 145, and the Arado 76. Heavier and twin-engine aircraft included in the mix as well. Upon successful flying of the Junkers W33, W44, Focke Wulf 58, Heinkel 51, Ar65, and Hs 123, the recruits earned their B license and officially received their Luftwaffen Flugzeugführerschein. After 100-150 hours, pilots were then able to qualify for specialist schools where they train in their designated field as jagdflieger, bombers, and beobachter. In specialty school, fighter pilots flew cross country and nighttime flights, then once they graduated, the total amount of flight time collected would reach an average of thirteen months and 200 flight hours. This was before the pilot was sent to his perspective Ergaenzungs where he was able to fly combat sorties.76 One flaw with German pilot training was the unwillingness to rotate veteran pilots out. Pilots who had fought in the Spanish Civil War or had gained experience fighting early in the Second World War were kept in the field. The reason was, if Germany was able to

have as many veteran pilots in the field as it would be able to train additional pilots while the experienced ones continue to fight. A large amount of high-ranking German pilot deaths early in the war caused a shortage of experienced pilots in the field. In turn, this meant Allied pilots still had large amounts of experienced men, allowing them to gain the upper hand.

**Voyenno-Vozdushnyye Sily Training**

Little documentation from western sources can be found when it comes to the specific training of VVS pilots during the Second World War. Some documents that include specific information before or after the war can be used to formulate a pattern and deduce how pilots may have been trained during the war when the VVS was in the process of modernizing. A few sources document the training of the Night Witches, a group of Soviet female night fighter pilots. By using these sources, we are able to create a picture of what flight training may have been like for these Soviet cadets.

The training of Soviet pilots was divided into three phases which consisted of the pre-war phase, the modernization phase, and the adaptation phase. The pre-war phase ended with the Great Political Purge of 1933. The modernization phase encompassed improvements in aerial doctrine and air power during World War II from 1933 to 1938. The adaptation phase after 1945, incorporated the copying of western aircraft beginning with the B-29, to close the gap in air power between the Russia and the West. For this thesis, the third phase emphasizes the importance of pilot training and adaptability in the heat of battle during the Luftwaffe invasion of the Russian mainland.

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In 1918, Andrei Nikolaevich Tupolev and Nikolai Y. Zhukovsky managed to create the Central Aerodynamics and Hydrodynamics Research Institute, along with the Zhukovsky Air Academy. Within the Academy, many of the studies were said to be obsolete and not important when it came to training cadets. Into the late 1920’s, the institute was recognized as a postgraduate institute. All of the candidates that went through the school were required to obtain an education from a university in order to continue through flight training. As well, many of the advancements in Soviet avionics were influenced and helped by the Germans. The creation of the Leipzig Air Base in Moscow to train German pilots was a way for Germany to work around the Treaty of Versailles and to increase relations between the two nations. In addition, Soviet cadets trained with German cadets and earn the same knowledge and education in basic flight.

By 1923, Aeroclubs were created across the Soviet Union and even attached to high schools as a massive air education campaign. These clubs allowed for semi-military education in glider flight, aerodynamics, thermodynamics, maintenance, and navigation. In addition to the civilian aeroclubs that began to develop throughout the country, many military pilot training programs coincided with these clubs to train pilots all over the country sponsored by the Soviet Komsomol. Within these flight institutions, there were general military fitness courses, basic flight courses, and sharpshooting.

Beginning in 1928 and continuing through 1938, the Soviets began to decentralize many of the flight organizations through the two Five-Year Plans. The first Five-Year Plan installed

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smaller departments within the Central Aerodynamics and Hydrodynamics Research Institute to better distribute power. By 1933, enterprises within these separate departments were being made and decentralization from the top down backfired and allowed for a capitalist-like competitive structure.\textsuperscript{83} Leipzig was shut down as German pilots did not find the air school was advanced enough to teach them what they needed to know; therefore, when the capitalist movement and shutdown of unsatisfactory air schools began, Stalin instituted the Great Purge and by 1938, most veteran air generals were relieved of their duty and were unable to teach cadets. In addition, engineers were removed, and the aircraft industry took a massive hit.\textsuperscript{84}

Between August and October 1941, well into the German invasion of the Soviet Union, the 27th ZAP was formed specifically for training on the P-40 Tomahawk and was stationed at Kadnikov airfield. A short time later, the 27th ZAP was disbanded and transferred to the 6th Air Brigade in July 1942 to begin training pilots on the P-40 Kittyhawk.\textsuperscript{85} These pilots needed to obtain and demonstrate proficiency with flying a basic trainer, advanced trainer, and a fighter. The basic Soviet trainer at this time period may have been the Polikarpov U-2, built in 1928 which served as a trainer for both civilian and military personnel. This aircraft was used to teach basic flight operations and navigation in the air.\textsuperscript{86} The Gribovsky G-25 was a tandem-seat basic trainer built in 1937 that was supposed to be the successor to the U-2. After the cadet graduated from the G-25 or U-2, the cadet moved on to the advanced trainer, the UT-1. The UT-1 was a highly maneuverable single-seat trainer that was used to teach pilots acrobatics and advanced flight maneuvers before their transition into training in the I-16 fighter, The UT-1 was used until

\textsuperscript{83} Alfonso, \textit{Femme Fatale}, 41.
\textsuperscript{84} Alfonso, \textit{Femme Fatale}, 42-3.
the manufacturing of the Gribovsky G-28, another advanced trainer built just prior to the invasion in May of 1941.\textsuperscript{87} By the end of their training before heading to the front lines, females in charge of fighter squadrons were required to hold a minimum of 500 hours of flight time and like-numbers were possibly acquired by male instructors and flight leaders too before they headed into the field.\textsuperscript{88} This number may look fairly large, but in 1939, a large number of Soviet fighter pilots held hundreds of flight hours already because of the invasion of Finland. This large flight time limit can also attest to the accountability many flight instructors and commanders held amongst their peers.

On many accounts of pilots, we get a glimpse at how difficult it was to fly for the Soviet Air Force and be trusted. Many of the Soviet Union’s respected pilots were lost early on and during the German advance into Russia, the VVS could not afford to make any simple mistakes. When it came to flight leaders, they needed to be extremely skilled, if not just as capable of handling missions as their peers. For example, Major Tamara Kazarinova was requested to be removed as flight leader simply because she did not demonstrate superior capabilities in flying to her wingmen.\textsuperscript{89} Only the best Soviet fliers were allowed to fly “lone wolf” missions, patrols, and conduct fighter sweep tactics because the pilots who did not conduct a high level of operation of military aircraft, were deemed a liability and unfit to operate important aircraft on their own.\textsuperscript{90}

By 1944, the Soviet Union was manufacturing 3,000 aircraft per month. As well, their manpower was well beyond the likes of the Luftwaffe. Although primitive in tactics and organization in 1941 and 1942, the ability to restructure their air arm and become quite possibly the largest air force of the war, while being at war, within a year is unheard of. This is perhaps in

\begin{footnotes}
\item[88] Alfonso, Femme Fatale, 25.
\item[89] Alfonso, Femme Fatale, 26.
\item[90] Alfonso, Femme Fatale, 26.
\end{footnotes}
part due to the rigors of the educational system and the ability to put out more graduates than other superpowers such as the United States and United Kingdom. The quality of Soviet education compared to the US standards were very high. Although Ramsay D. Potts Jr. focused on Soviet aeronautical engineering institutions, we can deduce that pilot training is held to a similar standard. Morale within the educational system is considerably high as well. Upon completion, a student establishes honors or is promised better pay, treatment, or reward.

A high morale mixed with a rigorous educational structure allowed for the development of a pilot who can operate under extreme conditions with the optimum capacity. The ability to break such a pilot’s mentality is difficult. Luftwaffe pilots demonstrated tremendous fighting ability in the air with advanced tactics and superior aircraft. This fact not only caused the Soviets many casualties but also forced the Soviets to reinvent themselves for the better. The Soviet aeronautical revolution gave the Soviets an elite level of education, a new manufacturing structure, and a massive reinvention of their tactics. This allowed them to come out ahead of an enemy that was tactically superior for the first half of the war.

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TACTICS

Air Marshall William Bishop, a Canadian World War I Ace, was regarded amongst his peers as one of the best all-around pilots at the closing of the First World War, regarded tactics as the second most important factor in air power behind the ability to fire guns accurately and effectively and flying ability itself. Proper use of tactics eliminates risks and puts the opponent in the worst position possible. The best most basic tactic to put into practice is the element of surprise. It mostly works in groupings of 4 and above due to the confidence of the pilots in their wingmen. In the case of a flight of 2 or a lone pilot, the chances of surprise drop dramatically due to their awareness being heightened.⁹³

In a dogfight, a pilot never lets any opponent on their tail, giving them the greatest chance of success in shooting an opponent down. With a group of aircraft, situate them in a formation that allows for better awareness of both the enemy and the pilot’s wingmen, it is possible to initiate successful defensive, offensive, and counterattacks when a formation is attacked from any angle. With that being said, the formations and fights vary by situation. So, the pilot always has to be adaptable and think quickly and act accordingly. When a pilot is above an enemy, it is advised to dive into them. Doing so allows for more maneuverability and gives the pilot the opportunity to have the energy retention to pull back up to an equal or greater altitude.

Different methods of fighting depended on specific factors with each aircraft manufactured from its perspective country. Edward H. Sims, a World War II fighter pilot and author of *Fighter Tactics and Strategy*, also connects fighter and pilot performance with a list of factors that make WWII fighter tactics more complicated than acknowledging that one country can win against another because of a better fighter plane. Although not complete, the factors

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considered when determining an aircraft and the pilot’s own capability included: speed, armament, how much stress the pilot and aircraft can withstand, service ceiling, armament reliability, field of view, acceleration, diving velocity, maneuverability, location, formation, and position. In order to achieve good results, it is also important to “feel” the aircraft. To be able to fight well, a pilot must have complete control of the aircraft, how it handles, and how it operates. If the pilot can do various aerial maneuvers consecutively and with confidence, he would instinctively be able to operate the aircraft with no doubt.

Regarding tactics, that is another factor Bishop considers widely important in dog fighting. Fighter tactics eliminate risks while exploiting the disadvantages of your enemy. Patience is a key aspect as well, because the moment a pilot succumbs to impatience and goes off on his own, the entire plan to exploit the enemy is gone. Whenever a pilot is on a flight, it is necessary to act instinctively and quickly. At any given point, in the midst of an air battle, there cannot be any hesitation. Any evasion, attack, and maneuver have to be done by muscle memory and that is only achieved through constant and consistent training.

**Imperial Japanese Army Air Force**

Traditional Japanese Army fighter tactics varied depending on the number of aircraft engaged and the type of enemy flying. On a typical sortie, a group of nine fighters would make up a *hikotai* or smaller units of fighters branched off from a larger aviation unit called a *kokutai*.

The *hikotai* would be divided into three groups of three planes in a “V” or echelon formation. “V” formations consisted of the lead pilot flanked by his wingmen on both sides as opposed to an echelon formation, where both wingmen would be staggered behind the lead pilot to one

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95 Sims, *Fighter Tactics and Strategy*, 76-78.
side.\textsuperscript{96} The formations would typically fly at 15,000 to 20,000 feet where an oxygen system and full covering would be necessary as pressurized systems were uncommon in fighters in this period.\textsuperscript{97} At such altitudes, the performance limits of the USAAF P-40’s were at their peak. Japanese pilots rarely engaged Allied fighters unless the pilots held the numerical majority. The Japanese often engaged in deception tactics. Major Iwori Sakai taught the “Sakai Method” in Japanese flight schools such as Akeno. This method was a blend of both British and American fighter formations and careful analysis of positions of attack and how to counter them.\textsuperscript{98} They understood USAAF pilots often attacked from above. So, they staged a fake dogfight by having one pilot fly at low altitudes, while the main fighting force would be providing high cover waiting for the enemy to engage. When an Allied fighter was engaged, the Japanese airmen would swarm down and attempt to separate and fight each enemy fighter one at a time. Japanese pilots were instructed to attack from the side, above, or out of the sun.

Japanese pilots prior to 1943, would utilize the \textit{Nakajima} Ki-43’s superior maneuverability by violently braking the aircraft close to stall and performing a handful of acrobatics and turns until they are able to shoot down the enemy plane. A few tactics practiced in training included the “Upper Rear Attack”, the “Hit and Split”, and the “Upper Front Attack.”\textsuperscript{99} The Upper Rear maneuver involved trailing the target aircraft 1,000ft above, before diving down at a forty-five-degree angle, firing at the closest point, and diving away. The portion where the pilot dives away would be the “Hit and Split.” At this moment, the pilot banks and uses their

\textsuperscript{96} After 1943, it is evident that Japan adopted western style of formations with a change to 2 plane sections and 4 plane flights with pairs of aircraft alternating attacks with one another.

\textsuperscript{97} The few aircraft during World War II that were in fact pressurized was the Boeing B-29 Superfortress, Junkers Ju-86P, Focke-Wulf Ta 152H-1, Supermarine Spitfire Mk. VI and VII, Westland Welkin, Vickers Wellington Mk. VI. All other fighters at high altitudes were required to carry oxygen masks.


momentum to pull up into a high G climb. The pilot needed to be careful not to pull too hard because the plane could break apart, especially if they were going too fast in a dive. In other cases, Japanese pilots took advantage of the Ki-43’s superior rate of climb. If evasive maneuvers are not successful, they would angle up and continue upwards into a high-angled climbing position where the Allied fighter would be caught in a stall. The Japanese pilot would then perform a snap loop or wing over onto their opponent.

Another evasive technique would be the Hineri-Komi or twist maneuver. It was developed in 1934 to counter western style tactics. The maneuver consisted of a half loop, and at the top of the loop, the rudder is pulled, allowing the aircraft to perform a “slide” and essentially turn sharply into the pursuing aircraft.\textsuperscript{100}

\begin{figure}[h]
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\includegraphics[width=\textwidth]{Hineri-Komi-Maneuver.jpg}
\caption{Hineri-Komi Maneuver}
\end{figure}

The Japanese after 1943 adopted the “Split S” maneuver more prominently which was a typical Allied fighter evasive maneuver, where an aircraft would pull a steep dive, roll over, and pull off a dive facing in the opposite direction.102 This maneuver allowed the pilot to achieve speed and momentum but at the cost of altitude. To the Japanese, the loss of altitude was negated by their aircraft being able to maneuver fairly well compared to the Allied fighters such as the P-40 where their main chance was to pull an Immelmann maneuver where they use the momentum gained in a dive to pull up to regain altitude and finish with a half roll into position to exploit their advantage of high speed dive attacks from an altitude favorable to the aircraft.

Japanese pilots also practiced chasing tactics as well as advantage vs disadvantage team dogfighting. Whenever a trainee gave chase, the instructor would try to shake them, and the trainee attempted to stay on their tail around 200 meters or else they would lose sight of the pilot they chased. Team dogfighting mimicked methods taken from the west. At 5,000 feet, several aircraft would dive in on another set of aircraft flying at 4,000 feet. The pilots at the lower altitude attempted to maneuver and evade the diving aircraft, and the diving pilots tried to capitalize on their advantage of altitude and speed.

All pilots were required to master the aircraft in ascents, descents, and max velocity turn dogfights. This often proved fatal as many pilots dove into the hillside after entering G-lock or causing the airframe to give out and break apart.103 When combat flying was not being practiced, they worked on formation or night flying. Their schedule would typically start off with dawn flying, breakfast, formation training, lunch, an hour nap, combat training, dinner, then nighttime

103 Kamikaze, 29.
flying. By the end of it, Japanese pilots would walk onto the battlefield with almost 1000 hours of flying experience under their belt.

A lot of this is also owed to the battle-hardened pilots as well. Japanese pilots engaged in months of grueling combat training and endured an air war with China and the Soviets above Manchuria before encountering the United States Army Air Corps. One tactic they especially exploited against the Soviets when Japan invaded Manchuria, was separating the individual enemy squadrons. The Soviets, upon receiving new I-153 and I-16 aircraft, attempted to fly in very close formations to create a large defensive perimeter. By doing so, no Soviet pilot had a blind spot. The Japanese pilots figured out, by causing their formations to break and engage them in a dogfight, the Ki-27’s maneuverability would favor the Japanese pilots. Upon learning of the Ki-27’s lack of armor and the Japanese attempt at bating the enemy into a two-circle dogfight, the Soviets employed hit-and-run tactics with their P-40’s. They attacked with height and speed to their advantage, slowly increasing the number of Japanese pilot casualties.

When General Masaharu Homma of the Imperial Japanese Army sent out his Ki-27 fighters against the Army Air Forces of the United States on December 8, 1941, the United States employed a similar fighter tactic. Boyd Wagner instructed his squadron to focus on a single high-altitude pass. Since the P-40E and the P-39, both carried tremendous momentum out of a dive, once a pass was made, the pilot used the speed acquired to their advantage in order to either climb back up to altitude or to drop down to low altitude and use the speed already obtained to get away. If a P-40 needed to evade a Ki-27 or Ki-43, it was possible for them after leveling off, especially because Japanese fighter aircraft were not constructed to handle diving characteristics. The 13th pursuit squadron Wagner commanded later became one of the highest

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104 Weiczko, Nakajima Ki-27 Nate, 39.
105 Weiczko, Nakajima Ki-27 Nate, 39-40.
decorated combat units of the Pacific Air War because of this tactic.\textsuperscript{106} This method of combat proved highly effective against these aircraft, especially in China with Claire Lee Chennault’s American Volunteer Group.

\textbf{German Luftwaffe}

One of the reasons Germany was able to achieve vast success in Poland in 1939, Denmark, Norway, and France in 1940, then on to Russia in 1941 was because of the \textit{Luftwaffe’s} implementation of tactical support of the \textit{Wehrmacht}.\textsuperscript{107} The minute the \textit{Luftwaffe} lost that superiority, German ground forces were forced back, which is what happened in North Africa, Sicily, Italy, France, and finally the last German offensive in Belgium in January 1945. Fuel supplies ran low so aircraft could not get into the air, and railways were bombed so it took weeks before supplies and reinforcements could make it to the front. Then when they finally made it, Allied fighters were waiting for them in the air along with ground troops on the ground.

The \textit{Luftwaffe} were known for their aggressive nature. The primary objective was to exploit the known disadvantages of the enemy aircraft. Within a \textit{rotte} while engaging in combat, the \textit{rottefuehrer} would be the one to initiate the attack while the \textit{katchmarek} guarded his rear and also served as a lookout for any incoming aircraft from other directions. Larger formations achieved this as well with Staffel formations flying in line astern while in step formation roughly 600 yards wide.

The \textit{Luftwaffe} maintained high cruising speeds and changed direction by completing the “cross-over turn” to defend against an impending attack. This turn focuses on preventing the outside aircraft from being left defenseless by switching positions between the inner and


\textsuperscript{107} Sims, \textit{Fighter tactics and Strategy}, 24.
outermost aircraft. As well, the aircraft switching positions to turn can hold their speed, eliminating the possibility of one falling behind.

Another tactic that was still widely used three decades after development, was utilizing the sun at their backs. Often, Luftwaffe pilots attempted to prevent turning fights, in favor of surprise attacks. They would often manage to bounce the enemy by making one firing pass from above with the sun behind them. The Me-109E through F’s advantage of a higher service ceiling than the Polish, British, and French fighters, gave it an edge; therefore, the Luftwaffe exploited the enemy’s disadvantage by almost always cruising as well as engaging aircraft from higher altitudes.\(^{109}\)

When a German fighter pilot is attacked from behind, they are instructed to bunt over into an Abschwung dive. This maneuver exploited the German direct fuel-injected engines of the early 1940s. The aircraft faced by the Luftwaffe in Europe, especially the early model British Spitfires, contained floating carburetors. When experiencing extreme G-forces, the engine encountered fuel starvation and the plane stalled.

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This was common amongst the early model Spitfires with the Rolls-Royce Merlin. This specific tactic was often highly useful in the early parts of the war. By 1943-1945, The tactic grew to become predictable. Officer Harold H. Brown, a Tuskegee Airman who trained in the P-40 before flying the P-51C, explained that “Germans typically will barrel roll and dive away. The issue is that left me more time to see you. So, my wingman and I rolled over and you can see the flashes as we peppered him all the way down.”

This maneuver during the later period of the war, was used for emergency purposes only. In most cases, the German pilot would couple an evasive maneuver with a turn into the direction it is being attacked to minimize the chances of a successful deflection shot.

Further on in the war, with the development of new enemy tactics and fuel systems in engines, those same Luftwaffe tactics became easier to counteract as more pilots who were experienced, understood and adapted the necessary countermeasures.

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**Royal Air Force**

The British began building twice as many fighters as the *Luftwaffe* in the late 1930’s and received a generous amount of P-40s from the US. By 1940, the British rivaled German air power in numbers. They made sure the aircraft contained oxygen masks and superchargers for high-altitude fighting.\(^{113}\) Initially, the *Luftwaffe* was able to score many victories with the Me-109.\(^{114}\) As the war progressed, the British claim to fame was their formation flying and communications.

Adolph Gysbert Malan, a South African Royal Air Force pilot, took part in the Battle of Britain and was known as an extremely talented tactician. He realized during the early stages of the Battle of Britain in 1940, RAF pilots experienced the same mistakes the Soviets made with flying tight formations, their ability to maneuver suffered because of this. Initially, the RAF incorporated flight formations of three aircraft in a “Vic” with two sections making a total of six aircraft within a section and normally two sections per flight.

![Vic Formation](image)

When a flight approached an enemy, the lead aircraft searches for the enemy formations. When an enemy is sighted, the formation would position itself accordingly. One issue with this is

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\(^{114}\) Sims, *Fighter Tactics and Strategy*, 23.

\(^{115}\) “Royal Air Force Tactics during the Battle of Britain.” 2010b. Classicwarbirds.co.uk. 2010.  
that a Vic formation was often used successfully with bomber formations. When a fighter escort presented themselves, this tactic caused issues when pilots would have to break off and engage, this left at least one pilot without a wingman. This was later modified to introduce a defensive weave at 1,000 feet above the first three sections to defend against *Luftwaffe* fighters. Although this minimized the chances of the first three sections being attacked, the 4th section often encountered heavy casualties by being left on their own above the rest of the flight.

By 1942, the finger-four formation was influenced by the *Luftwaffe’s Schwarm* which allowed pilots to always have a wingman to cover them with the flight leader and his wingman engaging in offensive operations, while their pair of wingmen provide defense for the flight leader.

![Finger-four squadron formation](image)

In addition to a large change in formations, the British often incorporated a psychological tactic known as a Big Wing. This formation involves the usage of finger-four squadrons in large numbers, thus overwhelming the enemy through sheer force alone. Instead of one or two flights,

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Luftwaffe pilots would encounter from three to five flights of aircraft. Although it allowed for high amounts of kills, the time it took to amass such a force took too long for it to be effective long-term.\textsuperscript{117}

What caused a significant impact in negating an enemy’s superior aircraft was the British ability to communicate effectively. The Dowding System, a ground-controlled interception network was spread out across the country. This system alerted pilots and sent them up swiftly in order to intercept an incoming raid before the enemy arrived at the target. This consistent network between radio command, ground forces, and the RAF into one unified air defense caused enemy formations to slowly break down, thus allowing British pilots to gain the upper hand despite the overwhelming odds experienced by the Luftwaffe.

Adolph Gysbert Malan came up with 10 rules for fighting enemy aircraft which were adopted by fighter command as a doctrine heavily used by pilots throughout the war after the Battle of Britain. His first rule was to fire short bursts of one to two seconds only when the gun sight is on target. The majority of aircraft during this time period only held enough ammo for up to ten seconds of firing time; therefore, pilots could not afford to waste ammunition, especially in the heat of battle.

His next rules focus on reaction and not to think in combat. A pilot should always focus on keeping a sharp lookout. The altitude gives pilots the initiative when an attacker approaches them. In a dogfight, always face the attacker. A pilot should act quickly and never fly straight and level for more than thirty seconds. In a dive, the pilot should make sure their formation is above to act as a guard before they hit hard and fast. This ensures a pilot always has cover as he engages the enemy.

The United States Army Air Force

The Americans adapted some of their strategies and tactics from the Germans. These tactics ranged from surprise “bouncing” attacks, “close-in” shooting, “fast pass from altitude,” and spontaneous size-up of enemy aircraft. All of these involve analyzing conditions in which an American pilot is entering the battle and making the necessary tactical changes. These conditions could include altitude, type of aircraft, and advantages vs disadvantages of not only the pilot’s aircraft but specifically the pros and cons of the enemy fighter as well.

The P-40 took a lot of punishment and delivered a significant amount of firepower. At altitude, it is documented as sluggish in acceleration with a rugged airframe. The high-powered engine and tendency to carry momentum in vertical flight meant it was capable of diving fast, with the ability to deliver massive amounts of firepower from the six .50 caliber guns and was still able to utilize the energy gained to pull back up to altitude while sustaining heavy G-forces. The Hit & Run techniques developed a way to trade kinetic energy for potential energy in order to achieve an altitude beyond the aircraft’s effective ceiling in order to set up for another attack. Often, especially close to the end of the war, many pilots incorporated this technique because, with aircraft becoming faster and more maneuverable, the classic turning combats became more dangerous.

The USAAF adopted the finger-four formation from the Luftwaffe during the Spanish Civil War. This formation allowed two pairs of aircraft to be paired together to provide support for each other. This formation also allowed aircraft to fly in a V formation and the fourth one would continue in a sweeping motion to provide supporting cover for the three aircraft. When flying in multiple Finger Fours, the formations would be spread out about 200 meters, as opposed to the original Japanese flight formations where they would also fly in a V formation in groups of three. This formation has a sound offensive structure where the flight leader has the
primary duty of seeking aircraft, and the wingmen focus on keeping formation and defending the flight leader whilst engaging the enemy. Despite the offensive success of the three-man Vic formation, it often led to a pilot being susceptible to an attack. Ki-43 pilots adopted the Allied finger four formations as well later in the war.¹¹⁸

The USAAF incorporated two types of maneuvers that gained lots of success against the IJAAF and IJNAF. The Beam Defense Position and the High-Side Gun Pass, most known as “boom and zoom.” In July 1941, Lieutenant Commander John “Jimmy” Thatch researched reports from the Flying Tigers on their advantages and disadvantages of the Ki-27 and Ki-43 against the P-40’s. Thatch understood the one major advantage was the Japanese fighters’ ability to maneuver very well in combat. A three-section T or V formation would be unsuitable because at least 1 aircraft would be left a sitting duck. He realized, if there were four aircraft split into pairs, they can be held accountable for the other and bait the zero to fly into the firing path of the other aircraft. This maneuver became so successful, the Army Air Force began adopting it after July 1942 and even the Japanese began to fear this tactic. Saburo Sakai, a leading Japanese ace pilot, witnessed Lieutenant Commander Tadashi Nakajima fall victim to this tactic:

“Lt. Commander Tadashi Nakajima encountered what was to become a famous double-team maneuver on the part of the enemy. Two Wildcats jumped on the commander’s plane. Nakajima experienced no trouble in getting on the tail of an enemy fighter, but never found a chance to fire before the Grumman’s team-mate roared at him from the side…he was forced to dive and run for safety.”¹¹⁹

¹¹⁸ Molesworth, P-40 Warhawk vs Ki-43 Oscar, 41.
Thatch understood the majority of the incidents involving Japanese fighters consisted of the pilots attempting to force the Allied fighters into a turning dogfight. By operating in a “beam” formation if a Japanese fighter pursued a pair of Allied fighters, the pair would begin a series of turns called a sandwich, then into a defensive split. As the defenders turn into one another, the second pair of fighters pull behind the Japanese aggressor while the first pair of defenders pull away, only to twist back in the opposite direction. They repeat this maneuver until the aggressor is downed or evades the fight.

Russia’s air arm, in ways like the Luftwaffe, was designed to work closely in support of ground units; therefore Russian’s understood the importance to intercept Luftwaffe aircraft before having the chance to support a ground assault. During the first several days of the Soviet-German conflict, the Russian air force was flying at least three sorties per day which increased in number as the war progressed. When it came to tactics, the Soviets can be considered unconventional. Yet, this may have given them the success they needed.

Alexander Pokryshkin, often regarded as one of the most talented group commanders to emerge during World War II, taught the Soviet air arm the modern tactics it would be associated with after 1943. He may not have been a part of an elite squadron such as the sixteen GIAP, but explaining his new ideas in Soviet fighter tactics can shed light on how elite squadrons such as them began to emerge from the VVS and revolutionized their fighter tactics in order to defeat the Luftwaffe in the P-40. The Russian adaptation of modern tactics came spontaneously and widely. Their transition from turn-based tactics to the contemporary philosophy of “altitude, speed, maneuver, fire” came with a sudden rush, much so that it took time in the midst of an ongoing war to catch up and provide consistent success.

The main issues surrounding the VVS dealt with the organization of combat operations and the lack of directives regarding how fighter aircraft are handled in the air. Examples of these directives include formation flying, mutual support, coordination, and most importantly, understanding of the enemy’s aerial tactics. Pokryshkin believed the best method to train pilots on superior tactics was to learn through combat and potentially take what tactics were used

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against them as their own. Altitude was deemed the primary advantage above all. To be at a
greater altitude than the enemy, the VVS achieved the ability to maneuver freely and obtain an
easy advantage over the enemy to observe and select the best target for success. The Soviets
adopted Hit & Run tactics as a way to obtain the second most important aspect, Speed. Speed
amongst the Soviets was crucial because it allowed the chance for a quick unopposed attack
before evading and gaining altitude. The Me-109 F and G models held a more powerful engine,
but with the introduction of the American Lend-Lease Aircraft, the P-39, and P-40, their more
powerful engines allowed the Soviets a chance to fight on par with their adversaries. Despite the
fact that the P-39 saw greater success amongst Soviet pilots than the P-40, the P-40 as well was
subject to changes that allowed the Soviets to operate at altitude. The Allison engine was
replaced by some Soviet M-105P because of a shortage of Allison engines.125 Despite the
shortage of parts, Soviet pilots still continued to stick to their tactics. With Speed and Elevation,
Pokryshkin’s next important tactic comes to mind, maneuverability. Flexible operations in
maneuverability on the vertical or horizontal Axis allowed a pilot to be in the optimum position
for the final important factor in aerial combat, Fire. The importance of firing at close range was
adopted from the exploits of Erich Hartmann, one of Germany’s leading aces, who Pokryshkin
understood only fired when Hartmann was sure not to miss. This tactic required a tremendous
amount of patience, discipline, and skill. For all 4 tactics to be effective, all pilots need to be in
sync with one another.

The transition from 1942 to 1943 brought a more structured fighting style for the VVS.
Early war pilots often flew in close Para formations, but now with the introduction of Radio
equipment in the Lend-Lease aircraft, the pilots found greater success in operating formations

125 George Mellinger, Soviet Lend Lease Fighter Aces of World War 2 (London: Bloomsbury Publishing,
2012), 28.
with a wider spread. Pilots soon mastered the opportunity to communicate effectively and coordinate attacks in the heat of battle. The Soviets embraced a more liberal structure of operations. Instead of resounding under a strict approach to fighting, they in turn opted to give pilots the ability to choose the formation, how to engage, what altitude, and the speed they should attack at the moment. This unconventional method allowed the VVS to not only adapt to combat situations at a moment’s notice but also be unpredictable.

The VVS began to realize, flying in a tight horizontal pattern did not allow them the maneuverability they needed to counter Luftwaffe attacks, due to either aircraft not being able to cover the other. The Rotte and Schwarm Luftwaffe formations allowed for an added measure of flexibility if an attack were to happen, as either aircraft would be covered by a wingman. Between 1942 and 1943, Luftwaffe accounts began to report the VVS copying their formations in order to exploit the advantages of the P-39 and the P-40’s added maneuverability while providing cover for each other. What is also interesting to note is the aggressive behavior of defensive tactics.

The defensive circle adopted by the RAF was another tactic the Luftwaffe noted as a popular tactic amongst the VVS. The only difference that proved deadly was the fact that if a Luftwaffe fighter were to dive in for a quick attack, it would be as if the entire circle imploded. VVS fighters from all angles attacked with considerable initiative and quick reaction. Georgiy Golubev described the violent air battles and what would happen during a defensive circle by stating, “Once a pilot entered this deadly environment, he found himself in a confusing vortex of flashing tracers and rattle of machine gun fire.” He goes on to say, “a diving Me-109 would trigger an attack, which in turn drew into battle the intended victim’s wingman.”

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126 Hardesty, Red Phoenix Rising, 201.
lasting tactic that proved highly impactful was the *Okhotniki* or the free hunter tactic.\textsuperscript{128} The tactic involved one para aggressively attacking the aircraft from the rear blind spots on either side, instead of from above. As the *okhotniki* was in progress, another *para* flying parallel to enemy formations, and working in tandem with antiaircraft batteries, attacked the topmost group in the bomber or fighter formations. This highly coordinated attack allowed the VVS to not only become extremely difficult to fight against. In addition, their fluidity and ability to be flexible in their combat formations to meet shifting combat needs took away the *Luftwaffe’s* ability to operate the Soviet skies with confidence and superiority.

By 1943, the VVS not only completely modernized their aircraft, but they restructured the way they fought. The *Luftwaffe* was in a battle of survival, and by the summer of 1943, the *Luftwaffe* accounts note that the VVS acquired a measure of air mastery that left the Soviets with the largest aerial triumph of the war. With 1,100 German aircraft destroyed, the battle of Kuban is the sight of the first time VVS units employed innovative tactics on a large scale and achieved a psychological victory over an enemy thought to be superior in both capability and aircraft.\textsuperscript{129}

\textsuperscript{128} Hardesty, *Red Phoenix Rising*, 204.
\textsuperscript{129} Hardesty, *Red Phoenix Rising*, 205
AIRCRAFT DESCRIPTIONS

The P-40 Warhawk, Tomahawk, and Kittyhawk

During the 1930’s, the United States Army Air Corps heavily emphasized the production of coastal defense and ground attack aircraft. Donovan Berlin started developing a fighter capable of taking punishment with ground attack operations, but also with enough speed and maneuverability to protect the coast against aerial invasion. The design consisted of a low to mid-altitude, pursuit aircraft.

When the Second World War began for the United States, the P-40 fought in different parts of the world which brought to light many of the disadvantages regarding the aircraft’s construction. The Allison engine was able to offer better aerodynamics, more power, and fuel consumption, but only up to 12,000 feet which was the limit of the Allison engine. The amount of armor gave the plane a heavier gross weight that caused a below-average rate of climb and an inability to maneuver well at low speeds. The way the guns were loaded made them prone to constant jamming. In addition, the aircraft was prone to snap-rolling if it was maneuvered at low speeds.
Joe Baugher, a Chicago-based archivist, created a database of United States military aircraft serial numbers from 1920 to the modern day. He included in his description of the P-40 by European standards, “the P-40 was already obsolete, and it never did catch up”\(^{130}\) when he referred to the P-40B’s lack of armor. The .30 caliber armament in four gun mounts on the wings and twin .50s in the nose did well enough, but it did not take away from the fact that the aircraft was produced based on the 1937 argument of bombardment being the primary offensive measure. As a defensive pursuit fighter, the high-altitude capabilities of the P-40 were ignored in exchange for producing a fighter capable of countering an attack on the United States coast. The design is often regarded as a detriment to aerial fights against German fighters because the Me-109 held a superior performance in multiple categories, including the rate of climb and service ceiling. The P-40B or Tomahawk IIA’s top speed was 350 mph with a service ceiling limit of just below 32,500 feet. The climb rate at 10,000 feet was at 3,000 feet per second and gradually gets lower as the altitude rises. The Allison V-1710 did not have a two-stage supercharger; therefore, for any fight above 20,000 feet, the performance of the Tomahawk IIA decreased.

The P-40A was the first P-40 in service, but the P-40B was the first combat-ready aircraft. The B model utilized the Allison V-1710-33 and added an extra gun in the fuselage bringing the firepower to four .30 caliber guns in the wings and two fuselage guns. This variant was used during the opening hours of the Pearl Harbor attack. The upgraded P-40C or Tomahawk IIB held a similar performance to the former variants. The Tomahawk IIB’s ability to carry an external fuel tank, self-ceiling fuel tanks, and more armor, allowed for much-needed changes from the P-40B including extended range and added protection.\(^{131}\) The improved


\(^{131}\) RAF installed .303 ammo instead of the US issued .30 caliber ammunition in the wings.
Allison in the IIB mixed with the additional weight of the self-ceiling fuel tanks and armor negated any improvements in performance. Caldwell, when asked about his experience flying the Tomahawk IIB, he stated “while inferior in performance, particularly at altitude, to the Me-109…the Tomahawk seemed to hang on to them well in a steep or vertical dive and, operating within its own altitude limitations, performed creditably in a dogfight.” That does not go on to say the P-40 was drastically better than the Me-109 E and F models below the 20,000ft threshold, but it was fully capable of putting up a significant fight against them when paired with a pilot of great ability.

France asked for 140 P-40B Warhawks and under the Lend-Lease Act, the United States agreed to supply them with the aircraft to help defend against Germany’s expansion. When France surrendered to Germany, the shipment was diverted to Britain when they were designated the Tomahawk I, IA, and IB.\(^{132}\) by 11 March 1941, 300 Tomahawk IIBs equipped with the Allison V1710-03\(^{133}\) were shipped to the Desert Air Force and Squadron 250, under the command of Squadron Leader John Scoular. Their objective was to obtain and keep air superiority in defense of ground forces as they cleared eastern Cyrenaica and Tobruk. It was not until the second week, that the P-40 squadron began to encounter the Me-109E model from the Luftwaffe. Surprisingly enough, the P-40 is documented with the ability to rival the Me-109 at medium altitude with identical maneuverability characteristics and speed.


\(^{133}\) Allison V1710-11 and the V1710-03 were both C series engines which produced 750-1,050hp at sea level. The engines are almost identical with a single stage/single speed supercharger, except gear ratios and a stronger reinforced drivetrain. These gears varied from shorter 6.23:1 ratios for added acceleration, to 8.77:1 which aids in higher top speeds. A full break down of the differences can be found in Daniel Whitney’s, Vee’s for Victory!: The Story of the Allison V-1710 Aircraft Engine 1929–1948.
The P-40D introduced a lot of cosmetic changes that inadvertently increased the weight while leaving the rate of climb and service ceiling unchanged. The V1710-39 F series replaced the C series counterpart in the previous version, raising the power by 100hp. The nose, landing gear, and fuselage were shortened 6 inches and the radiator was enlarged and moved forward to increase air induction and cooling for the supercharger. This version also allowed for the introduction of a 500lb bomb.\textsuperscript{134}

The P-40E kept the Allison V1710-39 but exchanged the four .50 caliber guns for six in the wings. The P-40E also incorporated the ability to carry a 1,000lb bomb. When the F model was developed, the Allison V1710 was replaced by the Supermarine Spitfire’s heart and soul, the Rolls-Royce Merlin 28, and put inside a Kittyhawk I. Performance was enhanced almost instantly with the two-stage supercharger and 300 horsepower increase. The service ceiling was enhanced from 12-15,000 feet to almost 20,000 feet. The maximum speed went from 360 to around 380 mph. Packard developed their own Merlin engine with the Merlin V-1650-1 and proceeded to put an air intake above the cowl to increase airflow into the engine.\textsuperscript{135} Although the improvements were slightly under the Rolls Royce Variant, they still yielded tremendous results.

The cooling system for the P-40 unexpectedly increased drag which negated any performance change. By 1943, Curtiss experimented with reducing the drag coefficient with the P-40K and L in order to increase performance. The traditional canopy was removed in favor of a “bubble” canopy but this simply allowed better visual. In addition, the two variants included a shortened fuselage, clipped wing tips, electric aileron trim, and water injection. four propeller blades. The Merlin was replaced with a more powerful Allison V-1710-21 which was a

\textsuperscript{134} “Curtiss P-40 Warhawk,” Aviation History Online Museum, \url{http://www.aviation-history.com/curtiss/p40.html}. Accessed February 7, 2023

powerplant shared by the P-51. The end result of all these changes was a new XP-40Q. Despite the changes, the P-40 was unable to match the performance of the P-51 and the fighter never went into production.\textsuperscript{136}

**Messerschmitt/Me-109**

The German Me-109, designed by Willy Messerschmitt, and Walter Rethel, and manufactured under *Bayerische Flugzeugwerke*, replaced the outdated *Arado* and *Heinkel* He.51 series aircraft. In 1934, the German Air Ministry called for a modern monoplane. The Bf-108 Typhoon was a touring aircraft, but it set numerous air records within a year of its production. Willy Messerschmitt used this aircraft as the basis for the 109, all he needed was a more powerful engine. The Junkers Jumo 210A became the primary choice.\textsuperscript{137} By 1937, the Bf-109B entered service as the premiere fighter for the Condor Legion. The Bf-109C included additional armaments from the B model and the following D model received a new engine, the Daimler-


\textsuperscript{137} The 700 horsepower British Rolls Royce Kestrel V was temporarily implemented into the Bf 109 and the German Air Ministry ultimately decided on the 109 with that engine, as the primary fighter for the *Luftwaffe*.  

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Benz DB 600A series. These upgrades culminated in the 1939 Me-109E. Within the E model were many different variations ranging from the E-1B to the E8. Each variation has slight differences, but the one Schroer and Marseille flew was the Me-109 E-3, with Marseille going on to fly the F-4 and G-2.

Generally, the Me-109E “Emil”’s strong suit is the ability to climb at a high rate of speed and operate at high elevations. With the 1,050 horsepower direct fuel-injected supercharged Daimler Benz DB601N in the Me-109E, the performance of the E model remained consistent almost entirely up to the aircraft’s service ceiling as the engine was specifically built to perform at high altitudes. The E-3’s armament of two 20mm cannons in the wings and two MG17s in the nose, held the performance and firepower to rival the early model Supermarine Spitfires during the Battle of Britain.

Within the North African Campaign, Marseille started off in the E-3 before moving on to the F-4 variant, codenamed Freiderich. This version was a massive improvement over Emil. For instance, the engine was replaced with a more powerful Daimler-Benz 601-E/N, the structure was more streamlined, and the fuselage was refitted to improve aerodynamics, and the tail wheel was now fully retractable to improve airflow. In addition to airflow, improvements in maneuverability were achieved with the rounding of the wingtips as well as new ailerons and a high lift device. Armament was changed a little bit as well. The two cannons were replaced with a single cannon firing through the propeller hub and two 7.92mm machine guns in the engine cowling.  

Marseille’s final aircraft, the Me-109 G-2, “Gustav,” he flew in North Africa up until his untimely death. The more powerful supercharged DB 605 A-1 replaced the Daimler-Benz DB

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601. In addition, the armament was changed to one 20mm cannon in the nose with 2x7.92 machine guns in the wings. The only difference is that this variant got rid of the pressurized cabin which was apparent in the G-5 series.

**Focke-Wulf 190D**

The 1939 *Focke-Wulf* 190A flew for the first time in late 1941. The aircraft was purposed as an air superiority fighter with enough stopping power to take down the USAAC B-17s. The Daimler Benz inside the Me-109 along with the construction of the plane’s airframe became difficult as German factories and production began to take a toll from bombings during the war and as resources began to run scarce. The BMW 801C became the engine of choice despite constant engine failures and overheating at long distances. The airframe for the FW-190 was constructed from recycled airframes out from field workshops before being tested and sent into

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Despite the issues Germany began to encounter in the mid to late war, the aircraft proved to be very lethal in the right hands.

The A8 or R8 *Sturmböcke* was outfitted with two MG151 20mm guns in the cowling and two in the wings. It also sported a new endeavor Germany was experimenting with. The GM-1 Nitrous Oxide system allowed the aircraft to operate at even greater altitudes than what the A8’s engine was rated for. *Rüstsätze* was outfitted as an option for any flight that wanted cannons instead of machine guns, bomb pods, advanced electrical systems, or fuel systems. Any Fw-190 with an included *Rüstsätze* was redesignated as R8. These variants included the replacement of the MG151’s in the wings with 650 rounds per minute autocannons in the wings and 30mm armor for the canopy and 5mm armor for the cockpit. The R8 could fly at 410mph at an altitude of 35,000ft but proved to be not as agile with the armor included. When attacking bomber aircraft, the FW-190 paired with Me-109’s in the *Sturmgruppe* tactic. This allowed them to approach from above and dive down on the bomber formations and fired the 20mm heavy machine guns to take out the rear gunner. From there, they would pull an *Immelmann* back up to altitude and “engage with the MK 108 30mm cannon, which was a formidable weapon. It could cut the wing off a B-17.” The more agile Me-109’s provided fighter cover and fend off any Allied fighters that may be in the area or escorting the bombers.

The D variants from the D1 to the D9 proved to be more agile and faster than the A model with the introduction of the Jumo 213A inline engine. This engine allowed the structure of the cowling to be slightly less bulky, which improved the aerodynamics of the airframe versus

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the bulkier radial construction of the BMW engine in the A series. The D series could fly at 426mph at 20,000ft and increased to 440mph at 36,000ft. The armament included 2 MG131 machine guns in the cowling and 20mm MG151 cannons in the wings. This armament and performance combination was enough to outclass the P-40 and rival the later model P-51 and Spitfire. The Tuskegee airmen encountered the D variants in the winter of 1943 when they were tasked with a bomber escort in the Merlin powered P-40L.

In comparison with other aircraft of the war, German fighter ace Erich Rudorffer mentioned the FW-190 was far superior to the P-40 and P-38 lightning, especially the early model ones in North Africa. The 190 was able to operate with greater performance at higher altitudes with a better climb rate.\textsuperscript{143} Air National Guard fighter pilot Ray Fowler flew the Fw-190 between Oregon and Virginia and noted the P-51 felt stronger and more powerful, but the 190 was crisper and more maneuverable. Compared to the late model Spitfire MK. V and Me-109, the Fw-190 was far more maneuverable and held better firepower as well, but the Me-109 operated better above 24,000ft.\textsuperscript{144}

The German fighter aircraft operated with more maneuverability and held higher firepower than some of the Allied counterparts. The Fw-190 was especially a handful to fighter pilots in the P-40 and later P-51. German tactics typically exploited the disadvantages of the Allies. For the P-40, the Fw-190 held a higher raw speed at higher altitudes and better armament. If a P-40 pilot was caught above 20,000 feet, he was in trouble if a capable German pilot could utilize the Fw-190’s speed. As the war progressed and Allied pilot skill improved, the disadvantages of Allied aircraft grew smaller, and the \textit{Luftwaffe} did not make some of the

\textsuperscript{143} Sims, \textit{Fighter Tactics and Strategy}, 174-5
necessary tactical changes to accommodate. German pilots lost skilled pilots and replaced them with new pilots who were not as experienced as the Allied counterparts with experienced pilots who rotated in and out of service. This minor mistake allowed many German pilots to fall to Allied pilots who engaged them. The performance differences between the P-40 and the Fw-190 ultimately did not matter, as experience and technique of flying the aircraft proved the success of the aircraft in battle.

**Ki-27/Ki-43 Oscar**

The *Nakajima* Ki-27 originated from a Japanese Army Air Force manufacturer competition between *Mitsubishi, Nakajima, Kawasaki, and Ishikawajima* in March 1927. Ishikawajima quickly left the competition after they realized their design was not fit to the Army standards. *Mitsubishi* made the half-metal, half-wood *Hayabusa* 1MF2 with a high output 600hp engine, but during flight tests, at 250mph, the aircraft disintegrated in a high-speed dive. *Kawasaki* completed building the German-influenced KDA-3 with a similar design to the 1MF2, but it was soon lost in an accident in Kakamigahara. *Nakajima* built the NC, a French *Nieuport*

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look alike, except, this was an all-metal design.\textsuperscript{146} The \textit{Koku Hombu} or Imperial Japanese Naval Air Force believed the \textit{Nakajima} was the best design. In 1931, the aircraft was dubbed the Type 91 and was put into service. The \textit{Kawasaki} Type 92 was put into service around the time of the invasion of \textit{Manchukuo} in 1932. Due to the horrible performance at low altitudes and teething issues, Type 92 was swiftly discontinued.\textsuperscript{147}

By 1935, \textit{Kawasaki} built the Ki-10 with a new improved engine, while \textit{Nakajima} finished the Ki-11 which ran a more powerful engine than the previous design, and the airframe was changed to resemble the American P-26. These two fighters exploited 2 very different styles of dog fighting. The \textit{Nakajima} Ki-11’s airframe gave it superior agility. The aircraft’s ability to outturn, roll, and maneuver better than the Ki-10 gave it an extraordinary edge over other fighters and was favored amongst the Japanese pilots.\textsuperscript{148} The Ki-11 was to continue redevelopment while \textit{Nakajima} started production on an advanced design that would be able to beat the prototype designs by the other two manufacturers in both maneuverability and speed.

The \textit{Nakajima} Ki-27 featured a closed canopy, a slightly less powerful engine, but a larger wing surface area to reduce loading, and a negative twist of the wings by 1.5 degrees, which increased agility at the cost of 3.5 mph.\textsuperscript{149} Despite the fact that the Ki-27 was slower at level speed, and was outclimbed by other aircraft in the advanced fighter competition, the Ki-27 was unmatched in agility and the lightweight aircraft was an astonishing 2000 pounds without fuel.\textsuperscript{150} The Ki-27B is a slightly heavier model (2400 lb.) than the previous Ki-27A, with a

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\item \textsuperscript{146} Wieliczko, \textit{Nakajima Ki-27 Nate}, 3-5.
\item \textsuperscript{147} Wieliczko, \textit{Nakajima Ki-27 Nate}, 7.
\item \textsuperscript{148} Wieliczko, \textit{Nakajima Ki-27 Nate}, 10.
\item \textsuperscript{149} Wieliczko, \textit{Nakajima Ki-27 Nate}, 16-7.
\item \textsuperscript{150} Wieliczko, \textit{Nakajima Ki-27 Nate}, 19.
\end{itemize}
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higher output engine pushing the top speed to 300 mph. Despite the lack of armor and light armament, the fighter proved to be a formidable aircraft in the Chinese theater.

In 1941, Japan felt the Ki-27’s performance needed to be enhanced in order to compete against the Flying Tigers in China. Hideo Itokawa, Nakajima’s aircraft designer, created the Ki-43 Hayabusa, nicknamed the “Oscar” by the Allies. Itokawa adopted, from the Type 00, a butterfly-shaped combat flap with cables attached to the Bowden levers atop the control stick. These flaps allowed this aircraft to create more lift at slower speeds, allowing the wings to experience a higher load and the plane to make tighter turns without stalling. Itokawa took the airfoil material of the Ki-27, mated it to a 950hp Ha-115 radial engine, and constructed a low-winged, all-metal monoplane with retractable landing gear that can outturn and outclimb the Type 00, and 150 mph faster than the Ki-27. From before the outbreak of war, the Japanese prioritized maneuverability and aircraft performance above all else in their fighter construction and it seemed to work tremendously well in the beginning. As the war progressed, Japan’s loss of experienced pilots took a toll. The new pilots entering the war were less accustomed to wartime situations and they were unable to capitalize on the advantages of the Ki-43 as strongly as the veteran pilots who flew before them.

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CONCLUSION

One common characteristic of successful pilots is the ability to adapt his own capabilities and limitations to gain the advantage they sought. It is not always that a pilot has the element of surprise or even the upper hand in some cases. He must be flexible, adapt, and modify what he was taught or learned, in order to achieve victory.\footnote{Sims, \textit{Fighter Tactics and Strategy}, Forward.}

The variables described above are what dictate a pilot’s success in air superiority. Clive Caldwell perfected deflection shooting techniques by developing a method of his own that worked for him, later becoming a staple in Desert Air Force training. This method of shadow shooting enabled him to turn his weakness into a strength and obtain high amounts of kills in deserts of North Africa. Hans Joachim Marseille perfected the art of maneuvering using his flaps and even lowering his landing gear to slow the aircraft down enough to out-turn his adversaries. He understood how the Lufbery defensive maneuver, often used by the RAF P-40’s, functioned. Marseille dove into the middle of them, maneuvered at low speeds in order to turn harder, and strike his targets swiftly,\footnote{Kurowski, \textit{German Fighter Ace}, 166.} and proceeded to dive away to obtain speed to repeat the process. He achieved more than 150 kills by simply adopting his own style of dogfighting and applied it to the situation at hand. Boyd Wagner was known in cadet training for being a showoff and daring, but a natural talent when it came to aerial acrobatics and exceptionally versed in aeronautical engineering. He cultivated the perfect mixture of knowledge and technique to push the P-40 beyond the limits of what a typical pilot would deem inaccessible.

The moments I described, give evidence that not only P-40 pilots, but other successful pilots utilized their skills learned in flight school and abilities they were naturally good at in order to achieve success. Major General Claire Lee Chennault learned the capabilities of the
Japanese aircraft and adopted Hit & Run tactics that allowed the P-40 to exploit the aircraft’s advantages to counter the Ki-27 and 43, mainly the high caliber weapon systems and superior dive capabilities. This adaptation allowed trained pilots such as Charles Bond Jr., “Tex” Hill, and other American Volunteers to score multiple victories per day in the P-40, against Japanese aircraft deemed one of the most maneuverable aircraft ever built during the war. Japanese pilots such as Colonel Kato and Sergeant Yoshito Yasuda used the environment to their advantage. By using cloud cover against enemy aircraft that outnumber them, they were able to evade multiple flights of P-40’s and even downed a few of them despite being outnumbered three to one. Lastly, the Tuskegee Airmen were put through a series of rigorous training in order to obtain a level of elite operation. The aircraft did not matter as much, if they were proficient at using it.

The idea to include multiple aircraft in this thesis is to emphasize that the P-40 was by no means invincible or technologically superior to other aircraft. The Axis pilots were just as capable of shooting down the P-40 as the Allies could shoot down a Ki-43, FW-190A, or a Me-109E. The pilots utilizing these aircraft were of two different calibers, one with high levels of training and flight hours with the ability to adapt to a situation in a split second, remain composed, and act instinctively. While there were pilots who simply did not have the battle prowess, the instincts, or the ability to quickly adapt to certain situations in order to achieve success. As the war progressed, this separation of skill became more apparent when Allied veteran pilots became more prominent and veteran Axis pilot losses were rising day by day.

The P-40’s performance was good enough to defend the Allied nations until wartime aircraft, like the P-38, P-51, and P-47, could be manufactured. The aircraft was constructed as a mid-range, low to medium altitude pursuit fighter for defense purposes against a possible homeland invasion. Despite the seemingly sluggish speed at high altitude, the P-40’s rugged
airframe allowed it to take a lot of punishment. After the P-40B, the aircraft was armed with six .50 caliber guns, and it had the ability to out-dive and maneuver with most air superiority aircraft of the same time frame at low and medium altitudes. The technological performance that gave it success throughout the war made up a small percentage of why it succeeded. A few important factors gave it the ability to continue defying odds in battle: tactics, techniques, and adaptability. One can argue that aspects of aircraft construction that enhance the rate of climb, maneuverability, armament, and other characteristics inherently make or break an aircraft. If this were the case, the P-40 would not have been as successful as it was.

When all fighter planes are constructed within the same era, other factors determine success in the air besides statistics of how an aircraft flies on paper. The P-40 encountered continuous modifications to include heavier firepower, the airframe was streamlined to increase range and speed. The engine was changed from the Allison to the Merlin, a higher output Allison, to the Russians using the M-105P and M-105R engines in the P-40Es in order to fight at higher altitudes in colder temperatures without breaking down. All these changes made minuscule improvements which may have given the aircraft a slight advantage under certain circumstances. These advantages meant nothing in the grand scheme of winning the war. Undeniably, the pilots flying this aircraft in various ways adapted to the situations at hand. These pilots fought air superiority aircraft in a fighter meant for ground, low, and medium altitude attacks, and achieved an honorable goal; they defended their home from oppressive expansion. 14,000 P-40 variants were built and were used in the defense of twenty-eight countries. The last P-40 in service was relinquished to reconnaissance duties in Brazil until 1958 when it was retired. The longevity of this aircraft further encapsulates what this thesis explains. With proper training, an aircraft can maintain operations well beyond the life span of the plane itself. The P-
40 was not technologically revolutionary by any means, but it brought forth revolutionary tactics by forcing pilots to adapt their skills in combat to achieve victory. This fighter serves as a reminder that it is not the aircraft that wins the war, but it is the people who fly them.
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