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THE P-51 MUSTANG AS AN ESCORT FIGHTER

DEVELOPMENT BEYOND DROP TANKS TO AN

INDEPENDENT AIR FORCE

by

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Contents

Illustrations

Page

Tables

Abstract

The P-51 Mustang was an outstanding fighter in World War II. Popular history gives the majority of the credit to the addition of drop tanks to this aircraft which extended its range and allowed it to be used as an escort fighter for bomber operations in World War II. This paper highlights the unique design characteristics of the P-51 Mustang with its Packard Merlin engine. The incorporation of innovative, laminar flow wings and aerodynamic "smoothing," along with a delivery oriented production system made the aircraft an outstanding escort fighter—the addition of the drop tanks just made it better. Because of this addition to the Allied fighting force, the doctrine of daylight, strategic, high altitude, precision bombing by United States bombers was successful in World War II and the United States Air Force was born.

Chapter 1

Introduction

In June 1943, General H.H. Arnold, Commander US Army Air Corps, sent this communiqué to Major General Barney M. Giles, Air Corps Director of Operations, Commitments and Requirements:

> Attached are Mr. Lovett's comments on the P-47 situation in England. This brings to my mind very clearly the absolute necessity for building a fighter airplane that can go in and come out with the bombers. Moreover, this fighter has got to go into Germany. Perhaps we can modify some existing type to do the job. The P-38 has been doing a fine job from North Africa in escorting our B-17's 400 miles or more. Whether this airplane can furnish the same close escort against the GAF on the Western Front is debatable. Our fighter people in U.K. claim that they can't stay with bombers because they are too slow and because they (the fighters) must have top speed by the time they hit the coast. The P-38 is not able for its poor acceleration, so perhaps it too will not be able to furnish close escort and be able to meet the FW's and 109's. About six months remain before deep daylight penetration of Germany begins. With this next six months, you have got to get a fighter that can protect our bombers. Whether you use an existing type or have to start from scratch is your problem. Get to work on this right away because by January, '44, I want fighter escort for all of our bombers from U.K. into Germany. H.H.A.[1]

The development of the escort fighter was indeed successful. No more dramatic testimony as to the effectiveness of the escort fighter can be given than by the enemy. During post-war interrogations Luftwaffe officers offered consensus as to the turning point of the daylight bombing campaign conducted by the Allies. They felt the crucial event was the introduction of long-range fighter escorts.[2] Goering, Chief of the

Luftwaffe, offered this comment when General Spaatz asked the question, "When did you know that the Luftwaffe was losing control of the air?" Goering replied, " When the American long-range fighters were able to escort the bombers as far as Hanover, and it was not long until they got to Berlin."[3] In further testimony Goering continued his discussion:

> The reason for the failure of the Luftwaffe against the Allied Air Forces was the success of the American Air Forces in putting out a long-range escort fighter airplane, which enabled the bombers to penetrate deep into Reich territory and still have a constant and strong fighter cover. Without this escort the air offensive would never have succeeded.[4]

This paper tells the story of how those fighters and bombers got to Berlin.

Notes

[1] "Case History of Fighter Plane Range Extension Program, Parts I and II," USAF Historical Research Document 202.2-11, 22 February 1945.

[2] Bernard Boylan, *Development of the Longrange Escort Fighter*, USAF Historical Study No. 136 (Maxwell AFB, AL: USAF Historical Division, Air University, 1955), 204.

[3] Ibid., 205.

[4] Ibid., 204.

Chapter 2

Thesis

Escort fighters changed the prosecution of the war by reducing the large numbers of bomber losses in the daylight strategic bombing campaign into Germany. Three fighters were involved in that successful long-range escort, the P-38 Lightning, the P-47 Thunderbolt and the P-51 Mustang. The mastery of these long-range escort missions is routinely attributed to the arrival of the "drop tank" which extended the fighters range so escorts into Germany were possible. The P-38 and P-47 fighters couldn't do this mission without the extra fuel from the "drop tank." But for the P-51, "drop tanks" were only part of its extended range capability; this aircraft already incorporated revolutionary designs that gave it great range without additional fuel tanks. The thesis of this paper will show that this aircraft was a highly successful fighter because it utilized radical design features that made it aerodynamically clean, exceptionally capable, highly maneuverable, and fuel efficient. The P-51 was much more than a long-range fighter with external fuel tanks. The technology in the Mustang involved revolutionary aerodynamics, a blending of two cultures—British and American, and risk-taking during acquisition and production that often can only be attempted in a crisis situation. This ultimately lead to a change in tactics from unescorted to escorted bomber operations, and successful war prosecution and victory. The "combined arms" approach successfully allowed for the conduct of daylight strategic precision bombing operations, thereby validating the need for an independent air force. Without this fighter and all the novel design characteristics it pioneered, the future of the United States Air Force was very uncertain. As this paper will show, it was only *this* highly revolutionary fighter, and not the other modified fighters of the day, that could validate that doctrine and make the independent air service a reality.

Chapter 3

Unique Design

In 1940, the British were engaged in war and desperately needed fighters. Following the Release of Aircraft Policy message in March 1940, the United States government allowed the Allies to buy certain types of modern aircraft. This agreement included a provision that the manufacturers would offer a more advanced model to the U.S. Army and the Allies would share their information regarding combat experiences in design and manufacture. [1] The Royal Air Force (RAF) liked the Curtiss P-40 design and contracted for nearly 1000 of the fighters, but still needed another source to supply the numbers they required which were in excess of Curtiss' capability to manufacture. North American Aviation (NAA) of Ingelwood, California was approached by the British Purchasing Commission to build additional aircraft using the Curtiss P-40 model. North American Aviation had a very good reputation for successful mass-production skills and in early February 1940 the British asked NAA's President Dutch Kindelberger to furnish the additional P-40s.[2] Kindelberger told the British, without any detailed drawings or plans, "I can build you a better airplane, and I can get it built fast."[3] Although the British desired more P-40s, they were convinced that the P-51 was a superb design and signed a contract for 400 P-51s. They stipulated the condition that the "Mustang," must be ready for flight in 120 days.[4]

The chief design engineer assigned to the "NA-73" Mustang project was Edgar Schmued, a German trained engineer who in 1930 immigrated to the United States via Brazil. A low-drag, high-lift wing was the order to fulfill, with the idea to adapt all phases of prototype development directly into mass production. As each section of the aircraft was detailed, the assembly lines were organized and planned to follow for mass production.[5] Many new ideas were tried, innovations that ranged from the addition of hydraulically-operated wheel fairing to cover the wheel wells (including the tail wheel) during takeoffs and landings, to a new cantilever engine mount built entirely of aluminum alloy providing improved rigidity, with better weight savings and accessibility.[6] Retracted gear doors (except during gear transit) helped maintain the smooth aerodynamic design of the aircraft.[7]

The most radical design feature was the advent of the laminar flow wing. The laminar flow theory had been known and studied by the National Advisory Committee for Aeronautics (NACA). Mr. A.C. Robinson of NACA provided NAA with the unpublished research data and design studies. The NACA officials had estimated the new airfoil would reduce drag 50 percent below that of a normal conventional wing.[8]

Laminar flow results from a symmetrical airfoil that has the same curvature on the upper and lower surfaces. The thin leading edge widens to a point of greatest thickness at the farthest aft point before air breaks down and providing less lift in the high-drag turbulent area.[9] In simple terms, the pressure producing lift is spread out more.[10] Figure 1 compares a cross section of the P-51 wing to that of the Spitfire and FW 190, illustrating the laminar flow concept.[11]

This design allowed for reduced peak airflow velocities over the wing, thus postponing and minimizing "compressibility" effects on the airplane (drag rise, lift loss, nose down "tuck," buffeting and loss of elevator effectiveness for dive recovery) which hampered other fighters of the day when approaching mach numbers greater than 0.7. The new airfoil provided an advantage in high-speed combat maneuvers.[12]

To produce the top aerodynamic efficiency from the laminar flow, an absolutely smooth surface was required. The engineers planned to paint and fill the wing surface to provide the necessary unvarying surface. The surface of the wing surface had to have an exceptionally smooth finish with less than .0005 of an inch surface roughness tolerated, and a maximum wave allowance was .0001 of an inch in any two inches of surface.[13] Countersunk rivets, Dzus fasteners, secured panels while still providing a smooth surface.[14]

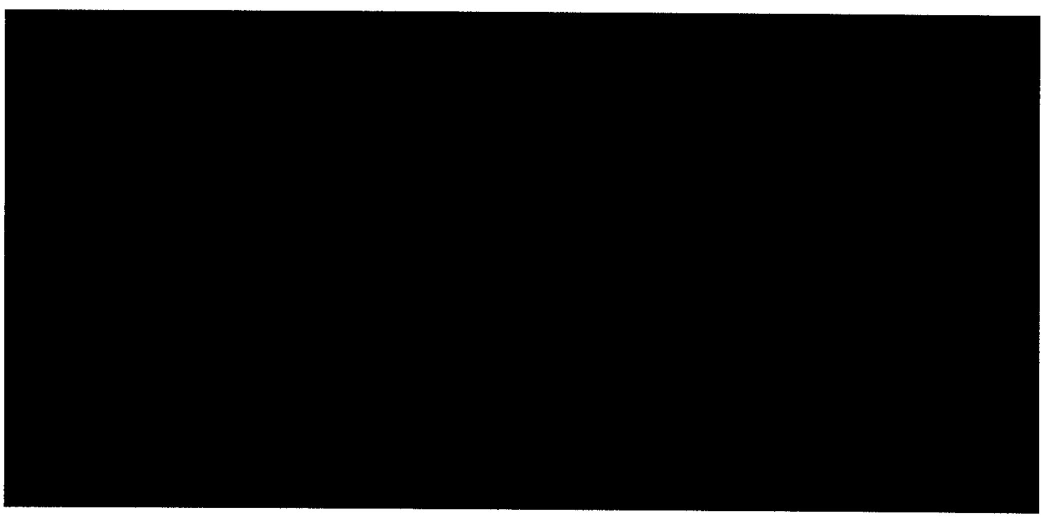

Figure 1. Wing Cross Sections[15]

During acceptance trials in Britain the aircraft was sprayed with a high-speed glossy paint finish to determine the actual effect of the finish when compared with a "standard" paint scheme. The lack of any discernible difference between the resulting flight performance using the two aircraft finishes surprised the engineers. It was concluded that the actual design and construction, especially the external smoothness could not be improved upon, and the design was especially aerodynamically "clean."[16]

To complement the aerodynamic efficiency, the placement of the drag-producing radiator and oil-cooler intake was another engineering success. The design engineers wanted to avoid placing the air scoop in the conventional position under the nose thereby reducing the drag factor on the airplane. The radical placement of the redesigned streamlined scoop on the underside of the fuselage, just aft of the pilot, resulted in significantly less resistance. Initially this location proved inadequate in terms of cooling efficiency of the engine, so the engineers then lowered the entrance to the scoop about one inch which bypassed the turbulent layer of air on the underside of the fuselage.[17] This position not only reduced drag and produced an efficient cooling system, but completely by accident, the radiator design actually provided about 300 pounds of jet thrust in a manner similar to a ramjet as the heat energy thrust was dissipated from the exit scoop.[18]

The aircraft armament was designed using the British specifications of two .30 caliber machine guns flanking a single .50 caliber gun in each wing, and a pair of .50 caliber guns in the nose which were deleted in early delivered aircraft.[19] Later versions of the Allison powered Mustangs would sport four 20 mm cannons to improve the lethality of the airframe, but the greater armament weight reduced the aircraft's performance significantly and these weapons were replaced.[20]

Notes

[1] Ray Wagner, *Mustang Designer: Edgar Schmued and the Development of the P-51*, (New York: Orion Books, 1990), 49.

[2] Ibid, 51

[3] Edward Churchill, "The Mustang," *Flying*, September 1944, 33.

[4] Robert W. Gruenhagen, *Mustang: The Story of the P-51 Fighter*, (New York: Arco Publishing, Inc., 1976), 39.

[5] Ibid., 39.

[6] Ray Wagner, *Mustang Designer: Edgar Schmued and the Development of the P-51*, (New York: Orion Books, 1990), 66.

[7] Larry Davis, *North American P-51: A Photo Chronicle*, (Westchester, PA: Schiffer Publishing, Ltd., 1992), 11.

[8] Edgar Schmued, "Evolution of the Mustang." *Skyways*, January 1944, 66.

[9] Robert W. Gruenhagen, *Mustang: The Story of the P-51 Fighter*, (New York: Arco Publishing, Inc., 1976), 40.

[10] Edgar Schmued, "Evolution of the Mustang." *Skyways*, January 1944, 66.

[11] Alfred Price, *Fighter Aircraft, Combat Development in World War Two*, (London: Arms and Armour Press, 1989), 31.

[12] John P. Reeder, "The Mustang Story," *Sport Aviation*, September 1983, 41.

[13] Alfred Price, *Fighter Aircraft, Combat Development in World War Two*, (London: Arms and Armour Press, 1989), 31.

[14] Robert W. Gruenhagen, *Mustang: The Story of the P-51 Fighter*, (New York: Arco Publishing, Inc., 1976), 43.

[15] Alfred Price, *Fighter Aircraft, Combat Development in World War Two*, (London: Arms and Armour Press, 1989), 31.

[16] Ibid., 57.

[17] Edgar Schmued, "Evolution of the Mustang." *Skyways*, January 1944, 66.

[18] Larry Davis, *North American P-51: A Photo Chronicle*, (Westchester, PA: Schiffer Publishing, Ltd., 1992), 10.

[19] Ibid., 11.

[20] Francis K. Mason, *Royal Air Force Fighters of World War Two*, (Garden City, NY: Doubleday & Company, Inc., 1969), 27.

Chapter 4

Initial Delivery

The airframe was ready in just 100 days, but installation of the Allison V-1710-39 engine with 1,150 hp was delayed because all available Allison engines were slated for P-40 production. The aircraft took to the air the first time on 26 October 1941 and the first plane was delivered to the British in November 1941, one month before the attack on Pearl Harbor.[1]

The British received the Mustang aircraft and began testing. During acceptance trials in April 1942 the test pilot issued this report: "The point which strikes me is that with a powerful and good engine like the Merlin 61, its performance should be outstanding, as it is 35 mph faster than a Spitfire V at roughly the same power."[2] So the original model, delivered with the relatively low power rated Allison engine, was outclassed as an interceptor and unsuitable for the British Fighter Command. Although a very capable aircraft, the fighter would undergo several modifications to improve its performance.

The fighter was used instead by the British Army Cooperation Command, replacing the Curtiss Tomahawk (P-40) as an ideal ground attack and tactical reconnaissance fighter.[3] The British "field tested" the Mustang in the Mediterranean Theater of Operations and submitted a report, "British Army Cooperation Tactical Employment of the Mustang I (P-51) in August 1943. Wing Commander Peter Dudjeon provided the following commentary:

> Actual combat has proved that the aircraft can run away from anything the Germans have. It's only inferior points are that it can't climb as well as the ME-109 and FW-190 and that at the slower speeds of close combat it loses effectiveness of aileron control and therefore has a poor rate of roll--but its turning radius with a slight amount of flap is shorter that either of the German aircraft. In view of the British experience, it is felt that we have a plane excellently fitted and suited for long range, low altitude day-light intrusion and for a medium altitude escort fighter to accompany our medium bombers.[4]

Despite the fine performance and handling features of the Mustang, it was still outclassed by the European fighters in 1942. The Assistant U.S. Military Attaché to England, Major Thomas Hitchcock, was aware of the limitations and suggested an improvement that would change the face of combat and bomber-fighter operations. (10:28) In October 1942, Major Hitchcock sent a summary of Mustang operations to Washington:

> The Mustang is one of the best, if not the best, fighter airframe that has been developed in the war up to date. It has no compressibility or flutter problems, it is maneuverable at high speeds, has the most rapid rate of roll of any plane except the FW 190, is easy to fly and has no nasty tricks. Its development and use in this theater has suffered for various reasons. Sired by the English out of an American mother, the Mustang has had no parent in the Army Air Corps at Wright Field to appreciate and push its good points. It arrived in England at a time when great emphasis was placed on high altitude performance, and because it was equipped with a low altitude engine, was of no particular interest to English Fighter Command. The Mustang was turned over to the English Army Cooperation Command for low-altitude work. It performed well at Dieppe [France]. The pilots who fly the Mustang are most enthusiastic about its performance. The development of the Mustang as a high altitude fighter will be brought about by cross-breeding it with the Merlin 61 engine.[5]

Armed with practical experience from North Africa and engineering estimates from the designers, the Mustang underwent a complete engine modification. Rolls Royce, the renowned British aircraft engine manufacturing firm, received approval to modify five Mustangs with the Rolls Royce Merlin 61 engine. This engine was already in use in the Hawker Hurricane and Supermarine Spitfire and their record against the Luftwaffe in the Battle of Britain had already proved the value of this powerplant. The Merlin engine produced a large amount of horsepower, 1,520 hp, and the key to its performance was in the supercharger. It was a two-stage, two-speed design that resulted in power over a greater range.[6] Prior to the first flight in the Mustang the Merlin 61 was modified by changing the "blower" ratio that produced a top speed of 433 mph at 22,000 feet when it flew for the first time on 13 October 1942. The "blower" ratio refers to the altitude at which the two-stage supercharger "kicks in" to provide the additional thrust needed for high performance at high altitudes.

The modified supercharger allowed the Merlin engine, now designated Merlin 65 with 1,490 horsepower, to develop more power at cruise power setting than the Allison engine had produced at full power.[7] The newer version of the engine had degraded performance above 25,000 feet compared to the original Merlin 61, but below this altitude its performance was unbeatable, and this new model provided the best overall capability for escort and combat encounters.[8]

The installation of the Merlin engine into the Mustang airframe was not an easy task. Mustang expert and author Larry Davis writes, "This wasn't your basic bolt a Chevrolet small-block V-8 into a '32 Ford and drive it away!"[9] It took some 223,000 engineering hours to accomplish the modification compared to the 78,000 hours NAA engineers and craftsmen took to build the original prototype from nothing.[10] Another modification was a propeller change from a three-blade to the four-blade Hamilton standard, which also improved efficiency. When all the changes were complete on the re-designated P-51B, the Mustang was clocked at a top speed of 447 mph at 30,000 feet, easily 100 mph faster than its predecessor with the Allison engine.[11]

While Rolls Royce was working on fitting the Mustang with a better engine, Packard Motor Company in Detroit adopted this superior design to the their own engines under a licensing agreement between the two companies. With the designation of "Packard Merlin" these engines produced in the United States helped offset the production shortfall in Britain. The Merlin 65 was known as the Packard Merlin V-1650-7 in the P-51 B, C and D models. The earlier Merlin 61 version was designated Packard Merlin V-1650-3. The C models were built in the Dallas Texas plant and both versions incorporated an 85-gallon fuel tank placed behind the pilot to increase range.[12] This tank dramatically affected the aircraft center of gravity when fully serviced and led to restrictions in aircraft maneuverability until the tank was exhausted.[13]

The Pilot Training Manual for the Mustang states, "When you are carrying more than 40 gallons of fuel in your fuselage tank, do not attempt any acrobatics. The weight of the fuel shifts the center of gravity back so the airplane is unstable for anything other than straight and level flight."[14]

To avoid the German U-boat menace the Army Air Force decided to try ferry flights to get combat aircraft to England.[15] Ferry tanks were incorporated in late 1942 into the attack/dive bomb version of the P-51, designated the A-36 model. The ferry tank held an additional 150 gallons of fuel.[16] As far as extending the range in combat, Ed Schmued, the chief Mustang designer at NAA wrote later: "The P-51B was the airplane destined to fly escort missions to Berlin."[17] The total fuel capacity was increased with the addition of combat drop tanks, either (2) 75-gallon tanks or (2) 110-gallon tanks in 1943 and 1944.[18] The tactical range was enough to escort bombers to any target in Germany with adequate reserves for aerial combat, and after dropping the 110-gallon tanks, the returning fighter formations could drop down and look for targets of opportunity.[19] Figure 2 illustrates one tactic of escorting bombers deep into Germany.

[Figure not available]

Figure 2. Fighter Escort Tactics[20]

Two recurring complaints by the aircrews, jammed guns and poor visibility, led to further modifications. The framed canopy had many blind spots, and was very uncomfortable for tall pilots. A British engineer, Robert Malcomb, solved the problem with a sliding, clear-view Perspex bubble canopy to fit the Mustang cockpit opening. The "Malcomb Hood" was popularly received by both British and American pilots.[21] A factory modification to the canopy would be produced in the P-51D model that was put into service in February 1944.[22] This variation had a full bubble canopy that resulted in unrestricted, 360-degree vision, and much greater headroom than in any other model.[23]

The armament problem fix was delayed until the P-51D model. The .50 caliber guns fitted in the wing bays were mounted at a side angle to allow for munition feed, but frequently jammed after only a few rounds had been fired.[24] In the D model the NAA engineers rearranged the guns, mounting them vertically, to bring the ammunition feed chutes in line with the gun mechanisms, thus eliminating gun jamming. For additional firepower, another .50 caliber gun was added to each wing, bringing the total to six .50 caliber machine guns.[25] The fighting capability included 500 rounds for each inboard .50 caliber gun, and 270 rounds for the other four guns. In lieu of external tanks two 500-

pound bombs could be installed and hardpoints for 10 five-inch rockets were added to subsequent versions.[26]

How did the aircraft perform as a fighter and escort? Captain D.F. Casey and Captain Trygve Sandberg wrote when they prepared the report of the P-51B during the Army Air Forces Board on the Tactical Employment Trials of the North American P-51B-1 in December 1944: "No other American fighter of the present types, can equal the excellent overall flying characteristics and performance of the P-51B above 25,000 feet. The airplane handles beautifully and feels extremely good in all maneuvers." During the Army Air Force trials the following report regarding escort duties was published:

> With its long range, high cruising speeds, and excellent fighting qualities, the P-51B airplane is very good for escort work. Pilot fatigue caused by poor cockpit ventilation and the not too comfortable seat, are disadvantages for long range flights.[27]

Notes

[1] Edward Churchill, "The Mustang," *Flying*, September 1944, 34.
[2] Alfred Price, *Fighter Aircraft, Combat Development in World War Two*, (London: Arms and Armour Press, 1989), 10.
[3] Francis K. Mason, *Royal Air Force Fighters of World War Two*, (Garden City, NY: Doubleday & Company, Inc., 1969), 27.
[4] "British Army Cooperation Tactical Employment of the Mustang I (P-51)," USAF Historical Research Document 180.6021-38, 26 August 1943, 2.
[5] Alfred Price, *Fighter Aircraft, Combat Development in World War Two*, (London: Arms and Armour Press, 1989), 38.
[6] Larry Davis, *North American P-51: A Photo Chronicle*, (Westchester, PA: Schiffer Publishing, Ltd., 1992), 29.
[7] Robert W. Gruenhagen, *Mustang: The Story of the P-51 Fighter*, (New York: Arco Publishing, Inc., 1976), 72.
[8] Ibid., 91.
[9] Larry Davis, *North American P-51: A Photo Chronicle*, (Westchester, PA: Schiffer Publishing, Ltd., 1992), 30.
[10] Ibid., 31.
[11] Ibid.

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[12] Ibid., 32.

[13] Robert W. Gruenhagen, *Mustang: The Story of the P-51 Fighter*, (New York: Arco Publishing, Inc., 1976), 91.

[14] Len Morgan, *The P-51 Mustang*, (Dallas, TX: Morgan Aviation Books, 1963), 67.

[15] Larry Davis, *North American P-51: A Photo Chronicle*, (Westchester, PA: Schiffer Publishing, Ltd., 1992), 16.

[16] Robert W. Gruenhagen, *Mustang: The Story of the P-51 Fighter*, (New York: Arco Publishing, Inc., 1976), 190.

[17] Ray Wagner, *Mustang Designer: Edgar Schmued and the Development of the P-51*, (New York: Orion Books, 1990): 113.

[18] Robert W. Gruenhagen, *Mustang: The Story of the P-51 Fighter*, (New York: Arco Publishing, Inc., 1976), 190.

[19] Ibid., 101.

[20] Alfred Price, *Fighter Aircraft, Combat Development in World War Two*, (London: Arms and Armour Press, 1989), 120.

[21] Larry Davis, *North American P-51: A Photo Chronicle*, (Westchester, PA: Schiffer Publishing, Ltd., 1992), 51.

[22] Robert W. Gruenhagen, *Mustang: The Story of the P-51 Fighter*, (New York: Arco Publishing, Inc., 1976), 211.

[23] Larry Davis, *North American P-51: A Photo Chronicle*, (Westchester, PA: Schiffer Publishing, Ltd., 1992), 61.

[24] Robert W. Gruenhagen, *Mustang: The Story of the P-51 Fighter*, (New York: Arco Publishing, Inc., 1976), 90.

[25] Larry Davis, *North American P-51: A Photo Chronicle*, (Westchester, PA: Schiffer Publishing, Ltd., 1992), 61.

[26] Ray Wagner, *Mustang Designer: Edgar Schmued and the Development of the P-51*, (New York: Orion Books, 1990): 122.

[27] Army Air Forces Board, "Tactical Employment Trials on the North American P-51B-1 Airplane," USAF Historical Research Document 245.64, 27 December 1944, 21.

Chapter 5

Competing Fighters

But how did it compare against the other American fighters of the day, the P-38 Lightning and P-47 Thunderbolt? In General Arnold's directive to Major General Giles to find the solution to the escort fighter, both of these fighters were mentioned. Both the P-38 and the P-47 had been in development prior to the beginning of the war and entered service with Eighth Air Force in July 1942 and December 1942 respectively.

The Lockheed P-38 incorporated some different design features, including a twin-boom so both engines could be mounted in the front. The tricycle gear, bubble canopy and short fuselage allowed the pilot great visibility. The specifications included an extremely high wing loading, 48.5 pounds, which for the time allowed for tight turns and good maneuverability.[1] The report by the Army Air Forces Board on the Tactical Employment Trials of the P-38 in May 1943 discussed its escort suitability:

> The P-38-G is a very good for escort duties and handles well at all speeds down to 160 MPH, which is necessary for escorting our present type bombers. As the view downwards is poor, great care must be taken to avoid being attacked from below, and it is therefore advisable for individual airplanes in the formation to be disposed in such a manner that the blind areas below are covered.[2]

In the Mediterranean Theater, it was an exceptional fighter, but in the northern European skies it had its difficulties.[3] The two Allison V-1710 engines, with counterrotating propellers, were rated at 1425 hp each allowing for a maximum speed of 402 mph at 25,000 feet. Unfortunately these engines had a long history of problems which can be classified into two separate categories.

Oil temperatures at high altitude above 22,000 feet were not sufficient to keep the oil consumption within a reasonable amount due to a repositioned intercooler system. An average consumption rate of two to four pints per hour increased to eight to sixteen pints per hour when operating above 25,000 to 30,000 feet--the regime for escorting bombers. This excessive oil loss halved the engine life, and when sudden surges in power were required as in combat, the engine seized or threw connecting rods.

The second problem experienced with high altitudes and cold temperatures was associated with the hydraulic regulators on the turbo-chargers. The cold, thick oil allowed the turbochargers to go out of control and subsequently fail. An option of replacing the Allison engines with Packard Merlin engines was discussed but not pursued beyond a prototype.[4] As late as June 1944, both Generals Doolittle and Spaatz remarked that the P-38 had some insurmountable problems to increase its performance. Doolittle noted, "The P-38 was a second-rate fighter when compared to the P-47 and P-51."[5] The aircraft was subsequently removed from service with Eighth Air Force in mid summer 1944, replaced by P-47s and P-51s.

The Republic P-47 Thunderbolt, also known as the "Flying Milk Bottle" because of its distinctive silhouette, was the toughest fighter in the theater. It could both give punishment with its eight .50 caliber machine guns mounted in the wings and take punishment, or battle damage, better than any other fighter of its day. However, its excessive weight of eight tons detracted from its overall performance.[6] The report by the

Army Air Forces Board on the Tactical Employment Trials of the Republic Airplane P-47 in February 1943 said about its escort suitability:

> Not to be used as a close escort fighter for protection of bombers because the slow escort speeds necessarily maintained would force the P-47-C to fight under extremely adverse conditions, i.e., slow speeds at medium altitudes, where its fighting performance is very poor. However, it is excellent for high top cover and escort cover, when used within its fuel range.[7]

With a Pratt and Whitney R-2800-59 radial engine rated at 2000 hp, the P-47 maximum speed was clocked at 433 mph at 30,000 feet. The addition of two 110-gallon wing drop tanks improved the tactical range from 200 miles to over 475 miles for escort duties.[8] Thunderbolt pilots were very satisfied with its performance and despite early mechanical problems, they felt the aircraft could do everything the enemy could, even the archrival FW 190. The Army Air Force Board results notwithstanding, maximum range was obtained by "nursing the throttle" to minimum cruising speed on long escorts. Even with the addition of external tanks, controllability problems were never a problem with the shift in center of gravity, as it was experienced on many other altered fighters.[9]

But the North American P-51 Mustang was to be the real answer to General Arnold's search for the escort fighter. Few will argue that the P-51 with the Packard Merlin engine wasn't America's finest all-round combat aircraft of the Second World War.[10] The P-51D with its Packard Merlin engine V-1650-7 rated at 1490 hp had a maximum speed of 437 mph at 25,000 feet and with two 110-gallon drop tanks made its tactical radius an unbeatable 750 miles.[11]

Notes

[1] Alfred Price, *Fighter Aircraft, Combat Development in World War Two*, (London: Arms and Armour Press, 1989), 20.

[2] Army Air Forces Board, "Tactical Employment Trials on the Lockheed P-38-G Airplane," USAF Historical Research Document 245.64, 22 May 1943, 22.

[3] Lt Col Waldo Heinricks, "A History of the U.S. VIII Fighter Command, 'Achtung Indianer,' " USAF Historical Research Document 524.058, July 1944, 158.

[4] Roger A. Freeman, *Mighty Eighth War Manual*, (London: Jane's Publishing Company Limited, 1984), 158.

[5] Bernard Boylan, *Development of the Longrange Escort Fighter*, USAF Historical Study No. 136 (Maxwell AFB, AL: USAF Historical Division, Air University, 1955), 180.

[6] Lt Col Waldo Heinricks, "A History of the U.S. VIII Fighter Command, 'Achtung Indianer,' " USAF Historical Research Document 524.058, July 1944, 149.

[7] Army Air Forces Board, "Tactical Employment Trials on the Republic P-47C Airplane," USAF Historical Research Document 245.64, 16 February 1943, 11.

[8] Roger A. Freeman, *Mighty Eighth War Manual*, (London: Jane's Publishing Company Limited, 1984), 191.

[9] Lt Col Waldo Heinricks, "A History of the U.S. VIII Fighter Command, 'Achtung Indianer,' " USAF Historical Research Document 524.058, July 1944, 150.

[10] David Birch, *Rolls-Royce and the Mustang*, (Derby, England: Rolls-Royce Heritage Trust, 1987), 7.

[11] Roger A. Freeman, *Mighty Eighth War Manual*, (London: Jane's Publishing Company Limited, 1984), 197.

Chapter 6

Performance Comparison

How did the capabilities of each aircraft compare against one another? The Army Air Forces Board on the Tactical Employment Trials of the North American P-51B-1 also included a comparison of the P-51B with that of the P-47D-10. The analysis is included as follows:

> The P-51B has a much smaller turning radius circle that the P-47D-10, and is able to get in behind the P-47D in one and one-half to two turns, after a head on approach. The war emergency speed of the P-47D-10 is comparable to that of the P-51B up to 30,000 feet, but above this altitude the speed of the P-51B increases rapidly over that of the P-47D. Up to 30,000 feet, either airplane may jump and catch the other if the approach is not seen too far away. However, if the P-51B is jumped by P-47D, it can turn into the P-47D and rapidly maneuver on to its tail. The P-47D cannot follow the P-51B in a dive at high altitudes as it is limited to a lower diving speed at those altitudes. The P-51B has a much superior rate of climb than the P-47D, and this superiority increases with altitude. The level flight acceleration of the P-51B is superior to that of the P-47D. When full power is applied to both aircraft from cruising speed in formation, the P-51B will pull rapidly away from the P-47D. The P-51B also holds it [sic] high speed longer than the P-47D in level flight after a dive, because it decelerates much slower.[1]

The report also compares the handling characteristics of the P-38J-5 to the P-51B. Again presented in original text:

> The turning circle of the P-51B is smaller than that of the P-38J-5, at all attitudes. It has a far faster rate of aileron roll through all speeds. The P-51B accelerates rapidly away from the P-38J in a dive, after reaching speeds of 325 I.A.S. With both airplanes in formation at cruising speed in

level flight, when full power is applied, the P-38J will pull several hundred feet out in front before the P-51B can reach maximum acceleration and overtake the P-38J. With slight advantage in altitude, the P-51B can jump the P-38J successfully and engage it in combat, due to its superior diving and top speed. The P-51B can evade being jumped by the P-38J, if it is seen in time, by dropping the nose and diving away If the P-38J has built up its speed in a dive and is not seen in time, the P-51B can turn sharply into the P-38J and evade its fire. The P-38J cannot follow the P-51B at high diving speed at altitude, due to its lower limits of allowable diving speeds. At high speed, it is impossible for the P-38J to keep its sights on the P-51B due to the P-51B's rapid rate of aileron roll, allowing it to reverse its direction of turn faster than the P-38J can follow.[2]

The P-51 was in a class all its own against other American and British fighters. Against the enemy's best fighters of the day, the FW 190 and Bf 109G, the P-51 again ruled the sky. In comparing the P-51B's maximum speed to the FW 190, the German fighter was nearly 50 mph slower at all altitudes, increasing to 70 mph slower at altitudes above 28,000 feet. Likewise against the Bf 109G, the Mustang was faster at all heights, clocked at 30 mph faster at 16,000 feet and over 50 mph quicker at 30,000 feet. The P-51B was considerably faster to all heights in a zoom climb compared to the FW 190, but the Bf 109G had very good climb and zoom climb characteristics compared to the P-51B, making their profiles very similar. In another spectrum, the P-51B could always out-dive the FW 190 and for defense against the Bf 109G, the Mustang could out-run the enemy in a prolonged dive.

The Mustang was much superior in a turning circle compared to the Bf 109G, but was a toss-up compared to the FW 190. Regarding roll rate, the FW 190 was the superior machine, but the Bf 109G was quite similar to the P-51B, with the American fighter having the advantage because the Bf 109G roll rate was compromised by wing slots that extend at inopportune moments.[3] In an attack against a FW 190 by a P-51B, the best maneuver was a high-speed zoom in order to gain the height initiative. For the defense, a steep turn followed by a full throttle dive increased the range before regaining the initiative in altitude and speed. In an attack with the Bf 109G, the Mustang could always catch the enemy with high overtaking speed. If jumped, the first maneuver should be a steep turn followed by a dive.[4]

The combat record of the Mustang shows its real superiority. The records indicate the P-51 was responsible for almost half of the enemy aircraft destroyed in Europe by U.S. fighters. The Mustangs units earned a kill ratio of 13 enemy aircraft destroyed per 100 sorties compared to four for the P-38 and three for the P-47 sorties.[5] Ray Wagner in *Mustang Designer*, quotes the following statistics regarding the Mustang's combat effectiveness:

> "Flying 213,873 sorties and losing 2,520 planes in combat, Mustangs claimed 4,950 aircraft destroyed in the air and 4,131 on the ground. Thunderbolts flew 423,435 sorties, lost 3,077 in combat, and claimed 3,082 destroyed in the air and 3,202 on the ground. Lightnings flew 129,849 sorties, lost 1,758 in combat, and claimed 1,771 destroyed in the air and 749 on the ground."[6]

Not only could the P-51 perform, it could do it cheaper than the competition! Army Air Force data from the time indicates an average cost per P-51 aircraft in 1945 was $50,985 compared to $83,000 for the P-47, and $97,147 for the P-38.[7]

Chart 1 in the Appendix compares the true speed and rate of climb of the three U.S. fighters compared to the enemy's capabilities. (15:Plate XV) Maximum true airspeed shows the P-51B (with the Packard Merlin 1670-3 engine) is clearly superior at nearly all altitudes, but slower than the P-47, P-38 and FW 190 in a lower altitude regime of approximately 18,000 to 23,000 feet. The second half of the same chart shows the rate of climb comparison (no zoom) for the same competitors. Again the Mustang out climbs the opposition in all scenarios, with the exception of the FW 190.

Chart 2 in the Appendix shows the climb and speed comparison of the Mustang compared to the other American fighters of the day.[8] This chart gives similar information to Chart 1 for American fighters only, again illustrating the superiority of the P-51B with the Packard Merlin 1670-3 engine.

The History of U.S. VIII Fighter Command gives additional information about aircraft capabilities in Chart 3 which details the range of each type of aircraft used by VIII Fighter Command. The two different types of escorts are represented—target support which is escort of the bomber by the fighter only over the target area for about 15 minutes. Figure 2 on page 14 shows this tactic. The other type of escort is penetration support—long-range escort which is flight along the entire bomber route to the target and back. The ranges in this scenario are less than in the target support tactic because the fighters had to fly a weaving pattern due to the speed differences between bomber and fighter escort. This additional maneuvering degraded the total combat range for the escort fighters.[9] These two diagrams show that the P-51B with internal fuel only in either escort tactics, out distanced the other escort fighters, P-47 and P-38H, of the period. The graph also shows that the P-51 using only internal fuel is only slightly less capable than the P-47 equipped with one 75-gallon drop tank. With external fuel tanks the P-51B was clearly superior in range compared to all the other fighters represented.

The data in Table 1 extracts data from Chart 4, Case History of the Fighter Plane Range Extension Program, and provides the real capabilities of the P-51 aircraft with respect to other U.S. fighter aircraft. (For complete data, see Chart 4 in the Appendix.)

This table highlights the previously discussed escort aircraft and reinforces the thesis concerning the capabilities of the P-51 aircraft.

Table 1. Performance Comparison—U.S. Fighters[10]

Aircraft	Conditions	Takeoff GW	Total Fuel	Fuel Cons[a]	Fuel Cons[b]	Dist to Climb[c]	Range Total Miles
P-38H	Internal Tanks Only	15,900	300	111	86	40	326
	(2) 150-Gal Ext Wg Tanks	18,000	600	111	98	50	1,005
P-47D	Internal Tanks Only	13,500	305	89	101	57	473
	(2) 150-Gal Ext Wg Tanks	15,600	605	89	125	81	1,045
P-51B	Internal Tanks Only	9,050	180	58	46	50	415
	(2) 150-Gal Ext Wg Tanks	11,150	480	58	59	80	1,570

[a] Fuel Consumed in Gallons for 5 min War Emergency Power & 15 min Military Power.

[b] Fuel Consumed in Gallons during Warm-up, Take-off, and Climb.

[c] Horizontal Distance to Climb to 25,000 feet.

When a comparison is made between the P-38, P-47 and P-51 aircraft, the first dramatic difference seen is in aircraft takeoff weight. The Mustang was considerably lighter than the other two fighters—a factor that affects other categories of performance. Fuel consumption for each aircraft with internal fuel and external tanks demonstrates the unbeatable fuel efficiency of this aircraft. The data in Table 2 depicts calculated fuel efficiencies (miles/gallon) derived from Table 1. This table clearly shows the superior fuel efficiency of the P-51 aircraft and is the key to the P-51's exceptional performance, with or without external fuel tanks.

While it may appear surprising that a "dirty" aircraft, one with external fuels tanks, would have better overall fuel economy than a clean aircraft, it is easy to explain. The additional fuel, used during takeoff, acceleration and climb, enables the fighter to carry a much greater amount of fuel to altitude. This greater fuel at altitude allows a much longer time at cruise parameters, which are much less consuming of fuel than takeoff and climb. Therefore, the overall ratio of cruise time to climbing and accelerating time is greater, thus increasing the fuel economy.

Table 2. Fuel Efficiencies—U.S. Fighters[11]

Type of Aircraft	Total Gallons Consumed[a]	Total Range in Miles	Fuel Economy (Miles/Gallon)
P-38H—int fuel	280	326	1.16
P-38H—ext tanks	580	1,005	1.73
P-47D—int fuel	285	473	1.66
P-47D—ext tanks	585	1,045	1.79
P-51B—int fuel	160	415	2.59
P-51B—ext tanks	460	1,570	3.30

[a] Actual tank capacity less 20 gal reserve at landing.

Although it exhibited better performance, had greater range, cost less than other fighters, and accumulated more air and ground kills than others, the P-51 was almost overlooked by the U.S. military. General H.H. Arnold frankly admitted this mistake in his memoirs: "It may be said that we could have had the long range P-51 in Europe rather sooner than we did. That we did not have it sooner was the Air Force's own fault."[12]

Army Air Force indifference to the P-51 was highlighted by the report presented to General Arnold on "The Future Development of Pursuit Aircraft," in October 1941. Included in the discussion were eight production and 18 experimental types, but the P-51 was not even mentioned. The Army overlooked the P-51 in favor of its own fighter development—the turbo-charged high-altitude P-38 and P-47 types, and the Curtiss P-40 successor, the P-60.[13] But with British support, the P-51 finally got noticed by the U.S. Army Air Force.

Two Americans in England recognized the potential of this fighter and urged Washington to take note of this remarkable aircraft. Major Thomas Hitchcock, Assistant Military Air Attaché, and John C. Winant, U.S. Ambassador to England did much to keep the Mustang in the limelight for potential use by the U.S. military. Major Hitchcock flew the aircraft several times and was an avid proponent. He hosted several Americans during visits to England to see first-hand the Mustang operations and those modifications made by the British.[14] Boylan, in his work on the "Development of the Longrange Escort Fighter," quotes Major General Orville Anderson's reception of the Mustang:

> And then it [the plan for the Mustang] came to the Munitions Building at that time . . . with the request from the British that we build them at least 500 a month of this new airplane, this Mustang. Not having had anything to do with the design, growth, tests of the P-51, we looked with disfavor on that airplane. We leaned much more strongly to the P-39, the Airacobra, and the P-40, two antiquated aircraft in 1941. But because of the need for compromise, now that this thing had been really built, and apparently to protect ourselves from sticking our chin out too far, we said, "Well now maybe there is some use for this airplane. It's a liquid airplane, therefore rather vulnerable to frontal fire." So we assigned it to production and called it an A-36. And the first 500 airplanes of this new unit, which was about six months late in its initial assignment, was [sic] made into an A-36. A dive-bomber with a liquid engine. [Sic] After we had built 500, we then belatedly recognized that maybe it was good enough that we could [sic] put it into our fighter echelon. This attitude of mind on the part of

> the Air Force policy makers and planners delayed the strategic deployment of this critical, almost decisive, weapon by well over nine months before it was actually deployed for combat.[15]

In early 1943, the need to protect bombers on their bombing missions was finally recognized. The previously quoted memo from General Arnold to Major General Giles on development of the fighter escort stresses the critical nature of this program. The first options explored were fighter versions of the B-17 and B-24, the XB-40 and XB-41. These aircraft were heavily armored versions on the same bomber airframes. A dozen of these aircraft were delivered to the European theater in May 1943, but the few missions flown by these slow, cumbersome aircraft showed this option was not the solution. What was needed was fast, long-range, maneuverable, and lethal protection for the bombers to continue their strategy of long range daylight attack of Germany.[16]

Based upon the capabilities of the long-range P-51 and the heavy losses encountered at Second Schweinfurt in October 1943, General Arnold directed the entire production of P-38s and P-51Bs for the next three months, October, November and December 1943, be sent directly to England. P-51s originally scheduled for tactical use by Ninth Air Force were rerouted to Eighth Air Force for strategic and escort missions. In early 1944 nearly all Eighth Air Force fighter groups were scheduled to convert to P-51s, with the excess P-47s going to Ninth Air Force.[17] By late 1944 only one VIII Fighter Command group had P-47s and the P-38s were gone from the inventory by mid summer the same year.[18] General Doolittle stacked the deck to ensure enough pilots were on hand by ordering all qualified P-51 pilots in Eighth Air Force, regardless of rank and assignment, to fly on every mission. The results support this astute use of resources. In July 1943 VIII Fighter Command had only 171 aircraft available on average and could escort on shallow penetrations only. By January 1944 the number of aircraft had increased to an average of 707 aircraft available, and deep penetration escorts were possible. P-51Bs assigned to VIII Fighter Command completed their first escort on 13 December 1943.[19] By the end of May 1944, using both the assets of VIII Fighter Command and Ninth Air Force for aircraft and pilots, nearly 1,300 fighters of all types engaged targets all over Germany.[20]

Notes

[1] Army Air Forces Board, "Tactical Employment Trials on the North American P-51B-1 Airplane," USAF Historical Research Document 245.64, 27 December 1944, 20.

[2] Ibid.

[3] Alfred Price, *Fighter Aircraft, Combat Development in World War Two*, (London: Arms and Armour Press, 1989), 87.

[4] Ibid.

[5] Robert W. Gruenhagen, *Mustang: The Story of the P-51 Fighter*, (New York: Arco Publishing, Inc., 1976), 101.

[6] Ray Wagner, *Mustang Designer: Edgar Schmued and the Development of the P-51*, (New York: Orion Books, 1990), 133.

[7] Ibid., 127.

[8] Army Air Forces Board, "Tactical Employment Trials on the North American P-51B-1 Airplane," USAF Historical Research Document 245.64, 27 December 1944, 23.

[9] Lt Col Waldo Heinricks, "A History of the U.S. VIII Fighter Command, 'Achtung Indianer,' " USAF Historical Research Document 524.058, July 1944, Plate XII.

[10] "Case History of Fighter Plane Range Extension Program, Parts I and II," USAF Historical Research Document 202.2-11, 22 February 1945, Enclosure 1.

[11] Ibid.

[12] Bernard Boylan, *Development of the Longrange Escort Fighter*, USAF Historical Study No. 136 (Maxwell AFB, AL: USAF Historical Division, Air University, 1955), 147.

[13] Ray Wagner, *Mustang Designer: Edgar Schmued and the Development of the P-51*, (New York: Orion Books, 1990), 83.

[14] Ibid., 138.

[15] Bernard Boylan, *Development of the Longrange Escort Fighter*, USAF Historical Study No. 136 (Maxwell AFB, AL: USAF Historical Division, Air University, 1955): 151.

[16] Ray Wagner, *Mustang Designer: Edgar Schmued and the Development of the P-51*, (New York: Orion Books, 1990), 112.

[17] Stephen L. McFarland, "Evolution of the American Strategic Fighter in Europe, 1942-44," *Journal of Strategic Studies*, June 1987, 195.

Notes

[18] Bernard Boylan, *Development of the Longrange Escort Fighter*, USAF Historical Study No. 136 (Maxwell AFB, AL: USAF Historical Division, Air University, 1955), 147.

[19] Ibid.

[20] Stephen L. McFarland, "Evolution of the American Strategic Fighter in Europe, 1942-44," *Journal of Strategic Studies*, June 1987, 195.

Chapter 7

Conclusion

The comparison of the P-51 to the Allied and enemy fighters has already been highlighted, and the obvious superiority of the fighter made it the most sought after fighter for escort purposes. As this paper has shown, the success of the fighter as an escort goes beyond the installation of external drop tanks. The innovative design using the untried laminar-flow concept, a radical scoop intake design, retractable wheel well doors, refined aerodynamic smoothness, along with an engine that could perform in the demanding flight regime, coupled with a production system that could deliver the number of aircraft demanded, was the genesis of this unique aircraft.

The maturation process continued when the airframe design merged with an outstanding engine that made the aircraft the prominent escort fighter of the day, even without drop tanks. Continual refinement, despite initial indifference and incorporation of advantages seen in other successful fighters, combined to deliver a top-notch aircraft that had the range, speed, agility and firepower to make both bomber escort operations and air superiority in Europe a reality.

It was *this* fighter that really turned the tide for daylight strategic precision bombing operations in 1944. The other modified fighters, the P-38 and P-47, contributed to the operation, but as this paper has shown, they were a less capable airframe and without the

Mustang, the escort operations could not have supported escorts all the way to Berlin. The P-51s alone could have handled the job.

Edward Maloney, curator of the Air Museum in Ontario, California, succinctly recorded the Mustang's achievements: "It was the first and only fighter to fly over all three enemy capitals—Rome, Tokyo and Berlin. It was the first fighter to escort bombers to Berlin and return. It was the first fighter to fly shuttle bomber missions to Russia, Italy, and North Africa. As time will prove, the Mustang will emerge as one of the great, immortal fighters of World War II."[1] Another record of achievement must also be chronicled: because of *this* fighter strategic bombing was successful, and the concept of an independent air service was finally accepted, leading to creation of the United States Air Force in 1947. Quite the legacy for a "Mustang!"

Notes

[1] Edward T. Maloney and Uwe Feist, *North American P-51 Mustang*, (Fallbrook, CA: Aero Publishers, Inc., 1967), 3.

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