THE EFFECTS OF POOR QUALITY ASSURANCE DURING GERMAN AVIATION MANUFACTURING ON THE LUFTWAFFE DURING WORLD WAR II

A thesis presented to the Faculty of the U.S. Army
Command and General Staff College in partial
fulfillment of the requirements for the
degree

MASTER OF MILITARY ART AND SCIENCE
Military History

by

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Fort Leavenworth, Kansas
2018

REPORT DOCUMENTATION PAGE

Form Approved
OMB No. 0704-0188

1. REPORT DATE *(DD-MM-YYYY)*	2. REPORT TYPE	3. DATES COVERED *(From - To)*
15-06-2018	Master's Thesis	AUG 2017 – JUN 2018

4. TITLE AND SUBTITLE

The Effects of Poor Quality Assurance during German Aviation Manufacturing on the Luftwaffe during World War II

5a. CONTRACT NUMBER

5b. GRANT NUMBER

5c. PROGRAM ELEMENT NUMBER

6. AUTHOR(S)

Michael J. Gallant, Major

5d. PROJECT NUMBER

5e. TASK NUMBER

5f. WORK UNIT NUMBER

7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)
U.S. Army Command and General Staff College
ATTN: ATZL-SWD-GD
Fort Leavenworth, KS 66027-2301

8. PERFORMING ORG REPORT NUMBER

9. SPONSORING / MONITORING AGENCY NAME(S) AND ADDRESS(ES)

10. SPONSOR/MONITOR'S ACRONYM(S)

11. SPONSOR/MONITOR'S REPORT NUMBER(S)

12. DISTRIBUTION / AVAILABILITY STATEMENT
Approved for Public Release; Distribution is Unlimited

13. SUPPLEMENTARY NOTES

14. ABSTRACT

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15. SUBJECT TERMS
World War II, Allied Bombing Campaign, German Aviation Production, Luftwaffe, Slave Labor Production, German Aircraft Quality

16. SECURITY CLASSIFICATION OF:			17. LIMITATION OF ABSTRACT	18. NUMBER OF PAGES	19a. NAME OF RESPONSIBLE PERSON
a. REPORT	b. ABSTRACT	c. THIS PAGE			19b. PHONE NUMBER *(include area code)*
(U)	(U)	(U)	(U)	102	

Standard Form 298 (Rev. 8-98)
Prescribed by ANSI Std. Z39.18

MASTER OF MILITARY ART AND SCIENCE

THESIS APPROVAL PAGE

Name of Candidate: Major Michael J. Gallant

Thesis Title: The Effects of Poor Quality Assurance during German Aviation Manufacturing on the Luftwaffe during World War II

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The opinions and conclusions expressed herein are those of the student author and do not necessarily represent the views of the U.S. Army Command and General Staff College or any other governmental agency. (References to this study should include the foregoing statement.)

ABSTRACT

THE EFFECTS OF POOR QUALITY ASSURANCE DURING GERMAN AVIATION MANUFACTURING ON THE LUFTWAFFE DURING WORLD WAR II, by Major Michael J. Gallant, 102 pages.

The Luftwaffe, under the leadership of Herman Göring, failed to achieve (its portion of) victory for Germany during World War II. This study evaluates the factors that resulted in poor quality assurance and poor aircraft quality within German aviation manufacturing that contributed to the Luftwaffe's failure. Worker shortages eventually led the German aviation industry to shift aircraft production to assembly lines and used unskilled workers that reduced aircraft quality. This study also examines the Allied bombing of German aviation industry factories resulting in the wide distribution of aircraft production, and further decreased aircraft quality. Finally, this study examines slave labor in the aircraft industry and the effects that sabotage and poor workmanship had on German aircraft quality during the war.

ACKNOWLEDGMENTS

Many people have assisted me with this project; without their help and support this would not have been possible. My wife, Genesis, and my children, Victoria, and Michael Jr., provided the support and encouragement needed to focus on and complete this project. My wife was instrumental in completing this project by helping proofread this document, giving suggestions on writing style, and helping format the charts and graphs featured throughout the document.

To my committee, thank you for your guidance, mentorship, and patience. Mr. Wilburn Meador guided and directed this project, keeping me on task and on glideslope. Semper Fidelis sir, you are a mentor that I will continue to look to in the future. Dr. Pierce provided valuable historical insights and sources that helped get and keep this project on track. Finally, Mr. Brown provided focused mentorship and direction through the entire process. Without this strong committee, I could not have completed this project.

Finally, Kai Freier enabled my access to the Deutsches Museum archives which contributed greatly to the research for this project. Vielen Dank, mein Freund, your help was much appreciated.

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ACRONYMS

BF/BFW	*Bayerische Flugzeugwerke*
BMW	*Bayerische Motoren Werke*
FW	Focke Wulf
GBA	Reich Plenipotentiary for Labor Mobilization
HE/He	Heinkel
JU/Ju	Junkers
ME/Me	Messerschmitt
No/Nr	Number
NARA	U.S. National Archives and Records Administration
POW	Prisoner of War
RAF	Royal Air Force
RLM	*Reichsluftfahrtministerium* or Reich Aviation Production Ministry
SDPAG	Steyr-Daimler-Puch AG
SS	*Schutzstaffel*
WVHA	SS Economics and Administration Main Office

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CHAPTER 1

INTRODUCTION

The failure of the German military during World War II has been studied in great detail. A contributing factor for this failure was Allied air superiority over Europe, enabling the destruction of numerous production facilities, hurting the German war effort. For the Luftwaffe, focus has been given to the destruction of ball bearing plants, fuel facilities, and overall pilot shortages by the end of the war. Not much effort has been given to study the production model for the Germans and how quality assurance could have contributed to the overall failure.

In 1932, German aircraft industry consisted of several small factories with skilled artisans producing a very limited number of aircraft. The total aircraft manufacturing force consisted of roughly 4,000 skilled workers. The aircraft produced were of high quality but in very limited numbers. By 1939, the German aircraft industry produced nearly 8,300 aircraft, and there were no worker shortages.[1] This changed when the German military drafted the majority of military age males to serve in the Wehrmacht. Expertise in aircraft production gave no exemptions to the draft, causing critical workforce shortages for production. The wide dispersion of manufacturing facilities due to Allied bombing campaigns exacerbated these shortages, resulting in irregular production rates and reduced levels of quality.

[1] Daniel Uziel, *Arming the Luftwaffe*, *The German Aviation Industry in World War II* (Jefferson, NC: McFarland & Company, Inc., 2012), 13.

Germany experimented with various production models during the war that led to increased production, but quality continued to fade. The methods included the shift to mass manufacturing techniques and the use of slave laborers to supplement the workforce. The cumulative effect was a fleet of unusable aircraft by 1945.[2] Poor quality and quality assurance thus contributed to the overall failure of the Luftwaffe.

As a military aviator, I have a vested interest in the quality of the aircraft that I fly. I have personally experienced quality and quality assurance issues with modern aircraft. My first experience with aircraft quality issues was when I served as the Airframes Officer in Charge and the Quality Assurance Officer in Charge of Light Attack Helicopter Squadron 269 during a transition from legacy to upgraded aircraft. The transition exposed several quality issues with the upgraded aircraft, which took years to fix. The issues ranged from poor blade construction techniques leading to heavy aircraft vibrations, component damage caused by flying through a 30-second rain shower, to transmission seals allowing water to seep inside transmission cases from exposure to fog. I have additional certifications with aircraft quality assurance from attending the Bell Academy in Fort Worth, Texas and attending the Aviation Maintenance Officer Course in Milton, Florida. The Bell Academy gave me certifications on aircraft flight characteristics, helicopter autorotations, and maintenance on Bell aircraft. The Aviation Maintenance Course certified me to supervise and oversee a maintenance division within a squadron. I attended Florida State University and received a Bachelor of Arts in

[2] Lutz Budraß. "Arbeitskräfte Können aus der Reichlich Vorhandenen Jüdischen Bevölkerung Gewonnen Werden. Das Heinkel-Werk in Budzyn 1942-1944," *Jahrbuch für Wirtschaftsgeschichte/Economic History Yearbook* 45, no.1 (1 June 2004): 41-64.

History, with a focus on World War II. My interest in this topic comes from my experiences within military aviation and family history both with the Luftwaffe and the Allies during World War II.

The primary research question of this thesis is: How did poor quality assurance caused by the German draft, the wide distribution of manufacturing facilities due to the allied bombing, and the inclusion of unskilled laborers and slaves in mass production facilities contribute to the overall failure of the Luftwaffe during World War II?

While answering the primary research question, it is important to answer the following secondary research questions:

1. What were the manufacturing conditions for the Luftwaffe before World War II?
2. How many German workers were pulled from factory jobs during the draft and what were the effects on production?
3. How did the German aircraft industry attempt to adapt to the Allied bombing campaign?
4. What issues arose from the dispersion of production facilities, and how did the Germans cope with them?
5. How did mass production impact the German aircraft industry?
6. What were the effects of utilizing slave labor for the German aircraft industry?

A substantial number of primary and secondary sources aided in answering the research questions and provided insight into the complexities with the production of aircraft through World War II. One of the more useful primary sources was The United States Strategic Bombing Survey which provided numerous reports on targeted factories

and the effects of Allied bombing on German manufacturing and their economy during the war. The Strategic Bombing Survey provided valuable insights into why German leadership made the decisions on manufacturing processes and locations during the war.

The United States National Archives and Records Administration's RG242, 243, and T83 provided German production records from all industries covering the periods before and during the war. They included interviews with the German leadership conducted in 1945-1946. Finally, they provided access to German records from the Luftwaffe and various governmental agencies within the aviation industry throughout the war.

Deutsches Museum FA001 and LRD provided production records from Heinkel, Messerschmitt, and Junkers through World War II. The documents gave insights to the decisions being made within the aviation through the war and how the industry increased production with decreasing supplies and worker shortages.

Albert Speer's book *Inside the Third Reich*[3] gave a firsthand account of the German leadership, their thought processes toward manufacturing before and during the war, and the decision to begin the use of forced labor in manufacturing.

A useful secondary source was Daniel Uziel's *Arming the Luftwaffe*, *The German Aviation Industry in World War II*.[4] The work provided detailed descriptions of German aircraft manufacturing from 1933 through 1945. It covered, in detail, the effects of the German draft on the workforce resulting in a shift to forced labor. It also detailed the shift

[3] Albert Speer, *Inside the Third Reich*, *Memoirs By Albert Speer* (New York: Macmillan Publishing Company, 1969).

[4] Uziel, *Arming the Luftwaffe*, *the German Aviation Industry in World War II*.

of German manufacturing from skilled artisans to a stamped mass production. Finally, it covered how German leadership decisions impacted aircraft development and manufacturing.

Daniel Uziel's "Jewish Slave Workers in the German Aviation Industry" featured within the book *Microhistories of the Holocaust*[5] detailed the lives of Jewish slave workers in the German aviation industry. It detailed the shift from skilled workers to an unskilled slave workforce, the working and living conditions of the slaves, and how slaves decreased production quality with acts of sabotage and poor workmanship.

Edward L. Homze's *Arming the Luftwaffe*, *The Reich Air Ministry and the German Aircraft Industry 1919-1939*[6] covered the way the Reich Air Ministry organized and developed the Luftwaffe and the aircraft industry during the interwar period. It also detailed the workforce, their training requirements, and production outputs. This source only covered manufacturing to the start of World War II but serves as a good source to build an understanding of early war manufacturing processes.

Ferenc A. Vajda and Peter Dancey's *German Aircraft Industry and Production 1933-1945*[7] was another good secondary source for this thesis. This work described the creation of the German aircraft industry in the 1930s, the organization of the Reich

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[5] Daniel Uziel, "Jewish Slave Workers in the German Aviation Industry," in *Microhistories of the Holocaust*, eds. Claire Zalc and Tal Bruttmann (Oxford, England: Berghahn Books, 2017), 151-170.

[6] Edward L. Homze, *Arming the Luftwaffe*, *the Reich Air Ministry and the German Aircraft Industry 1919-1939* (Lincoln: University of Nebraska Press, 1976).

[7] Ferenc A. Vajada and Peter Dancey, *German Aircraft Industry and Production 1933-1945* (Warrendale, PA: Society of Automotive Engineers, Inc., 1998).

Aviation Industry, aircraft production figures through the war, and the struggles of the aircraft industry during the war. It only lightly touched on manufacturing processes and the effects of utilizing forced labor on the aircraft industry.

Williamson Murray's *Strategy for Defeat*, *The Luftwaffe 1933-1945*[8] detailed the development of the air industry in the 1930's and the political infighting leading to the selection of certain airframes over others for production. It also described the effects of allied bombing on key infrastructure while the Luftwaffe was suffering high losses from 1943-1945. This source doesn't detail production types, training, or issues in the manufacturing process, but does cover the declining operational readiness due to defects and poor maintenance from 1943-1945.

Lutz Budraß's *Arbeitskräfte Können Aus der Reichlich Vorhandenen Jüdischen Bevölkerung Gewonnen Werden. Das Heinkel-Werk in Budzyn 1942-1944*[9] provided a detailed analysis of the German Ultra program. It detailed the selection of Budzyn, Poland for an aircraft plant well outside of allied bombing range. It gave an account of the coordination between the SS and the Heinkel-Werk in providing slave laborers from concentration camps for working the factory lines. The document also detailed the issues with utilizing forced labor, ultimately resulting in zero flyable aircraft being produced over the factory's three-year production run. This document was very focused and provided valuable insight into the production process and forced labor.

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[8] Williamson Murray, *Strategy for Defeat*, *the Luftwaffe 1933-1945* (Maxwell Air Force Base: Air University Press, 1983).

[9] Budraß. "Arbeitskräfte Können aus der Reichlich Vorhandenen Jüdischen Bevölkerung Gewonnen Werden. Das Heinkel-Werk in Budzyn 1942-1944," 41-64.

This thesis consists of six chapters. Chapter 1 gave a general overview of the thesis purposes, research questions, and concluded with a literature review. Chapter 2 will cover the development of the German aircraft industry from 1933-1939. It will examine the system for manufacturing and the challenges associated with the aircraft industry during that period. It will conclude with the effects of the draft on the aircraft industry. Chapter 3 focuses on early war production and the difficulties faced by the aviation industry caused by worker shortages. Chapter 4 will examine the challenges the aircraft industry experienced due to allied bombing and dispersion of manufacturing. Chapter 5 examines the transition of the aviation industry to a mass production model and the inclusion of forced labor. Chapter 6 will summarize and give conclusions about the various production models and the effects of poor quality assurance on the German war effort. By looking into the effects of poor quality assurance on the Luftwaffe, one gains a better understanding of how modern air efforts could be affected by similar issues. Quality assurance can make or break operations and needs to be maintained to the highest standards to prevent mishaps or catastrophic failure.

CHAPTER 2

1933-1939 REBIRTH OF THE GERMAN AIRCRAFT INDUSTRY

The Treaty of Versailles ended World War I in 1919 and placed numerous limits on German manufacturing and military. Specifically, the treaty forbade Germany from producing or possessing military aircraft, engines, or equipment. Germany was required to turn over to the Allies, or destroy, their entire air force and military pilot training programs could not exist. The German air force was destroyed by 1920, meeting the requirements set by the treaty. This resulted in a very small German aircraft industry from 1920-1933 which focused mostly on civilian transport aircraft. The aircraft industry was so limited that between 1920 and 1932 a total of 3,284 aircraft were produced, with the majority being nonmilitary aircraft.[10] Focusing on 1932, German aircraft production was 36 units with a workforce of roughly 3,990 skilled laborers.[11] The German aircraft industry experienced a major shift with the rise of the Nazi party and the appointment of Adolf Hitler as the *Reich Chancellor* on 30 January 1933. A period of rearmament followed, eventually leading to World War II.

Rearmament began with the establishment of political offices to oversee various production industries. Albert Speer was appointed as the head of the Chief Office of Construction (1934-1939), later assumed the role of Minister of Armaments and War Production (Feb 1942), ultimately being responsible for all products ranging from

[10] Vajada and Dancey, *German Aircraft Industry and Production 1933-1945*, 9.

[11] Uziel, *Arming the Luftwaffe*, *the German Aviation Industry in World War II*, 7.

buildings to tanks.[12] The establishment of the aviation ministry *Reichsluftfahrtministerium* (RLM), in April 1930, with Herman Göring appointed as the Air Minister, gave him the responsibility for all aviation-related products.[13] In essence, Germany had a parallel production system with ground-based production and construction being the responsibility of Speer and aviation production falling under RLM. The RLM started with two production divisions: the *Luftschutzamt* was the military department and was headed by Colonel Eberhardt Bohnstedt, while State Secretary for Aviation, Erhard Milch, headed the civil department known as *Allgemeines Luftamt*. This two-division framework only lasted from May 15 to August 31, 1933, then was replaced with a single administrative structure under the direction of Göring and Milch.[14] Milch had a strong aviation background with experience as an aerial observer during World War I and later served as the general director of the German national airlines Lufthansa.[15] Utilizing his experience, with guidance from Göring, the RLM split into six departments which focused on key aspects of the aviation industry. The departments were the Central Branch, General Air Office, Administration Office, Personnel Office, Air Command Office, and Technical Office. With the consolidation of the RLM to a single

[12] Speer, *Inside the Third Reich*, 26.

[13] Uziel, *Arming the Luftwaffe*, *the German Aviation Industry in World War II*, 8.

[14] Homze, *Arming the Luftwaffe*, *the Reich Air Ministry and the German Aircraft Industry 1919-1939*, 57-58.

[15] Ibid., 58-59.

administrative structure, most German aviation production and development began focusing on military requirements.[16]

Though the Treaty of Versailles still placed restrictions on the German aviation industry, the RLM immediately instructed the increase of aviation production. The focus was on the production of current aircraft types and the development of new and updated models of aircraft. Göring directed a one-year manufacturing program, from May 1933 until April 1934, with the goal of manufacturing 294 military aircraft.[17] Seeing more potential within the aircraft industry, Milch developed a very detailed plan for the implementation of a 1,000-aircraft production goal. The idea was to get a large enough investment into the aviation industry to set the foundation for greater production capabilities in the future. Most of the planned aircraft would be training aircraft to build the Luftwaffe pilot corps, with roughly a quarter of the aircraft being military combat aircraft.[18] Milch's plan was successful in rapidly expanding the aircraft industry resulting in a roughly 11,000 man workforce, up from 3,990, by the end of 1933.[19] For 1934, Milch increased the production goal for aircraft to 4,021 aircraft by 1 October 1935. This was called the Rhineland Program, and the intent was again to increase aviation production capacity.[20] Due to the increase of production from 1933-34, the existence of

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[16] Uziel, *Arming the Luftwaffe*, *the German Aviation Industry in World War II*, 9.

[17] Vajada and Dancey, *German Aircraft Industry and Production 1933-1945*, 10.

[18] James S. Corum, *The Luftwaffe*, *Creating the Operational Air War*, *1918-1940* (Lawrence: University Press of Kansas, 1997), 162.

[19] Ibid., 163.

[20] Vajada and Dancey, *German Aircraft Industry and Production 1933-1945*, 12.

the Luftwaffe could no longer be hidden and was announced on 1 March 1935. By the time of the announcement, the Luftwaffe had over 800 operational combat aircraft. Milch added additional production requirements to the Rhineland Program in October 1935, calling for the additional production of 3,280 combat aircraft for the Luftwaffe. By mid-1935 the aircraft industry employed 60,894 workers and was growing at a rate where the workforce doubled annually.[21]

Table 1 and Figure 1 demonstrate the rapid growth in the German aviation industry during the early 1930's. Due to the Rhineland program, the aviation industry rapidly expanded to meet the demands of the German government.

Table 1. German Aircraft Production Rates, 1933-1935

Year	Number of Workers	Number of Aircraft Produced
1932	3,988	36
1933	11,000	368
1934	33,285	1,968
1935	60,894	3,183

Source: Created by the author using data from Ferenc A. Vajada and Peter Dancey, *German Aircraft Industry and Production 1933-1945* (Warrendale, PA: Society of Automotive Engineers, Inc., 1998), 15-22.

[21] Corum, *The Luftwaffe*, *Creating the Operational Air War*, *1918-1940*, 164-165.

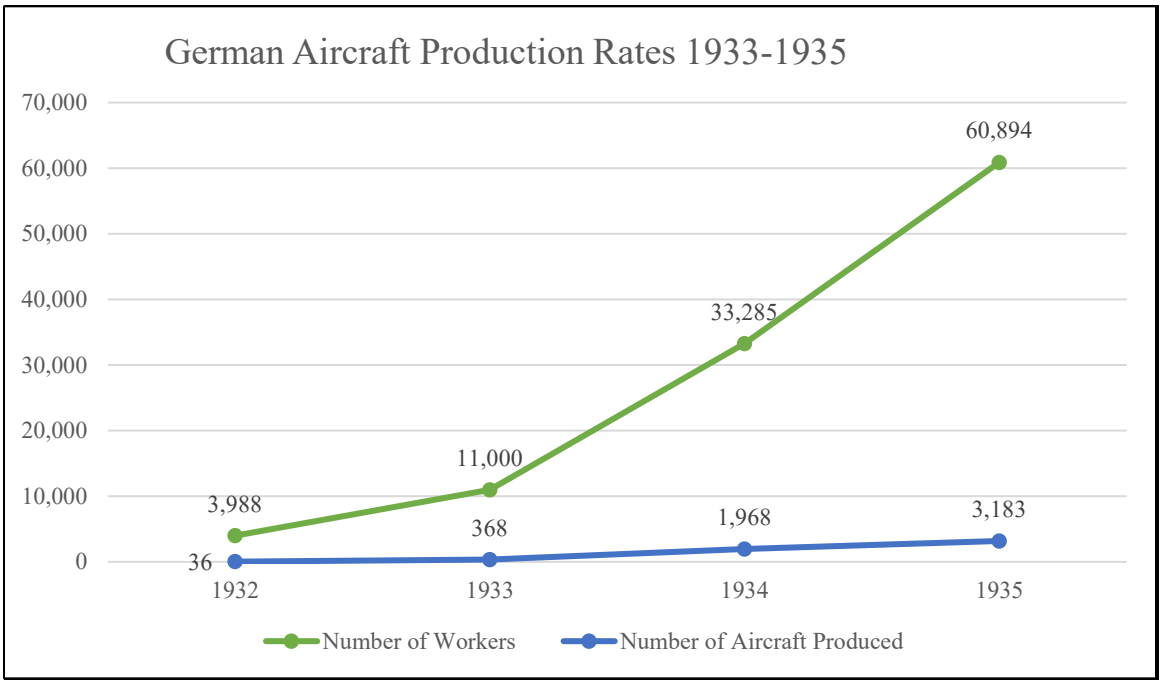

Figure 1. German Aircraft Production Rates, 1933-1935

Source: Created by the author using data from Ferenc A. Vajada and Peter Dancey, *German Aircraft Industry and Production 1933-1945* (Warrendale, PA: Society of Automotive Engineers, Inc., 1998), 15-22.

Due to the rapid increase of the workforce and the training required to manufacture aircraft, the actual number of aircraft produced was under the numbers that RLM was requesting. RLM accepted the lower production numbers because their overall goal was to increase production capacity within the aviation industry. By the end of 1935, the German aircraft industry was able to produce aircraft numbers very close to the requests that Milch and the RLM were requiring.[22]

[22] Vajada and Dancey, *German Aircraft Industry and Production 1933-1945*, 14-15.

The production gains achieved could not counter the personal and professional issues that existed between Erhard Milch and Herman Göring. Milch was an expert in his field that planned every aspect of production. He also gained the reputation of being a brash and abrasive man.[23] Milch made some public presentations giving the impression he was running RLM and the Luftwaffe, further driving a wedge between himself and Göring. Milch continued to irritate Göring by privately referring to himself as the minister.[24] Milch sought to bolster his political influence and position by building connections within the Nazi party and Hitler, making removing him from the RLM and other positions of responsibility very difficult. By 1936, Göring began searching for a way to control the rise of Milch. Göring appreciated the organizational and managerial capabilities of Milch but did not want to lose position or power that he had gained over the years. The solution for Göring was to make Milch his deputy so that a safe balance could be maintained between the two men. Milch was also relieved of his responsibilities as the head of the Technical Office within RLM, removing his influence from aircraft production. The replacement for Milch within the Technical Office was Colonel Ernst Udet, a war hero from World War I, who had no experience in managing a large production system.[25]

Udet co-owned a small aircraft production facility in the 1920s and was surrounded by competent individuals within RLM, giving Nazi leadership the assumption

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[23] Homze, *Arming the Luftwaffe*, *the Reich Air Ministry and the German Aircraft Industry 1919-1939*, 101.

[24] Ibid., 102.

[25] Uziel, *Arming the Luftwaffe*, *the German Aviation Industry in World War II*, 9.

that he possessed the managerial skills to be successful. Göring brushed aside any reservations about Udet's qualifications but privately voiced some concerns. However, Udet inherited a smoothly functioning Technical Office that, nonetheless, saw numerous production problems during his tenure.[26]

1936 started well for the German aircraft production industry. The foundation laid by Milch with coherent production plans and goals, substantial raw material reserves, tooling, and manpower set Udet up for success.[27] The rapid growth of the air industry resulted in a young but skilled workforce that was susceptible to being drafted.

Table 2 and Figure 2 demonstrate the composition of the German aviation workforce by mid-1936. It highlights a young workforce consisting mostly of men under the age of 35 making for a production system that was susceptible to a military draft.

[26] Homze, *Arming the Luftwaffe*, *the Reich Air Ministry and the German Aircraft Industry 1919-1939*, 103.

[27] Vajada and Dancey, *German Aircraft Industry and Production 1933-1945*, 23.

Table 2. German Aviation Workforce Mid-1936		
Worker Type	Total Industry Number	Percentage of Workforce
Male, Manager	5,730	4.6 %
Male, Technical Worker Under 35 35-45 Over 45	7,907 2,996 1,460	6.3% 2.4% 1.2%
Male, Skilled Worker Under 35 35-45 Over 45	54,862 14,419 9,312	43.9% 11.5% 7.5%
Male, Unskilled and Trainees	22,326	17.9%
Female Workers	5,866	4.7%
Totals	124,878	100%

Source: Created by the author using data from Edward L. Homze, *Arming the Luftwaffe, the Reich Air Ministry and the German Aircraft Industry 1919-39* (Lincoln: University of Nebraska Press, 1976), 109-111.

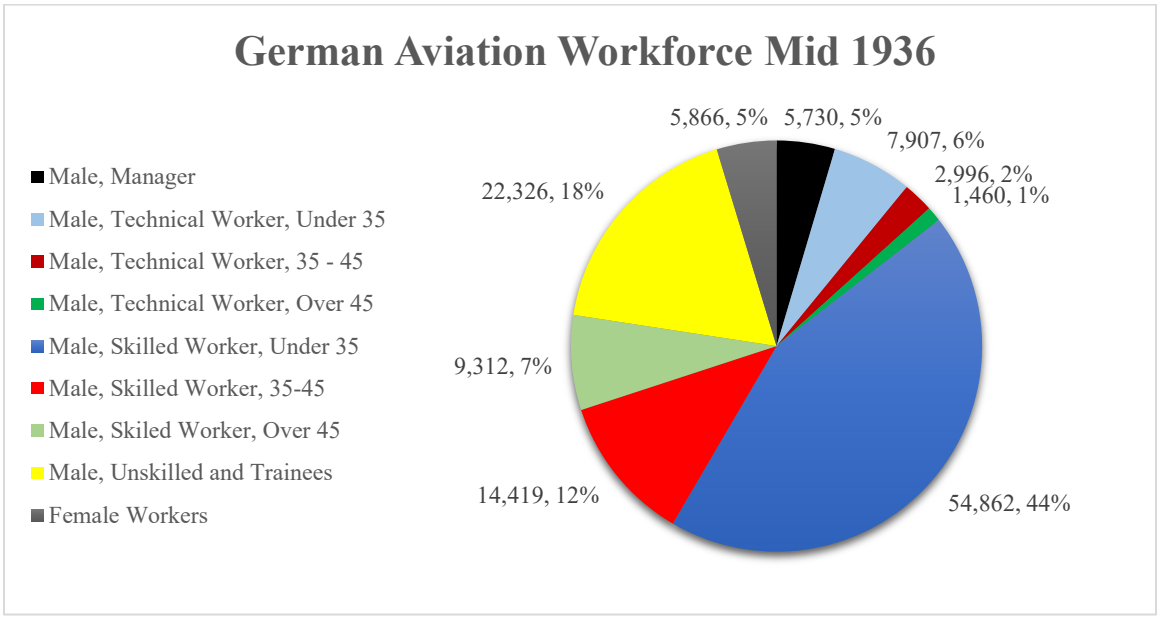

Figure 2. German Aviation Workforce Mid 1936

Source: Created by the author using data from Edward L. Homze, *Arming the Luftwaffe, the Reich Air Ministry and the German Aircraft Industry 1919-39* (Lincoln: University of Nebraska Press, 1976), 109-111.

The younger workforce within the aviation industry enjoyed higher wages than other industries. The average annual wages for an aircraft worker was 2,600 Reichmarks versus 1,700 for other type industry workers. Higher pay enticed the highest qualified individuals to work for the aviation industry leading to a very skilled and motivated workforce.[28] The result of the strong workforce with all other factors was aircraft production meeting and exceeding requirements through 1936. The aviation industry produced 5,112 aircraft with 2,530 being combat-related aircraft in 1936. This equated to a 58.7 percent increase in aircraft deliveries over 1935 totals.[29] By mid to late 1936, production began shifting to new models of aircraft with a focus on dive bombers, modern fighter aircraft, and twin-engine bombers. The resulting aircraft would end up being the majority of types seen during World War II.

Through 1936, Udet released a series of revised production goals. He issued *Lieferplan Nr2*, *Nr3*, *and Nr4* in rapid succession. *Nr2* increased the total number of aircraft ordered from 11,158 to 12,309. *Nr3* again gave minor adjustments to production goals. *Nr4* required the production of an unwieldy 80 types, models, and series of aircraft.[30] Some interlocking problems began affecting aircraft production late in 1936. First, Udet continuously adjusted production goals and plans. Trying to produce 80 types of aircraft made it difficult for manufacturers to train and focus their workforce.[31] Next, a

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[28] Homze, *Arming the Luftwaffe*, *the Reich Air Ministry and the German Aircraft Industry 1919-1939*, 109.

[29] Vajada and Dancey, *German Aircraft Industry and Production 1933-1945*, 24.

[30] Ibid., 23-24.

[31] Ibid., 24-25.

major raw material shortage, including steel, aluminum, oil, and numerous other resources, became unmanageable by December 1936. As a result, the RLM ceased non-combat related production and discontinued outdated types of combat aircraft.[32] It also resulted in the Four Year Plan. Headed by Göring, the goal of the plan was to make Germany more self-sufficient. The Third Reich's financial shortcoming was numerous financial inadequacies seen through Germany. Steeply rising costs of developing, testing, and producing advanced aircraft forced the Technical Office to make corrections. Instead of funding development and production from one pot of money, funding came from two sources. One was used to fund production, and the other would fund research and development. Firms such as Heinkel and other large manufactures used the financial shortages to gain advantages over smaller firms by advertising that they could outproduce smaller factories achieving 30 percent lower per unit cost. A consolidation within the aviation industry began occurring with the government choosing winners and losers.[33]

On 11 January 1937, the RLM proposed more changes to production and *Lieferplan Nr4.* The changes were an effort to modernize the Luftwaffe's inventory with increases to the fighter and twin-engine bomber production goals. Udet and the Technical Office also limited development of new aircraft to Bayerische Flugzeugwerke (BFW), Heinkel, and Junkers. By April 1937, Udet and the Technical Office decided to scrap *Lieferplan Nr4* and created the *Production Program Nr5*. The new plan covered production goals from April 1937 to October 1938 and requested aircraft production to

[32] Homze, *Arming the Luftwaffe*, *the Reich Air Ministry and the German Aircraft Industry 1919-1939*, 111.

[33] Ibid., 111-113.

total 18,620 units.[34] Of the 18,620 aircraft, 10,677, including aircraft already produced, needed to be completed by April 1937 with the remaining 7,943 to be completed over 18 months from May 1937 through September 1938. To meet the goals, average monthly production needed to be 441.2 aircraft, which was lower than the prevailing average of 483.8, due to anticipated difficulties associated with the introduction of new aircraft models and resource shortfalls.[35]

By April 1937, resource shortfalls and budget issues began greatly impacting RLM and aircraft manufactures. The RLM ordered cutbacks, and the process of auditing projects for overruns began. The Technical Office's audit showed that some airframes took over eight months to build with over 30,000-man hours committed to producing them. The audits resulted in the cancellation of numerous projects. 162 semi-finished airframes would be scrapped, and 2,100 workers would be laid off.[36] In July of 1937, RLM sent a sweeping directive reducing the number of redundant capability aircraft types. It called for more parts interchangeability and normalization of production procedures through the industry.[37] RLM also reorganized in July 1937, with the intent of simplifying the bureaucracy responsible for aircraft production. The actual result was The

[34] Vajada and Dancey, *German Aircraft Industry and Production 1933-1945*, 28.

[35] Homze, *Arming the Luftwaffe*, *the Reich Air Ministry and the German Aircraft Industry 1919-1939*, 151.

[36] Vajada and Dancey, *German Aircraft Industry and Production 1933-1945*, 31.

[37] Homze, *Arming the Luftwaffe*, *the Reich Air Ministry and the German Aircraft Industry 1919-1939*, 155.

Ministry of Aviation became more complicated and bureaucratic further complicating the development of aircraft within the Reich.[38]

In early September 1937, RLM replaced *Production Plan Nr5* with *Production Plan Nr6*, again changing aircraft production requirements focusing on the period from September 1937 through March 1939. The new plan focused on producing fewer types of aircraft with longer serial production runs. It also adjusted total cumulative production goals to 22,200 aircraft completed by March 1, 1939.[39] By the end of 1937, the German aircraft industry produced 5,606 aircraft with 118,500 skilled factory workers.[40] Continuous changes by Udet and RLM led to difficulties that would continue to fester through 1938.

The German aviation industry and the RLM started poorly in 1938. On 11 January, Schwerin von Krosigk, Germany's Finance Minister, briefed the RLM about the deteriorating financial situation within the Reich, and that rearmament programs needed to be drastically scaled down to preserve finances and resources. The budget reductions caused decreases in aircraft production and manpower on spare parts production lines.[41] RLM and Udet released *Production Plan Nr7* in January 1938 which projected manufacturing from January 1938 to June 1939. Updated requirements were 8,205 aircraft averaging 456 new airframes per month.

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[38] Vajada and Dancey, *German Aircraft Industry and Production 1933-1945*, 31.

[39] Homze, *Arming the Luftwaffe*, *the Reich Air Ministry and the German Aircraft Industry 1919-1939*, 155.

[40] Vajada and Dancey, *German Aircraft Industry and Production 1933-1945*, 25.

[41] Ibid., 38

In early 1938, the RLM developed the German War Mobilization Plan. The plan limited aircraft production to only bombers and fighters during the war and gave the responsibility of planning personnel increases within production facilities to the various manufacturers. Each company had to submit wartime manning requirements to RLM within the year. For example, Focke Wulf stated its wartime manpower at its facilities needed to raise from 7,547 to 11,436.[42] When all aircraft producers made their wartime manning reports, the Mobilization Plan was modified to increase the aircraft production workforce from 119,200 to 180,900 workers. The plan also estimated that aircraft plants needed 13 months to reach wartime manpower levels.[43] It became evident to Udet and RLM that Germany was not ready to go to war. By the middle of August 1938, RLM issued *Production Plan Nr8*, which covered production goals from 1 April 1938 to 31 March 1940. This was also evidence that the German Air Ministry did not believe that there would be a war in the near future. The total aircraft production was adjusted to 16,404 units over two years at a rate of 684 per month. Germany also revealed the strength and disposition of the Luftwaffe to Europe in August of 1938. This led France and the Soviet Union to mobilize along their borders. The various mobilizations caused RLM and Udet to quickly release a series of new production plans ending with *Production Plan Nr10* which covered a rapid expansion of production capacity from January 1939 to June 1941. It called for the production of 31,300 new aircraft and the

[42] Uziel, *Arming the Luftwaffe*, *the German Aviation Industry in World War II*, 147.

[43] Vajada and Dancey, *German Aircraft Industry and Production 1933-1945*, 40.

addition of 230,000 more workers.[44] 1938 ended with 146,263 workers employed and 5,235 aircraft produced. The aircraft industry began gearing up for war with an unlimited budget for expansion.[45] RLM still believed that war would not begin until 1941 and continued increasing production requirements to meet that timeline.

Production planning began in 1939 with a focus on equipping fighter squadrons with 18 aircraft and provided for a 50 percent reserve by April 1940. Twin engine bomber squadrons maintained an equipping standard of 12 aircraft and the same reserve within the same timeframe. By the end of February 1939, a draft of *Production Plan Nr11* was put together which encapsulated the various aircraft needs with requirements for the production of 3,918 bombers and 3,941 fighter aircraft.[46] February 1939 led to further streamlining of aircraft production with RLM licensing numerous firms to produce the primary airframes for the Luftwaffe such as the He-111 bomber, Ju-88 bomber, Bf-109 fighter, and the He-59 seaplane. Firms such as Arado and Fieseler began producing examples of the three airplane types and canceled their internal aircraft model development.[47] RLM gradually reduced the required production number and types of aircraft while consolidating production facilities into groups manufacturing specific aircraft models by region. For example, eight plants in central Germany were producing

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[44] Vajada and Dancey, *German Aircraft Industry and Production 1933-1945*, 45.

[45] Homze, *Arming the Luftwaffe*, *the Reich Air Ministry and the German Aircraft Industry 1919-1939*, 190.

[46] Vajada and Dancey, *German Aircraft Industry and Production 1933-1945*, 45-48.

[47] Uziel, *Arming the Luftwaffe*, *the German Aviation Industry in World War II*, 12.

Ju-88 bombers. The theory was, production consolidation would facilitate rapid production increases while simplifying the supply process for the factories when the war began.[48] March 14, 1939, saw Czechoslovakia split into Slovakia and Czech territories.[49] The next day the German army entered the Czech territory with no shots fired. With the occupation of the territory, Germany acquired the Czech air force and a developed aircraft manufacturing industry. *Production Plan Nr11* was finalized by 1 April 1939 with production requirement projections covering from April 1939 to March 1942. The plan included the newly gained production capacity from the Czech territory.

A series of events following the release of *Nr11* cast doubt on the ability to accomplish the various goals within the RLM. In May of 1939, shortages of steel, aluminum, copper, and various other metals were hitting the aircraft industry. The Minister of Aviation (Milch) recommended that Udet and RLM reduce production goals by 35 percent to account for the shortages. Continuous technical problems also impacted aircraft production. The complexity of many of the required aircraft types made it necessary for the retooling of many plants which slowed or even stopped production for up to three months. By August 1939, RLM and Udet were releasing daily aircraft production requirement changes leading to confusion within the aviation industry.[50] The result of the confusion was the reduction of actual aircraft production versus the goals set by RLM. In August 1939, the aviation industry produced 427 but had the goal of over

[48] Vajada and Dancey, *German Aircraft Industry and Production 1933-1945*, 45.

[49] Ibid., 45-46.

[50] Ibid., 45-48.

600.[51] By the eve of the invasion of Poland, the German aviation industry had *Production Plans Nr11-14* with little real direction or leadership from Udet or RLM.[52]

Table 3 and Figure 3 show the production output and the increase of the workforce within the German aviation industry from 1936-1939. It highlights a steady expansion through the thirties followed with rapid increases on the eve of the invasion of Poland.

Table 3. German Aircraft Production Rates, 1936-1939

Year	Number of Workers	Number of Aircraft Produced
1936	100,900	5,112
1937	118,500	5,606
1938	146,263	5,235
1939	Approx. 164,200	8,295

Source: Created by the author using data from Ferenc A. Vajada and Peter Dancey, *German Aircraft Industry and Production 1933-1945* (Warrendale, PA: Society of Automotive Engineers, Inc., 1998), 24-48.

[51] Homze, *Arming the Luftwaffe*, *the Reich Air Ministry and the German Aircraft Industry 1919-1939*, 231.

[52] Uziel, *Arming the Luftwaffe*, *the German Aviation Industry in World War II*, 12-13.

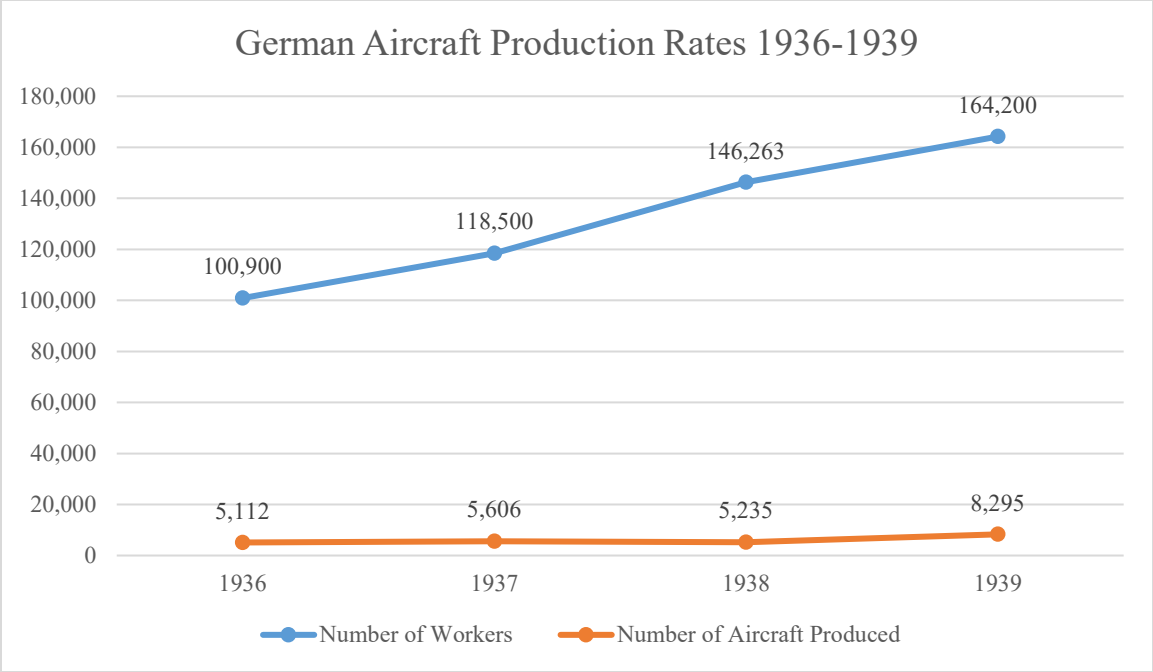

Figure 3. German Aircraft Production Rates, 1936-1939

Source: Created by the author using data from Ferenc A. Vajada and Peter Dancey, *German Aircraft Industry and Production 1933-1945* (Warrendale, PA: Society of Automotive Engineers, Inc., 1998), 24-48.

World War II began in Europe September 1, 1939, with the German invasion of Poland. Germany entered into war with an aviation industry that was still in development and a Luftwaffe that was not equipped to sustain a large volume of combat losses. RLM and Udet were changing their production guidance daily confusing the aviation industry.[53] Limited steel, aluminum, copper and other metals existed within Germany, leading to competition for resources between all production industries.[54] The average age

[53] Vajada and Dancey, *German Aircraft Industry and Production 1933-1945*, 48.

[54] Ibid., 46.

of an airframe worker was under 35 making the aircraft industry workforce vulnerable to the draft. Unemployment in 1939 Germany was very low, resulting in no real production manpower reserves to offset a draft.[55] The end of 1939 saw the implementation of the draft in Germany resulting in the aviation workforce losing half of the workforce with no near-term replacements. German factories went from operating two production shifts of 8 hours per day to one shift per day. The average worker participated in a 40 hour work week.[56] Germany also limited their workforce primarily to men, further limiting the ability of the aircraft industry to replace lost elements of the workforce. In contrast, Great Britain utilized women to fill many worker shortages caused by their rapid expansion of the armed forces. On several occasions, requests were made to Hitler to mobilize women, but he refused to utilize women in factories as had occurred during World War I.[57] The decision to minimize the use of women in the German workforce hurt aircraft production well into the war.

The process of training workers and replacement workers within the German aviation industry was a time-consuming endeavor. The aviation industry had an artisan manufacturing system where highly skilled laborers handcrafted aircraft. There was little mechanization, and teams of artisans would build a single aircraft from start to finish. German aircraft manufacturing utilized a stationary factory floor with fuselages parallel to each other instead of an assembly line. A professional airframe technician was trained

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[55] Uziel, *Arming the Luftwaffe*, *the German Aviation Industry in World War II*, 11-12.

[56] Ibid., 13.

[57] Murray, *Strategy for Defeat*, *the Luftwaffe 1933-1945*, 99.

over a four year period, as an apprentice, before being assigned to a production team. Impeding the training process, many of the older craftsmen were unwilling to share their production knowledge due to the status that their expertise gave them. The long training time for technicians made it difficult to expand the aviation industry for war with enough skilled laborers.[58] The long training process was in contrast to the Allies who quickly adopted mass-production assembly lines to produce aircraft making it unnecessary to train skilled labor. The British and American Governments also were able to mobilize their automotive manufacturing capacity for aircraft production versus the Germans who did not.[59] The German aviation industry was at a manning and production capacity disadvantage when war broke out from which it never recovered.

The rebirth of the German aviation industry started with a clear direction under the leadership of Milch and the RLM. From 1932 through 1936 production goals were set and production capacity gradually increased. Even when the industry did not meet production goals, the RLM continued to increase production goals with the intent of increasing overall production capacity. Milch turned over the RLM to Udet in 1936 leading to multiple production plans and weaker leadership. Production capacity and employment continued to increase through 1939. However, the aviation industry began to be impacted by shortages of raw materials. The aviation industry was ultimately unprepared for the start of the war in both production capacity and manpower. When the draft reduced the workforce, most production facilities went from two shifts to one. The

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[58] Uziel, *Arming the Luftwaffe*, *the German Aviation Industry in World War II*, 27-29.

[59] Ibid., 29-31.

process of training new workers was time-consuming, and the organization of the production lines prevented the rapid construction of combat loss replacement aircraft. 1939 ended with the German aircraft industry lacking direction and an artisan system of manufacturing that could not meet the demands of a long war.

CHAPTER 3

1940-1942 EARLY WAR PRODUCTION

The Luftwaffe was a large and formidable force during the invasion of Poland on 1 September 1939, but it was not ready for a long war. The RLM had not yet achieved the production goals required to sustain a large war with reserve aircraft and parts. The war started roughly two to three years before the RLM forecasted that they would be ready. Additionally, the Reich had no major stockpiles of raw materials such as aluminum, copper, rubber, fuels, and other necessary items to sustain production and war. Compounding the issue, the Luftwaffe lost 285 aircraft over Poland, including 78 bombers, 67 single engine fighters, and 63 reconnaissance aircraft. 279 additional aircraft were damaged bringing the total aircraft lost and damaged to over one month's aircraft production capacity in Germany for this time.[60] Germany utilized over 60 percent of its bomb stockpiles making it impossible for immediate continued attacks into other objective areas. The draft directly impacted the RLM's ability to account for all of the issues.

Germany experienced a major worker shortage with the start of the war. The aviation industry possessed a large factory capacity regarding floor space and machinery, but it could not properly man the factories. The limited number of skilled factory technicians led the RLM to reduce the training time of four years down to three. The three-year program still took a relatively long time to train workers and failed to aid in

[60] Vajada and Dancey, *German Aircraft Industry and Production 1933-1945*, 51.

increasing production.[61] Recruiting factory workers to enter the apprenticeship program became difficult for the RLM and aviation industry due to low unemployment rates throughout Germany. To help solve the problem, the German government enacted a law on *Dienstverpflichtung*, by which German workers not in the armaments industry could be forced to work in armaments factories. Many Germans were unhappy with the German government forcing them to change jobs leading to some production quality issues through 1941.[62]

In an attempt to get the aviation industry back on track, the RLM established a new building program on 25 October 1939. It had similar production goals as *Production Plan Nr14* with a limited production target of 2,216 military aircraft and added the requirement to start the production of concrete bombs filled with shrapnel. Concrete bombs were cheaper, quicker to produce, and were considered superior to small steel cased bombs. Meanwhile, the Luftwaffe started rebuilding and preparing for new campaigns due to the rejection of Hitler's offer of peace, on 12 October 1939, by the British and French governments. The aviation industry was unable to meet the production goal of 2,216 aircraft and only produced 1,961 aircraft from September-December 1939. German manufacturers could produce 88.5 percent of the production requirement due to workforce shortages. Bomber production had the hardest time meeting the requirement of

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[61] Uziel, *Arming the Luftwaffe*, *the German Aviation Industry in World War II*, 145-146.

[62] Lutz Budraß, Jonas Scherner, and Jochen Streb. "Fixed-Price Contracts, Learning, and Outsourcing: Explaining the Continuous Growth of Output and Labor Productivity in the German Aircraft Industry during the Second World War," *The Economic History Review* 63, no.1 (2010): 119.

901 aircraft by only completing 736 in the allotted time. Junkers Ju-88 production only met 53.5 percent of the RLMs goals during this period as they lost the highest percentage of their workforce to the draft.[63]

Herman Göring attempted to streamline aircraft production while saving resources in early February 1940 by ending development projects that would take several additional years to complete. Göring believed the war would end sometime between 1940-1941 and wanted to focus on aircraft production, not development.[64] Following instructions, the Technical Office canceled the Me-262 fighter project, the Jumo 004 jet engine, research on air to ground missiles, and many other important projects. Additionally, the RLM encouraged firms to increase workers' hours on the assembly lines to increase production and offset combat losses from Poland. Firms such as Junkers increased the work week to 53 hours in late 1939. They followed with another work hour increase to 56 hours early in 1940 and a final increase to 58 hours in late 1940.[65] The increase of hours brought some improvement to productivity, but the draft continued to take the key talent from aircraft production. Udet and the RLM attempted to further compensate for worker shortages by leveraging occupied territory production capacity.

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[63] Vajada and Dancey, *German Aircraft Industry and Production 1933-1945*, 51-53.

[64] Ibid., 54.

[65] Budraß, Scherner, and Streb, "Fixed-Price Contracts, Learning, and Outsourcing: Explaining the Continuous Growth of Output and Labor Productivity in the German Aircraft Industry during the Second World War," 118-119.

The RLM ordered 1,797 Czech aircraft of various types in preparation for future operations in Europe.[66]

The RLM used the winter of 1939-1940 to refit the Luftwaffe with replacement aircraft compensating for losses over Poland. Simultaneously, Hitler developed secret plans for the invasion of Denmark and Norway for the spring of 1940. On 9 April 1940, the operation started for the seizure of both countries.[67] Within the first few hours, Danish resistance collapsed. Norway was surprised by the attack but provided more resistance than the Danish. After the first 24 hours of operations, Germany controlled all important harbors and airfields. The Luftwaffe played a critical role in the operation by maintaining air superiority, providing close air support to ground forces, and supplying ground forces.[68] Conventional resistance to the invasion ended around 10 June 1940, and Germany controlled Norway through the end of the war.

On 10 May 1940, Germany began an offensive against Belgium, France, and Holland. German air attacks accompanied the start of the operation and aimed to achieve air superiority over southern France. The Luftwaffe was key to the success of the operation even though the defenders had more fighter aircraft. Germany had 1,016 single-engined fighters against 1,151 French, 81 Belgian, and 58 Dutch Fighters.[69] On the first day of the battle, Germany lost 83 aircraft including 47 bombers and 25 fighters. The

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[66] Murray, *Strategy for Defeat*, *the Luftwaffe 1933-1945*, 99.

[67] Vajada and Dancey, *German Aircraft Industry and Production 1933-1945*, 54.

[68] Murray, *Strategy for Defeat*, *the Luftwaffe 1933-1945*, 35.

[69] Vajada and Dancey, *German Aircraft Industry and Production 1933-1945*, 54.

following day the Luftwaffe lost an additional 42 aircraft including 22 bombers, eight dive bombers, and ten fighters.[70] By the end of the first week of fighting, German aircraft losses totaled 304 aircraft destroyed with 51 damaged. The losses equaled 19 days of production capacity and would be difficult for the RLM to replace. The high losses forced the Luftwaffe to change their focus to close air support versus more wide-ranging operations. The battle of Dunkirk led to more losses within the Luftwaffe. Over nine days from 26 May-3 June 1940 the Germans lost 240 aircraft while the Royal Air Force (RAF) lost only 177.[71] By the conclusion of combat operations in France in early June 1940, the Luftwaffe lost 1,428 military aircraft with 488 additional aircraft damaged. The Luftwaffe experienced high losses over France resulting in them having lower combat strength compared to the RAF.[72]

In late June 1940, Hitler believed that England would sue for peace and the war was over. He ordered the demobilization of some ground forces and the decrease of aircraft production. Production halted for the Bf-109F, He-111P, Ju-87B, and numerous other types of aircraft. The Luftwaffe had 841 serviceable bombers and 700 fighters remaining with no major planned refitting. By mid-July, it became clear that Great Britain would not sue for peace, and plans began for the air war against England.[73]

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[70] Murray, *Strategy for Defeat*, *the Luftwaffe 1933-1945*, 37.

[71] Ibid., 39.

[72] Vajada and Dancey, *German Aircraft Industry and Production 1933-1945*, 54-55.

[73] Murray, *Strategy for Defeat*, *the Luftwaffe 1933-1945*, 44-45.

In July 1940, the German aircraft industry could only produce 139 aircraft compared to the English producing 490 aircraft (mostly fighters). Germany lacked raw materials and the workforce to quickly produce replacement aircraft in preparation for the Battle of Britain.[74] The battle began in July with the Germans conducting exploratory operations over the English Channel. By 1 August 1940, the Luftwaffe began attempting to achieve air superiority over Great Britain. The week of August 13-19 the Luftwaffe lost 284 aircraft totaling seven percent of the total force structure. The Luftwaffe lost a total of 774 aircraft through combat actions in August which was 18.5 percent of Germany's aircraft.[75] In early September 1940, the Luftwaffe shifted from attacking military targets to bombing British cities. The shift transitioned the fight from the Battle of Britain to the Blitz. The Battle of Britain enacted a heavy toll on the Luftwaffe that was near impossible to rectify.

Table 4 and Figure 4 show the aircraft losses felt by the Luftwaffe from July through September 1940. The losses accounted for 37 percent of the total aircraft possessed by the Luftwaffe. The high attrition rate of aircraft and aircrews made it difficult for Germany to maintain the war effort.

[74] Vajada and Dancey, *German Aircraft Industry and Production 1933-1945*, 55-58.

[75] Murray, *Strategy for Defeat*, *the Luftwaffe 1933-1945*, 49-50.

Table 4. German Aircraft Losses, July-September 1940		
Aircraft Type	Beginning Strength	Total Destroyed
Close Recce	312	8
Long-Range Recce	257	70
Single Engine Fighters	1,107	518
Twin Engine Fighters	357	235
Bombers	1,380	621
Dive Bombers	428	88
Transport	408	15
Coastal	233	81
TOTALS	4,482	1,636

Source: Created by the author using data from Williamson Murray, *Strategy for Defeat, The Luftwaffe 1933-1945* (Maxwell Air Force Base: Air University Press, 1983), 53-55.

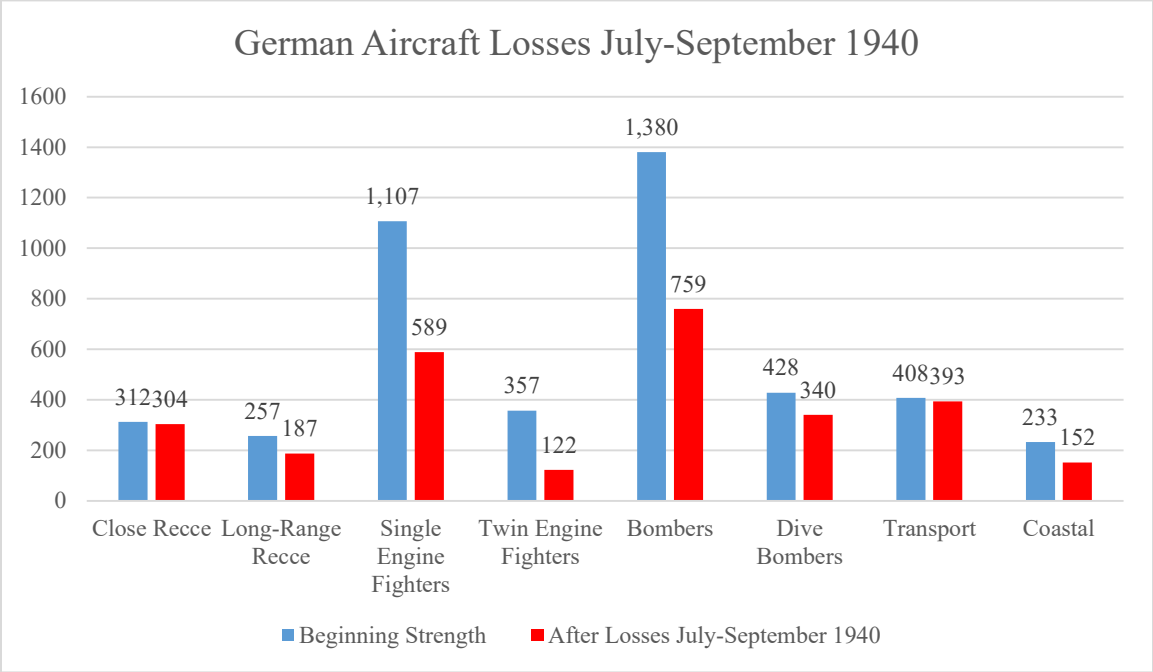

Figure 4. German Aircraft Losses, July-September 1940

Source: Created by the author using data from Williamson Murray, *Strategy for Defeat, The Luftwaffe 1933-1945* (Maxwell Air Force Base: Air University Press, 1983), 53-55.

On 20 August 1940, Hitler gave the RLM priority to manufacture seven different aircraft types, up from one (Ju-88). A month later Göring gave the RLM several additional new priorities. The RLM and Udet were receiving conflicting guidance and had difficulty prioritizing an overstretched aviation industry. The RLM released *Production Plan Nr18* on 1 October 1940 to consolidate the various priorities from leadership. The plan restarted the production of the Ju-87B and He-111. It also reduced the production requirement for Ju-88s through 1941 and postponed the introduction of the He-177 heavy bomber. Fighter production would remain constant even though demand for fighters was increasing. By 17 October, a minor revision to the plan came from the RLM requesting manufacturers to meet a 450 aircraft per month goal by March 1942. Hindering production were resource shortfalls caused by the diverting of raw materials to ground-based armament production over aircraft. Hitler and Göring began demanding higher production in November 1940 but failed to resource the aviation industry properly. The Technical Office within the RLM began revising production goals on a monthly basis starting on 1 November 1940. The latest revision decreased the production rate of combat aircraft, issued numerous directives for the conversion of old bombers for new roles and initiated a large glider building program.[76] From the beginning of the war to the end of 1940, the RLM released six Production Plans. Luftwaffe aircraft numbers were practically the same as the beginning of the war, while Great Britain and Russia were rapidly increasing stockpiles.

[76] Vajada and Dancey, *German Aircraft Industry and Production 1933-1945*, 58.

Attempts were made by the RLM to reduce worker shortages through 1940. *Dienstverpflichtung* and the laws associated with it were utilized to get German workers into the aviation industry from other manufacturing sources. Total worker shortages were not solved, leading to many companies requesting the leveraging of women to fill vacancies. Albert Speer used statistics from World War I that showed higher employment rates for women in the same factories that still existed in 1940. He also showed German leadership pictures of women working munitions lines from 1918.[77] Hitler was initially hesitant to allow women to fill factory vacancies, but he eventually capitulated. In mid-1940, limited numbers of female workers began working the production floor. Many companies forced already employed female workers to move from office work to the production floor leading to dissatisfaction. Arado, for example, utilized a 19.9 percent female workforce in mid-1940. Arado and other companies began feeling negative effects by late 1940 when dissatisfaction with work conditions, government financial support given to military spouses, and hours led to 74 percent of the female workforce quitting their jobs. Arado saw a decrease from 19.9 percent of their workforce being female to under 15 percent by the end of 1940. The drop in the female workforce continued through 1941. The attempt to ease worker shortages by using females never saw success due to the high attrition rates.[78]

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[77] Speer, *Inside the Third Reich*, 220.

[78] Lutz Budraß, Jonas Scherner, and Jochen Streb, "Demystifying the German Armament Miracle during World War II. New Insights from the Annual Audits of German Aircraft Producers" Yale University Economic Growth Center Discussion Paper No. 905, Yale University, New Haven, CT, January 2005, 12.

The winter of 1940-1941 was particularly harsh resulting in further lower production output by the German aviation industry. Of 230 single-engine fighters requested for January 1941, the industry completed 79. On 1 February 1941, the RLM released *Lieferplan Nr19*, yet another production plan for the aviation industry to interpret. The new plan increased the fighter production requirement and several other modest production increases. It called for the production of 1,515 aircraft per month with 460 being fighters and 480 being bombers. By 15 March 1941, the plan was again modified and became *Lieferplan Nr19/2*. The updated plan added a projection for aircraft production from 1940-December 1942 totaling 32,119 aircraft. It reduced monthly production requirements to 1,235 aircraft in an attempt to compensate for workforce shortages on production lines.[79] The German aircraft manufacturing system was able to produce 1,174 aircraft in March 1941 even with critical workforce shortages. By 15 June 1941, a new Production Plan was released reducing monthly aircraft production requirements to 1,100 through 1942. On the eve of Operation Barbarossa, the Luftwaffe had less operational combat aircraft than before the Battle of Brittian. The Germans had roughly 1,400 operational aircraft versus the Soviet Union's 20,000.[80]

With production levels falling through early to mid-1941, Udet and the RLM could no longer hide the growing disparity between planned and actual production totals. The Luftwaffe's low operational rate also highlighted the lack of replacement aircraft within the inventory. To correct production issues, Göring reinserted Milch into aircraft

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[79] Vajada and Dancey, *German Aircraft Industry and Production 1933-1945*, 58-59.

[80] Ibid., 59.

production chain. Milch had wide powers over the aircraft industry including the right to open or close factories, to confiscate raw materials, to transfer or dismiss designers, and to be able to redesign or reorganize industrial production. Milch also had the task of quadrupling aircraft production.[81]

Milch immediately began consolidating power and set out to restructure the failing aviation industry. He looked at resource shortfalls within the industry and identified numerous sources of waste. An example of this was Messerschmitt factories hoarding enough aluminum to build tropical shelters and ladders for use in vineyards. He also halted the serial production of new aircraft types and focused the industry on producing existing models. He began the shift from artisan manufacturing to a mass production model and gave manufacturers a standard production template for an eventual re-tooling of their factories. He also released directives to aircraft producers focusing on production over quality.[82]

Operation Barbarossa started 22 June 1941 and had immediate effects on the aviation industry. Before the invasion, the Soviet Union was the chief resource provider to the RLM. With raw materials no longer flowing into Germany from Russia, the RLM had to decrease aircraft production.[83] Milch released the *Göring Program* on 15 September 1941 which decreased the number of aircraft models manufactures could

[81] Murray, *Strategy for Defeat*, *the Luftwaffe 1933-1945*, 102.

[82] Ibid., 103.

[83] Vajada and Dancey, *German Aircraft Industry and Production 1933-1945*, 60.

produce from 32 to 12 combat types and further reduced monthly production requirements. It also demanded the production of 50,000 aircraft by March 1944.[84]

Worker shortages continued to plague the aviation industry through the fall of 1941 resulting in manufacturers having difficulty replacing high combat losses. As the Wehrmacht surged into Russia, they captured hundreds of thousands of working aged men. When aircraft producers requested prisoners be sent to factories to reinforce the production lines, Hitler refused to allow the transfer. POWs were allowed to work farms and other non-production jobs, but the aviation industry was off limits. Thus Germany failed to take advantage of a workforce resource and many prisoners starved to death in prison camps.[85] Manufacturers were permitted to begin recruiting workers from occupied territories with some successes. The aviation industry found that Russian and Ukranian women were the best option to recruit. They were less likely to sabotage aircraft on the production line, and they came up to 90-100 percent of the productivity of German workers.[86] As foreign workers arrived, the issue of interpreters became noted. Germany did not have enough interpreters to handle the various linguistic groups, making some workers useless until the communication barriers could be solved. The RLM again began

[84] Vajada and Dancey, *German Aircraft Industry and Production 1933-1945*, 62.

[85] Murray, *Strategy for Defeat*, *the Luftwaffe 1933-1945*, 99.

[86] Budraß, Scherner, and Streb, "Fixed-Price Contracts, Learning, and Outsourcing: Explaining the Continuous Growth of Output and Labor Productivity in the German Aircraft Industry during the Second World War," 118-120.

a push to hire German women to fill worker shortages as a stopgap while translators received training.[87]

Through the fall of 1941, Ernst Udet became progressively more depressed. He was being held responsible for the failures of the RLM to meet production demands. On 17 November 1941, Udet shot and killed himself. He was remembered as an exceptional pilot but was a terrible organizer. He also lacked the technical knowledge necessary to run the RLM. Erhard Milch assumed full responsibility for the RLM and began programs to increase production rates.[88]

The Eastern Front was hard on the Luftwaffe. The Luftwaffe averaged 741 aircraft losses per month. The loss rates totaled roughly 16 percent of their aircraft inventory every month. The cumulative effect of extremely high attrition rates resulted in a very weak German Air Arm. Over the year, the Luftwaffe lost 5,450 combat aircraft, well exceeding the production capacity within the aviation industry. By the end of 1941, German aircraft production could no longer sustain high combat losses.[89]

Table 5 and Figure 5 show the authorized number of combat aircraft within the Luftwaffe from September 1939-December 1941. Also, it demonstrates decreasing percentages of operational aircraft due to high combat losses. It highlights the devastating effect that Operation Barbarossa had on German aviation readiness.

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[87] Speer, *Inside the Third Reich*, 220.

[88] Vajada and Dancey, *German Aircraft Industry and Production 1933-1945*, 64.

[89] Ibid., 64-65.

Table 5. German Aviation Readiness, September 1939-December 1941			
Date	Authorized Strength	Actual Strength	Percentage
September 1939	2,950	2,916	98.9%
December 1939	3,313	3,258	98.3%
March 1940	4,034	3,692	91.5%
June 1940	3,714	3,327	89.6%
September 1940	3,547	3,015	85.0%
December 1940	3,792	3,050	80.4%
March 1941	4,100	3,853	94.0%
June 1941	4,228	3,451	81.6%
September 1941	4,318	3,561	82.5%
December 1941	4,344	2,749	63.3%

Source: Created by the author using data from Williamson Murray, *Strategy for Defeat, The Luftwaffe 1933-1945* (Maxwell Air Force Base: Air University Press, 1983), 101.

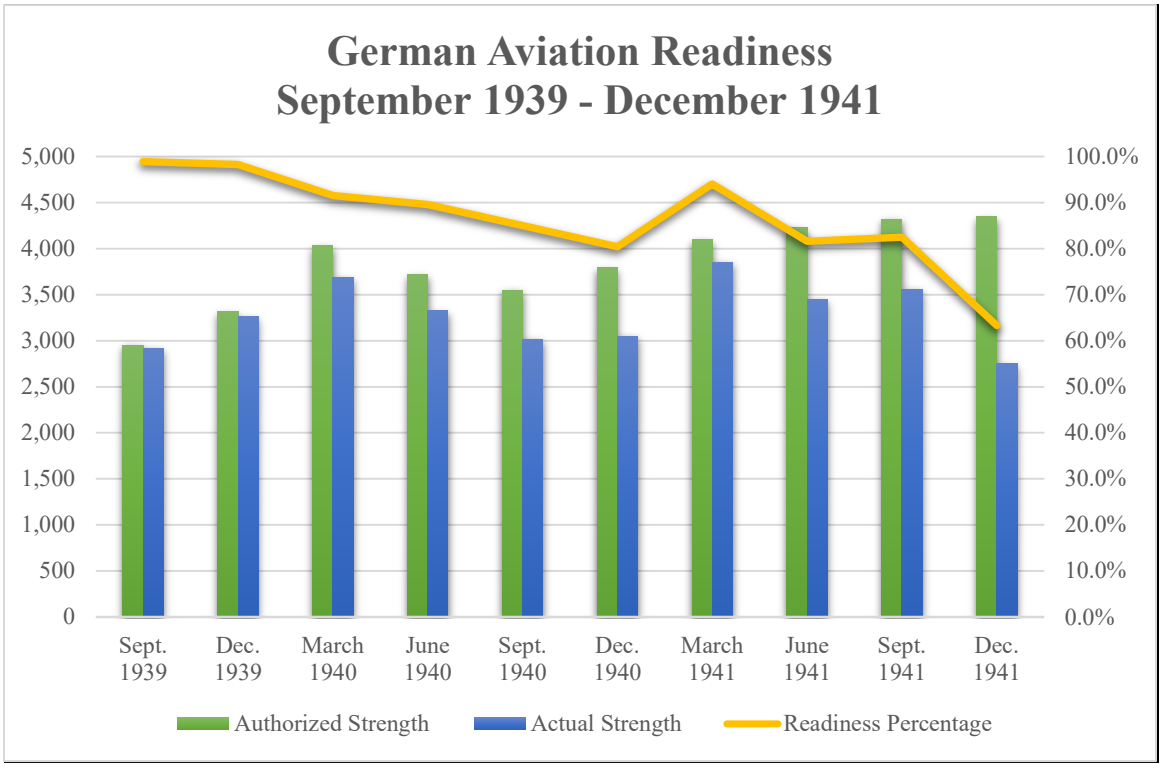

Figure 5. German Aviation Readiness, September 1939-December 1941

Source: Created by the author using data from Williamson Murray, *Strategy for Defeat, The Luftwaffe 1933-1945* (Maxwell Air Force Base: Air University Press, 1983), 101.

Starting in January 1942, the Luftwaffe began shortening pilot training by a full month to offset high aircrew losses on the Eastern Front. The chaotic state of the aviation industry made it impossible for the Luftwaffe to project how many new aircraft it would be receiving every month. Numerous aircraft programs began collapsing such as the Me-210 and He-177 due to their combat ineffectiveness. By 10 January 1941, the Luftwaffe inventory on the Eastern Front had 1,560 combat aircraft of which 623 were combat ready. The RLM and Milch conducted a study on the aviation industries capabilities and released their findings. RLM released the *Studie 1011* in February 1942 and gave a detailed analysis of what frontline units needed from the aviation industry. It also scheduled the production of 97,000 aircraft by December 1945. The requested production equaled a monthly average of 2,250 aircraft, much higher than German producers had met to that point.[90]

Worker shortages continued to hurt the RLM and German manufacturers early in 1942. By June 1942, Focke Wulf's general director began complaining by letter to the Industrial Committee for Production of Luftwaffe Equipment about the manpower shortages. Focke Wulf demanded 4,250 additional workers for its expanded production requirements. The RLM was able to provide 320 new workers while at the same time Focke Wulf lost 1,434 men to the draft. Worker shortages continued to prevent many firms from having a second production shift further limiting aircraft production rates.[91] A further attempt to get more women on production lines was made by Albert Speer who

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[90] Vajada and Dancey, *German Aircraft Industry and Production 1933-1945*, 65.

[91] Uziel, *Arming the Luftwaffe*, *the German Aviation Industry in World War II*, 146-147.

had assumed the role of Armaments Minister in February 1942. Hitler wanted no female workers but above all "not mothers of many children." This resulted in a half million women beginning the process of becoming factory workers. Speer also formed "directive committees" for developing various types of weapons and "directive pools" for the allocation of supplies. Alongside the pools, Speer set up development commissions in which military officers met with the best designers and gave suggestions for improvement. Speer also mobilized the economy of Germany for war, resulting in all production being focused on war equipment.[92] All of the changes resulted in some production increases by the end of 1942.

The RLM released *Lieferplan Nr21* with the goal of producing more fighter aircraft to fend off Allied bomber incursions over German territories. The plan was modified by August 1942 to reflect updated aircraft needs. The plan included the production of 71,848 aircraft by 1945 with a monthly production average of 2,394 aircraft. The production figures included 1,300 fighters and 700 bombers monthly production requirements. By 1 September 1942, the plan was already outdated, and RLM replaced it with *Plan 221/1*. Several iterations of production plans continued to give direction to the aviation industry through the end of 1942. Production rates slowly increased from 1,486 aircraft per month in January to 2,064 by October 1942.[93]

An interesting phenomenon began to surface through 1942 with German workers that were forced under *Dienstverpflichtung* to begin work in aircraft factories. Several

[92] Speer, *Inside the Third Reich*, 208.

[93] Vajada and Dancey, *German Aircraft Industry and Production 1933-1945*, 68.

audits showed a growing dissatisfaction with German workers by both the RLM and aircraft manufacturers. For example, Arado complained that German workers required extensive training and supervision before they could use them on the factory floor. Arado also fired 1,100 workers in 1942 for lack of production aptitude. The belief within the industry was "forced" German workers purposely tried to demonstrate incompetence thus forcing their release from production responsibilities. The effects were delays on production lines, lower quality in manufacturing, and a greater dependence on foreign workers. As the numbers of German workers decreased on the production floor, many firms such as Heinkel were able to increase their total workforce by up to 40 percent by hiring foreign workers. Anti-Bolshevik propaganda helped recruit displaced persons from the Stalingrad Campaign. Most of the displaced workers were skilled and experienced. The increase in the workforce enabled many firms to start a second production shift resulting in an overall increase in production rates for 1942.[94] Many of the foreign workers chose not to renew their contracts starting August of 1942, leading to a large exodus within the aviation industry. The RLM conducted a meeting on 26 August 1942 where a report showed that Junkers lost 38 percent of foreign workers, BMW lost 24 percent, Arado lost 18 percent, Daimler-Benz lost 26 Percent, and Heinkel lost 10 percent.[95] Again the aviation industry was facing severe worker shortages.

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[94] Budraß, Scherner, and Streb, "Fixed-Price Contracts, Learning, and Outsourcing: Explaining the Continuous Growth of Output and Labor Productivity in the German Aircraft Industry during the Second World War," 119-120.

[95] Uziel, *Arming the Luftwaffe*, *the German Aviation Industry in World War II*, 149.

As 1942 came to an end, Milch and the RLM began full-scale implementation of assembly line type manufacturing within the aviation industry. They also began hardening factories and dispersing production lines making them less susceptible to air attacks. Foreign workers began to outnumber German workers on production floors, but worker shortages continued to plague factories. Göring recommended that foreigners be forced to renew their one-year contracts by law to mitigate worker shortages. However, Hitler wanted the industry to begin looking at the untapped potential of the hundreds of thousands of prisoners rotting in concentration camps.[96] 1942 was another tumultuous year within the aviation industry. It set the stage for the remainder of the war with the Luftwaffe well behind the Allies in both numbers and capabilities.

[96] Uziel, *Arming the Luftwaffe*, *the German Aviation Industry in World War II*, 149, 149-150.

CHAPTER 4

1943-1945 ALLIED BOMBING CAMPAIGNS

> The threat of Allied bombers forced us to disperse manufacturing. Under dispersal, aircraft quality suffered considerably. Fittings sometimes did not meet tolerances. Because there was more than one source for each component and subassembly, there was not satisfactory interchangeability.
>
> —Herman Göring, Interview #56, U.S. National Archives and Records Administration

Germany had hoped for rapid victory with the continuation of Operation Barbarossa in 1942. The rapid victory never occurred, and early in 1943, Von Paulus' army surrendered in Stalingrad. Two years of the Soviet Campaign and offensives had strained all German war industries. Additionally, the Allies were in North Africa and could reach Greece and other Axis territories. The US Army Air Force was building combat power in Great Britain with preparations to begin offensive bombing by summer 1943. The German aircraft industry soon would receive greater production requirements and stress that it would have difficulty meeting.

By January 1943, the German aircraft industry was able to produce 1,574 aircraft, which was under the numbers requested by the RLM to replace combat losses. Between November 1942 and January 1943, the Luftwaffe suffered 2,238 combat aircraft losses in the Mediterranean alone. The majority of the losses were fighter aircraft (888 Bf-109 and FW-190). The Soviet Campaign saw an additional 2,564 combat aircraft losses with similar high fighter losses. Fighters were needed everywhere, and there were not enough to go around.[97]

[97] Vajada and Dancey, *German Aircraft Industry and Production 1933-1945*, 76.

Seeing the build-up of bombers in Great Brittian, the RLM prepared a general dispersal plan for the entire aviation industry. The RLM required all aircraft producers to submit detailed preliminary dispersal plans to their respective oversight agencies. The dispersal plans included production redundancy in case main production facilities were damaged or destroyed by Allied bombers. The mode of dispersal for factories was internal dispersal first where factories organized unused equipment within unused warehouses to continue production if the main line was damaged. The warehouses were on the perimeter of the main production factory facilitating a quick transition of production. The RLM also made plans to relocate damaged production to facilities that made similar aircraft. For example, Focke Wulf 190 production would transfer from Oschersleben to unused factory space in Focke Wulf's Bremen main factory. The host factory production would, in theory, not be affected and the visiting production would see a minimal decrease in production. The plan also accounted for a factory with 100 percent damage. This required the complete relocation of the factory outside of bombing range, which required massive transportation efforts and cost. The RLM's only recommended the dispersion plan to the industry, but most producers ignored the request due to cost. The RLM did release a requirement in late 1942 to disperse material stores, which was followed by the industry.[98]

On 18 February 1943, Joseph Goebbels delivered a speech on "Total War" in Berlin. The focus of the speech was to get the total commitment of the domestic reserves to the war effort and to get the population mobilized. It was also a veiled attempt to get

[98] Uziel, *Arming the Luftwaffe*, *the German Aviation Industry in World War II*, 111.

the mob to pressure those not committed to the effort to get in line. A surge in aircraft production occurred after the speech resulting in the production of 2,004 aircraft in February 1943, an increase of 27 percent over January production.[99]

Another worker shortage hit the RLM and the aviation industry in February 1943 when Otto Saur, the State Secretary for Armaments Production, diverted the best welders from aircraft to tank production. Milch was forced to ask again that aircraft production lines utilize women to fill vacancies, but the German leadership presented numerous barriers to this.[100]

Herman Göring held a major conference on 22 February 1943 to simplify and streamline aircraft production in an attempt to relieve worker shortages. The conference resulted in several decisions including the cancellation of many prewar aircraft production requirements and designs, the introduction of Me-262 jet fighter production, and the approval of several heavy bomber designs for production. As as a result of the conference and a focused workforce, March aircraft production reached 2,166 aircraft including 962 fighters. Still under the number required to replace combat losses, but the increase aided the German war effort.[101]

Beginning in March 1943, the RAF Bomber Command targeted the Ruhr at night. The Brittish bombers inflicted heavy damage on several German cities, including many vital industrial plants. The raids inflicted heavy damage on the RAF as well with 872

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[99] Vajada and Dancey, *German Aircraft Industry and Production 1933-1945*, 76.

[100] Ibid., 77-78.

[101] Ibid., 76-78.

bombers destroyed during 43 raids in the spring of 1943. The RLM increased the night fighter production requirements on the industry due to the raids. The result of the raids on production within the Ruhr was over 40 percent for large firms and over 80 percent for small firms.[102]

On 12 April 1943, the Allies developed the Combined Offensive Plan II.B. which set goals and targeting requirements for the RAF and the Eighth Air Force. The goals included the reduction of German fighter production by 43 percent, bomber production by 65 percent, ball bearing production by 76 percent, and synthetic rubber production by 50 percent.[103] On 17 April 1943, 115 aircraft from Eighth Air Force attacked the Focke Wulf factory near Bremen. The attack did minimal damage to the Focke Wulf production lines due to FW voluntarily dispersing their production lines just a few months earlier.[104] Many aircraft firms began voluntarily dispersing and relocating factories to the East away from bombing range after seeing the success of Focke Wulf's dispersion. The RLM had to approve the relocations and provided financial support to producers to speed up the process.[105]

The RLM released *Production Plan 223-1* on 15 April 1943 which emphasized fighter aircraft production over bombers. The plan included 1,115 Bf-109 fighters to be produced by December 1944, 800 Me-209 fighters by July 1945, and included the Me-

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[102] Murray, *Strategy for Defeat*, *the Luftwaffe 1933-1945*, 167-169.

[103] Vajada and Dancey, *German Aircraft Industry and Production 1933-1945*, 78.

[104] Uziel, *Between Industrial Revolution and Slavery*, 287.

[105] Vajada and Dancey, *German Aircraft Industry and Production 1933-1945*, 80.

262 as a design study. The program required the production of 2,673 aircraft per month, still under what was required to replace combat losses.[106]

The RLM also began a program of weaning the aviation industry from artisan manufacturing to a mass production assembly line model in April 1943. By deskilling the workforce, the RLM aimed to increase production while reducing time to train the workforce. The RLM produced a general design for factories which included several production halls interconnected by roads and railroads over several mile areas. The majority of the production halls made components and attached them to a fuselage under construction. The fuselage moved on a conveyor belt or cradle from one end of the production hall to the other. When the incomplete fuselage exited the first production hall, trucks or trains transported the fuselage to the next production hall for further assembly. The process repeated until a completed aircraft exited the final production hall. The RLM set the goal of having all factories switched to modern manufacturing systems and sufficiently dispersed by the end of 1943.[107]

From April through October 1943, the first of four phases of the Combined Bomber Offensive focused on high priority targets. Included as top priority targets were aviation factories, oil refineries, and ball bearing factories. The Eighth Air Force conducted 13 attacks in the first phase on Me-109 and FW-190 factories, and one strike focused on Daimler-Benz engine manufacturer. The raids were conducted at the operational range of the Eighth and Fifteenth Air Force's bombers with no fighter escort

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[106] Vajada and Dancey, *German Aircraft Industry and Production 1933-1945*, 80.

[107] Uziel, *Between Industrial Revolution and Slavery*, 287-292.

over Germany. The results were high attrition within the Eighth Air Force but included the destruction of an FW-190 plant at Marienburg, East Prussia. The damage done by Allied bombs during this phase of the Bomber Offensive was high because the targets had not been completely decentralized and dispersed.[108] This increased the rate that German factories dispursed raising demand on the German transportation industry.

By July 1943, German aircraft production was 2,475 aircraft with 1,263 being fighters. This was the peak of aircraft production in 1943 followed with declining production for the remainder of the year. Allied attacks on factories in July and August 1943 resulted in the reduction of fighter production by about 200 units per month. July saw 1,109 fighters produced and August followed with 986. Constant attacks by Allied bombers on factories and logistics networks hindered aircraft production. The Combined Bombing Campaign began having an effect on German leadership with Albert Speer giving the following quote:

> The first serious air raid on Hamburg in August 1943, was extraordinarily impressive. We were convinced that the quick repetition of such an attack on six other German cities would necessarily lead to a lessening of the will to continue armament and war production . . . The air raids were not repeated to such an extent, however, and in the meantime, the population was able to get accustomed to the air raids and, together with the armament industry, were able to collect valuable experience.[109]

Milch also began publicly stating that Germany had lost the war and a change was necessary.[110]

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[108] United States Strategic Bombing Survey, *Aircraft Division Industry Report,* 2nd ed., 1947, 67-68.

[109] Ibid., 71.

[110] Vajada and Dancey, *German Aircraft Industry and Production 1933-1945*, 80.

The RLM quickly released a new production plan on 8 August 1943 titled *Plan 233-11 The Reich Defence Plan* to deal with the Allied bomber problem. The new plan called for the production of 4,150 single-engine fighters and 1,750 twin-engine fighters to be produced per month. The increase in fighter production was a 120 percent increase over previous levels, but bomber production was also to continue based on previous requirements.[111] General Adolf Galland saw the value of increased fighter production, but argued for the canceling of all production and focusing only on the production of the Me-262 jet fighter. The high speed of a jet fighter combined with heavy cannon armament could be used to more efficiently clear the skies of bombers.[112] Milch argued that it would be impossible to halt all production for the new Me-262 but facilitated an optimum schedule for the production of the jet fighter. The RLM added goals to the production program including 60 Me-262s by November 1944, 200 in January 1945, 400 in March, 600 in June, and 1,000 per month from September 1945 and on.[113]

The continued heavy bombing resulted in the release of several changes to production requirements including increases to fighter production and decreases in bomber production through 1943. Though the requirements were adjusted, the German aircraft industry could only produce 982 fighters in September, 1,103 fighters in October, 937 fighters in November, and 721 fighters in December. The combination of day and

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[111] Vajada and Dancey, *German Aircraft Industry and Production 1933-1945*, 80-81.

[112] Raymond F. Toliver and Trevor J. Constable, *Fighter General the Life of Adolf Galland* (Zephyr Cove, NV: AmPress Publishing, Inc., 1990), 238-239.

[113] Vajada and Dancey, *German Aircraft Industry and Production 1933-1945*, 81-82.

night bombing (particularly the Schweinfurt and Regensburg raids in August 1943), with the active process of factory distribution, led to the lower production numbers. The low fighter production numbers meant that Germany could not sustain the fighter losses over Russia, Italy, and West Europe. The Luftwaffe was equipped with insufficient numbers of fighters and had no means of securing air superiority over any of Germany's areas of operation.[114]

In spite of worker shortages, the inability of the aviation industry to meet the demand for combat replacements and heavy bombing by the Allies, the German aviation industry still produced more aircraft than ever. The industry produced 25,527 aircraft which is a 64 percent increase from 1942. The increase in demand for fighters resulted in 11,198 fighters produced, a rise of 101 percent. Ground attack aircraft production saw a 182 percent growth as well, with only minor increases to bomber production.[115]

The Allies conducted the second phase of the Combined Bomber Offensive from November 1943 through January 1944. The German aircraft industry received practically no bombings during this period giving the Luftwaffe a chance to rebuild after a hard 1943. The Allies sustained such high losses during the first phase of the operation that the decision was made to wait for long-range fighter escorts to arrive in Europe. The weather was poor during this period as well preventing air operations. The Eighth Air Force used

[114] Vajada and Dancey, *German Aircraft Industry and Production 1933-1945*, 83.

[115] Ibid., 85-86.

the second phase of the Combined Bomber Offensive to build up its full strength of heavy bombers in preparation for follow-on offensive operations in 1944.[116]

On 4 January 1944, Adolf Hitler held a war conference where Albert Speer released that the armaments industry was short four million workers across the board. Germany needed a solution for the shortages due to the looming allied invasion somewhere in Europe. Suggestions came to leverage more women for production lines and the use of greater numbers of forced laborers. Not much changed from the conference, but the aviation industry received a renewed focus on jet aviation and further guidance for distribution with hardened production facilities.[117]

The Allies began their third phase of the Combined Bomber Offensive in February 1944. This phase lasted from 20-25 February and is called the "Big Week." The offensive included the first major use of the P-51 long-range fighter by the Allies, providing long-range cover for entire bombing missions.[118] The "Big Week" targeted 23 airframe and three aircraft engine plants. The concentration of the attacks had a very damaging effect on the German aviation industry. A total of 40 percent reduction of aircraft production occurred after the raids. The Eighth Air Force experienced high losses but also claimed 432 German aircraft destroyed, 124 damaged, and 219 aircraft as

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[116] United States Strategic Bombing Survey, *Aircraft Division Industry Report*, 68.

[117] Vajada and Dancey, *German Aircraft Industry and Production 1933-1945*, 86.

[118] Murray, *Strategy for Defeat*, *the Luftwaffe 1933-1945*, 237.

probably destroyed.[119] Germany saw a loss of 56.4 percent of their fighter force in one week. The serious losses felt by the Luftwaffe led Allied planners to believe that the Germans no longer had air superiority over Europe.[120]

The "Big Week" came as a serious shock to the German psyche leading to more changes within the aviation industry. The most important production programs received priority to move underground, and the remainder of the aviation industry received further dispersion orders. The aviation industry was able to disperse from 27 main locations to over 729 smaller plants between April and August 1944 in a four-phase operation. Phase one would identify locations for the production facility. During phase two, an advanced party prepared the new location. Phase three transferred the production line to the new location. Phase four included reassembly of the production line and the beginning of aircraft production. The further dispersal of the aviation industry was very expensive, increased the workforce size requirements by up to 50 percent, and further strained German logistics.[121]

The "Big Week" also contributed to the formation of the *Jägerstab* (Fighter Staff) on 1 March 1944. The *Jägerstab* served as a governmental task force whose aim was to increase production of fighter aircraft. It also replaced the RLM as the controlling agency for aircraft production. The task force consisted of government and SS personnel, as well

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[119] United States Strategic Bombing Survey, *Aircraft Division Industry Report*, 68.

[120] Murray, *Strategy for Defeat*, *the Luftwaffe 1933-1945*, 239.

[121] Uziel, *Arming the Luftwaffe*, *the German Aviation Industry in World War II*, 113-115.

as representatives of the aircraft manufacturers. Albert Speer established the task force with the blessing of Erhard Milch. Both individuals carried the title of Joint-Chairman but gave control of the day to day operations of the *Jägerstab* to the Chief of Staff Carl Saur. Speer and Milch remained intimately involved in decision making and the dispersion process.[122]

The *Jägerstab* established a system of salvage teams to rapidly recover aircraft and equipment that received damage during bombing raids. This was an attempt to minimize the high losses felt by the Luftwaffe both in production and in the air. The focuses of the salvage teams are summed up in the following intercepted *Jägerstab* communication:

> The extraordinarily difficult situation in the air defense of the homeland requires with all emphasis: (1) The speedy salvage of all fighter and heavy fighter aircraft and their immediate return for their repairs. (2) The unrestricted employment of salvage personnel for salvage tasks. Subordinate units are expressly forbidden to employ them for any other purpose. (3) That spare parts be acquired by repair and salvage units by removal from aircraft worth salvaging only in case of absolute necessity. (4) That repair of aircraft in your area energetically speed up in order to increase serviceability and to relieve supply.[123]

The salvage teams worked tirelessly to recover damaged equipment and aircraft with great success through the remainder of the war.

Additionally, the *Jägerstab* quickly released a new production program, *No225*, which increased fighter production across the board. The increase included traditional

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[122] Vajada and Dancey, *German Aircraft Industry and Production 1933-1945*, 117-119.

[123] Murray, *Strategy for Defeat*, *the Luftwaffe 1933-1945*, 245.

fighters (Me-109 and FW-190), night fighters, a requirement for 60 Me-262 jet fighters per month by October 1944, and the production of the Me-163 rocket fighter.[124]

The fourth phase of the Combined Bomber Offensive occurred from March through May 1944. This period saw the heaviest bombing of aircraft factories and their subsidiaries conducted during the offensive. The goal was to break the back of the aviation industry. The Eighth and Fifteenth Air Forces conducted ten attacks on aircraft engine plant and 63 attacks on airframe factories with a focus on fighter production. Additional attacks focused on synthetic oil production and ball bearings production. The end of the fourth phase concluded the High Priority Campaign of the Combined Bomber Offensive. Between June 1944 to the end of the war, the aircraft industry received lower priority, but still received a fair percentage of targeting.[125]

Table 6 and Figure 6 show the number of attacks conducted by the Eighth and Fifteenth Air Forces on airframe and aircraft engine plants during the four phases of the High Priority Campaign portion of the Combined Bomber Offensive.

[124] Murray, *Strategy for Defeat*, *the Luftwaffe 1933-1945*, 86-89.

[125] United States Strategic Bombing Survey, *Aircraft Division Industry Report*, 69.

Table 6. Attacks on Airframe and Engine Plants by the Eighth and Fifteenth Air Forces			
Phase/ Dates	Fighter Plants (FW-190 and Me-109)	Other Airframe Plants	Engine Factories
Phase One/ Apr-Oct 43	13	0	1
Phase Two/ Nov 43- Jan 44	3	4	1
Phase Three/ Feb 20-25, 44	12	11	3
Phase Four/ Mar-May 44	44	19	10

Source: Created by the author using data from United States Strategic Bombing Survey, *Aircraft Division Industry Report,* 2nd ed., 1947, 69.

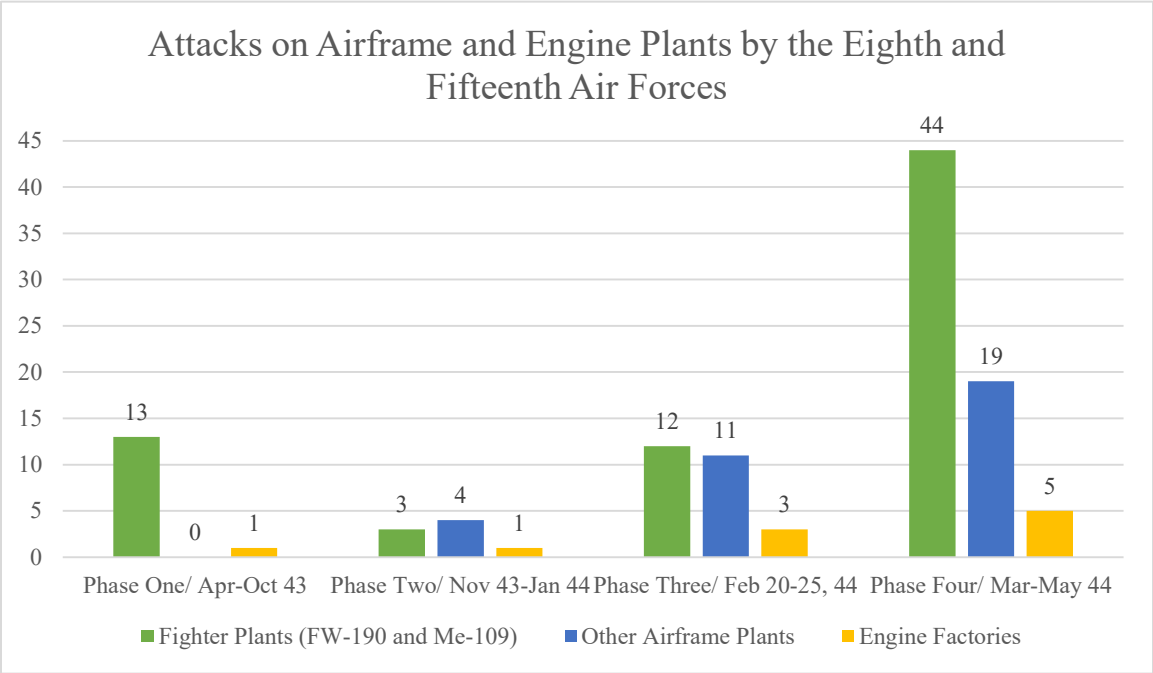

Figure 6. Attacks on Airframe and Engine Plants by the Eighth and Fifteenth Air Forces

Source: Created by the author using data from United States Strategic Bombing Survey, *Aircraft Division Industry Report,* 2nd ed., 1947, 69.

The four phases of the High Priority Campaign during the Combined Bomber Offensive intended to reduce the German aviation industry to a point where the Luftwaffe could no longer function. The initial results of the campaign show that the raids did affect production early. The formation of the *Jägerstab* reduced the effect of the raids with the organized dispersion and hardening of airframe production facilities. The United States Strategic Bombing Survey discovered after the war that German fighter production increased tremendously after the campaign. Regardless of production, the Spring of 1944 resulted in the defeat of the Luftwaffe giving the Allies air superiority for the remainder of the war.[126]

The *Jägerstab*, under the guidance of Milch and Saur, dispersed numbers of German aviation factories over the spring of 1944. They also sought to harden production by moving key factories to bunker and cave complexes. An example of this is the *Mittelwerke* tunnel complex in Nordhausen. Milch tasked Junkers to begin construction of the Me-262 jet fighter and some other fighter models in the Nordhausen complex. The hard work of Milch, Saur, and later Speer efficiently prepared the aviation industry to function in austere conditions. Fighter production doubled between 1943 and 1944, showing the success of the three men.[127]

Milch began to lose favor with German leadership over the spring of 1944. Hermann Göring headed several aviation conferences in May 1944 where Milch failed to

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[126] United States Strategic Bombing Survey, *Aircraft Division Industry Report*, 69-70.

[127] Uziel, *Arming the Luftwaffe*, *the German Aviation Industry in World War II*, 115-117.

receive invitations. On 23 May 1944, Milch finally received an invitation to attend a *Jägerstab* meeting. During this meeting, Adolf Hitler asked Milch the total production numbers for the Me-262 jet fighter. When Milch answered zero, the Fuhrer became enraged, setting in motion the eventual firing of Milch. Milch's last act with the *Jägerstab* occurred on 2 June 1944 with the signing of the Fighter Staff Treaty with Hungary. Within the treaty, 75 percent of fighter production within Hungary would be for German aviation units. On 20 June 1944, Göring informed Milch that all military arms production now fell under Speer and that Milch had to resign from the position of State Secretary.[128]

The Allied invasion of Normandy, on June 6, 1944, exposed how weak the Luftwaffe was after the spring of 1944. The Luftwaffe conducted 319 sorties against the 14,700 flown by the RAF and the Army Air Force. A combination of issues paralyzed the Luftwaffe, from ball bearing shortages to oil shortages, and finally, aircraft losses were greater than what the industry could replace. By June 7, 1944, Saur received orders to hasten production of the Me-262 and the Dornier 335 high-speed bomber in an attempt to halt Allied gains. The Luftwaffe continued to experience high losses and only had 1,375 fighters in operational condition by the end of June 1944. Hitler began requesting increases in fighter production and reductions in bomber production by the end of June.[129]

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[128] Vajada and Dancey, *German Aircraft Industry and Production 1933-1945*, 90,117.

[129] Ibid., 92-93.

The *Jägerstab* developed the *Blitzprograme* and *Production Plan 226-2* in early July 1944, to answer the Fuhrer's demands. The *Blitzprograme* canceled the development and production of 20 aircraft types leaving 11 for aircraft producers. *Plan 226-2* required the production of 6,400 aircraft per month with the majority being fighter type aircraft.[130] The *Jägerstab* also increased the work week from 50 to 72 hours to keep production lines open longer to meet production demand. Employees worked seven days a week, and when production fell behind, they received no holiday or Sunday breaks. Additionally, plants and equipment not damaged by Allied bombs had to run double shifts and increase production output. To ensure that aircraft plants met production demands, Saur placed personal representatives at all major facilities. Any plant that failed to meet production demands resulted in the arrest and confinement of their management.[131]

By September 1944, Allied advances were pressuring Germany from two sides. Many within German leadership believed that the war would last several more years, with the heavily defended German borders. The aviation industry received yet another production plan on 15 September 1944 anticipating a longer war. The plan increased fighter production while reducing bomber production to almost nothing. Germany faced shortages of raw materials and fuel to produce and fly the aircraft.[132] Germany began harvesting downed aircraft for raw materials throughout occupied territories to offset

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[130] Vajada and Dancey, *German Aircraft Industry and Production 1933-1945*, 91-92.

[131] United States Strategic Bombing Survey, *Aircraft Division Industry Report*, 83.

[132] Vajada and Dancey, *German Aircraft Industry and Production 1933-1945*, 93-94.

material shortages.[133] By October 1944, German aircraft were produced mainly from the remains of Allied aircraft. Quantity and not quality became the driving force within the aviation industry leading to the adoption of the *Volksjäger* (Peoples Fighter) program.[134]

The use of unskilled labor with mass production techniques would be the way that Germany could regain control of the air over Europe. German leadership selected the Heinkel 162 as a cheap and easy airframe to produce to serve as the *Volksjäger.* This aircraft would be easy to fly and needed minimally trained aircrews to fly. Plans and plants were selected to facilitate four production lines the goal of manufacturing 4000 He-162's a month. Wood would be the primary building material relieving stress on salvage crews to provide raw materials. Plants selected to manufacture the He-162 operated twenty-four hours a day with two 12-hour shifts.[135] Problems plagued the development and production of the He-162 leading to zero combat-ready versions produced in 1944.[136]

The German aircraft industry continued to produce fighter aircraft through the end of 1944. By December 1944, the Luftwaffe fighter strength was at 2,260 operational aircraft, the strongest point of 1944. Additionally, the Luftwaffe had 1,256 night-fighters,

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[133] United States Strategic Bombing Survey, *Aircraft Division Industry Report*, 82-83.

[134] Vajada and Dancey, *German Aircraft Industry and Production 1933-1945*, 93-94-95.

[135] Ibid., 93-94.

[136] Uziel, *Arming the Luftwaffe*, *the German Aviation Industry in World War II*, 244-245.

892 dive bombers/ground attack aircraft, and 528 bombers.[137] As Germany became healthy with aircraft, they faced severe pilot shortages. Due to a lack of training-aircraft and fuel, Germany produced under 4,000 replacement pilots in 1944. The pilots produced in 1944 received training on obsolete aircraft and typically ended their training early to attach to units in dire need. Inexperience led to continued high attrition of German aircraft and pilots through 1944.[138] The German aircraft industry operated above all expectations in 1944 but failed to change the tide of the war.

On 1 January 1945, the Luftwaffe launched a surprise attack on some Allied bases in Belgium. The attack caught the Allies by surprise and resulted in the destruction of nearly 400 aircraft on the ground. The Germans lost 227 fighters in the raid with two-thirds being shot down by German anti-aircraft fire. The New Year started better than 1944 ended with the great success of the raid. The German aircraft industry started 1945 with over 700 dispersed factories with 300 smaller component and equipment firms, and more than 385,000 workers manned the various aviation factories.[139] After the initial success of the 1 Jan raid, Germany began losing land and equipment quickly. Germany faced the Soviet Union with only 450 aircraft, with the US and Great Britain facing over

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[137] Vajada and Dancey, *German Aircraft Industry and Production 1933-1945*, 93-95.

[138] Murray, *Strategy for Defeat*, *the Luftwaffe 1933-1945*, 254-255.

[139] Vajada and Dancey, *German Aircraft Industry and Production 1933-1945*, 97-98.

1500. The Allies began focusing bombing efforts on Me-262 factories on January 5, 1945, with the goal of setting jet fighter production back by three months.[140]

Germany began experiencing high losses on both fronts with no means of replacing the losses. By mid-January, the Allies destroyed Germany's ability to produce synthetic oil. The Luftwaffe lost 552 aircraft in Poland as the allies gained huge swaths of land. On 20 January, the release of the *Fuhrernotprograme* occurred which refined priorities for the aviation industry. It focused on the production of the *Volksjäger* with little emphasis on any other types of aircraft.[141]

The Allies began Operation Clarion on 22 February 1945 which targeted the *Reichsbahn* (German Railways). 9,000 bombers targeted bridges, railway, locomotives, and wagons. This effectively paralyzed the transportation system of Germany resulting in production ceasing in the majority of German factories. Many aircraft production types were halted as a result, such as the Junkers 388 bomber so that the industry could focus on necessary aircraft.

By March 1945, US troops reached the Rhine River. The first week of March saw the destruction of 1,738 Luftwaffe aircraft on the ground. German industry produced 1,838 aircraft in March, which were the last production numbers for the war. One last production plan was released on 16 March 1945. Named *Production Programme 228-2*, this plan focused on Me-262 production and required manufacturers to produce 1,618 aircraft in March with a peak of 2,080 aircraft produced per month by October. Germany

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[140] Vajada and Dancey, *German Aircraft Industry and Production 1933-1945*, 98.

[141] Ibid., 98-99.

lost the Ruhr and Silesia production regions by the end of March making the production plan executable. Germany soon collapsed under the pressure of the Allies ending the war in Europe.

Additional pressure to the German aviation industry came with the Low Priority Campaign of the Combined Bomber Offensive from June 1944 through the end of the war. Other targets than the aviation industry took priority during this campaign, but the regular targeting of aviation targets continued. The dispersal and hardening of many factories reduced the overall effectiveness of Allied bombing but still pressured industry. By September 1944, jet aircraft manufacturing became the second highest priority for Allied bombers to destroy. On 24 October 1944, aircraft related targets became confined to jet airframe factories, jet engine factories, conventional aircraft engine factories, fighter airframe factories, airfields associated with jet aircraft, and airfields with high concentrations of aircraft.[142] Keeping the pressure on the aviation industry aided in the Allied victory within Europe.

Table 7 and Figure 8 show German aircraft production from 1942 through 1945. It shows increases in production in spite of heavy bombings by the Allies. It also demonstrates the shift from production of all types of aircraft to only combat aircraft production within the aviation industry by 1945.

[142] United States Strategic Bombing Survey, *Aircraft Division Industry Report*, 70.

Table 7. German Aviation Industry Production, 1942-1945			
Year	All Aircraft Type Production	Combat Aircraft Type Production	Percent Combat Aircraft
1942	15,556	11,752	75%
1943	25,527	20,327	79%
1944	39,807	35,394	88%
1945	7,052	7,052	100%

Source: Created by the author using data from United States Strategic Bombing Survey, *Aircraft Division Industry Report,* 2nd ed., 1947, 78.

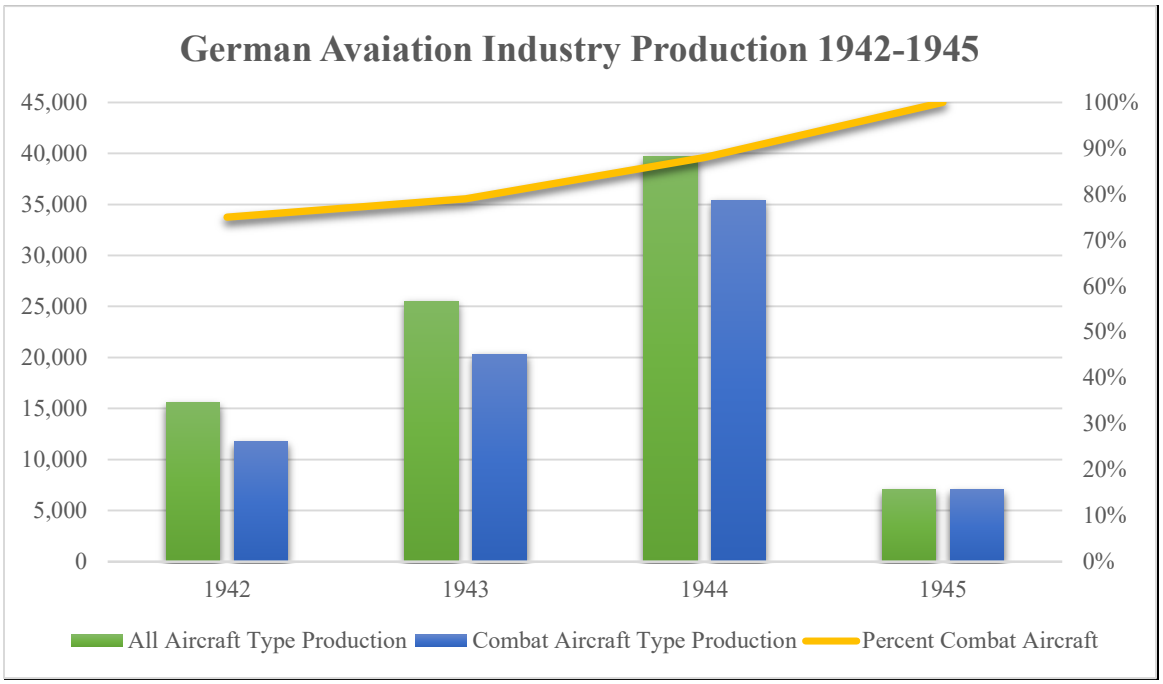

Figure 7. German Aviation Industry Production, 1942-1945

Source: Created by the author using data from United States Strategic Bombing Survey, *Aircraft Division Industry Report,* 2nd ed., 1947, 78.

The increase in German aviation production through the war indicates that the Allied Combined Bomber Offensive did little to impact the aviation industry. The truth is that the bombing campaign greatly impacted aircraft production and the quality assurance

associated with that production. The Strategic Bombing Survey concluded that German aircraft saw a five to ten percent reduction in flight performance because of the factories attributed to production.[143] The decision to distribute/ disperse the production of aircraft came directly as a result of the damage caused by heavy bombing. Though this decision enabled the continued production of aircraft through the war, it led to many unintended consequences within the aviation industry.

One of the operational difficulties caused by dispersion was the reduction in the efficiency of production. Large facilities enable efficient production by having all necessary elements and personnel in one location. The process of dispersion reduces production efficiency by 20-25 percent simply by not having all necessary items in one place. A larger workforce is needed in the dispersion to operate all necessary production equipment. The necessary workforce can grow by as much as 50 percent to meet production demands. The increased workforce needs training, billeting, food, and pay, which adds to the cost of dispersion.[144]

German aircraft production occurred in austere conditions, sometimes outside or in caves, due to the dispersion caused by Allied bombing. Workmanship became inferior in many facilities due to the austere conditions. Aircraft parts such as airfoils, ailerons, and rudders needed to exact tolerances in production. Jigs and precision equipment needed to be on level ground while producing those items. Resulting panel gaps and

[143] United States Strategic Bombing Survey, *Aircraft Division Industry Report*, 89.

[144] Ibid., 86.

frame misalignments caused numerous German aircraft to fail in flight.[145] General Adolf Galland explained to American interrogators, after the war, how dispersion led to a decline in the quality of aircraft with this statement: "Because the assembly lines were interrupted. The planes no longer were in assembly halls, but somewhere the control surfaces were manufactured, in another plant, fuselages were made, construction took place in destroyed halls and construction took place in the open air instead of under roofs."[146]

In an attempt to get better production out of airframe workers, the Airframe Main Committee arranged to have aircraft wing panels of downed American planes sent to all production factories. The American panels had relatively superior workmanship with little to no panel gaps, good polish, and smooth finishes.[147] In September 1944, Ernst Heinkel used the well assembled American aircraft panels to inspire his workforce. He blamed the inferior German fit and finish for poor aircraft performance and demanded that his workforce receive better training and facilities to achieve better workmanship.[148]

Poor quality assurance standards leading to poor fit and finish also were caused by limited experienced inspection personnel within the aviation industry. Before the

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[145] United States Strategic Bombing Survey, *Aircraft Division Industry Report*, 89-90.

[146] National Archives and Records Administration (NARA), RG243/32/Box 2, USSBS: Interview no. 35, General Galland (Part II), 4 June 1945, 3.

[147] United States Strategic Bombing Survey, *Aircraft Division Industry Report*, 90.

[148] Uziel, *Arming the Luftwaffe*, *the German Aviation Industry in World War II*, 69.

dispersion of production, all manufacturers and factories had a team of very experienced inspectors that conducted rigorous checks on all produced airframes and components. Dispersion caused by Allied bombing resulted in many factories not having qualified inspection personnel, due to the sheer quantity of factories and the speed of dispersion. Manufacturers lacked enough competent inspectors to place in each location, so inspectors rotated to factories to conduct inspections.[149] Compounding the issue, when Saur became chief of the *Jägerstab* in March 1944, he insisted that the Government Inspection Office personally inspect all aircraft coming off of production lines.[150] They no longer could deputize experienced factory workers to do vital production inspections. By the middle of 1944, the Government Inspection Office no longer traveled to satellite factories. They stayed at the main production facilities, resulting in less focus on aircraft production quality throughout German aviation manufacturing.[151]

German aviation manufacturing also depended on calibrated production tools, master tools, and checking fixtures. The rapid execution of factory dispersion meant that a shortage of precision equipment existed within the industry. Production firms had to rotate this equipment from factory to factory to facilitate the construction of aircraft. Many locations used inadequate, uncalibrated, or unproven tools in aircraft production. Facilities that heat treated metal structural components sometimes failed to meet proper

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[149] United States Strategic Bombing Survey, *Aircraft Division Industry Report*, 90.

[150] Ibid., 91.

[151] Uziel, *Arming the Luftwaffe*, *the German Aviation Industry in World War II*, 70.

physical qualities due to the lack of calibrated ovens. The structural components could and sometimes did fail in flight.[152]

Allied bombing also interrupted the flow of supplies to aviation factories. With the destruction of the rail system and precision targeting of transport trucks, many facilities were unable to receive raw materials, aircraft components, tools, fuel, etc. This forced many factories to find substitutes for missing materials in aircraft. Many components such as airfoils were composited together with wood and downed Allied aircraft. The substitutions had to be approved by qualified engineers, but often led to poor fit and finish within the airframe.[153] The Me-262 jet aircraft production was an example of this. Armament hatch covers, engine cowlings, sheet steel cockpits, and fuselage panels used varying construction methods and materials sourced from downed Allied aircraft and the local environment. The resulting surface finishes were coarse, had wide gaps between panels, and contributed to in-flight issues such as metal panels falling off. In February 1945, Messerschmitt's chief test pilot reported on the poor construction and quality control of Me-262's operating within the Luftwaffe.[154] The poor quality was not limited to the Me-262 and included all types of aircraft flying within the Luftwaffe

[152] United States Strategic Bombing Survey, *Aircraft Division Industry Report*, 90.

[153] Ibid., 90-91.

[154] Uziel, *Arming the Luftwaffe*, *the German Aviation Industry in World War II*, 69-70.

leading to many squadrons stripping aircraft before use to conduct their own inspections before flying the aircraft in combat.[155]

Fuel shortages, caused by Allied bombing, experienced by Germany from the summer of 1944 to the end of the war, caused a reduction from two hours to 30 minutes for the final run-in time on engines. This increased the susceptibility to total engine failure in flight. Ammunition shortages caused the discontinuation of weapons testing before fielding weapons in combat. Test firing in flight also ended leading to the installation of warning tags on all aircraft stating that pilots needed to be careful when making their first shots.[156]

Herman Göring acknowledged the marked drop in the production quality of German aircraft after the war. He attributed the inadequate quality to the dispersal of the aviation industry in 1944 caused by the threat of Allied bombers.[157] The conduct of the Combined Bomber Offensive placed great pressure on the German aviation industry leading to dispersion. This dispersion led to numerous production issues that ultimately contributed to the failure of the Luftwaffe and Germany during World War II. The German aviation industry did their best to meet the demands of war, but they failed overall.

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[155] United States Strategic Bombing Survey, *Aircraft Division Industry Report*, 90.

[156] Ibid., 90-91.

[157] NARA, RG243/32/Box1, USSBS: Interview no. 56, Reichsmarshal Herman Göring, 6 July 1945, 2-3.

Aircraft Production Maps

Figures 8 and 9 show how the German aviation dispersed during World War II. Figure 1 shows the concentration of factories in central Germany before the war in 1939. It also highlights the small size of the aviation industry before the war. Figure 2 visually demonstrates the dispersion of the German aircraft industry by 1944 caused by Allied bombing. It also highlights the massive expansion of the industry to meet wartime production requirements.

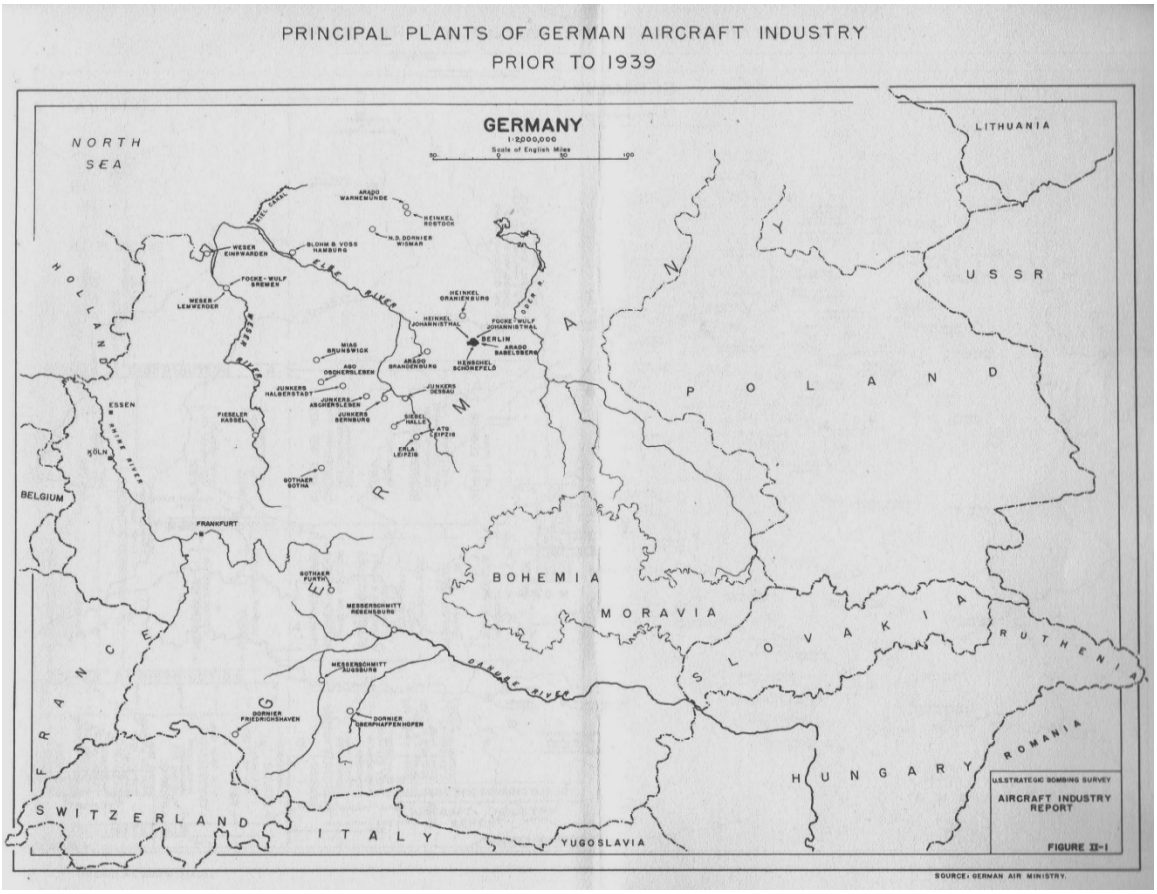

Figure 8. Pre-War German Aviation Factory Dispersion

Source: United States Strategic Bombing Survey, *Aircraft Division Industry Report*, 2nd ed., 1947, 32-33.

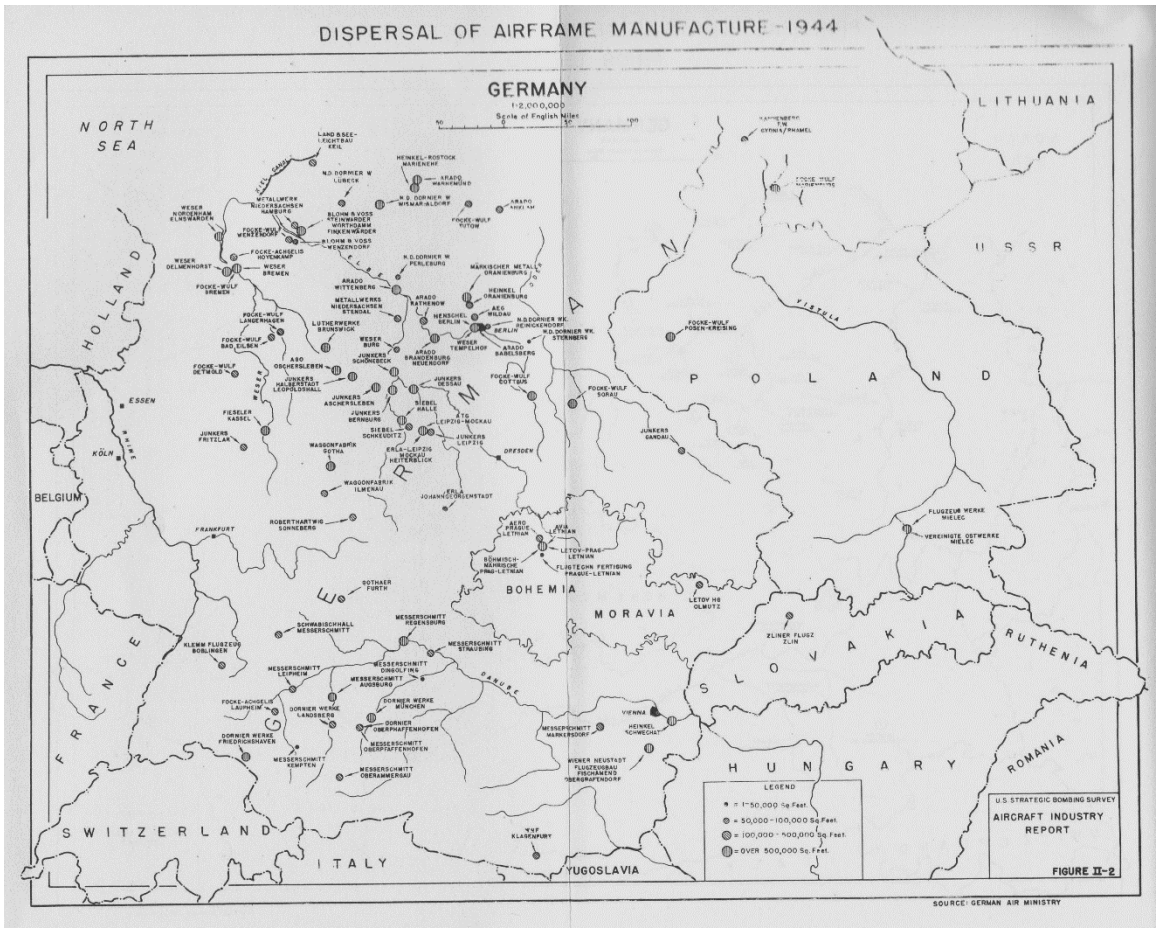

Figure 9. German Aviation Factory Dispersion By 1944

Source: United States Strategic Bombing Survey, *Aircraft Division Industry Report*, 2nd ed., 1947, 32-33.

CHAPTER 5

SLAVE LABOR IN THE GERMAN AVIATION INDUSTRY

The German aviation industry faced continuous worker shortages throughout World War II. Aggravating the issue, Germany massively expanded the aviation industry with the outbreak of war, but also reduced the workforce with the drafting of military-age males including skilled factory workers.[158] The hiring of female workers and foreign skilled workers never solved the workforce shortages felt by the aviation industry.[159] The solution to the worker shortages slowly shifted from paid skilled workers to forced unskilled labor. By March 1942, the SS oversaw around 80,000 inmates. Within a year, this number increased to 224,000 inmates. Prisoner populations increased to 714,000 people by January 1944.[160] With pressure mounting to increase aircraft production, the RLM ultimately tapped into the large prisoner population and began the use of slave labor in all war production.

Albert Speer came out against the use of slave labor in war production early in the war. The SS under Heinrich Himmler began attempts to gain access to armaments production as early as 1941. Himmler asserted to Adolf Hitler that the prisoner population would solve the workforce shortages. Speer believed that Himmler was trying

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[158] Uziel, *Arming the Luftwaffe*, *the German Aviation Industry in World War II*, 11-12.

[159] Budraß, Scherner, and Streb. "Demystifying the German Armament Miracle during World War II. New Insights from the Annual Audits of German Aircraft Producers," 12.

[160] Uziel, *Arming the Luftwaffe*, *the German Aviation Industry in World War II*, 161.

to expand his power and gain entrance to armaments production. Himmler began pressuring many of Speer's assistants to use slaves for armaments production. Himmler wanted to convert concentration camps into modern factories with the SS having direct control of production. Speer and his assistants fought against bringing the SS into armaments production arguing that the SS had failed with many simple projects and armament production entailed many complicated processes outside the skill of slaves. Ultimately, Hitler decided to begin large-scale use of slaves on September 21, 1942, after Heinkel proved that slaves could handle complex production tasks. Hitler gave the stipulation that prisoners were to work in factories under the direct guidance and supervision of the industrial armaments organization.[161]

One of the earliest documented use of forced labor in aviation production occurred in 1941 with the Austrian armaments manufacture Steyr-Daimler-Puch AG (SDPAG). This company built aircraft engines and related parts. Due to the rapid expansion of engine production in 1941, the SDPAG turned to the SS to fill workforce shortages. The SS provided 300 inmates from the Mauthausen concentration camp, who made the 30 km commute to the factory daily. Georg Meindl, the director of the SDPAG, requested that a camp be made closer to the factory to increase factory productivity. The SS agreed to the request and established a labor camp outside of the SDPAG factory in March of 1942. The SDPAG's arrangement with the SS was a local initiative and

[161] Speer, *Inside the Third Reich*, 369-370.

received no direction from the RLM. The SPDAG became the model for forced labor utilization within the RLM, with a labor camp being located just outside of the factory.[162]

Milch and Udet began high-level discussions on the introduction of slave labor starting on 8 August 1941. The discussions revolved around a new BMW engine plant in Allach Germany, with an assembly line production model reducing the need for skilled labor. The RLM envisioned this factory as the primary producer of the BMW 801 engine, which was the primary engine in the FW-190F. The RLM designed the factory with state of the art equipment and the ability to easily expand. The Allach facility produced the first series of the BMW 801 in March 1943, well behind schedule due to development issues and organizational difficulties within the RLM.[163]

The discussions between the RLM and SS over the use of slaves were the first of their kind within the armaments industry. Milch and Himmler continued to foster the relationship between the RLM and SS resulting in a verbal agreement for roughly 11,000 male workers on 24 January 1942. The agreement became formal and placed in writing on 27 January 1942. The SS did not provide any workers until March 1942 due to discussions amongst German leaders. Eventually, Oswald Pohl, the head of the Economics and Administration Main Office (WVHA) of the SS, approved the transfer of 4,000 male workers to various RLM facilities. Pohl promised a further 5,000 female workers within a few weeks of the delivery of the male workers. Preventing the transfer of large numbers of prisoners due to the belief that slaves were incapable of complex

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[162] Uziel, *Arming the Luftwaffe*, *the German Aviation Industry in World War II*, 161.

[163] Ibid., 161-162.

aircraft manufacturing, Hitler restricted the size of slave labor groups. As a result, slaves could only be used to fill gaps in aviation production lines during this time. Himmler and Milch continued to foster close relationships resulting in the RLM receiving priority of inmate labor over other industries.[164]

Heinkel began requesting slave labor for their Oranienburg-Germendorf plant in early 1942. The RLM and SS agreed to allocate 400 Soviet inmates to this factory due to its proximity to the Sachsenhausen concentration camp. Heinkel utilized the inmates in the production of Germany's most complicated aircraft the He-177, proving that slaves could achieve satisfactory results on complex assembly lines. Through the summer of 1942, the plant lost most of its skilled German workforce to the draft. Heinkel increased their utilization of forced labor with minimal impact on production. Eventually, slaves constituted 48 percent of the Oranienburg-Germendorf factory workers. The positive impression of using inmates gained from Heinkel's experience led to the easing of restrictions on the use of slaves on production lines.[165] Heinkel began requesting forced laborers for all of its factories due to the success of the Oranienburg factory.

Heinkel did report some negative aspects to the use of forced labor as well. Kerl Hayn, the director of the Oranienburg-Germendorf plant, reported to Milch and the RLM that many of the workers were weak and undernourished upon their arrival to the factory. The workers needed extra rations to be productive on assembly lines. Hayn advocated for extra provisions for future utilization of inmate workers to increase productivity. He also

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[164] Budraß. "Arbeitskräfte Können aus der Reichlich Vorhandenen Jüdischen Bevölkerung Gewonnen Werden. Das Heinkel-Werk in Budzyn 1942-1944," 48-51.

[165] Uziel, "Jewish Slave Workers in the German Aviation Industry," 154-155.

requested the colocation of camps with factories and that the workers living in the camps receive better living conditions. Hayn's recommendation became standard practice within the aviation industry.[166]

On March 21, 1942, Hitler directed Himmler to create a foreign and forced labor recruitment division within the SS and titled the division Reich Plenipotentiary for Labor Mobilization (GBA). Hitler chose Fritz Sauckel to head this new division and directed Sauckel to bring needed workers to the Armaments Ministry by any means whatsoever. By August 1942, Sauckel "recruited" 1.6 million foreign workers from prisoner of war and concentration camps. He also began forcibly moving non-prisoner workers from French aircraft factories and moving them to non-aviation related factories in Germany. Companies such as Messerschmitt and Focke Wulf lost productivity in France due to this reallocation leading to protests directly to Albert Speer.[167]

In late 1942, Messerschmitt began cooperating with the SS and requested workers for its factories located in Bavaria. In October 1942, the GBA provided 2,299 inmates to Messerschmitt's Augsburg factory. Buchenwald concentration camp provided workers, but again workers transited greater than 40 km, reducing productivity. Messerschmitt requested the colocation of camps for prisoners with all factories in the same model as Heinkel's factories. In turn, the GBA established concentration camps around all Heinkel

[166] Budraß. "Arbeitskräfte Können aus der Reichlich Vorhandenen Jüdischen Bevölkerung Gewonnen Werden. Das Heinkel-Werk in Budzyn 1942-1944," 52.

[167] Speer, *Inside the Third Reich*, 219-221.

and Messerschmitt factories. The factories with attached prison camps became known within the RLM as concentration camp factories.[168]

During 1943, concentration camp labor became widespread through the German aviation industry. Junkers, BMW, Arado, and Daimler joined the ranks with concentration camp factories.[169] Focke Wulf resisted the trend, concentrating on locating factories in occupied territories and recruiting workers from the local area.[170] Ironically, Focke Wulf felt the negative impact of the GBA's forced reallocation of workers from France to Germany, causing reduced FW-190 production, ultimately forcing them to begin using forced labor later in the war.[171]

By the end of World War II, slave labor produced most German aircraft and aviation-based weapons. Programs such as the Me-262, Arado 234, He-177, and V1/V2 missiles all had some level of forced labor during production. Production plans for Germany's last resort fighter the He-162 included massive use of slave labor.[172] The shift to slave labor virtually solved German workforce shortages by 1944. Most factories utilized 25-30 percent forced labor while Heinkel employed as much as 70-80 percent

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[168] Uziel, "Jewish Slave Workers in the German Aviation Industry," 155-157.

[169] Uziel, *Arming the Luftwaffe*, *the German Aviation Industry in World War II*, 182-183.

[170] Uziel, "Jewish Slave Workers in the German Aviation Industry," 156-157.

[171] Ibid., 156.

[172] Vajada and Dancey, *German Aircraft Industry and Production 1933-1945*, 204.

forced labor at its factories. Slave labor directly contributed to the high production output of the aviation industry during 1944 in spite of Allied bombing campaigns.[173]

An additional aspect of slave labor usage in aircraft production applies to the German "Ultra" program. The RLM initiated the "Ultra" program in the spring of 1942 in an attempt to increase production while minimizing the effect of Allied bombing. On 22 May 1942, Milch started planning "Ultra." The plan included massive aircraft production facilities, located in Poland and Czechlosovakia outside of Allied bombing range, that utilized modern production line assembly in the model of the American "Willow Run" production facility.[174] Heinkel, Junkers, and Henschel Aircraft Works received the tasking from the RLM to begin construction of the "Ultra" factories. The RLM tasked Heinkel and Junkers to focus on bomber production and Henschel focused on fighters. "Ultra" factories workforce by design included 90 percent prisoners with 10 percent oversight from Germans.[175] The RLM also dictated that the factories have floor space of greater than 600,000 square meters to maximize production. Heinkel started construction in Budzyn, Poland while Junkers selected Oels, in Lower Silesia. Henschel selected several towns in Czechlosovakia but never began construction during the war. Rising war

[173] Uziel, *Arming the Luftwaffe*, *the German Aviation Industry in World War II*, 193.

[174] Budraß. "Arbeitskräfte Können aus der Reichlich Vorhandenen Jüdischen Bevölkerung Gewonnen Werden. Das Heinkel-Werk in Budzyn 1942-1944," 48.

[175] Ibid., 48-50.

costs also forced Junkers to cancel construction in Oels by the end of 1943. Heinkel became the only manufacturer that completed an "Ultra" factory during the war.[176]

Heinkel began construction of the Budzyn complex, known as "Block Budzyn," in June 1942 with roughly 2,100 Jewish construction workers. Heinkel planned for 30,000 workers for the Budzyn complex and placed the request to the SS/GBA. Heinkel received roughly 1,000 production line workers initially but had to fight continuously to not have their workers exterminated by SS death squads. An example of this occurred on 12 July 1942, when a death squad liquidated a labor camp in Josefow. Heinkel leadership formally complained to the SS stating that production had been set back by months due to this act.[177] By September 1942, the Budzyn plant started production of the Ju-88 bomber. The factory also received tasking to produce the Ju-188 bomber and the He-219 night fighter. Officially, production began inside the Budzyn complex on 1 November 1942 with a workforce of 3,950 people.[178]

"Block Budzyn" grew through 1943 and employed roughly 6,000 workers consisting of 500 Germans, 2,100 Jewish workers, and 3,400 foreign prisoners. Heinkel experienced language barrier issues with the foreign prisoners, mostly Soviet and Polish, and began using Jewish prisoners to help translate.[179]

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[176] Uziel, *Between Industrial Revolution and Slavery*, 286.

[177] Budraß. "Arbeitskräfte Können aus der Reichlich Vorhandenen Jüdischen Bevölkerung Gewonnen Werden. Das Heinkel-Werk in Budzyn 1942-1944," 58-59.

[178] Ibid., 60-62.

[179] Uziel, *Arming the Luftwaffe*, *the German Aviation Industry in World War II*, 171.

During its production run, "Block Budzyn" never produced a workable aircraft. The factory complex operated from November 1942 to 22 January 1944 and had numerous production issues. Heinkel reported that well maintained and new factory machines continuously broke down. This indicated sabotage and resulted in very slow production progress down the assembly lines. Many components needed additional inspections and in many cases to be started over due to production equipment issues. Additionally, The RLM and *Jägerstab* continuously changed aircraft types that the "Block Budzyn" complex produced. Every two months a new production requirement arrived at Heinkel, requiring the complete retooling of the factory complex. Raw material shortages also plagued the facility. Finally, production quality decreased through 1943 within the complex.[180] By January 1944, the "Block Budzyn" complex closed due to the production issues and the proximity of the Red Army. The facility failed to meet any expectations and drained the German aviation industry of valuable resources and workers.[181]

German aviation line workers did receive better living conditions than their nonaviation factory counterparts. Many of the firms that employed forced labor received incentives from the RLM for productivity. In turn, inmates received rewards for productivity and quality of manufacturing. For example, a worker in an aviation parts factory received 36 hours off after working four nights in a row.[182] From 1943, two shifts

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[180] Budraß. "Arbeitskräfte Können aus der Reichlich Vorhandenen Jüdischen Bevölkerung Gewonnen Werden. Das Heinkel-Werk in Budzyn 1942-1944," 62-64.

[181] Ibid., 41-43.

[182] Uziel, "Jewish Slave Workers in the German Aviation Industry," 162.

per day became the standard within the aviation industry. Inmates worked 12-hour shifts seven days per week averaging between 175-235 hours of work each month.[183] The high workload required that the workers receive more food and water to keep them productive. Many workers received billeting in multiple story buildings equipped with straw beds and pillows. This billeting came with showers and bathrooms as well. The workers reported reasonable treatment from German coworkers and foremen, and supervision being provided mostly by civilians versus the SS.[184] The Heinkel Oranienburg factory also had inmate workers submit suggestions for the improvement of production. If the suggestion was useful, inmates received extra rations. The factory received over 200 recommendations resulting in improved productivity.[185]

People selected to work in aviation factories had longer life expectancies and received better treatment. As the war progressed, this began to change. Living conditions began to deteriorate as the SS became more involved with production in late 1944. SS guards began beating workers on production floors and deprived inmates of food for the slightest offense. The degrading conditions reduced worker motivation and led to higher illness and death rates within the workforce. With the workforce falling apart, German aircraft manufacturers increased requests for replacements to the GBA. The new workers

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[183] Uziel, *Arming the Luftwaffe*, *the German Aviation Industry in World War II*, 218.

[184] Uziel, "Jewish Slave Workers in the German Aviation Industry," 160-161.

[185] Lutz Budrass, "Der Schritt Über die Schwelle. Ernst Heinkel, das Werk Oranienburg und der Einstieg in der Beschäftigung von KZ-Häftlinge," in *Zwangsarbeit Während der NS-Zeit in Berlin und Brandenburg*, ed. Winfried Meyer (Potsdam: Berliner Wissenschafts-Verlag, 2001), 158.

took time to train, but often never made it to production lines due to SS atrocities. In turn, production numbers reduced, and in many cases quality fell.[186]

Slave labor also brought the fear of sabotage to the aviation industry. From 1943-1945, sabotage impacted all aspects of German aviation. As the SS became more involved in aviation production, occurrences of sabotage increased. Motivated foreign prisoners and Jewish slaves damaged products, production machines, and purposely failed to adhere to manufacturing standards. Underground networks trained workers how to sabotage aircraft correctly. To weaken wings, workers drilled out the back side of rivets or replaced strong rivets with weaker types. Workers also urinated on electrical components leading to electronics rapidly degrading or failing at inopportune times.[187] The sabotage contributed to deteriorating aircraft quality throughout the war. Numerous pilots expressed concern due to large amounts of forced landings caused by sabotage. Milch, and later the *Jägerstab*, demanded severe punishment for any worker caught sabotaging aircraft or equipment. In many cases, workers found sabotaging received on the spot death sentences. Their bodies remained on factory floors to set the example for other workers. Fear of sabotage grew to a point where no slave could be on a production floor without an armed escort. When air raids occurred, slaves went to shelters to prevent free access to unfinished aircraft.[188]

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[186] Uziel, *Arming the Luftwaffe*, *the German Aviation Industry in World War II*, 224-225.

[187] Uziel, "Jewish Slave Workers in the German Aviation Industry," 163.

[188] Ibid., 162-163.

The German aviation industry started the war with reservations about the use of slave labor. The start of the war led to worker shortages that the RLM had difficulty coping with. By 1942, Heinkel began requesting workers from SS prison camps to fill gaps caused by the draft. Heinkel saw success with forced labor leading to more production firms requesting workers from the SS. By the end of the war, most aviation producers utilized slave labor. To keep the workforce motivated and focused, aviation factory workers received better living conditions. As the SS became more involved in aviation production the workers' living conditions reduced. Productivity reduced with the worsening living conditions and acts of sabotage increased. Sabotage directly affected the Luftwaffe's ability to wage war in the air. Ultimately, the decision to use slaves in production contributed to declining German aircraft quality and aided in the failure of the Luftwaffe during World War II.

CHAPTER 6

CONCLUSION

Post World War I, the German aviation industry was small and produced limited numbers of aircraft for civilian use by highly skilled artisans. With the rise of the Nazi party and the appointment of Adolf Hitler, in January 1933, as the *Reich Chancellor*, German war industry saw a rebirth. The aviation industry began rapidly expanding production and the workforce focusing on military aircraft. As 1933 progressed, Erhard Milch became the head of the RLM, under direct supervision from Herman Göring, and gave precise direction to the aviation industry for both production and manning goals. Milch worked within the aviation industry and had a lot of managerial experience. From 1933 to 1936 the German aviation industry more than doubled in size annually. Though the aviation industry failed to meet production plan requirements, the goal for the RLM was increasing the workforce ultimately leading to increased production capacity. Training workers took a lot of time under the artisan system, up to four years for an airframe worker, so the process of growing the aviation industry took time. Additionally, the rapid growth led to a young workforce. As the aviation industry grew, Milch began to consolidate power and influence. A minor feud developed between Göring and Milch leading to the promotion of Milch, out of his position within the RLM, so that Göring could better control him.

Colonel Ernst Udet replaced Milch within the RLM and had no experience with production management. Under the direction of Udet, the RLM continuously changed production goals, leading to confusion and waste within the aviation industry. Additionally, raw material shortages contributed to changing production goals. The

aviation industry continued to grow, doubling in size every year from 1936 to 1939. The workforce still mainly consisted of young workers that took years to train. By the eve of World War II, the aviation industry was two to three years away from being ready for war production requirements.

September 1, 1939, Germany invaded Poland, leading to the drafting of the majority of military-aged factory workers. The draft reduced the workforce by roughly half, having immediate negative impacts to aircraft production. Fewer workers forced factories to reduce production from two shifts to one. Additionally, factories did not have enough inspectors, leading to some aircraft quality assurance issues early in the war. Compounding worker shortages, the RLM and Udet continued to lack direction and continued to change production requirements. Attempts by the aviation industry to leverage women and foreign workers to offset worker shortages never completely solved the hole created by the draft. The aviation industry continued to grow, and production continued to increase through 1941. Even with growth, the aviation industry could not effectively replace combat losses and keep the Luftwaffe properly equipped. This led to Udet being replaced with Milch by mid-1941.

Under Milch, production continued to increase, but the RLM still suffered from worker shortages. Aggravating the issue, foreign workers started not renewing their contracts. By 1942, German law started pulling workers from outside industries and forcing them to work in aviation factories. Additionally, factories forced foreign workers to renew their contracts. This contributed to production delays and decreasing quality due to workers lacking motivation.

The RLM began shifting the aviation industry from artisan manufacturing to assembly line manufacturing in late 1942. The goal of this change included solving worker shortages by simplifying manufacturing and reducing training time. Factories also began to disperse and harden their workspaces to make them less susceptible to air attacks. Finally, many factories began looking to forced labor to solve worker shortages. The Luftwaffe ended 1942 behind the Allies in numbers, capabilities, and production capacity.

From 1943 to the end of the war, the Allies conducted the Combined Bomber Offensive. Allied bombers began targeting German aircraft production, forcing the RLM to disperse manufacturing. The "Big Week" from 20-25 February 1944, heavily damaged the aircraft industry and forced further dispersion. It also contributed to the *Jägerstab* which superseded the RLM as the controlling agency for aircraft production. Carl Saur obtained the position of Chief of Staff for the *Jägerstab*, with Milch and Albert Speer giving direction to Saur. Milch fell from favor and retired from the aviation industry by June 1944. The *Jägerstab* established salvage teams to recover equipment from bombed factories and continued to give the aviation industry production plans.

Production continued to increase through 1944, but quality rapidly decreased leading to lower operational readiness for Luftwaffe squadrons. The aviation industry faced numbers of issues due to dispersion caused by Allied bombing, which led to the reduction of aircraft production quality. First, production efficiency reduced due to dispersion. With several factories being utilized to make an airframe, the aviation industry required a larger workforce, transportation for the fuselages under construction, and more production equipment. The time to make a single aircraft greatly increased.

Next, aircraft production occurred in austere conditions such as caves and forests. Jigs and aligning tools require level surfaces to accurately align aircraft panels. Uneven terrain in forests and caves contributed to poor panel alignment and quality assurance issues with newly produced aircraft. Limited numbers of inspectors reduced the quality of produced aircraft as well. With greater dispersion, German aircraft production had too few inspectors to man all assembly lines. Many aircraft received no inspections leading to aircraft failures in combat. Allied bombers also attacked German transportation systems. The aviation industry experienced production delays, raw material shortages, and tool shortages due to no trucks or trains being available. The aviation industry began harvesting downed Allied bombers and using alternate materials to complete aircraft leading to further quality degradation. Dispersion and the difficulties associated with it greatly reduced the quality of German aircraft contributing to the failure of the Luftwaffe during the war.

The use of slave labor in aircraft production also degraded German aircraft quality throughout the war. Starting in 1941 through the end of the war, large numbers of prisoners worked in German aviation factories. Sabotage increased, and aircraft quality decreased as greater numbers of slaves worked in the aviation industry. Sabotage included drilling the backs of rivets on wings, urinating on electronics, and poor alignment of vital aircraft panels. Anyone found conducting an act of sabotage faced an immediate death sentence. However, rates of sabotage increased through the war. Sabotage conducted by slaves seriously decreased German aircraft quality and led to numerous catastrophic failures within aircraft during combat operations.

German aircraft quality and quality assurance standards decreased through World War II. A number of factors contributed to this decrease. The overall effect of the draft reducing the number of skilled aviation workers led to worker shortages through the war. Reduction of training time and overtasking experienced workers led to initial quality issues. The shift to mass production facilitated with unskilled workers and slaves also contributed to the reduction. Production increased, but acts of sabotage and low worker motivation reduced production output and quality. Finally, Allied bombing forced the aircraft industry to disperse leading to numerous issues further reducing the quality of German aircraft and quality assurance standards. Ultimately, this poor quality and poor quality assurance standards contributed to the overall failure of the Luftwaffe.

As can be seen by this analysis, decisions made by German leaders led to the reduction of quality assurance standards and ultimately quality for aircraft during World War II. Quality assurance and overall aircraft quality are as important today as they were in 1945. Delays in testing have resulted in numerous modern aircraft programs of record being canceled. In turn, minor deviations from requirements and aircraft quality have been accepted to prevent project cancellation and get new aircraft to the operating forces. The operating forces then have to work through and correct the aircraft deficiencies. Maintaining the highest standards in aircraft production is imperative to the lives of the aviators strapping on the aircraft.

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