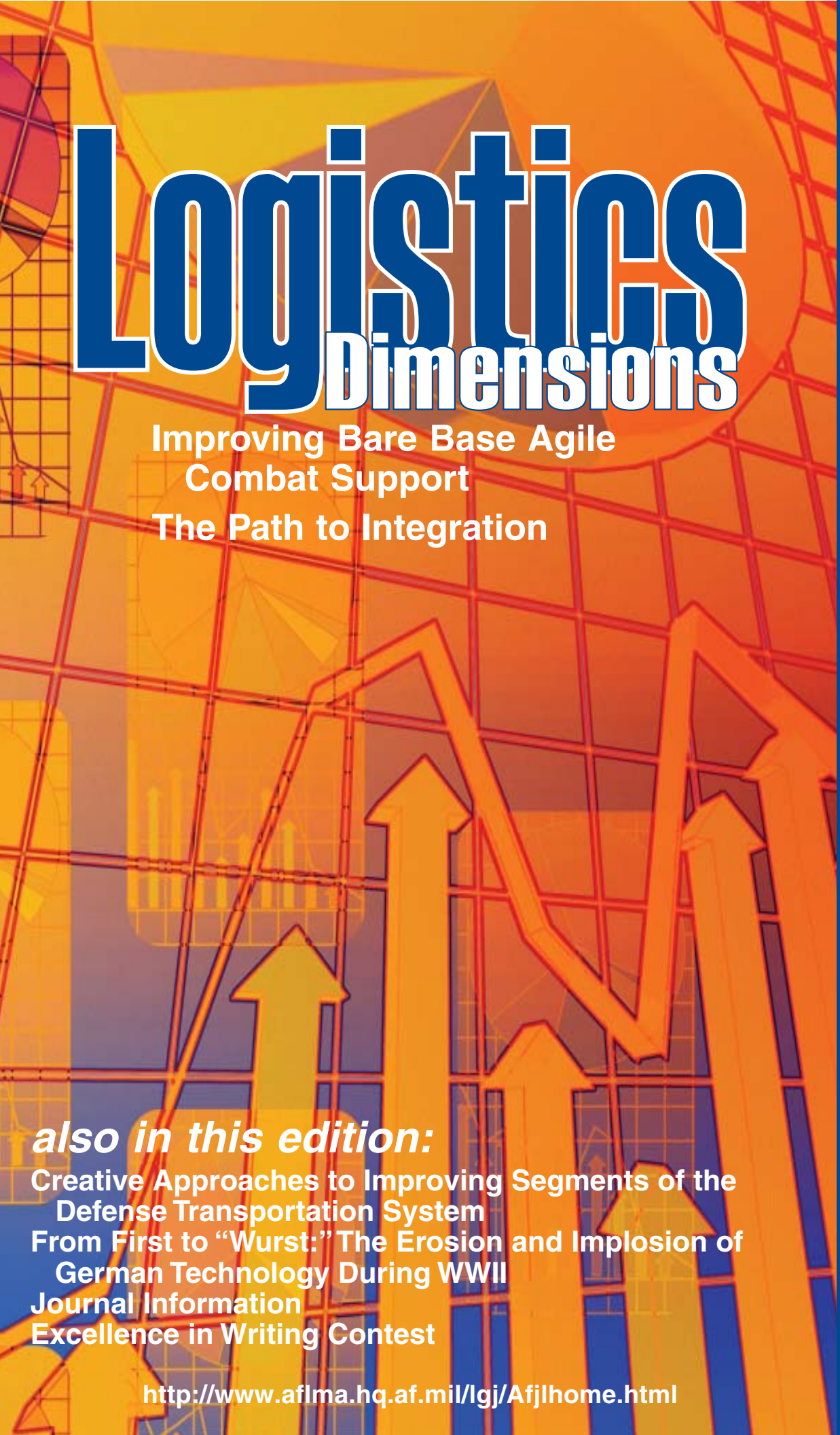

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The German management system, especially in terms of the technological industry, was a complex and convoluted bureaucratic nightmare.

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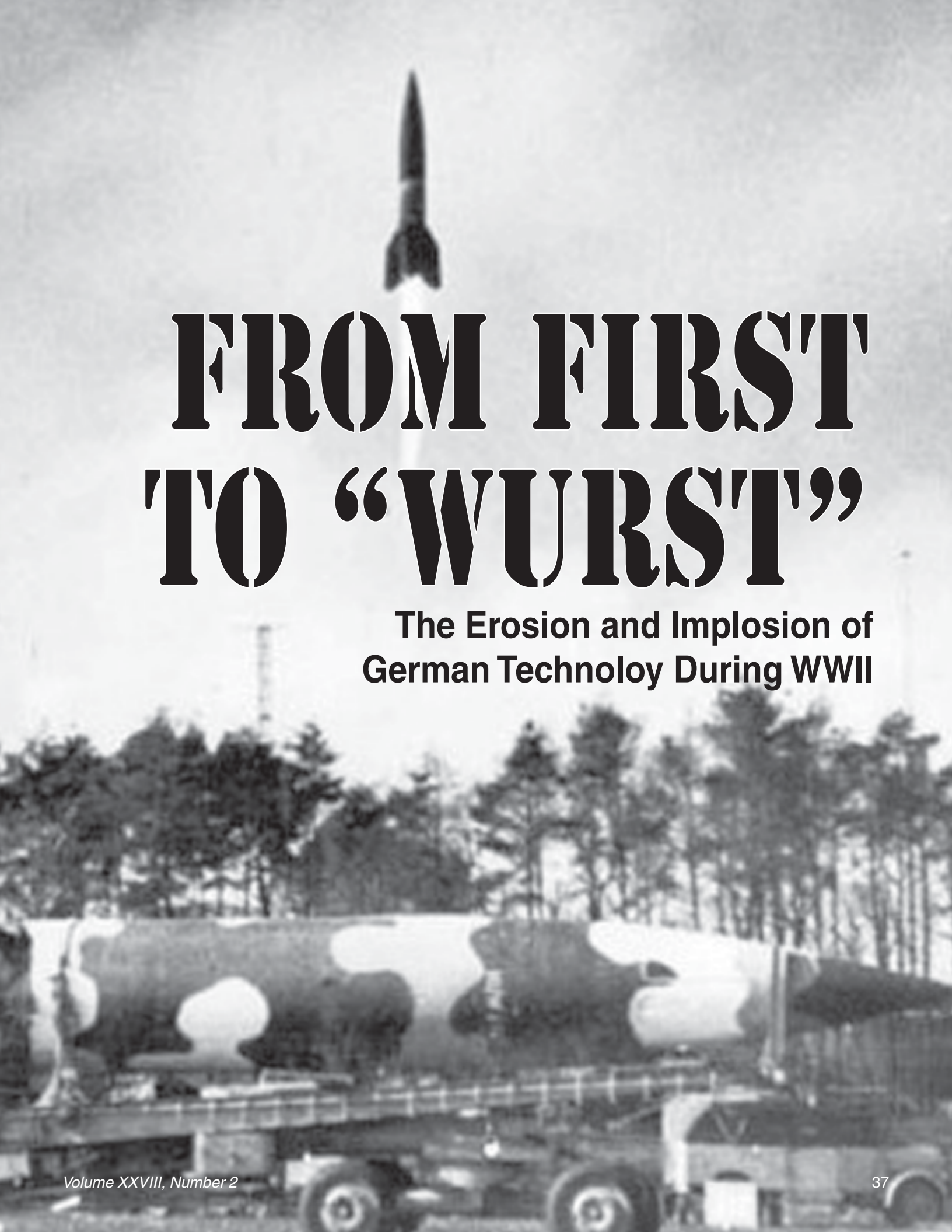
In the Beginning

At the outset of the German buildup for World War II, the Germans were, arguably, the most technologically advanced nation in the world. Despite the limitations in the Treaty of Versailles, they secretly designed and built some of the most advanced aircraft in the world. From research into all metal aircraft, such as the Junkers Ju 52,[1] to the Messerschmitt Me 262, the world's first jet fighter,[2] the Germans were on the technological front lines. Yet, in a scant 10 years, the German nation ceased to exist. After the war, with its country divided in two, the technological advances were divided among the conquering powers. Indeed, the battles 5 years later between the Mikoyan-Gurevich MiG 15 and the F-86 were more among German engineers than among the nations actually at war.[3] The reasons for the implosion of the German state are manifold, two of which are addressed herein.

From a technological standpoint, many of the German designs and innovations remain valid. They were the true innovators of some of the world's current aircraft. Indeed, the Germans pioneered the use of wind tunnels, jet aircraft, pusher propellers, metal aircraft, and rockets in an attempt to overwhelm their Allied adversaries. Under the guise of Operation Paperclip, many German scientists and engineers were brought to America to work their magic on the American industry. Despite all this talent and its potential, few of the German designs were actually used during the war. Although their relevance is unquestioned, especially in view of current American (and worldwide) aircraft, they were untapped by the German leadership.



FROM FIRST TO "WURST"

The Erosion and Implosion of German Technoloy During WWII

The German management system, especially in terms of the technological industry, was a complex and convoluted bureaucratic nightmare. Their system of committees and rings, coupled with a lack of centralized control at the top, served to undermine an economy that was resource-poor, in terms of both monetary and natural resources. This mismanagement, exacerbated by the effects of the Combined Bomber Offensive, transformed the German industry from one of the best to one of the worst, a system ready to implode had it not been helped on by the Allies. Further compounding the situation was the influence of Adolf Hitler. A man with a continental worldview and a penchant for doing things his way, Hitler was more of a hindrance to industry than a help. His constantly changing requirements led to costly and lengthy delays to the production of many aircraft. His inability to look beyond continental Europe from a practical standpoint ensured the German state never had a practical long-range bomber until it was too late. Indeed, the Germans ended the war with the same fighter and bomber with which they began the war, with only minor modifications and a dwindling ability to mass-produce them.

Many of the lessons from the German experience with technology and management are applicable today to the US Air Force. Without a doubt, today, the United States is the technological superpower of the world, yet it is plagued by many of the same problems that the Germans faced. Many of America's technological advances seem to be done for the sake of technology, rather than for an operational military need. Indeed, many of the needs of the American military may be met, in the short term, with existing technology or modifications thereto, rather than new programs. The true transformation of the American military and its technology will be a departure from the stovepipes of military acquisition, in which each service acquires its own (often redundant) systems, to a process of standardization among the equipment used to meet each service's needs. Furthermore, American military management is becoming as complex as that of the Germans. True, Americans have much more to worry about than the Germans; for example the whole, poorly understood realm of space. The United States tends to solve its lack of understanding with additional bureaucracy, which exacerbates the overall situation. Alignment under a specific, overarching unified command could eliminate some of the waste and ensure an interoperable, standardized force for the future. Indeed, if the Department of Defense (DoD) does not learn and heed the lessons of the past, it is doomed to repeat them.

This article examines the efforts and impacts of German technology, both during World War II and today. Furthermore, it examines the impact and folly of German management of the technological industry and that industry's subsequent implosion. Finally, this work draws some parallels between the World War II German system and the current American system, fully recognizing the difference between the totalitarian German state and the democratic American state. Despite the glaring and obvious difference between the two, there are similarities that could have a negative impact on America's ability to wage war.

Technical Marvels

At the outset of World War II, the Luftwaffe was, undoubtedly, the world's supreme air force. It had the most advanced fighter and bomber aircraft and the best trained crews. Despite this, the Luftwaffe suffered severe losses during the course of the war, including the loss of air superiority over continental Europe, which led to the downfall of the Third Reich. Its loss can be attributed to several factors, not the least of which was its inability to take advantage of, or maintain, the technological superiority enjoyed at the outset of hostilities. The technological superiority was not limited to aircraft fielded during the war but includes some interesting technical innovations that arose during the war but not fielded by the Luftwaffe. Many of these technical innovations are just now being exploited to their fullest potential. Indeed, many of the technological innovations taken for granted today were first developed in the factories and design laboratories of Messerschmitt, Heinkel, Arado, Focke-Wulf, Henschel, and Junkers. These companies—and the designers for whom they are named—were at the forefront of technical innovation during not only their time but also current times. Many of their innovations—such as canards, boundary layer control, sweptwings, variable wings, jet engines, and more—are widely used today and accepted as industry standards. By examining Luftwaffe technological innovations, we can see a clear inspiration and technological marvel that transcends the aircraft industry today and whose impact is just being realized.

Wind Tunnels

One of the most enduring innovations of the Luftwaffe was its pioneering work with wind tunnels.[4] These devices allow an aircraft, or representative model, to be tested under conditions closely simulating those encountered during flight. By using inexpensive scale models of the aircraft, the engineers were able to determine if their design could withstand the rigors of flight across the spectrum of the flight regime. By varying wind velocity, the German engineers were able to simulate high- and low-speed flight regimens. Similarly, by varying wind velocity, they could examine high and low angle-of-attack regimes. By combining the results of these two areas of study, they could determine the robustness and feasibility of the design in relative combat situations. The essential information that arose during these tests was the feasibility of the design, answering several fundamental questions: would the wings remain attached at high speed and high angle of attack; would the aircraft stall at low speed and high angle of attack; what are the impacts of adding externally mounted items to the aircraft; what would happen to the aircraft once an externally mounted device was dropped (would it become unstable, thus unflyable); and what are the impacts on the aircraft center of gravity? These are fundamental questions concerning the flight worthiness of the aircraft that could be ascertained without having to risk the loss of a prototype or pilot.

Additionally, wind tunnels allowed for the testing of new technologies to smooth the flow of air across the wing. The Germans tested boundary area fences, leading-edge flaps, and boundary layer control, all in an effort to affect the flow of air across the wing surface.[5] With the straight, perpendicular wing style of the day, these aerodynamic controls would ensure the flow of air across the top of the wing was as smooth as possible, thus making the airflow faster and generating more lift. This increase in lift would generate more maneuverability in fighters and more load capability in bombers and more range in both types of aircraft. They tested each of these on many of their experimental designs, but the results of this work only were beginning implementation at the end of the war.

Although the wind tunnels continued to operate throughout the war, their later years' usage was confined to refinement of the V1 and V2 rocket designs. Their staffs were increased in numbers, although those numbers were not used for testing; rather, they were used to mass-produce both weapons. The wind tunnels did stop work during the war after Peenemunde was bombed during the Combined Bomber Offensive, but this was only a brief work stoppage. Once the wind tunnels were relocated to Kochel, they were operational again. Despite this extraordinary testing, the German leadership was determined, by 1944, to focus all efforts on the defense of the Reich. Thus, the tunnels were not utilized to their full potential. The efforts of the personnel assigned to the tunnels were focused solely on one weapon system, not toward testing new technologies or capabilities. This failure to take full advantage of their technological capabilities is a true failure of the German leadership.[6] Indeed, the Germans missed out on several opportunities to exploit fully the wind tunnels, especially in the area of wing design. In this case, the designs were robust and innovative but were not tested by the Germans. Many designs were not tested and developed until long after the war.

The Wings of Man

To increase range and speed, one of the most enduring German technological innovations was the sweeping of wings. During the war, the Germans experimented with a variety of wing sweeps and designs, many of which are prevalent today. Indeed, the most enduring innovation of the Luftwaffe engineers was the rear sweep to a wing, which was found on many of the experimental aircraft designed during the war period.[7] Again, with an eye toward speed and range, the rear sweptwing offers a unique way of increasing lift without increasing weight. By canting the wing aft, the actual lifting area of the wing increased because of the distance the air must flow over the wing. This is done without increasing the surface area of the wing and incurring the corresponding weight penalty, resulting in an aircraft that has greater speed, payload capacity, and range (although all three must be balanced).

The tradeoff with this, however, is limited low-speed maneuverability. The reason here is the specific area where lift is generated. As with all perpendicular and rear sweptwings, the actual lift is generated at the wingtips due to the directioning of the laminar (air) flow over the wings. With perpendicular wings, this lift is approximately abeam the center of gravity on the aircraft, allowing low-speed flight and relatively high angle of attack. With rear sweptwings, the lift is aft the center of gravity, making low-speed flight unstable, thus dangerous. Therefore, by sweeping the wings aft, they were able to gain speed, lift, payload, and range while trading off low-speed maneuverability. The question the German engineers faced then was how to keep these increases without sacrificing the low-speed regime. Their answer was twofold: increase power (without the weight penalty) and change the sweep of the wings in flight.

One of the earliest proposals, although the Germans never flew it, was a swivel wing. Designed by Blohm and Voss, the idea was to have a single wing that would rotate from perpendicular to canted, depending on mission flight parameters.[8] This aircraft then would be able to take advantage of the low-speed characteristics of a perpendicular wing as well as the high-speed characteristics of a canted wing (less drag, more lift). This concept, although viable, was not proven until the National Aeronautics and Space Administration flew an oblique wing on the Ames AD-1 research aircraft in 1979.[9] Another wing technological approach to overcome the low-speed and high-speed maneuverability tradeoff came through the use of variable sweptwings. Familiar today for application on the F-14 Tomcat, the variable sweep technology is designed to move both wings from a perpendicular configuration at low speed to a rear swept configuration at high speed for the aforementioned reasons. A similar variation yielded the experiments into a solid delta-wing configuration, which consisted of a swept leading edge with a perpendicular aft edge and solid material in between, which yielded some successes but not until long after the war ended.[10]

One of the technological innovations the Germans actually flew in prototype was forward sweptwings. In this instance, Junkers took a conventional wing and swept it forward instead of rear. Coupled with jet engines, this aircraft more than compensated for the low-speed maneuverability liability of rear sweptwing aircraft.[11] By sweeping the wings forward, Junkers changed the lift characteristics of the wing. No longer was lift generated at the wingtips, but with forward sweptwings, lift was generated at the wing root, which was adjacent to the center of gravity. The drawback to this design was the directioning of the wingtip vortices. In rear sweptwing aircraft, the vortices generated by the wind movement across the wing (a spiraling whirlwind) are directed across the wing and behind the aircraft causing little effect to the handling. In the case of the Ju 287, these vortices were now directed along the wing toward the fuselage, making high-speed or high-angle-of-attack flight dangerous. During high speed or high angle of attack, the vortices would overcome the elasticity of the wing, causing the wing to twist off. This difficulty was not overcome until the American X-29 program in the 1980s. Although not currently used, forward sweptwing technology provides a short-term capability, one that is already proven.

All these experiments into increasing speed, range, lift, and payload were never incorporated into the German production. Many were exploited after the war, however, and remain in use today. Facing an ever-expanding war situation, Hitler issued a series of Fuehrer directives in September 1941 that curtailed work on nonessential projects.[12] Hitler's continental worldview was coming into direct conflict with his strategic expansions. By attacking Britain and later Russia, Hitler overtaxed his economic capability to conduct a strategic two-front war.[13] His economic focus switched to producing existing technologies en masse to stem the staggering losses of his overreach. In essence, he sacrificed quality and innovation for quantity.[14] This is prevalent throughout the Germans' technological innovations.

My Grandma Wants to Fly Jets

The second technique available to the Germans for increasing the lift, speed, payload, and range of their aircraft was to couple the rear sweptwings with jet engines. These engines were able to generate much more power than their propeller counterparts and could run on alternate fuels.[15] Although Messerschmitt was the first company to produce a jet aircraft, the first to design and test-fly one was Heinkel.[16] Heinkel actually began his research with the experimental He 178 by coupling jet engines with a perpendicular wing as a planned proposal for a two-engine fighter

contract. This never panned out for Heinkel,[17] but Messerschmitt was able to couple the jets with a rear sweptwing design that became the Me 262, the world's first jet fighter. Alas, the Me 262 never entered full production, primarily because of an argument between Hitler and General Adolf Galland over its specific role. Galland argued for the Me 262 to be a pure fighter aircraft, but Hitler was interested in making it a fighter/bomber. This led to a redesign of the Me 262 from fighter to fighter/bomber and back to fighter toward the end of the war.[18] The Me 262 did see some action against Allied bombers, but this was very late in the war, and it did not have much impact on the outcome of the war. Although a successful design, the Me 262 was fraught with powerplant problems. The Jumo 004, the primary jet engine of the time, had a service life of 4-5 hours before it had to be replaced, making the maintenance and logistics of this aircraft cumbersome.[19]

Messerschmitt and Heinkel were not the only ones to experiment with jet engines. Arado had an impact on the US Navy F7U-3 Cutlass of the Korean era.[20] The centrifugal jet engine developed by Focke-Wulf became the primary powerplant for the Yakovlev Yak 15, the first Soviet jet aircraft, used during the Korean war era.[21] Arado also had success with the Ar 234, the first high-altitude, jet-powered reconnaissance airplane.[22] This aircraft was the precursor to the SR-71 Blackbird and the U-2 Dragon Lady. Although these designs had impacts after World War II ended, only the Me 262 was produced in any appreciable quantity by the Germans, and this was late in the war, after the war had been lost.

The Eyes Have It

In addition to out-of-the-box thinking on aircraft design, the Germans were also the first to field and operate an instrument system, both for their own airfields (a precursor to the current instrument landing system [ILS]) and for directing their planes to a target. The first was the Lorenz beam system for blind landing, which consisted of two transmitters located on opposite sides of the airstrip runway. Both transmitted in simplified Morse code, one solely dots, the other solely dashes. The spacing of the dots and dashes was such that, where beams overlapped, a continuous tone was heard.[23] By moving left and right until the continuous tone was heard, the pilot would be aligned directly on the airstrip center line. Thus, in conditions of restricted visibility, the pilots could find their airfield. The limitations of the system were many. It did not take into account crosswinds or turbulence.[24] However, as pilots became skilled in the operation of this system, they could compensate for these difficulties and keep the continuous tone.

The other disadvantage to this was the lack of altitude information. The beams would guide a pilot to the airstrip, but in conditions of zero visibility, they did not provide altitude. This can be overcome by the directioning ability of the transmitters. Essentially, the overlap portion of the beams (the area with the continuous tone) was conical. As the pilot flew toward the airfield, the cone narrowed toward the centerline. Thus, the absence of a tone could indicate the pilot was too high, and he could compensate accordingly. All in all, it is a risky system, but it is better than nothing. Without this, the pilots would have to divert to another airstrip, one not weathered in, which further added to the distance they needed to fly. This became a significant factor during the Battle of Britain when the German fighter escorts were flying at their maximum radii. Any additional flight time or distance could prove disastrous.

The offensive adaptation of the Lorenz system was known as the *Knickebein* system. Designed to be a long-distance target designator for use during night bombing, the Knickebein system consisted of two Lorenz transmitters, one that looked at the target along the ingress line, the other at the target from the profile. The pilots, using the Lorenz system in reverse, would fly away from the first transmitter while maintaining the steady tone in their headphones. Once they were in range of the target, they would switch to the frequency of the second transmitter, while occasionally checking with the first transmitter to ensure they were still on the proper vector. When the second transmitter gave them a steady tone, they were directly over the target and could release.[25] A subsequent refinement of this system, known as the *X-Geraet*, followed the same logic as the Knickebein system, with some refinements. Instead of using the beam intersection to mark their target, the pilots would fly the original beam toward the target. The second transmitter was actually a collection of transmitters, each of which would broadcast on a particular vector. Where each beam of the second transmitter intersected the first beam, the pilots had to hack a certain distance from the target. The *X-Geraet* pilots then would drop flares to literally light the way for the planes that followed.[26]

A further refinement of this technique was the Y-Geraet system, receiver and transmitter combination, where the aircraft will fly a designated vector and periodically retransmit a signal from the ground transmitter. A ground receiver would pick up the retransmitted signal. By calculating the phase shift, the difference in time between the transmitted and received signals, ground controllers had a picture of whether or not the pilot was on vector and could correct their pilots accordingly.[27] This type of ground control (although not the *Y-Geraet* style system) is used today by the ground tactical air control squadrons.

The advantages of these systems, despite their drawbacks, are obvious from the German point of view. They had the ability to direct and control their aircraft as well as recover them in less than optimal conditions. These systems also facilitated night bombing, which adds a psychological effect to the physical effect and destruction. From the British point of view, these systems were of import as they were easy to overcome. Radio frequencies operated over long distances are easy to disrupt once the transmit and receive frequencies are known. The Germans kept their systems simple, using dots and dashes on prescribed frequencies, but the British overcame this by inspecting aircraft that had been shot down. The British did not need to know what to listen for once they had the frequency. Using a technique known as meaconing, whereby the British flooded the various German frequencies with extra traffic, the British were able to defeat the Knickebein and *X-Geraet* systems.[28] To overcome the *Y-Geraet* systems, the British merely jammed the frequency.[29] Despite their limited operational life, these systems were the predecessors to the current ILS and radar systems, both of which allowed for night bombing. As the Combined Bomber Offensive demonstrated later in the war, the Allies were able to keep pressure on the German homeland through daylight bombing by American planes and night bombing by British planes. Without radar and ILS, these night bombings would not be possible, providing the Germans with time to reconstitute or continue production without feeling the effects of bombing.

Subsequent Aircraft Technologies

Faced with the challenge of designing aircraft that could outperform their enemies, the German engineers looked at ways to improve the speed, maneuverability, and altitude of the fighter force. The root reason for this work was the theory that to defeat the Allied bomber streams they would have to attack them at their weakest point, which was from above. Thus, they needed aircraft that could fly at extreme altitudes. In addition to their work on jet engines, the Germans looked at ways to improve propeller-driven aircraft. One of the technical solutions to this problem was fielded in their fighter force. They replaced the old radial air-cooled and liquid-cooled engines with a high-compression piston engine. Essentially a sealed, self-contained engine that was not dependent on a bladder of coolant, this engine allowed fighters to perform negative *g* or inverted maneuvers.[30] This gave them a significant maneuvering advantage when engaging enemy formations. Additionally, this engine would increase the performance envelope of the bomber fleet, allowing them to fly farther than they could with the radial engines. Alas, the performance increase in bombers was not enough to have a significant impact on the war, but the impact of the souped-up fighters was felt. The Allies were able to counter this added threat; however, the Germans succeeded, at least initially, in almost equaling the score with their fighters. Additionally, by examining defeated aircraft, the Allies were able to capitalize on German technological advantages.

Another engine modification fielded by the Germans in limited numbers was a relocation of the engine and propeller. Some of the German aircraft that flew as prototypes had pusher-type propellers. Located at the rear of the fuselage, these pusher propellers were more efficient in terms of fuel usage than traditional puller propellers. The Germans were never able to capitalize much on pusher-propeller aircraft during the war because of their management practices, but the pusher propeller is in use today on long-duration aircraft such as the Predator. Although these were significant technological innovations, ones that have endured and are still in use today, the Germans were unable to capitalize on them because of their failure to properly implement modernization and upgrade their aircraft fleet. As indicated earlier, the German industrial capability was stressed to maintain production of existing aircraft to counter the Allied mass of aircraft. This left nothing for development of new technology.

The interwar years saw the rise of Lufthansa as a commercial airline of the Weimar republic. Headed ostensibly by Hugo Junkers, the main workhorse of the Lufthansa commercial fleet was the Ju 52, an all-metal commercial airliner. The Ju 52, pressed into service during the war as both a cargo aircraft (people and materiel) and a limited bomber, had the capability to carry more items than the previous wood and canvas aircraft. To offset the additional weight, Junkers put on a third engine. This venerable aircraft saw service throughout the war, although primarily as a cargo and troop carrier, eclipsed in the bomber role by the He 111 and Ju 88. Nevertheless, most aircraft built during the war were made of metal, thus more robust and survivable than the previous wood and canvas design. The use of metal aircraft also allowed German engineers to examine the possibility of pressurized cabins.[31] During the war, pilots who flew above a certain altitude were required to use oxygen to counteract the effects of altitude. As an aircraft rises in altitude, the oxygen concentration in the ambient air lessens. If an aircraft flies high enough, it can lead to oxygen depravation, causing the pilot and crew to black out. With the advent of pressurized cabins, the aircraft would be able to fly higher without the requisite oxygen aboard. By pressurizing the cabins, the ambient air within the cabin maintains the same oxygen concentration as it would sitting on the ground, negating altitude sickness and oxygen depravation. Although the Germans never fielded this, it is in wide use in all aircraft applications today.

Good Ideas, But…

Throughout World War II, the Luftwaffe sought to maintain its technological superiority over the Allied forces do this by designing capabilities into their aircraft that would allow them to fly higher and faster than the Allied aircraft.[32] This led to an "explosion of new project activity unequalled in the history of aviation, an explosion that was fueled even further in 1944 by the lifting of all patent protection."[33] The German aircraft industry was populated with some of the premier engineers and designers of the time who were able to come up with some truly revolutionary ideas for designing and building aircraft. The Germans were the first to design and use jet engine aircraft, metal aircraft, instrument navigation, sweptwing technology, and advanced testing through wind tunnels. Some of their more radical designs, such as the Gotha flying wing concept,[34] would not be realized until many years after World War II. Indeed, many of their innovations were picked up quickly by the Allied forces. Bower astutely notes:

> Since 1945, the genesis of weapons by all four Allies has been dominated by the inheritance of Germany's wartime inventions. Indeed, the Korean War can be viewed, on the technical level, as a trial of strength between two different teams of Germans: those hired by America and those hired by the Soviet Union. The aerial dogfights between the Soviet MiG-15 and the American F-86 Sabres—both designed by German engineers—dispelled for many their doubts about the expediency of plundering Germany's scientific expertise.[35]

Thus, the Germans did not lack grand and effective technological innovation. Yet, they were resoundingly unable to take advantage of this situation and were completely unable to bring these revolutionary concepts into operation. The reasons for this are manifold, but the centermost reason for their inability to exploit their technological superiority lay with the complex, convoluted, and inefficient management system in place in Germany during World War II.

Management for Dummies

One of the most overlooked practices in the business of technological innovation is the impact of management on the overall process. Management of technology is crucial to the successful implementation of revolutionary ideas and processes. Management needs to be not only knowledgeable about the designs and ideas of the engineers but also receptive to them. Management needs to provide a roadmap to what is to be accomplished. Without clear-cut direction, meaning a vision and goal not micromanagement, any technological advance is doomed to irrelevance. An overall strategy will provide the engineers with the proper vector to direct their abilities and ideas. Furthermore, management needs to provide clear and unambivalent boundaries to the efforts of the engineers to ensure

the technological innovations and ideas stay focused and attainable. Finally, the management structure needs to be streamlined and simple to allow ideas to flow not only laterally but also vertically. Binding management to a complex and suffocating bureaucracy will have the same effect on the industry as a whole.

Alas, the Luftwaffe found itself in just such a predicament during the war. It had a complicated and convoluted approval process for the technological advances forwarded, one that was wasteful of not only resources but also time. It had little strategic direction and no boundaries on the effort to advance technology. It also had the wrong people in charge of the various agencies that headed up, collectively, the overall effort. The result was a host of revolutionary innovations that would have all but guaranteed they remained technologically superior but were doomed to be merely paper tigers by the bulging management process and poor leadership. These paper tigers were exploited by the Allied powers after the war, but the Luftwaffe was unable to take advantage of them. The overall operational result was an air force that ended the war with the same equipment with which it began, quality equipment at the start but obsolete in 1945 when compared with the equipment of the Allies.

Who's in Charge?

At the core of the management of Luftwaffe technology was Hermann Goering. As Hitler's duly appointed head of the Luftwaffe, he was responsible for ensuring the Luftwaffe had the necessary tools to prosecute the war. The Luftwaffe was responsible for determining its own requirements to ensure it could fight. Similarly, the navy and army each had that responsibility. While this is to be expected, what was lacking in Germany overall (and the Luftwaffe, in particular) was centralized control. There was no one agency in charge of military procurement. Indeed, "production was pitifully small. The fault lies clearly with the Technical Office whose lack of initiative cannot be ignored and with the Luftwaffe General Staff...which failed completely to provide the guidance expected of it."[36] Thus, there was no direction, no vectoring of the effort to ensure the proper item was developed. In other words, there was no one in charge.

Further complicating the effort was the process for placing something on contract. The Luftwaffe would award a production contract for an aircraft based solely on its design.[37] This essentially skips the research-and-development portion of modern-day acquisitions, with the Luftwaffe assuming the risk that the design will not work. In many cases, the prototypes developed did not meet expectations (or requirements).[38] Thus, large quantities of resources were spent and expended for something that did not work. This is an incredibly ineffective way to manage a contract. Further increasing the drag on the resources was the number of programmatic changes enacted. With the swift progress of the war and the swifter progress of implementing minor technological changes, the German factories and modernization centers were hard-pressed to keep up.[39]

Finally, to keep the costs from escalating beyond what was already wasted, the Germans enacted price fixing for the industry. Essentially, a contractor could choose one of three pay categories: one which they were not taxed (but had to be a low contract bid), one where they were taxed, and one where they were taxed and some of their costs recouped. The latter only could be chosen with approval from the government.[40] In essence, from a fiscal point of view, German management of the contract process was a shambles. Valuable resources were wasted by betting the design would work, and the designs were changed constantly, costing more resources and further straining an industry that was undermined by fixing prices to the advantage of the government. This poor fiscal policy was further convoluted by the complicated organizational structure of the German industry.

Early German industrial organizational structure was an attempt to maintain centralized control over industry as it attempted to shift to a wartime footing. In each of the industries of the Third Reich was one person at the head. Directly beneath the head was a main committee, made up of the industry leaders. Ostensibly, the function of this main committee was to evaluate the way each of the companies in the industry did business, select the best from each, and have all factories implement these best practices. Further refining this process, there were special committees under the main committees that dealt with specific parts of the whole. These special committees were also responsible for implementing best practices among their subordinate factories in an effort to increase standardization and efficiency and reduce cost.[41] In theory, this seems to be a sound business practice; however, management by committee (or in this case, by many committees) was not very practical. When combined with poor fiscal guidance and a lack of strategic direction, this system merely complicated the problem.

Furthermore, in 1940, a system of rings was introduced into the industry. These rings were essentially committees but not limited to one industry. These rings were concerned with items and issues that transcended all industry. For example, the ring concerned with the making of steel would have an impact on all committees who used steel (which was all of them). The system that finally evolved consisted of "4 main rings for subcontracting and 8 main committees for the finished product."[42] Each of these committees and rings had subcommittees and subrings to them, further increasing the bulging bureaucracy. Known as Self-Government of Industry, this system could be effective in the hands of a skilled manager like Albert Speer. The armament industry under Speer became more efficient and productive[43] despite the complicated system. However, under managers like Karl-Otto Saur, the opposite happened. Indeed, as Goering stated:

> Saur was a man completely sold on figures. All he wanted was a pat on the shoulder when he managed to increase the number of aircraft from 2,000 to 2,500. Then the Luftwaffe was blamed that we had received so and so many aircraft and where were they.[44]

Unfortunately, for the Luftwaffe, this thinking tended to dominate the war-production effort. The result was a gross number of aircraft (quantity), many of which were unusable or obsolete (quality).

Quantity Versus Quality

One of the toughest challenges faced by management in a technological industry is the issue of quantity versus quality. Both are important and must be effectively blended to have a successful program. Unfortunately, for a country whose industry was poorly managed and resource-constrained and faced with an enemy with a seemingly endless supply of high-quality equipment, the natural tendency to fight mass with mass (matching quantities) overrode the necessity to instill some quality in the airplanes produced.[45]

The result was a large number of inferior aircraft that could not have kept pace with the Allies, even if they were numerically similar. In mortal combat, quality is often the divide between success and failure. This was proven by the Tuskegee Airmen flying bomber escort from Italy. Although the number of P-51s sent to escort a bomber formation did not change drastically, they still escorted more than 200 missions without a single bomber loss. This is attributed to both the skill of these pilots and the quality instilled in the machines they flew. Alas, the Germans did not have the quality in their aircraft to overcome this.

By war's end, the Germans had lost the technological superiority they owned at the beginning. Although this can be directly attributed to their management system, this issue was further exacerbated by their failure to integrate the capabilities of the captured lands effectively. Indeed, rather than capitalizing on the capabilities of the workers in the conquered lands, the Germans merely plundered them and brought their populations into slave labor.[46] They failed to realize and take advantage of what was available to them. The result was a slave workforce that resented its masters. Needless to say, this was another cause of their diminished quality. Finally, as the war progressed, the Germans began conscripting just about any male with a pulse, regardless of his civilian expertise. This led to a lack of skilled workers, without whom quality suffered.[47] This is almost a double tap for quantity over quality—specifically, make the armed forces larger to counter the large force regardless of special (or needed) skills, depriving industry of the skilled workers necessary to instill quality in products sent to the armed forces.

However, equipment was not the only area in which quality suffered. As the war progressed, training for pilots was cut almost in half, primarily because of the need to have replacements for pilots lost in combat. The result was pilots significantly less skilled than earlier groups that entered combat. Poorly trained pilots, flying inferior equipment against a determined enemy on two fronts, is a sure recipe to create an even greater need for replacement pilots. In short, the German economy and industry could not keep up with the demands of a two-front, widely flung war and elected the desperation strategy of throwing everything it had into the fray, regardless of training or expertise. The result is obvious.

Although the complicated nature of industry organization is certainly a contributing factor to the inability of the Germans to exact victory, the lack of management and leadership from the top down definitely compounded the problem exponentially. Without a sound and appropriate strategy or roadmap, anything attempted has the distinct probability of failure. From the beginning, the German strategy focused on Europe and a blitzkrieg style of warfare. As Hitler's aspirations grew (and the war with them), the overall German strategy failed to take these new ideas into account.

Strategizing

From the beginning, the Nazi party rose to power in Germany under the guise of nationalism. Many Germans were still upset over the limitations imposed by the Treaty of Versailles at the end of World War I, in particular the clause that laid the blame for World War I and the resultant carnage squarely on the Germans. Additionally, the German people were adamant about reclaiming the land annexed away from them by the Treaty of Versailles. Undoubtedly, there were also some bad feelings about the French, who were seen as most responsible for the War Guilt clause. Thus, there were some strong feelings of being unfairly and cruelly treated in the aftermath of World War I. This was exacerbated further by the inability of the Weimar Republic to effectively fill the void left by the abdication of the Kaiser. The general disgruntlement of the German people led to a fierce feeling of nationalism and a desire to put someone into power who could actually do something about their situation.

Enter Adolf Hitler, a recognized and decorated World War I veteran who had the charisma and rhetoric to rouse the population. Simply put, he knew what to say and had a forceful enough presence to ensure the people believed him. After his election to chancellor and the death of President Paul von Hindenburg, Hitler combined the two offices into that of Fuehrer and began to attempt to make good on his nationalism pledges. Realizing one of the reasons for the German defeat in World War I was the failure to generate the economy to a war footing, the Third Reich began increasing its economic capability.[48] Ostensibly, this was to continue the nationalistic regaining of indigenous German lands unfairly removed from them. This included the German pushes into Austria; the Sudetenland; Czechoslovakia; and ultimately, Poland. This desire to increase their *lebensraum*, or living space, was risky, however. At any point, the Allied powers (then Britain and France) could respond.

Hitler was emboldened during the operations prior to Poland by the lack of Allied response to his offensives. He assumed they would continue their policy of appeasement after the Poland campaign, especially after he signed a nonaggression treaty with the Soviet Union. Allied appeasement ended with the invasion of Poland, and both Britain and France declared war on Germany. Hitler was ready for this, however, and ordered his troops into France, occupying, in short order, about two-thirds of France.

From here, things began to go south for the Reich, despite their strong army and technological superiority. Up to this point, every campaign engaged in by the Germans had been a blitzkrieg-style campaign:[49] hit the enemy hard and fast to overcome their defenses and then bring them into the Fatherland. As such, the German economy was geared to this type battle. There was reconstitution time between the battles, giving the economy and industry time to recoup the losses. Germany's continental focus was driving its blitzkrieg strategy, and its economy was geared to this. Thus, it produced high-quality, short- and medium-range fighters and bombers in large quantities to accommodate the blitzkrieg of the enemy. Since many of the battles took place within easy distance of Germany, there was no need to delay the production of aircraft to build and stock spare parts; they would just make another airplane to replace the damaged or destroyed ones.[50] While this worked well at the outset of the war, its significance grew as the German battlespace expanded greatly. Compounding this, pilot training was limited to tactical training only,[51] as there was no need to think beyond this level. Yet, with the onset of the Battle of Britain, the Germans changed strategy, whether or not they realized it.

Strategy Shift

World War II might have ended differently had Hitler elected to maintain his *lebensraum* policy and restrict his actions to continental Europe. Nevertheless, he attacked Britain, ostensibly to ensure the British stayed out of the war. From a tactical point of view, this was a huge mistake. To attack London, his fighters

(upon whom the bombers relied for protection) had to operate at the limits of their range if they were to successfully return to France. In other words, he was now fighting a strategic war with a tactical force. Hitler had arbitrarily escalated things, a precursor of things to come.

As the war progressed, Hitler would return time and again to the concept of changing things to fit his worldview *du jour*, with no apparent thought to the impact on either society or industry. The most glaring example of his inconsistency concerns the Me 262, the world's first jet fighter. Originally designed as a fighter, Hitler ordered it changed to a fighter/bomber against the advice of Erhard Milch and Galland. The resultant delay to retrofit the Me 262 to a fighter/bomber ensured that, when it was ready for use as a bomber, the need was for fighters to defend the dwindling Reich. The Me 262, again at Hitler's insistence, was re-retrofitted back to a fighter, another delay to the program that ensured it was not introduced into the war until early 1945.[52] The argument over the Me 262, in which Goering sided with Milch and Galland, marked the beginning of the end of Goering's favor with Hitler. The result was a complete lack of Luftwaffe representation at future meetings.[53]

After the loss in the Battle of Britain, Germany took a pause to recoup its losses; then Hitler made another large strategic mistake—he attacked the Soviet Union. Once again, he escalated the war effort to strategic levels with only a tactical industry and military. The results were disastrous for the Reich. They severely overextended themselves on the Eastern Front, which ensured their already fragile logistics support was stretched too thin. Additionally, the demands on industry for a two-front war were too hard to bear. In short, production could not keep up with losses, and there was almost no way to resupply the troops because of a lack of transport aircraft.[54] Finally, the German leadership severely underestimated the Allies' drive and dedication while simultaneously overestimating their own ability.[55] This ill-equipped armed force with little reconstitution ability, fighting a war that was larger than it was prepared for or capable of, with no clear written strategy and numerous changes to the direction of the effort, would have ensured the Reich imploded. However, the Allies were not content to take the time to allow this to happen. They decided to help it on its way through the Combined Bomber Offensive.

Allied Impact on German Strategy

The Combined Bomber Offensive was a massive push by American and British air forces to provide continuous day and night bombardment of the German homeland, focusing on its industrial capabilities. The American forces were responsible for the daylight bombing, the British for nighttime bombing. The Combined Bomber Offensive almost stopped before it started, primarily because of a lack of fighter escorts for daylight raids. The massive formations of B-17 aircraft were susceptible to the German fighter aircraft, and the resulting losses almost ended this aspect of the offensive. This changed with the introduction of the P-51, a highly maneuverable and capable fighter with range to escort the bombers all the way to their targets. These fighter escorts also served a second function, that of *attriting* the German fighter force—essentially a trench-style slugfest in the air. It was extremely successful in this second role, removing German air superiority over continental Europe and ensuring Allied planes could roam the European Continent with relative impunity.

The effects on the German industry are even more telling. In addition to other targets, the Allied offensive destroyed the German transportation network, severely limiting its ability to operate a dispersed industry. Furthermore, the Allies concentrated their efforts on the critical Ruhr valley, which was the location of German stocks of coal.[56] The coal was used as a power-producing source and critical to the German war industry. The effects of these raids were felt throughout German society and industry as it placed severe hardship on its already overstressed and limited supply of raw materials and transportation. Compounding the German situation, the Allies struck many of its fuel sources. Indeed, in the after-war interrogations, Goering admitted that fuel was a significant limiting factor to production, especially in the production of a four-engine bomber. In discussing the He 177, Goering said, "I had to ground that aircraft because it consumed too much gasoline, and we just didn't have enough for it."[57] Finally, the Allied attacks had a significant impact on the German industry's depots and production facilities.[58] The Combined Bomber Offensive was more than a combination of American and British bombing techniques. It combined with the Germans' inefficient and poorly managed industry to finally break the back of the German war machine.

Summing Up

Throughout the war, the German state was unable to take advantage of many of its indigenous capabilities. Beginning with decentralized control of their procurement process and abetted by a complicated and wasteful fiscal policy, the industry simply could not keep up with the demands of the war. Furthermore, its organizational structure was not conducive to change. Its system of committees and rings with all the subcomponents thereof was an attempt to increase efficiency and reduce cost through standardization of production practices. It actually did not happen that way, as it was a system that could not grow to fit the increased need. The Germans effectively proved that management by committee does not work in a wartime situation. Compounding this further were the people they placed in charge. With a few notable exceptions, the men selected to run the industry were party lackeys who had limited experience and know-how when it came to running an industry.

Strategic direction from the state leadership was completely lacking. What began as a continental campaign to reverse the perceived unfairness of the Treaty of Versailles rapidly expanded into a global strategic battle for world dominance, all with an economy that was geared toward a blitzkrieg-style tactical engagement. German industry was never able to recover from this continental focus, dooming the strategic efforts to failure. Furthermore, the personal and direct involvement of Hitler into all aspects of the war effort only served to confuse and befuddle the national leaders. In other words, absolutely no direction was provided to guide the war effort. This led to numerous production delays as aircraft were constantly fitted and refitted to meet the ever-changing requirements. Additionally, the German leadership had two key misconceptions that may have attributed to their constant change. First, they underestimated the Allies, and second, they overestimated themselves. The added impact of the Combined Bomber Offensive served to exacerbate an already deteriorating situation and helped ensure the 1,000-year Reich lasted a mere 12 years.

Forward to the Future

As the US Air Force begins its fourth major transformation in 11 years, there are some striking similarities between what it currently faces and those challenges faced by World War II Germany. Notable among them is a strong sense of nationalism. No one can doubt the surge in American patriotism since the 11 September 2001 events, and one cannot overlook the sense of outrage and frustration at the horrific waste of human life and American potential. Yet, a parallel can be drawn between this and the general feelings of the average German during the interwar period. The Germans felt a sense of outrage and frustration at not only the loss of land but also the humiliation that accompanied the Treaty of Versailles. In hindsight, these feelings perhaps are justified, but the results for Germany were disastrous. Fortunately, the American people are not following the same political trend, nor could we, given our process for electing our officials and the constraints and restraints placed upon them.

Currently, there is no real centralized control over the US Armed Forces acquisition program. As it was for the Germans in 1935, the US Armed Forces currently follow separate stovepipes for acquisition of weapon systems. There are separate DoD programs for ballistic missile defense among the Army, Navy, and Air Force, as well as different programs for acquisition of unmanned aerial vehicles. The acquisition programs for the F-35 joint strike fighter follow the same path, each service pursuing its own agenda to meet its own needs. This was exactly the same at the beginning of the German buildup for World War II. Each service had its own unique requirements, and each pursued them independently of the other. The result was an egregious waste of valuable and limited resources, both natural resources and dollars. In essence, they ended up paying for essentially the same thing three times. It is the same today with the American military. We have separate programs for the X-45 Air Force unmanned combat aerial vehicle and the X-47 Navy unmanned combat aerial vehicle. Both are experimental, and both operate more or less independently of the other. The end result will be two unique systems that meet specific needs without addressing the overall interoperability between systems. While the Germans were not faced with each branch of the service creating its own flying machine, the overall competition between the Services for constrained resources and the inability of the leadership to differentiate, much less prioritize, among the service requirements led to incredible waste and effort.

Similarly, the US Air Force, today, faces much the same challenge as the Luftwaffe, specifically determination of mission and needs. As the Luftwaffe vacillated between a fighter and bomber, the same struggle goes on today in the US Air Force. With the cost of each individual unit escalating rapidly (because of the investment in technology), what is the priority, fighters or bombers, given that the United States really cannot afford both? Further complicating matters is the need to build tankers and lift aircraft. While the Luftwaffe merely ignored this, to its detriment, this remains a central concern for Air Force officials. While not a concern for the Luftwaffe, the American conundrum is compounded by the oft-overlooked integration of space into the battlespace. The items placed in space are extremely expensive and difficult to make, yet, paradoxically, are always there to aid the warfighters. As long as these systems continue to perform, they will be overlooked largely by people who do not understand their mission or importance until it is too late. All these compete for limited resources, those doled out with a medicine dropper by a dubious legislative branch. This merely compounds the larger issue facing the Air Force today, that of identity.

Transformations

Since 1992, the Air Force has undergone four major transformations. The Air Force has evolved from the Cold War hallmarks of Strategic Air Command, Military Airlift Command, Tactical Air Command, and Air Training Command to the current configuration of Air Combat Command, Air Mobility Command, Air Education and Training Command, Air Force Space Command, and Air Force Materiel Command. Designed to be functionally aligned, each command was changed to be a stand-alone force capable of operating within its own unique and nonoverlapping mission areas. The Air Force then transformed to the expeditionary air forces, an idea that creates ten stand-alone composite forces to handle regional situations worldwide. In essence, the expeditionary air forces are a combination of the functionally aligned major commands of today and the geographically aligned major commands of yesterday. Each air expeditionary force contains strategic and tactical elements yet draws from the respective major commands for expertise. Finally, the Air Force is transforming to a task-force-based concept, which is essentially a subset of the expeditionary air force designed to handle a specific contingency as it arises. All this combines to leave a large uncertainty about the mission and function of an air force.

When asked exactly what it is the Air Force does, the answer depends on when the question is asked or what is going on in the world. In other words, there is limited identity within the Air Force about its mission. This is exacerbated by the fact the corporate identity seems to change with each new Chief of Staff. As Goering's Luftwaffe provided little or no unique identity and mission to its members, so the Air Force faces the same dilemma. The result has been a restructuring of the Air Force from one that can fight an outmoded form of war to one that can survive in an outmoded form of peace. American worldview, like that of the German forces during World War II, has remained stagnant. While paying lipservice to a contingency-based, flexible, expeditionary force, the Air Force remains firmly locked in the planning and budgeting of a Cold War, two major-theater-war mentality.

The one issue the Department of Defense has handled well is the creation of the unified commands. Each command is designed to be a warfighter or a functional command with expertise in either a particular area of responsibility or a particular function. There is no overlap in responsibility (except for the functional commands, which operate somewhat autonomously of the geographic commands), yet each of the unified commands manages to share resources and information without regard to which component provided it. In many ways, this mentality needs to transcend the programmatic stovepiping in each of the military branches.

The issue of technology is becoming the forefront of American procurement and acquisition issues. As the Germans did in 1935, America now enjoys a technological superiority over friend and foe alike. At the present, there is no match for American technological know-how and application. Yet, this technology is only as good as its application. As the Germans found out,

developing technology just because you can is a poor reason to carry out a government program. While the Germans had some technological innovations, such as jet engines and wind tunnels, many of their technological advances were not realized until after the Reich had vanished. Indeed, developments such as the Gotha P.60 flying wing-style fighter were not adopted until recently with the advent of the B-2 Spirit. The German programs were mismanaged from above almost from the start, including no boundaries on where technology could go. The American problem is more geared to including technology into *simple* problems, simply because it is possible. Many of the acquisition programs undertaken by the Air Force fail to consider the *low technology* or already existing technology approach, often at a large pricetag for a limited capability.

Further complicating the picture is the management of our acquisition programs. In most cases, for a new system, it can take 10-20 years from identification of the problem to fielding a system to defeat or answer the problem. Often, the items fielded are obsolete before they enter production because of changing world needs. Granted, the Department of Defense has not fallen into the pitfall that awaited the Germans; namely, changing existing programs to meet evolving needs. However, the Department of Defense tends to create a new program to handle a problem, which significantly compounds the ability to field forces capable of responding in the manner in which they are needed. Each of these programs will compete for existing, limited funds, resulting in a compromise that answers neither the existing problem nor the original problem. Additionally, the acquisition process is bureaucratically robust. Very little can overcome the inertia of the albatross (the bureaucracy) surrounding acquisition programs, and nothing gets through quickly. The Department of Defense has so many layers of management to get through that it becomes almost a self-licking ice cream cone when faced with an immediate and unforeseen threat. In certain rare circumstances, this inertia can be overcome, but these are the exceptions rather than the rule.

Finally, the American worldview is stagnant. As the Germans could not see beyond continental Europe, so the Americans cannot see below the strategic layer. The Germans could not see the forest for the trees, and America cannot see the trees for the forest. America still believes, despite the 11 September attacks, that it cannot be touched by a foe. Americans believe the way to counter potential foes is to apply a strategic, precision, lethal force. This may be true when it is a contest between nations, but in a contest between a nation and a nonstate actor, this meets limited success. Thus, America's worldview and its Armed Forces must be ready for strategic and tactical wars, both conventional and unconventional.

The real answer lies in establishing a warfighting entity that is impartial with respect to the Services' ability to handle the acquisition and technology programs for the entire Department of Defense. The logical choice is to place the integration of all military needs under the unified command tasked with determining the training and evaluation needs for joint forces, United States Joint Forces Command. With its overarching view of all the unified commands, it is in the unique position to determine what is necessary to fight and win America's wars, both in terms of manpower and equipment. Furthermore, it should be charged with ensuring the interoperability of these programs to meet service-specific needs with minimal changes. In this time of limited resources and increasing needs, standardization is required without sacrificing individual service-unique needs. Additionally, a streamlining of the acquisition process is required to ensure timely answers to emerging needs. Without these changes, our system becomes almost as cumbersome as the World War II German system, a system that can (and in the case of World War II, Germany, did) implode if left alone long enough.

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(Improving Bare-Base Agile Combat Support from page 15)

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27. The final leg of truck to destination is descriptive of the fact that once an item arrives at an aerial port it still has to be moved to an operating location.
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36. The WRM facility at Al Udeid, Qatar, was used for lodging during the initial stages of Enduring Freedom while the Harvest Falcon kits were being readied for use.
37. During the buildup for Iraqi Freedom, planners were unwilling to discuss the use of local hotels in Doha, Qatar, to allow for a faster force closure at Al Udeid AB. Instead, a 4-month delay was allowed for the contracting of tents, latrines, and other infrastructure additions to Al Udeid.
38. Boley, 42.
39. HQ AF/IL Bare-Base Systems Update, slide 14.
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(*Creative Approaches to Improving Segments of the Defense Transportation System* continued from page 33)

RDD of 444 indicates handling service for customers collocated with the storage activity or for locally negotiated arrangements. An RDD of 555 indicates exception to mass requisition cancellation, expedited handling required. An RDD equal to 777 indicates expedited handling required for reasons other.

21. DoDR 4140.1-R.
22. Author's telephone interview with TACC/XOGE, 17 Feb 04.
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26. Area A. To locations in the vicinity of Alaska (Elmendorf AFB), Hawaii (Hickam AFB), North Atlantic (Thule AB, Greenland, and NAVSTA Keflavik, Iceland), and the Caribbean (NAS Guantanamo Bay, Cuba, and NAVSTA Roosevelt Roads, and Puerto Rico). Area B. To locations in the vicinity of United Kingdom (RAF Mildenhall, England) and Northern Europe (Ramstein AB, Germany and Lajes AB, Portugal, Azores). Area C. To locations in the vicinity of Japan (Yokota AB and Kadena AB, Okinawa), Korea (Osan AB), Guam (Andersen AFB), Western Mediterranean (Spain (NAVSTA Rota), and Italy (Aviano AB, NAS Sigonella, Olbia, and Naples). Area D. Hard lift areas—all other destinations not listed as determined by USTRANSCOM; for example, low-use Alaska (Eielson AFB, Adak, Eareckson AS, and Galena), low-use Japan (Itazuke, MCAS Iwakuni, Misawa AB), low-use Korea (Kunsan AB and Kimhae), Indian Ocean (Diego Garcia), New Zealand (Christchurch), Singapore (Paya Lebar), Greece (Souda Bay), Turkey (Incirlik AB), Southwest Asia (Saudi Arabia (Dharan and Riyadh), Kuwait, Bahrain, Oman (Fujairah), and Israel (Tel Aviv). The time standards for port of debarkation for Area D are lower than the other areas. EXP. Commercial door-to-door air service is only for OCONUS shipments that are transportation priority 1 or 2. It is an alternative service to be used when established AMC channel service is not adequate. The intransit-to-theater standard for commercial door-to-door air service (that is, segment H) encompasses the total time for contract transportation rather than individual nodes.
27. Table AP8.T1 from Appendix 8 of DODR 4140.1-R.
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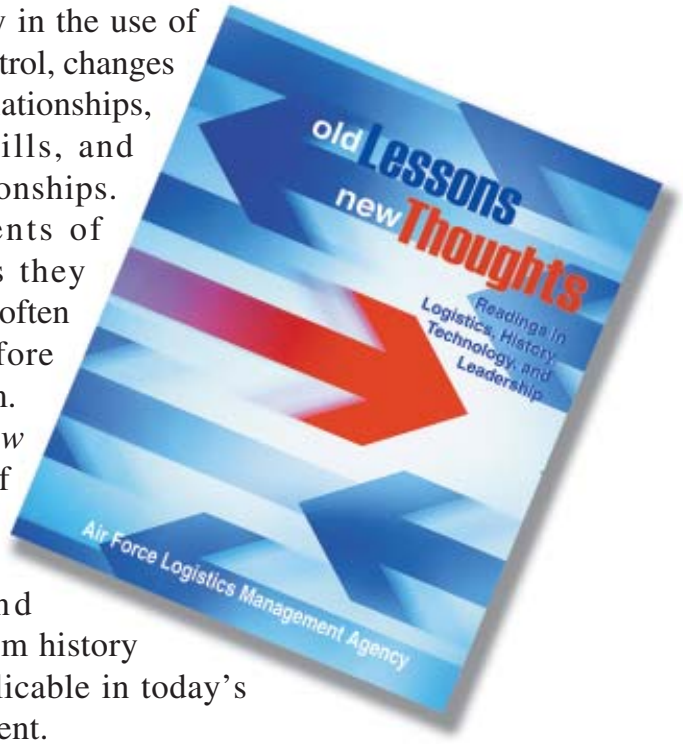

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