Liberty University

World War Two Glider Borne Forces: The Role of British Doctrine in Effective Military Change

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by

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Introduction

The United States' National Defense Strategy has shifted from fighting an asymmetrical, fourth generation adversary utilizing counterinsurgency and unconventional warfare to preparing for a peer/near peer conventional conflict focused on the Pacific and Central Europe. Modern maneuver commanders and operational planners can apply the economy of force, criticality of speed plus precision in kinetic engagements, value of highly trained, task organized small units, and technological incorporation knowledge gathered from analyzing the World War II glider operations executed by Germany, Great Britain, and the United States. Gliders were sailplanes that had a higher ratio of lift to drag than a motorized airplane.[1] They were lightweight aircraft snatched fully loaded from the ground by towplanes, pulled to a high altitude, released by disengaging a towrope, then glided silently and stealthy over many miles before landing in small open spaces or conducting controlled crash landings on rough terrain.[2] The research is not attempting to make an anachronistic case for gliders as a modern vertical envelopment mobility asset. It is empirically examining which nation best leveraged the glider borne force capabilities using the analytical tools of PEST (Political, Economic, Socio-Cultural, and Technology) and M from DIME (Diplomacy, Information, Military, and Economic).[3] Therefore, a study that assesses the degree of effectiveness by which World War II belligerents employed the new glider technology can yield lessons for the development of modern strategy.

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[1] Grover Loening, "Ships Over the Seas: Possibilities and Limitations of Air Transport in War," *Foreign Affairs* 20, no. 3 (April 1942): 490.

[2] United States Army Ordnance Corps, "Gliders Away," *The Military Engineer* 36, no. 225 (July 1944): 246-47.

[3] Joint Chiefs of Staff, *Joint Doctrine Note 1-18: Strategy* (Washington, DC: United States Department of Defense, 2018), I-4.

War drives strategic, tactical, and technological change. Vertical envelopment concepts were initiated in World War Two due to the lessons learned from trench warfare in the First World War. Gliders were a vertical envelopment change that had to be managed, tactics-techniques-procedures (TTPs) developed and codified, and operationally implemented. How each nation accomplished that varied. Clausewitz saw the nature of warfare as defined by the interplay of passion, chance, and creativity. He also felt that war reflected the nature of the societies waging it.[4] This thesis will examine the German, American, and British glider capability integration, doctrine development, manning-training-equipping processes, proponent and opponent mindsets' within the respective military hierarchies, and technological innovations that emerged from each country's program. It will provide an empirical, comparative analysis revealing how Great Britain succeeded over the others at implementing and pre-eminently leveraging glider capabilities in World War II.

Allied primary source materials were acquired from archived doctrine publications, technical documents, oral histories, and official after-action reports. Equivalent Luftwaffe, or German Air Force, primary sources are rare due to wartime record destruction. Historians are forced to rely on mostly unsubstantiated interrogations and interviews predominantly from Generalmajor Herhudt von Rhoden. Select, senior Luftwaffe staff officers contributed as well. These are now held as the von Rhoden collection at the U.S. National Archives and Records Administration. This audiotape collection has been neither converted into written materials nor digitized for online access. Ergo, the von Rhoden sources are difficult to empirically analyze. Secondary era sources containing Luftwaffe personnel oral interviews and wartime diaries are utilized as primary sources due to their first person, wartime experience(s) content. Captured

[4]Joint Chiefs of Staff, *Joint Doctrine Note 1-18: Strategy*, I-3.

Luftwaffe glider training and recruitment films, translated and reproduced, are also used in a primary source capacity.

The First World War's combat casualty rates resulted from tactical incompetence and sheer incomprehension of the devastation possible from modern armaments. The 1916 Battle of the Somme saw the British suffer 58,000 casualties on the first day.[5] This engagement included a horse-mounted cavalry charge that German machine guns annihilated. Somme was lauded by British officers for the great bravery demonstrated by the English fighting man, noted especially for enduring artillery fire undreamed of before World War One.[6]

Stalemated trench warfare led to repeated frontal assaults that rapidly depleted the man power of each side. Germany's 1918 spring offensive inflicted 200,000 British casualties with 70,000 captured in sixteen days. French Prime Minister Georges Clemenceau was concerned that with Russia's collapse one million Imperial German Army troops would be freed to completely crush the western front.[7] The French and British 800,000 casualties from this offensive were offset by the American Expeditionary Force's arrival. Germany's 600,000 could not be replaced.

This level of carnage led political and military leaders alike to contemplate new ground warfare concepts. Winston Churchill served as the British Minister of Munitions from 17 July 1917 to 10 January 1919. He proposed on 21 October 1917 the use of airlifted troops, dubbed "flying columns" to fly behind the German lines, land, disembark, and assault them from the

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[5] A. V. Gompertz, "The Battle of the Somme," *Professional Memoirs, Corps of Engineers, United States Army and Engineer Department at Large* 10, no. 50 (March-April 1918): 235.

[6] Ibid., 245.

[7] The Earl of Derby to Mr. Balfour regarding the German offensive of 21 March 1918. This attack had pushed the British back and threatened the left flank of the French. *Confidential Print: First World War: General Correspondence [Part XI]* 1917-1918, Foreign Office. FO 438/11, United Kingdom National Archives.

rear.[8] This was not conceptualized solely from Churchill's tactical genius but from logistical necessity as Great Britain's industrial base was not forecasted to meet 1918's munitions requirements.[9]

General Billy Mitchell was head of the World War One American Army Air Service. The Meuse-Argonne offensive from 26 August to 11 November 1918 saw America incur 117,000 casualties from the 600,000 engaged. Mitchell designed, proposed, and got approval for a parachute drop behind enemy lines to mitigate such bloodshed. General Pershing had authorized Mitchell's bold scheme of maneuver to drop the entire U. S. First Infantry Division, the "Big Red One," from bombers to seize the fortress of Metz. The 11 November 1918 armistice was signed before Mitchell could implement his initiative.[10]

Churchill and Mitchell were advocating for a military concept known as vertical envelopment: a tactical maneuver in which troops, either air-dropped or air-landed, attack the rear and flanks of an enemy force, in effect cutting off or encircling the enemy force. It allows the ground commander the tactical versatility to threaten enemy rear areas, cause him to divert combat elements for rear area security, bypass enemy defenses, and increase mobility speed.[11] Aviation and airborne warfare were nascent technologies yet to be coalesced into a military ground force mobility, or movement, capability.

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[8] Major F. O. Miksche, *Paratroops* (New York: Random House, 1943), 3.

[9] Winston S. Churchill, *Munitions Possibilities of 1918,* 21 October 1917. CAB 24-30-36, United Kingdom National Archives.

[10] Lewis H. Brereton, *The Brereton Diaries* (New York: William Morrow, 1946), 309.

[11] United States Marine Corps, *Air Assault Operations* Marine Corps Tactical Publication 3-01B (Washington DC: Department of the Navy, HQ United States Marine Corps Combat Development Integration, 2019), 4-7.

During the interwar years, Allied air-landing concepts were conducted on a small-scale basis. American Major General Preston Brown experimented by air transporting a battery of field artillery from the Atlantic to the Pacific side of the Panama Canal in 1931. Brown proceeded in 1933 to move an entire artillery battalion by airlift.[12] Captain (later General) George Kenney air-landed an infantry detachment behind enemy lines during a 1932 maneuver exercise at Fort Du Pont, Delaware.[13] The British Army mimicked Kenney's action and moved an infantry battalion by air from Egypt to Iraq in 1932.[14]

These evolutions were reflective of the advantages and flexibility afforded the ground commander by vertical envelopment. Motorized, large capacity transport aircraft made it feasible to overcome vast distances quickly and increase mobility. While the Allies could practice these concepts, albeit on a reduced scale due to the military budgets of the Great Depression, Germany was restricted from having a military air corps. The 1919 Treaty of Versailles forbade Germany from having any motorized aircraft assigned to the military other than seaplanes for mine-sweeping duties.[15] There was no mention of sailplanes, or what came to be known as gliders.

Versailles's Article 198 inflamed young Weimar Republic Germans to spearhead the gliding and soaring initiatives of the 1920s. Recreational aviation gliding emerged as a German national sport. The Deutscher Luftsport Verband, or German Airsport League, envisioned a landing field and glider club in every German municipality. Militarily, the Treaty of Versailles handicapped Germany in the age of aviation but the Germans found ways to circumvent these

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[12] James A. Bassett, "Past Airborne Employment," *Military Affairs* 12, no. 4 (Winter 1948):207.

[13] John T. Ellis, Jr., *Army Ground Forces Study No. 25: The Airborne Command Center* (Washington DC: Historical Section Army Ground Forces, 1946), 1.

[14] Bassett, "Past Airborne Employment," 207.

[15] Treaty of Peace Signed at Versailles by the Allied and Associated Powers and Germany, 28 June 1919, Article 198, page 111.

restrictions through military aviation exercises concealed as leisure activities. Gliding proved essential to the Luftwaffe's covert establishment.[16]

German gliding transcended beyond a national pastime. It became international and was dominated by Germany in the 1930s. The National Socialist German Workers' Party (NSDAP or Nazi) harnessed it to cultivate nationalism. The Nazis strongly encouraged all young Germans to take up gliding. The Hitler Youth were allowed to commence initial gliding training at age 14.[17] Former members of the Imperial German Air Force, most notably Hermann Goering and his fellow World War One veteran and close friend, Luftwaffe General Kurt Student, visualized how gliders possessed distinct military capability.[18]

Political, economic, and socio-cultural dynamics unequivocally influenced the American and British interwar gliding endeavors. The strong economies of the 1920s coupled with the lack of political restrictions on military aircraft reduced gliding to minor, select aviation aficionados. It was a sport never taken seriously by the United States compared to Germany whose gliding clubs in 1926 accomplished 450 flights just in the month of September alone.[19] Lost in the prosperity of the Roaring Twenties was the Wright Brothers had, shortly after their revolutionary motorized flight in 1911, established the record for gliding duration with a nine minute and forty-five second flight. This record stood until 1922 when a German named Hentzen usurped it by

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[16] Peter Fritzsche, "Machine Dreams: Airmindedness and the Reinvention of Germany," *The American Historical Review* 98, no. 3 (June 1993): 688-702.

[17] Alan Lloyd, *The Gliders: The Story of Britain's Fighting Gliders and the Men Who Flew Them* (London: Leo Cooper, 1982), 12-13.

[18] Milton Dank, *The Glider Gang: An Eyewitness History of World War II Glider Combat* (Philadelphia: Lippincott, 1977), 21-23.

[19] Alexander Klemin, "Learning to Use Our Wings," *Scientific American* 137, no. 1 (July 1927): 73.

staying aloft for three hours and six minutes. Americans predominantly viewed gliding as an afterthought prior to the Great Depression.[20]

The 1929 Stock Market crash impacted the field of aviation to a lesser extent than other economic areas. Great Britain's 1931 civilian aviation sector accounted for 100,000,000 British pound equivalency in industrialized capital and employed 70,000 people.[21] In England, France, the United States and elsewhere, gliding was minimally embraced and casually pursued.[22] Germany remained the gliding vanguard. The Great Depression left a paucity of government funding for social recreation programs in England. This impacted the potential for cultural growth and interest in gliding. The British government annually funded only 5,000 pounds for the gliding movement in the 1930s.[23] American gliding efforts remained internalized to small, unsubsidized clubs and private owners. The NSDAP allocated 60,000 pounds yearly to German gliding clubs. German gliding societies achieved phenomenal performance accomplishments like Walter Dreschel's altitude record of 21,939 feet and Kurt Schmitt's flight duration record of 36 hours and 35 minutes.[24]

These milestones were viewed by some outside of Germany with trepidation. Churchill had ominous pre-suppositions about what he dubbed "German airmindedness." While the 1919 Treaty of Versailles restricted Germany's naval and army size, Churchill warned that air forces restrictions were easily obfuscated. There had been considerable growth in German commercial

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[20] Alexander Klemin, "Learning to Use Our Wings," *Scientific American* 139, no. 4 (October 1928): 373.

[21] N. A. V. Piercy, "The Present Position in Aeronautics: Lecture III," *Journal of the Royal Society of Arts* 79, no. 4114 (25 September 1931): 946.

[22] Ibid., 952-954.

[23] R. Kronfeld, "Gliding and Soaring," *Journal of the Royal Society of Arts* 87, no. 4523 (28 July 1939): 949.

[24] Ibid., 963-964.

aviation and a huge volume of Germans, both male and female, had participated in the glider clubs as early as 1924.[25] He warned that while Germany had not officially and transparently violated Article 198, their tremendous gains in civilian aviation technology, coupled with a voluminous cadre trained in aviation fundamentals from the gliding clubs, could easily and expeditiously reinforce and operationalize any covertly formed military air force.[26]

Airborne warfare, vertical envelopment, was on the precipice of becoming a reality. It represented a revolution in combat maneuver. Each nation which incorporated gliders designed, developed, and implemented them in contrasting ways. Glider borne forces, and how they were utilized, evolved across the duration of World War II as the strategic position(s) changed for Britain, Germany, and the United States.

[25] Winston S. Churchill, *The Second World War: The Gathering Storm* (Boston: Houghton Mifflin, 1948), 46-48.

[26] Ibid., 111-113.

Chapter One

Glider Military Emergence and Interpretations

10 May 1940 debuted glider vertical envelopment at the forefront of maneuver warfare. Operation Granite was the glider borne assault that captured the then considered impregnable Belgian fortress of Eben Emael in the opening moves of the Battle of France. Eighty-five Fallschirmjaegar (translated as hunters from the sky), German paratrooper engineers, conducted a precision glider landing on top of the fortress and secured it despite being outnumbered by almost a ten-to-one ratio.

Germany revealed within the first forty-eight hours that they had utilized a new method of attack executed by a hand-picked detachment of airmen commanded by just a lieutenant. Speculation was rabid as to what occurred and what the new method of attack entailed. News outlets proclaimed that Eben Emael fell suspiciously fast, and the Germans had some new, deadly unforeseen engine of warfare.[1] It was reported that neutral military attaches from Switzerland claimed the Germans had developed a nerve gas agent that rendered the Belgian garrison immobile.[2] The Luftwaffe had thrust glider borne forces and glider capabilities into the operational realm of World War II vertical envelopment.

The historiography established on World War II glider borne forces has focused on each respective country's utilization of gliders inside their unique doctrinal concepts of airborne warfare. Historians have, for the majority, assessed glider operations as abysmal failures outside of narrow aperture, pre-rehearsed commando raids. Some interpretations rapidly dismissed glider

[1] A. D. Emmert, "A Secret Weapon: Some of the Possibilities Suggested by the Fall of Eben Emael and Germany's Dark Reference to a New Instrument of Attack," *The Baltimore Sun,* 13 May 1940, p. 10.

[2] Robert Kleiman, "The Secret of Eben Emael: New Weapon is Explosive, Gas, or Propaganda Weapon Experts Believe," *The Washington Post,* 13 May 1940, p. 1.

programs as complete wastes of wartime resources and manpower. This consensus predominates across the scope of most historiographical reviews. There are, however, historical analyses that supported American, British, and German glider endeavors. These positions tend to be biased and nationalistic.

American interpretations began with Lieutenant General James M. Gavin's article "Airborne Armies of the Future" (April 1947) in the *Marine Corps Gazette.* Gavin was a para-trooper, the commanding general of the United States Army's 82NDAirborne Division during the Second World War, and at age 37 the youngest major general to command an American division in that war. He authored *Airborne Warfare* (1947) and *On to Berlin: Battles of an Airborne Commander 1943-1946* (1976). General Gavin argues that gliders were the key to airborne doctrine and tactics. The fundamental backbones of successful vertical envelopment assault were anti-tank defense and austere airfield engineering construction.[3] Gavin describes how an amphibious landing required a seaport for combat sustainability, and a ground division at least one quality road for a main supply route. Airborne divisions, on the other hand, required only an airfield to land supplies and reinforcements. Gliders carrying anti-tank capabilities, engineering assets, artillery, reconnaissance and mobility vehicles should be among the first airborne assets to land. Gavin writes that Americans piloting U.S. built Waco and British built Horsa gliders were highly successful in these heavy lift capacity roles.[4]

Samuel Lyman Atwood Marshall a retired Brigadier General of the United States Army Reserve and World War One combat veteran was recalled from his civilian journalist career to serve on the newly created U.S. Army's Center of Military History during World War II. Initially

[3] James M. Gavin, "Airborne Armies of the Future," *Marine Corps Gazette* 31, no. 4 (April 1947): 44-45.

[4] Ibid., 48-49.

assigned to the Pacific, he was transferred to the European Theater of Operations where he served as the chief combat historian. Marshall presents an American celebratory analysis of Allied glider design while declaring the use of gliders overall an unmitigated disaster in the Normandy invasion. This contradicted Gavin's combat subject matter expert account on gliders. Gavin formed his position from observations as he jumped into Normandy the night of 5 June 1944 while Marshall derived his from after action reviews. Marshall's *Night Drop: The American Airborne Invasion of Normandy* (1962) says that the glider units suffered so many casualties from the nighttime landings that they played no effective role, principally due to the British Horsa with its wooden design. The American Waco and its sturdier steel-tube frame enabled the American glider troops to land with fewer impact casualties.[5] Marshall reiterates this American glider design exuberance when he described the follow-on landings on 7 June 1944. Marshall deems these daylight landings catastrophic owing to the British Horsa design and that the American Waco's had greater survivability.[6]

Milton Dank's *The Glider Gang: An Eyewitness History of World War II Glider Combat* (1977) chronicles the Allies joint glider operations, but with an objective view of their efficacy. Dank, who flew Waco gliders for the 439TH Troop Carrier Group from February 1944 to June 1945, concedes that the American glider pilots did not favor the Horsa over the Waco.[7] He does not endorse Marshall's overly laudatory American position or argue over the glider contribution to World War Two airborne operations. He concludes *The Glider Gang* by posing the question

[5] S. L. A. Marshall, *Night Drop: The American Airborne Invasion of Normandy* (Boston: Little Brown, 1962), 84-85.

[6] Ibid., 105, 117-18.

[7] Milton Dank, *The Glider Gang: An Eyewitness History of World War II Glider Combat* (Philadelphia: J. B. Lippincott, 1977), 94.

upon the reader and posterity to determine if the price paid in glider pilot casualties and combat wrecked gliders was worth it.[8]

The venerable Stephen E. Ambrose founded the National D-Day Museum which subsequently morphed into the National World War II Museum. Addressing the operational results on 6 June 1944, Ambrose states in *D-Day June 6, 1944: The Climatic Battle of World War II* (1994) that American operations were a disaster that resulted from horrible intelligence, poor training, and even poorer operational planning. He completely refutes Marshall's analysis that it was glider design differences between the American Waco and British Horsa that resulted in a 16 percent glider casualty rate.[9] Ambrose correctly identifies this as a huge casualty rate for any type of unit to sustain before seeing combat but concurred with General Gavin's position in his "Airborne Armies of the Future" (1947) article that the anti-tank guns and jeep mobility assets afforded by those gliders were incalculable.[10]

The American scholar, anti-glider consensus interpretations expanded in the late twentieth and twenty-first centuries. Janet Bednarek is a professor of history at the University of Dayton and worked as an aviation historian for the United States Air Force. Her article for *Air Power History* "The American Combat Glider Program, 1941-1947: Damned Fool Idea" (1996) reflects that the United States glider program was doomed from its inception. There was absolutely no viable doctrine produced, no advocates within the political hierarchy of the U.S. military, and once funded was plagued by contractual waste, fraud, and abuse. Eleven companies were awarded Waco fabrication contracts, of which only four had ever built any type of

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[8] Dank, *The Glider Gang*, 258-60.

[9] Stephen E. Ambrose, *D-Day June 6, 1944: The Climatic Battle of World War II* (New York: Simon & Schuster, 1994), 218-221.

[10] Ibid., 222.

airframes. Bednarek even condemns S. L. A. Marshall's venerated Waco and contends the money, resources, and time would have been better allocated to more engine propelled airframes.[11]

Robert Guttman is a United States Merchant Marine Officer who writes historical articles for *Navy Times* and *Aviation History* magazine. He presents in "Costly Assault Vehicle" (2006) that the U.S. investment in producing 12,393 Waco's ensured that gliders would form a segment of Allied airborne forces, immaterial of their efficacy. Guttman follows the consensus that they were disastrous from inception. Starting with the invasion of Sicily in Operation Husky, 9 July 1943 through D-Day to Operation Market Garden in September 1944, Guttman reinforces Ambrose's analysis of poor intelligence, planning, and implementation leading the gliders to their fate. He also supports Bednarek's positions on construction/contractual errors resulting in mechanical catastrophes in all three major European operations.[12]

Stephan Wilkinson asserts that every large-scale operation undertaken by the Americans, and the British, was a total calamity in his article "One Way to Hell: Were Assault Gliders the Worst Idea of World War Two?" (2010). Wilkinson is a frequent writer for *Military History, Aviation History,* and *Smithsonian Air and Space.* It made no difference if the gliders were the American steel-tubed frame Waco or the wooden British Horsa. Gliders were placed into airborne divisions' inventories due to suppositions that glider infantry, unlike their paratroop

[11] Janet R. Bednarek, "The American Combat Glider Program, 1941-1947: A Damned Fool Idea," *Air Power History* 43, no. 4 (1996): 40-45.

[12] Robert Guttman, "Costly Assault Vehicle," *Aviation History* 16, no. 6 (July 2006): 43-45

brethren, needed no special training, arrived as a cohesive unit and not scattered, and brought jeeps and artillery.[13] These were the strong point lobbied by General Gavin in "Airborne Armies of the Future" (1947) and Ambrose in *D-Day June 6th, 1944: The Climatic Battle of World War II* (1994). Wilkinson states that the massive casualty rate was not offset by the anti-tank guns and jeep mobility provided through glider landings.[14]

The initial work on England's glider program was Ronald Seth's *Lion with Blue Wings* (1955). It provides a chronicle of the British Glider Pilot Regiment. It did not make a historical argument on glider forces, but it is considered the foundational work that initiated British glider historiography.[15]

A series of American and British scholars have analyzed Britain's glider program to explore similarities to the United States program. Doctrinal problems, military hierarchy apathy, and political infighting were just as common in England as in America. The British volume of work's limited compared to the American, yet an interpretation of British successful progression emerged.

Don Wyckoff was an enlisted, infantry United States Marine that received a battlefield commission while serving with the Seventh Marine Regiment in World War II. He ultimately retired as a full Colonel (O-6). Most glider literature focused on the European Theater of Operations, but Colonel Wyckoff's "Super Soldiers" (1963) applauds the British use of gliders in Burma. The Chindit Force, led by the eccentric Orde Wingate, conducted a large-scale glider

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[13] Stephan Wilkinson, "One Way to Hell: Were Assault Gliders the Worst Idea of World War II?" *Military History* 27, no. 2 (July 2010): 26.

[14] Ibid., 30.

[15] Alan Lloyd, *The Gliders: The Story of Britain's Fighting Gliders and the Men Who Flew Them* (London: Leo Cooper, 1982), 214.

assault using 100 gliders and 600 sorties of transport aircraft. Wingate put 12,000 men, a division sized unit, behind the Japanese lines while simultaneously striking them from the front in a classic hammer-and-anvil maneuver.[16]

Dank's *The Glider Gang: An Eyewitness History of World War II Glider Combat* (1977) addresses the foundational glider problems within the British military. Initiated by Winston Churchill, due to Germany's Eben Emael glider success, in a 22 June 1940 prime minister edict, the glider pilots would operationally belong to the British Army. The Royal Air Force would control glider pilot training and tow plane support. Both services had a lukewarm, at best, reception to this decree.[17] The Royal Air Force was desperate to increase its fighter and bomber strength. Post-Dunkirk, the British Army's center of gravity was on reequipping and preparing for the perceived eminent German invasion of the British Isles.[18] This caused considerable delays, initially, in bringing glider capability online. The British eventually fielded two airborne divisions with integrated glider doctrine after Hitler shifted his strategy to Russia post Battle of Britain.[19]

Alan Lloyd joined the British Army in 1945 before his civilian writing career. In *The Gliders: The Story of Britain's Fighting Gliders and the Men Who Flew Them* (1982), he reinforced Colonel Wyckoff's analysis of Wingate's large-scale glider operation success in Burma.[20] Lloyd presents an antithesis to Marshall by describing the British glider landings at

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[16] Don P Wyckoff, "Super Soldiers." *Marine Corps Gazette* 47, no. 11 (November 1963): 26-28.

[17] Dank, *The Glider Gang,* 29.

[18] Ibid., 30.

[19] Ibid., 94.

[20] Lloyd, *The Gliders,* 68.

Normandy as unequivocal successes that resulted in their extensive use in Operation Market Garden.[21] The problem with the American landings was not Marshall's Waco versus Horsa issue. Dank concurs with Ambrose's analysis of poor intelligence and even poorer American operational implementation owning to topography. The British zone in east Normandy had favorable gliding landing zones, due to better reconnaissance, while the American zone in the west was congested with the now infamous bocage hedgerows that tore gliders apart.[22]

Ambrose's *Pegasus Bridge: June 6, 1944* (1985) and *D-Day June 6th, 1944: The Climatic Battle of World War II* (1994) resonate with high praise for British glider performance. The coup de main glider assault that seized the Caen Canal bridge at Benouville was proclaimed by Ambrose as the greatest feat of arms in the entirety of World War II. Had those glider borne troops suffered mission failure, the Normandy beachheads would have been opened to three German panzer divisions whose onslaught could have portended the failure of the entire invasion.[23] British gliders were doctrinally utilized like the Americans': to reinforce previously dropped paratroopers, bring in anti-tank guns and field artillery, and deliver jeeps for ground mobility. The British, though, selected better landing zones clear of any bocage hedgerows. This was due to better aerial photographic reconnaissance and operational planning. Ambrose notes this allowed sixty-nine gliders of the British 6TH Airborne Division safe landing; with forty-nine precision landings in the correct zone, in the dark at 0300 6 June 1944.[24]

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[21] Lloyd, *The Gliders,* 101.

[22] Ibid.

[23] Stephen E. Ambrose, *Pegasus Bridge: June 6th, 1944* (New York: Simon & Schuster, 1985), 181-183.

[24] Ambrose, *D-Day June 6th, 1944: The Climatic Battle of World War II,* 219.

John William Greenacre was a British Army Air Corps reconnaissance helicopter pilot commissioned in 1988. In *Churchill's Spearhead: The Development of Britain's Airborne Forces in World War II* (2010), he analyzes the British airborne forces, including glider formations, from infancy to the war's completion. Greenacre focuses on an empirical, unbiased analysis over five core areas that synergistically impacted glider operations, resisting the overly pro-glider perspective. Politics, technology, personnel and their training, command principles, and doctrine are Greenacre's focus. Overall, the British used a "bottoms up – we'll build it as we fly it" method that did quickly implement airborne warfare. This methodology lacked institutional backing, solid doctrine, and did not invoke hierarchical systemic change necessary to fully implement vertical envelopment in World War II.[25] Greenacre posits that while British glider forces had tactical successes, these shortfalls inhibited their maximum effectiveness.

Military historiography has frequently tended to be concerned, and biased, toward one contingent in topics that are multi-faceted. This premise has held true when discussing the van-guard of not just glider combat applications, but vertical envelopment as a revolution in military affairs. The World War II German Luftwaffe implemented the first operational, combat vertical envelopment forces. They have been deified and overly celebrated, as a consensus, across the scope of literature.

Richard Eells served during World War II in the United States Army Air Forces. He then went on to become the chief of the aeronautics division at the Library of Congress. His article "Aeronautics" (1949) discusses how this consensus began concerning the Luftwaffe. Most of what was recorded did not come from basic source materials. Dispersion of records, especially

[25] John William Greenacre, *Churchill's Spearhead: The Development of Britain's Airborne Forces During World War II* (London: Pen & Sword Aviation, 2010), 200-204.

on the Eastern Front, as Germany retreated and fires from Allied bombings destroyed records that would have been valuable for historical reconstruction. A fire in Vorderriss, Bavaria alone lost 250,000 Luftwaffe documents in May 1945.[26]

James H. Tate received an Army commission as an infantry lieutenant upon graduation from the University of Georgia, May 1942. He was wounded in France, July 1944 and recalled to active duty for the Korean War where he served as a public information officer at the United Nations Korean Armistice Conference. Tate continues the German adulation in his article "Air-borne Training" (1955). He declares that gliders were an important part of German airborne success in the invasions of Holland, Belgium, and Crete. They had initiated military glider training in 1937 and their unbridled accomplishments drove the Allies to respond by establishing their own glider forces.[27]

Peter Fritzsche is the W. B. & Sarah E. Trowbridge professor of history at the University of Illinois and has authored ten books. His article for *The American Historical Review* "Machine Dreams: Airmindedness and the Reinvention of Germany" (1993) agrees that Germany had great glider forces as part of a dominant air force. What Hitler called "chains of Versailles" led German society toward embracing alternative aviation concepts like sailplanes, or gliders.[28] 60,000 young Germans earned gliding licenses in the 1930s. Fritzsche correlates this into the great German aviation successes in the early year of World War II.[29]

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[26] Richard Eells, "Aeronautics," *Quarterly Journal of Current Acquisitions* 6, no. 4 (August 1949): 46-47.

[27] James H. Tate, "Airborne Training," *Ordnance* 39, no. 208 (1955): 561-62.

[28] Frtizsche, "Machine Dreams: Airnindedness and the Reinvention of Germany," 691-693.

[29] Ibid., 700-702.

William H. McRaven is the current University of Texas president, was the commanding officer of Joint Special Operations Command for Operation Neptune Spear – the raid that killed Osama bin Laden and is a retired Navy SEAL Admiral. In his work *Spec Ops Case Studies in Special Operations Warfare: Theory and Practice* (1996), McRaven counters Ambrose's view that the British seizure of Pegasus Bridge was World War II's greatest feat of arms. He instead bestows that title on the German glider borne seizure of Fort Eben Emael. Admiral McRaven attributed this success to superior German glider design, pilot and glider troop training standards, and German operational doctrine.[30]

Free lance journalist and author Greg Annussek argues in *Hitler's Raid to Save Mussolini: The Most Infamous Commando Operation of World War II* (2005) that Operation Oak was the greatest Second World War feat of arms. Operation Oak was the German glider raid that rescued Benito Mussolini from his Gran Sasso mountain hotel prison on 12 September 1943. He follows suit with Ambrose and McRaven in praising the gliders' abilities to facilitate the swift insertion of troops with precision. Annussek also contends that gliders were representative of early stealth technology as they were virtually silent on approach after being released from their tow plane(s).[31]

These accomplishments were mere small-scale commando raids using gliders argues Bernd Horn in "The Airborne Revolution" (2005). Horn is a retired Canadian Army infantry Colonel, author, and military history teacher. His article for *The Quarterly Journal of Military History* counters that these typified German triumphant interpretations are inherently flawed. He

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[30] William H. McRaven, *Spec Ops Case Studies in Special Operations Warfare: Theory and Practice* (Novato, CA: Presidio Press, 1996), 62-68.

[31] Greg Annussek, *Hitler's Raid to Save Mussolini: The Most Infamous Commando Operation of World War II* (Cambridge, MA: Da Capo Press, 2005), 203-207.

states that while these irrefutably were outstanding special operations raids, Germany only conducted one conventional, large battle with gliders. Operation Mercury, the purely airborne invasion of Crete 20 May 1941 – 1 June 1941 had a fifty eight percent casualty rate that drove Hitler to forbid any further large vertical envelopment operations.[32] The fact that purely air landed troops took a well defended island, with no supporting amphibious assault, and no German Navy gunfire support had the opposite effect on the Allies. Eben Emael's glider seizure had stoked the Allies' imagination to use gliders only in the same limited raiding capacity. Horn's analysis is that Crete initiated their development of the large airborne vertical envelopment potential in maneuver warfare.[33]

Glider borne forces were a component in the vertical envelopment emerging technology of World War II. They represented a significant change in how ground commanders could leverage the third flank, the overhead one, to conduct kinetic strikes at the tactical, operational, and strategic levels of war. How the respective belligerents implemented this change lends important lessons to the modern military leader on what works, and equally important, what doesn't work when conducting technological changes in warfare. This is arguably more crucial now than in World War II as industry changes occur so frequently. Chapter 2 will analyze the German glider program. Chapter 3 will cover the Allies, Great Britain and the United States, from 1940 through 1942, while Chapter 4 examines the Allies from 1943 through the war's conclusion.

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[32] Bernd Horn, "The Airborne Revolution," *The Quarterly Journal of Military History* 17, no. 4 (2005): 68-70.

[33] Ibid., 71.

Chapter Two

Fallschirmjager und Flieger Korps – German Foundations

German culture embraced aviation possibilities in the 1870s. Chancellor Bismarck's Prussian generals first considered the third flank, the overhead one, and aerial weapon delivery during the Franco-Prussian War of 1870.[1] What Churchill dubbed German airmindedness during the 1920s and 1930s had its foundation laid by nineteenth century Prussian army generals. German society post-Treaty of Versailles championed aeronautical endeavors, and sport gliding particularly, as a means of cultural pride and rejuvenation. The NSDAP eventually harnessed this gliding passion to infuse virulent nationalism, increase military spending, and overhaul German society's educational systems to facilitate technological and military advances.

The German populace desired rearmament with a strong military aviation component prior to Hitler assuming power in 1933. The First World War's zeppelin and airplane bombings caused German pre-suppositions of heightened destruction in future conflicts. Aviation's continued growth in potential military applications contributed directly to this fear.[2] 1920's air power advocates Giulio Douhet (Italy), Lord Trenchard (Britain), and General Billy Mitchell (USA) academically theorized how air power would undermine civilian will and government support by directly bombing population centers and sewing panic. These foreign, WWI Triple Entente allies highlighted civilian vulnerability to strategic bombing: bombing designed to shatter civilian morale.[3] Mitchell and Churchill saw the sky in World War One as a military maneuver possibility to overcome stalemated trench warfare. Weimar Germany, totally

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[1] Eells, "Aeronautics," 47.

[2] Fritzsche, "Machine Dreams: Airmindedness and the Reinvention of Germany," 685.

[3] Ibid., 689.

forbidden by Versailles' Article 198 from having any military aviation component, culturally viewed the sky as an avenue that left them completely open to foreign subjugation by air power.

Germany demanded equality in disarmament by the early 1930s. The German position was the perceived non-compliance by the Triple Entente victors with their own politically mandated self-disarmament. Universal disarmament was the fundamental precept of Woodrow Wilson's Fourteen Points, Article V of the Treaty of Versailles, and the League of Nations Covenant. Germany had acquiesced and complied completely while the Allies continued military procurement.[4]

The German government insisted on the disarmament goals set in the Versailles Treaty. They mandated all states execute disarmament using the same basis and methodology. Germany viewed disarmament as the complete abolition of offensive weaponry. France and Great Britain had maintained acquisition of weapon systems forbidden to Germany between 1919 and 1931: heavy artillery, tank, submarine, and military aviation platforms[5]. Germany abided Woodrow Wilson's fourth Fourteen Points precept and maintained a restricted armament program that only ensured internal security.[6]

This armament imbalance in the early 1930s air age created a German cultural mindset of jeopardy. Yet, it served as an opportunity for national renewal. Germans envisioned aviation, in all forms, as a highly poignant symbol of potential resurgence.[7] This ideal was culturally and

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[4] Otto Hoetzsche, "The German View of Disarmament: An Address Given at Chatham House on 17 November 1931," *International Affairs (Royal Institute of International Affairs 1931-1939)* 11, no. 1 (January 1932): 40.

[5] Ibid., 46-48.

[6] Woodrow Wilson, *The Fourteen Points: An Address to a Joint Session of Congress*, 8 January 1918.

[7] Shepard Stone, "The Rearming of Germany," *Current History (1916-1940)* 39, no. 3 (December 1933): 299.

technologically in place prior to the Luftwaffe's official formation in 1935.[8] The S.S. established a sport-aviation (gliding) corps modeled from the civilian Deutscher Luftsport Verband (German Airsport League) in 1933.[9] Goering, Reich Minister of Aviation, poured state sponsored political and financial support into the Deutscher Luftsport Verband. The German Airsport League used this Nazi subsidization to steadily advance toward their stated goal of a gliding club in every community.[10]

German commercial aviation assets pre-Luftwaffe were highly advanced and designed to transform rapidly into bombers and military transports. This was foundational to German military glider successes. A fully combat loaded glider required a towplane engineered to provide enough lift to get it airborne. Furthermore, towplanes required the range and fuel efficiency to reach designated altitudes and release point distances.[11]

Germany raised military economic expenditures before Hitler's 1933 chancellorship. The 1931 German government allocated 6,000,000 equivalent British pounds of deutschmarks to its Treaty of Versailles mandated 100,000 strong army. Great Britain, conversely, spent 4,000,000 pounds in the same year on a British Army that was fifty percent larger. That German figure was 60% larger than Kaiser Wilhelm's 1913 Imperial German Army budget, yet the Kaiser's army numbered 500,000.[12]

Hitler's accession increased defense spending while the NSDAP effectively controlled the German media's ability to report it. The Nazi's spent an estimated 678,200,000 deutschmarks

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[8] Fritzsche, "Machine Dreams," 692-693.

[9] Stone, "The Rearming of Germany," 297.

[10] Fritzsche, "Machine Dreams," 702.

[11] Stone, "The Rearming of Germany," 298.

[12] Ibid., 296.

in 1933 for the German army and navy. This was supposedly funding the limited 100,000 personnel army and a navy authorized to have no vessel exceeding 10,000 displaced tons. The European nations, particularly those granted their borders by the Treaty of Versailles, began to view a rearming, Nazi-led Germany with heightened apprehension.[13]

Educational reorganization was a key NSDAP objective. The Nazi regime revamped all educational systems on Wehrinstinkt: the instinct of war for national defense. This ideal was perceived as the foundational basis of the Fascist state.[14] It was applied to curricula at primary schools, secondary schools, and universities. Air power was seen as critical to the survival of Nazi Germany. Accordingly, the Reich Ministry of Education issued a 17 November 1934 decree that mandated teaching aviation in all schools[15].

Youth school leisure activities were redefined and instituted as Wehrsports, or military sports.[16] The German Airsport League glider clubs were a classic Nazi Wehrsport. They taught theoretical aerodynamics, aviation specific meteorology, and aerial navigation principles.[17] Sport gliding enhanced and cultivated the Nazi valued traits of service and sacrifice. Teamwork was essential to this Wehrsport. It required a crew of six to eight working in close coordination to launch a glider manually without the support of a towing vehicle or towplane.[18] Fascist National Socialism emphasized national strength in unity. Mussolini stated everything within the state,

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[13] Stone, "The Rearming of Germany," 296.

[14] I. L. Kandel, "Education in Nazi Germany," *The Annals of the American Academy of Political and Social Science* vol. 182 (November 1935): 158-162.

[15] Fritzsche, "Machine Dreams," 702.

[16] Kandel, "Education in Nazi Germany," 160.

[17] Fritzsche, "Machine Dreams," 700-702.

[18] Ibid.

nothing is outside the state, everything done is for the state. The Nazis expanded Il Duce's concept to encompass cultivating teamwork, unity, and national cohesion through the educational reforms of Wehrinstinkt and Wehrsports.[19]

The Nazis purged university professors labeled with supposed politically objectionable tendencies. In reality, the Reich regarded these professors non-Aryan under German racial purity laws. German university science departments lost forty-four percent of their cumulative professors between 1933-1937.[20] Student enrollment declined in German university engineering, science, and mathematic programs with Nazi educational reforms. The 1932-33 fall semester saw 14, 477 engineering and 12, 591 mathematics and natural science enrollees. The 1936 fall semester enrollments declined to 7,649 in engineering majors and 4,616 in math and natural sciences.[21]

The NSDAP promulgated the Wehr prefix throughout the German university system. Physics became Wehrphysik. The University of Berlin renamed its science department the Wehrtechnike on 26 November 1937. Nazism embraced and supported science for its military application potential, not for the intrinsic value of scientific advances.[22] Higher educational institutions were deprived of any semblance of academic freedom and objectivity. Nazism relegated science to Wehrtechnike and state mandated servitude.[23] Nazi-controlled academic

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[19] Thomas Woody, "Principles of Totalitarian Education," *Proceedings of the American Philosophical Society* 82, no. 1 (23 February 1940): 45-50.

[20] E. Y. Hartshorne, "The German Universities and the Government," *The Annals of the American Academy of Political and social Science* 200, (November 1938): 222.

[21] Ibid., 224.

[22] Ibid., 225-227.

[23] Kandel, "Education in Nazi Germany," 162.

planning boards created the Wehrwissenschafts, or defense science majors, with aeronautics, including glider design, being among the first curriculum implemented.[24]

In a decree on 30 January 1933, Hitler declared himself Reichs-Chancellor with supreme control over the Heer (German army) and Kriegsmarine (German navy). German National Socialism centered on the Leader. Its totalitarian political nature meant that no status based upon specialized technical achievement was accorded unless it had Hitler's sanctified approval. The Reichs-Chancellor was the genius in all state activity, especially the military. The senior officers were mere analysts and consultants. Within German Nazism, the Leader delegated limited, high-level authority to followers that had only proven their fealty through complete acquiescence.[25]

The NSDAP political system afforded the Luftwaffe more autonomy in glider design, military experimentation and personnel selection than the Heer and Kriegsmarine. Hermann Goering was the President of the Reichstag, the number two political position behind Hitler, when the Reich-Chancellor made him the senior Luftwaffe military officer. Goering had also been serving as Reich Minister of Aviation. Nazi Germany established the Luftwaffe on 26 February 1935. This unique political situation allowed the Luftwaffe, with its senior military officer the number two Nazi politician, certain advantages over the Heer and Kriegsmarine.[26]

Nazism created the Luftwaffe with a unique cross-functionality between the NSDAP and the German armed forces. The German cultural aviation obsession and the National Socialist behavioral traits German society displayed through the Wehrsport gliding clubs gave Hitler

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[24] Hartshorne, "The German Universities and the Government," 226.

[25] Hans Gerth, "The Nazi Party: Its Leadership and Composition," *American Journal of Sociology* 45, no. 4 (January 1940): 519-520.

[26] Ibid., 522.

confidence to empower Goering with near complete autonomy in building the Luftwaffe.[27] Goering's political clout built the Luftwaffe as a volunteer force. Luftwaffe personnel were highly screened and selectively chosen based off physique, morale, and high aviation subject scores in the classroom and the gliding clubs. These criteria enabled the Luftwaffe's dominant combat performances early in World War Two. This included highly successful glider borne operations.[28]

Germany developed the first combat glider technology by synthesizing a military focused education system, an aviation obsessed populace, and increased military expenditures. The Nazi military defense budget increased proportionally with the Luftwaffe's emergence. 1932 Germany had a 58 million deutschmark gross national product with one percent defense spending.[29] Nazi Germany raised 1935 military expenditure to eight percent of a 74 million gross national product. This did not include camouflaged, extra-budgetary allocations that were revealed at the Nurnberg trials.[30] British and American 1935 defense spending was two percent and one percent, respectively, of their gross national products.[31] These Allies continued to lag in 1938 in which Germany raised military spending to 17 percent of its gross national product.[32]

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[27] Norman W. Caldwell, "Political Commissars in the Luftwaffe," *The Journal of Politics* 9, no. 1 (February 1947): 59.

[28] Ibid., 59-60.

[29] Swiss Federal Statistical Office, *Statisticher Jahrbuch 1935,* (Neuchatel: Switzerland, 1935), 423-427.

[30] Walter Genske, *Nurnberg Document Schwerin-Krosigk # 324,* 1947. Genske was a senior official in the Third Reich Finance Ministry. He provided in an affidavit at the Nurnberg Trials that extra defense spending was allocated, and hidden, toward the Luftwaffe. This was an open violation of the Treaty of Versailles that Hitler wanted to keep secret until he had the necessary military power to prevent the Allies from using armed intervention to enforce Versailles' tenets.

[31] League of Nations, *Armaments Yearbook* (Geneva: Switzerland, 1935): 784, 856.

[32] Genske, *Nurnberg Document Schwerin-Krosigk # 324.*

Britain increased 1938 military spending to 8 percent while America continued to stagnate at 1 percent.[33]

The Luftwaffe conducted military testing of the DFS 230 combat glider in 1938. This glider was designed at the Deutsche Forschnungsantalt Fuer Segeflug (DFS), an affiliate of the Rhoen Aviation Research Institute. Hanna Reitsch, the infamous German aviatrix, conducted the first DFS 230 test flight in late 1937.[34] DFS derived the parameters from a three-person meteorological observation glider produced in 1932.[35] The 230 had one pilot and carried 2,800 pounds: nine fully loaded combat troops or equivalent cargo loads like anti-tank guns and motorcycles.[36] Its design was a steel tubing framework fuselage and high-set, thick stressed plywood wings. The wings were a unique German technological advancement. Aeronautical engineers had largely dismissed thick wing designs that were thought to have high drag to lift ratios, regardless of material composition. German aircraft designers Junkers and Fokker disproved this postulate. They discovered using thick wood wings provided improved drag to lift rations while reducing overall glider weight.[37]

The DFS 230 design displayed versatility in take-off and landing. The pilot would jettison a wheel carriage used for take-off if the landing zone was short or confined. The glider then landed on a central undercarriage ski. This ski ran from the nose down the centerline to the

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[33] League of Nations, *Armaments Yearbook* (Geneva: Switzerland, 1938), 171, 881.

[34] James N. Mrazek, *Fighting Gliders of World War II* (New York: St. Martin's Press, 1977): 29.

[35] Ibid., 24.

[36] Ibid., 29.

[37] N. J. Hoff, "A Short History of The Development of Airplane Structures," *American Scientist* 34, no. 3 (July 1946): 371-374.

midway point.[38] The 230's lightweight and wing design allowed towing by multiple Luftwaffe airframes. These included transport aircraft (JU-38, -52, -53, -90, FW 200), medium and heavy bombers (ME 110, HE 111), air superiority and fighter-bombers (JU-87, ME 109.)[39]

As a rapid combined arms doctrine, blitzkrieg drove German technological change in gliders. Operation See Lowe, or Sea Lion, was the German plan to invade Great Britain in 1940. The airborne assault portion required glider cargo capacities beyond the DFS 230. German military planners ascertained mission failure without immediate availability of glider borne heavy weaponry: panzers (tanks), self-propelled guns, and the ubiquitous German 88-millimeter artillery piece.[40] Hitler indefinitely postponed Operation Sea Lion in October 1940. However, the demands of the proposed invasion drove German aeronautical engineering to provide two answers to its airborne tactical problem: the Gotha GO 242 and the Messerschmitt ME 321 Gigant (Giant).

Gotha's 242 moved critical logistics, trucks, and field guns for Rommel's Africa Korps and on the Eastern Front. This glider carried 8,000 pounds of cargo or twenty-three troops. It overcame the great distances required for logistical mobility in the North African deserts and Russian steppes. The Gotha incorporated the 230's droppable wheel undercarriage and had skids upfront and in the middle. A plough was used to brake the glider quickly in confined landing zones. This adaptation proved useful as the GO 242 successfully resupplied encircled Wehrmacht units in Russia.[41] The Gotha was crewed by a pilot and co-pilot. Size and cargo

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[38] Mrazek, *Fighting Gliders of World War II,* 29.

[39] Mischke, *Paratroopers,* 80.

[40] Mrazek, *Fighting Gliders of World War II,* 37.

[41] Ibid., 32-37.

weight (15,000 pounds combined maximum) limited its towplanes to the JU-52 transport or HE 111z bomber. These heavy lift capable airframes still needed assistance in safely getting a loaded Gotha aloft. German technological innovation contributed by attaching a bank of four rockets to the Gotha's rear fuselage, fired during take-off for additional thrust.

Messerschmitt's Gigant was the largest operational glider ever constructed. It's unloaded weight was 26,000 pounds. It required a runway of 4,000 feet with no cargo. The four-engine JU-90 transport was required to get it aloft empty. These were few in number and could not lift a loaded ME-321. The Gigant weighed 70,000 pounds fully loaded. It carried a heavy tank, an 88-millimeter artillery piece with its towing vehicle, or 200 troops.[42]

Messerschmitt developed a towing system combining three independently rigged ME 110 bombers, launched simultaneously, that finally achieved loaded Gigant lift. This method lost valuable airframes and pilots in testing. Eight rockets, attached to the Gigant, were required to assist the ME 110s. A special towplane was built to overcome the problem, the Heinkel 111z. This aircraft was two twin-engine Heinkel 111 bombers joined together with a fifth engine in the middle. It was flown by two full crews, one in each respective aircraft, from either cockpit. This design proved successful in getting the massive ME 321 aloft. Few in number, it served solely on the Russian front to move men and materials.[43]

German technology led to phenomenal glider advancements. Germany pioneered using rockets for glider take-off assists and landing braking systems. They deployed the first parachute brake: a parachute at the end of a glider's fuselage, initiated by the pilot that allowed precision landings in narrow areas. The Luftwaffe considered all gliders, regardless of role, combat

[42] Mrazek, *Fighting Gliders of World War II,* 39-40.

[43] Ibid., 38-42.

aircraft. They were the only military that armed each glider with machine guns: one for the DFS 230, two for the GO 242, and eight on the ME 321.[44] Germany leveraged its political, economic, societal, and cultural base to field the world's first combat gliders. Like all military technological changes, German gliders required proper operation and warfare integration for success. Doctrine and training drove the Luftwaffe's early glider achievements.

Clausewitz said that war was a reflection of the society(ies) that waged it. Luftwaffe glider troops displayed this axiom. Germany's glider borne forces were unique in several respects. First, Goering's position allowed the Luftwaffe its own organic ground combat elements, the Fallschirmjager divisions, that were separated from the Heer (army). This doctrinal organization prevented some of the early issues faced by the Allies who suffered from conflict between departments and commanders in coordinating land-air operations. The Fallschirmjager did not compete with another service branch for air assets. Second, they were double volunteers: first for the Luftwaffe (and its aforementioned stringent standards) and then for the Fallschirmjager. Third, their training regimens were demanding and arduous. These combined factors produced an elite force.

The Luftwaffe formed the First Fallschirmjager regiment (1FJR) in 1938. It consisted of three maneuver battalions plus a regimental headquarters (HQ) section, regimental signal (communications) platoon, medium field artillery (75 millimeter) company, and the Pionier (combat engineer) platoon. Each battalion had three companies, battalion HQ element, signals squad, and a heavy weapons company: two heavy machine gun (HMG) platoons totaling eight MG-34s and two heavy mortar platoons totaling four 81-millimeter mortars. The FJR company had three platoons, company HQ and signal squad. FJR platoons comprised a small HQ, 50-

[44] Mrazek, *Fighting Gliders of World War II*, 58-62.

millimeter light mortar squad, 37-millimeter anti-tank gun team, and three light machine gun (LMG) squads with supporting riflemen. The LMG squads each had two MG-13 (later updated to the MG35/36). Fallschirmjager doctrine had the LMG as the principal maneuver element within a squad. The riflemen supported the LMG. This was not the case for the Allies. The Allied riflemen were the maneuver element while the squad automatic weapons, the Browning Automatic Rifle (U.S.) and Bren (Great Britain) provided support.[45]

Germany fielded three separate FJRs by March 1939. General Kurt Student consolidated them into Sieben Flieger-Division (Seventh Air Division) and added a signal battalion, medical battalion, and divisional support elements.[46] Student permanently assigned four air transport groups to Sieben Flieger-Division in February 1941. This formed the XI Flieger Korps (Air Corps). The Luftwaffe supported vertical envelopment prior to XI Flieger Korps with Transport Group One. Possessing organically assigned air transport for training and operations proved instrumental in early German airborne success.[47] This organic attachment of support aircraft was in stark contrast with the challenges faced by Allied planners, which will be discussed in Chapters 3 and 4.

The XI Flieger Korps had 848 dedicated JU-52 transport aircraft. JU-52s served as glider towplanes, parachute transports, and air-landed German Army conventional units, equipment or supplies. Each air transport group had four wings with four squadrons per wing. The Luftwaffe

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[45] Miksche, *Paratroopers,* 23-24.

[46] Ibid., 25.

[47] War Department, *Special Bulletin No. 35 G-2 Battle of Crete* (Washington, DC: Military Intelligence Division, 1941), 24. All material from this source was from a report submitted 7 June 1941 by an American intelligence official in Cairo. This information was obtained by British interrogation from a 25-year-old German glider pilot captured at Canea, Crete on 20 May 1941,

doctrine assigned twelve JU-52s per squadron, plus five more in a HQ squadron. Therefore, each wing had 53 transport planes, each group 212, and the Flieger Korps 848.[48]

Fallschirmjager doctrine designated the parachute battalion as the largest maneuver element. However, Luftwaffe planners' task-organized the Fallschirmjager based off mission requirements. They designed force sizes and skill compositions to meet unique operational tasks.[49] Ergo, Fallschirmjager fought division sized engagements and conducted small, commando raids.

The Germans realized early and rapidly that glider borne forces were unique. They were neither flying soldiers nor airmen assigned a special duty. They represented new ground combat maneuver elements that required training and integration into the new German maneuver warfare, blitzkrieg. The Academy of Air Warfare (Luftskriegacademie) established the Fallschirmjager basic combat school in 1937. It accepted only volunteer men with no physical defects, high intelligence, and great academic achievement. They underwent basic and advanced infantry, demolitions, language, map-reading, and riverine operations.[50]

Kurt Schultz recalled how instructors drilled personnel to their physical limits. Classes commenced with 100 men for eleven weeks. Pass rates rarely exceeded 30 men. Weapons training qualified all graduates in rifles, pistols, machine pistols, light machine guns, heavy machine guns, light and heavy mortars. Medical personnel had to complete the weapons portion twice.[51]

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[48] War Office, *Notes on the German Army No. 38: XI Corps and the Attack on Crete* (London: The War Office 20 March 1942), 17.

[49] War Department, *Special Bulletin No. 35 G-2 Battle of Crete*, 20.

[50] Miksche, *Paratroopers*, 18-21.

[51] Greg Way, *Fallschirmjager!: A Collection of Firsthand Accounts and Diaries by German Paratrooper Veterans From the Second World War* (Warwick, U.K.: Helion & Company, 2019), 26-28.

In an interview given by Karl-Heinz Pollman, recruits also completed parachute and job training after the basic combat course. These proved academically and physically challenging. Fallschirmjager Pioniers (combat engineers) had advanced demolition, construction, bridge fabrication, and heavy equipment operation tests. The physical test required passing a full combat load 30-kilometer march.[52] Medics received basic and advanced training, including field (outside of a medical facility) surgery techniques. They had to perform, if required, as the only medical provider in austere environments.[53] The Luftwaffe cross-trained personnel outside of their primary specialty. Medic Sebastien Krug stated he completed sniper and assault engineer courses.[54] Job training specialty courses emphasized night exercises which focused on hand sketched map navigation and small unit combat maneuvers.[55]

Germany utilized parachutists as primary glider troops. Fallschimrjager Kurt Englemann told how his unit commenced glider training in the DFS 230 on 16 June 1938.[56] The Luftwaffe did land conventional Heer units by glider as follow on reinforcements. However, Fallschirmjager exclusively conducted precision glider commando raids and initial mass vertical envelopment attacks. German generals felt airborne operations required highly trained, specialized men. They had to be purely volunteers, tough and eager for action, and outfitted with the best equipment. Thus, FJRs trained for both parachute and glider landings.[57]

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[52] Way, *Fallschirmjager!*, 135.

[53] Ibid., 28.

[54] Ibid., 98.

[55] Martin Poppel, *Heaven & Hell: The War Diary of a German Paratrooper* (Kent, U.K: Spellmount Limited, 1988), 10-17. Translated from German by Dr. Louise Willmot.

[56] Way, *Fallschirmjager!*, 148.

[57] Generalleutant Werner Ehrig et al., *Airborne Operations: A German Appraisal* (Washington, DC: United States Army Center of Military History Publication 104-13, 1951), 43-50.

The Luftwaffe rapidly produced high-caliber glider pilots. Volunteers entered the German Air Force standard pilot pipeline. Those with gliding experience from the clubs and Wehrsports transferred from power-driven aircraft to an accelerated six-week military glider course.[58] They started immediately on operational flying. They specialized in perfecting diving angles and precision landings on confined areas.[59] The eleven-week Fallschirmjager basic combat school followed Luftwaffe glider pilot training. The pilots trained to fight as infantry after landing.[60] The Americans did not adopt this until after Normandy, while the British conducted it from inception in their Glider Pilot Regiment.[61] Luftwaffe glider pilots performed as combat multipliers: precision pilots that also fought as elite infantry.

Operation Weiss commenced on 1 September 1939. The Germans invaded Poland using combined arms warfare labeled blitzkrieg, or lightning war. Military leaders have historically resisted technological change. Tactics, techniques, and procedures untried by combat provided an ambiguous, gray realm. The German High Command reflected this atypical mindset in planning Operation Weiss. They designated the FJRs as strategic reserves, with 250 JU-52s allocated for parachute operations. The operational plan (OPlan) and order of battle (OOB) omitted gliders.[62]

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[58] War Office, *Notes on the German Army No. 38,* 38. The German glider prisoner of war confided that he started flying gliders at age 15, 1931. The NSDAP accelerated German Airsports League (DVL) with funding.

[59] War Department, *Special Bulleting No. 35 G-2,* 27-28.

[60] War Office, *Notes on the German Army No. 38*, 38-39.

[61] George Chatterton, *The Wings of Pegasus: The Story of the Glider Pilot Regiment* (London, Macdonald & Company, 1962), 20-22.

[62] Robert M. Kennedy, *The German Campaign in Poland (1939)* (Washington, DC: Department of the Army, 1956), 68-72.

Hitler summoned General Student to the Reich Chancellery on 27 October 1941. He outlined for Student his plan using Luftwaffe gliders to seize Fort Eben Emael in Belgium. Hitler directed Student to analyze it overnight, report the next day, and provide his input. Student concurred and Hitler ordered him to immediately initiate mission training for Operation Granit.[63]

Germany planned to attack France by rapid movement into Belgium and Holland. This diversionary maneuver served to draw the French First Army and British Expeditionary Force north from the Maginot Line. The main German thrust was Erich von Mainstein's and Heinz Guderian's armored penetration through the Ardennes Forest, behind the French and British. The Germans intended to double envelop them and defeat them in detail. [64]

The northern German feint required two panzer corps crossing Belgium's Albert Canal. This could only be accomplished at three bridges. Fort Eben Emael guarded these bridges. Artillery fired from Eben Emael could stop any German movement over them. Eben Emael, therefore served as the strategic key for the Battle of France. Germany had to seize it in the first stage.[65]

The Luftwaffe task-organized for this commando assault to seize the fort. Sturmtruppe Granit (Assault Force Granit) consisted of eighty-five Luftwaffe personnel: two officers, eleven glider pilots (who fought as infantry post-landing), and seventy-two enlisted men. It was a hybrid unit in size and skills. Stumrtruppe Granit consisted of Fallschirmjager infantry, signal experts, and combat engineers.[66] Training began in November 1939. Sturmtruppe Granit conducted day

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[63] McRaven, *Spec Ops Case Studies in Special Operations Warfare: Theory and Practice,* 30-33.

[64] Ibid., 31.

[65] Ibid.

[66] Ibid., 37.

and night glider assaults six days a week. The Pioniers trained with new technology: shaped charges, in 50 and 12.5 kilograms, detonated on captured Polish fortifications having the same concrete thickness as Eben Emael, intelligence provided by German engineers who helped in its design. Fallschirmjager combat engineer Kurt Engelmann described how the shaped charges with a hollowed sphere channeled high explosive demolitions to penetrate fortifications.[67]

The gliders had to land directly on Eben Emael's topside. The fort was impenetrable and impregnable by any land approach. The surface was 900 meters on a north-south axis and 700 meters at maximum width.[68] Fort Eben Emael's garrison numbered 850 Belgian soldiers on the eve of the assault. 10 May 1940, the German gliders released from their JU-52 towplanes at 2,600 meters altitude and 25-kilometer distance. Eleven DFS 230's landed precisely, beginning at 0525, on top of Eben Emael.[69] Sturmtruppe Granit eliminated all gun emplacements with shaped charges. They drove the garrison into the depths of the fort. Assault Group Granit, outnumbered ten to one, held the fort until it was reinforced and relieved the following day. The task force's casualties totaled six dead and eighteen wounded.[70]

The Germans had achieved total surprise. German technology provided two key military solutions to the Eben Emael tactical problem: shaped-charged explosives and gliders as stealth technology providing vertical envelopment for an objective that could not be taken by ground assault. The light-weight penetrators blasted the fortifications and gliders landed the assault force

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[67] Way, *Fallschirmjager!*, 148-151.

[68] Ibid., 152.

[69] Ibid.

[70] Ibid., 154.

covertly with precision.[71] German glider pilots contributed with their civilian flying club experience. They pointed out in the training phase that the DFS 230 required a braking mechanism for Eben Emael's restricted landing area.[72] These technological changes enabled Operation Granit's mission success.

The next use of glider capabilities by Germany was in the Balkans campaign's final phase in the Spring of 1941. 2ND FJR combat engineer elements landed by DFS 230, secured the Corinth Canal bridge, and removed demolitions charges minutes prior to a parachute drop.[73] The glider borne Pioniers and Fallschirmjager paratroops overwhelmed Greek defenders. The S. S. Leibstandarte Adolf Hitler mechanized infantry division sped across the only connection between the Peloponnese and Greek mainland.[74] This blitzkrieg operation saved time, men, material, and fuel. It pushed the Greek and British allied contingent rapidly off the Peloponnese onto Crete.[75]

Operation Mercury was Germany's purely airborne invasion of Crete. There was no amphibious infantry invasion for a double envelopment. The Kriegsmarine, or German Navy, provided no naval gunfire support. The Luftwaffe had air supremacy, but General Student's XI Air Corps had one envelopment option, the overhead. Glider borne assault was at the forefront of Germany's first large scale airborne operation.

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[71] George G. Heilmeier, "Guarding Against Technological Surprise," *Strategic Studies* 2, no. 2 (1978): 81-82.

[72] McRaven, *Spec Ops Studies in Special Operations Warfare: Theory and Practice,* 42.

[73] Way, *Fallschirmjager!,* 291.

[74] Bob Carruthers, "World War II from Primary Sources: Through German Eyes the Balkans, Greece, and Crete 1941," produced by Paul Dunn, Pen & Sword Digital, 2012, 40:39.

[75] Miksche, *Paratroops,* 40-41.

The Luftwaffe had utilized the year between Eben Emael's glider seizure and the Battle of Crete. Student expanded and developed Flieger Korps capability for the airborne phases of the cancelled Operation Sea Lion. This included adding the First Glider Assault Regiment to XI Air Corps. Kurt Student did not design it using the standard FJR organizational doctrine. He assigned four battalions to the regiment. The first three battalions had a battalion HQ element, signal section, and four maneuver companies. IV Battalion, 1ST Glider Assault Regiment, was comprised of battalion HQ, signal section, 75-millimeter artillery company, and an anti-tank gun company.[76]

The maneuver battalions possessed the standard HQ and signals elements. Four companies, vice three in the FJR, composed their manning levels. The companies had a headquarters and signal platoon, but the HQ platoon also had a light mortar squad and man-carried anti-tank gun squad. Four maneuver platoons completed the company. These platoons had four squads: an HQ squad with a light mortar, signal squad with a LMG, and two squads of HMGs. The riflemen supported the machine guns, keeping with standard German doctrine. [77]

Germany conceived the 1ST Glider Assault Regiment as the vanguard of vertical envelopment. It delivered 2,000 assault troops plus 230 combat trained glider pilots who could land with precision on their objectives.[78] This capability brought heavy weapon engagement faster than often scattered parachute units[79].

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[76] War Office, *Notes on the German Army No. 38*, 40.

[77] War Office, *Notes on the German Army No. 38*, 40-42.

[78] Ibid., 40.

[79] Miksche, *Paratroops*, 74-75.

Crete possessed strategic value in the eastern Mediterranean. It offered airbases for German attacks on Egypt and the Suez Canal. British control allowed air excursions over the southern Balkans, south Italy and the Aegean Sea. Suda Bay's anchorage handled vessels up to 7,000 displaced tons. Crete was highly valued by both sides.[80]

A joint Australian, British, Greek, New Zealand force defended Crete. It numbered just over 42,000. The defenders were exhausted and demoralized from the Greek mainland campaign. Their air support sortied from British territory in Africa. Artillery, supplies, and anti-aircraft guns were minimal.[81] The Royal Navy was hesitant to major commitment in Cretan waters with Luftwaffe air supremacy overhead.[82]

The action opened on 20 May 1941. Continuous air bombardment forced the defenders to take shelter. ME 110 bombers served as towplanes in this initial attack. They cast off the glider towropes, then swept in and bombed the defenders. 1ST Glider Assault Regiment's DFS 230s arrived on their targets immediately after the last bomb detonated. The Luftwaffe troops had great technological and tactical advantage over the defenders, who had prepared for a parachute drop after the initial bombardment.[83]

Germany augmented 1ST Glider Assault Regiment and 7TH Air Division with air transported infantry. The 22ND Infantry Division used this tactic in the Holland campaign.[84] 3RD and 5TH Mountain divisions arrived by air transport on Crete. The glider borne

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[80] Miksche, *Paratroops,* 42-44.

[81] Francis W. De Guingand, *Operation Victory* (London, U.K.: Houghton & Stoddard, 1947), 82-84.

[82] Dank, *The Glider Gang: An Eyewitness History of World War II Glider Combat,* 31.

[83] Miksche, *Paratroops,* 45.

[84] War Office, *Notes on the German Army No. 38,* 10-11.

Fallschirmjager secured an airfield at Maleme. This air bridge landed 25,000 German troops, heavy equipment, and artillery.[85]

The defenders fought back gallantly and ferociously. The battle raged till 29 May 1941. German air supremacy and mountain infantry proved instrumental in securing Crete. German airborne troops suffered a fifty-eight percent casualty rate. They never recovered from Crete in two critical ways. First, they lost irreplaceable experienced, highly selected, extensively trained personnel. Second, the staggering casualty rate compelled Hitler to declare a moratorium on any further large-scale airborne operations.[86]

As a result of the Crete invasion, Germany restricted glider operations almost exclusively to logistical missions on the Eastern Front. The GO 242 and ME 321 provided critical ordnance and supplies to the Wehrmacht. Glider borne forces conducted only two small-scale raids over the remainder of World War Two. Two DFS 230's landed Fallschirmjager Pioniers behind French and British lines in eastern Algeria. Parachute inserted Pioniers landed simultaneously on the night of 30 December 1942. The combat engineers had orders to blow up Allied supply lines destined for Tunisia. The operation failed and Karl Heinz-Pollman stated that only two men from an entire company returned to German lines, further undermining confidence in glider assaults.[87]

The second raid was infamous much more for its sensationalism than strategic accomplishments. A mixed assault force made up of Fallschirmjager and SS commandos rescued a deposed Benito Mussolini from captivity in the Hotel Imperatore. The Imperatore sat at 7,000

[85] Miksche, *Paratroops,* 46.

[86] Poppel, *Heaven & Hell: The War Diary of a German Paratrooper,* 55-67.

[87] Way, *Fallschirmjager!,* 141.

feet on a plateau atop Italy's Mount Gran Sasso.[88] Twelve DFS 230s used both the parachute brake and plough skid braking systems to precisely insert Major Mors (FJR) and Otto Skorzeny's (SS) teams. The first glider touched down at 1400, 12 September 1943. The team had Mussolini safely secured fifteen minutes later with zero loss of life and only ten wounded from glider 8's rough landing.[89]

Germany thrust glider technology into modern maneuver warfare. Their society and culture embraced sport gliding during the interwar years. The Nazi political system leveraged this passion for aviation, overhauling German educational systems to center on aviation and its emerging technical advancements. This produced the leading glider designs and glider borne military force in early World War Two. This same political system abruptly ended German glider combat applications. Hitler refused to analyze any post-Crete after action reports beyond the fifty-eight percent casualty rate. National Socialism sanctified the infallible Fuhrer.[90] His edict shut down major German glider assaults and it went unquestioned and unchallenged. The Allies, America and Great Britain, had examined Luftwaffe accomplishments and begun exploring glider potential within their own respective militaries

[88] Annussek, *Hitler's Raid to Save Mussolini*, 204-207.

[89] McRaven, *Spec Ops Case Studies in Special Operations Warfare: Theory and Practice*, 182-184.

[90] Hermann Goering, *Germany Reborn* (London: Elkin Mathews & Marrot, 1934), 79.

Chapter Three

Allied Glider Forces 1920s Through 1942

The Allies developed airmindedness during the interwar years. They conceptualized it differently than the German government and culture. This was primarily due to the political situations. Germans adopted airmindedness for national revitalization and fear of how its neighbors might harness the military possibilities. Britain and the United States visioned aviation increasing communications and furthering free market economic developments. However, they did not orchestrate governmental interjections into early commercial aviation growth and development. This inaction impacted the economic, cultural, social, and technological aspects of glider development.

Isolationism and armament reduction dominated American and British political thought post World War One. Military aviation growth impacted international relations. The 1922 Five Power Navy Treaty left France and Italy with the lowest tonnage of capital ships. They rapidly built combat aircraft to maintain military leverage. Neither refused subjugation in a potential ratio strength aerial power conference.[1]

Great Britain initiated the air limitation talks, but only to check growing French air power. British diplomats and military leaders refused to sign any aviation armament ration treaty until the Royal Air Force (RAF) was equal to French air strength. The United States military held the records for speed, duration, altitude, and sole in-flight refueling capability. The U. S. aeronautical industry, however, remained hanging by a thread. The bicameral Congress allocated

[1] Clifford Albion Tinker, "Aerial Diplomacy," *The North American Review* 219, no. 820 (March 1924): 336-338.

meager peacetime funds for commercial aviation research, education, and military aircraft quantities. American aviation manufacturers struggled to stay in business.[2]

Great Britain shifted from relying on free market capitalism driving aviation advances in 1925. The British government signed a contract with Imperial Airways for ten years. Imperial Airways received 1,000,000 pounds on a sliding scale, decreasing over the next decade. They agreed to expand aircraft manufacturing, design, and testing.[3] His Majesty's government required all Imperial Airways aircrew to join the RAF Reserve. This established a vast cadre of trained aviators, factories, design engineers, and ancillary ground service capabilities in the case of a national emergency.[4]

America continued behind European aviation during the late 1920s. Berlin, Paris, and London had modern airport facilities. New York City did not possess a single landing field in 1927. Passengers flew into Newark, New Jersey and took ground transportation over the Hudson River. London had begun construction on connecting its subway system to its airport. Coordinated civilian air transportation did not exist in the United States. The Weimar Republic had fully nationalized German commercial aviation while American aviation remained constrained by political isolation.[5] British private sector aviation investment grew to 100,000,000 pounds by early 1929.[6] This failed to keep pace with Germany's commercial aviation growth.

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[2] Tinker, *Aerial Diplomacy,* 340.

[3] William Sefton Brancker, "Commercial Aviation," *Journal of the Royal Society of Arts* 73, no. 3785 (June 1925): 652.

[4] Ibid., 658.

[5] Anthony H. G. Fokker, "Air Transportation," *The Annals of the American Academy of Political and Social Science* 131 (1927): 183-187.

[6] P. R. C. Groves, "The Influence of Aviation on International Affairs," *Journal of the Royal Institute of International Affairs* 8, no. 4 (July 1929): 292.

Britain recognized how commercial aviation easily converted to military use. Sir Samuel Hoare stated in the House of Commons how failure to publicly finance aviation had set Britain back: in 1926 England was the second greatest air power and in 1929 they were fifth. The RAF did establish its first gliding effort during this austere period. No. 7 Bomber Group formed the RAF Gliding Club in 1926. It was ostensibly a recreational program, but provided affordable, valuable flight time to bomber pilots.[7]

Aviation fascinated American and British culture despite governmental reluctance to allocate funding. Philanthropic, civic minded groups, and school districts interceded to cultivate societal interest in aviation. The Air League of the British Empire leveraged Lord Baden Powell's Scout Association to incorporate aviation articles and fund Scout air race attendance. Air League influence crossed the Atlantic, convincing Lauren and Winthrop Rockefeller to fund the Air Youth of America program. The Air League placed its publications in British school libraries at no cost.[8]

Kansas City, Missouri School District incorporated aviation curriculum in 1926. This included physics laws affecting flight, aviation history, and applications for transportation. The elementary schools started miniature airplane construction. This was the first American school district to make aviation education a core precept.[9] Three hundred U.S. public schools taught some degree of aviation instruction by 1929. Fifty had aeronautic specific subjects, the

[7] Groves, "The Influence of Aviation on International Affairs," 299-303.

[8] Air League of the British Empire, *The Air League Bulletin* 3, no. 53 (1925).

[9] I. I. Cammack, "Aviation in the Public Schools," *The Journal of Education* 104, no. 23 (December 1926): 599.

remainder connected aviation as modules within traditional subjects or through extracurricular activities.[10]

British and U. S. aviation culture interest continued despite the 1929 Great Depression. The U. S. government trended toward supporting, meagerly, general aeronautical education programs in the 1930s. This included aviation history, basic aviation science, weather effects on flight, control instruments and the industry's economic impact(s). Motorized flight was the main line of effort. Small, private clubs conducted American gliding programs.[11]

By 1932, British aeronautical education remained in the technical specialty school domain. Gliding clubs had emerged at some secondary schools and universities. These clubs conducted beginner level instruction, modeled upon but, nowhere near the robust German Airsport League. They had little equipment due to no public funding and limited private donations. British flight industry proponents opined that the Empire's strategic, commercial, and future prosperity depended on aeronautical development.[12] British gliding advocates concurred that England required an aviation centric culture. Gliding, they argued, offered the most cost-effective means of achieving that end state. Ironically, the British aviation industry displayed open hostility to this ideal and resisted privately funding gliding club expansions.[13]

The British Air League started providing flight stipends for English youth to attend motorized flight technical schools. The Young Pilots Fund aided secondary and college

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[10] Roland H. Spaulding, "Aviation and the Public-School Curriculum," *Junior-Senior High School Clearing House* 4, no. 2 (October 1929): 116.

[11] James E. Mooney, "A National Survey of Aeronautical Education," *Social Science* 8, no. 1 (January 1933): 53-55.

[12] E. C. Gordon England, "Soaring Flight: Its Function in Aviation," *Journal of the Royal Society of Arts* 80, no. 4143 (1932): 534.

[13] Ibid., 538-546.

graduates to certify as pilots.[14] The League mimicked the German Airsport League by aiming to have a qualified pilot in every English village.[15] These initiatives coincided chronographically with Hitler's open declaration of the Luftwaffe but yielded miniscule results. The British Air League and the RAF bi-laterally formed the Air Defence Cadet Corps in 1937. The Air Ministry did allocate funding to establish this program that recruited males aged 16-18.[16] They designed it to eventually provide the RAF with pilots and aircrews. The Air Ministry interjected into the British public-school systems and encountered some opposition. The London County School Council mandated their focus was to educate children and not conduct quasi-military training.[17]

The United States was substantially behind England and Germany in aviation education by the late 1930s. In 1939, the Federal Office of Education began to provide financial assistance for high school aviation vocational education. Its goal was to enroll 7,000 high school boys in aviation mechanics training in the 1940 school year. They encouraged an aeronautical trade school curriculum that covered physics flight principles, ground school training on radios and weather, and glider construction and flying.[18] Operation Granit caused an immediate change in Allied lethargy toward aeronautical advances, gliders in particular.

Churchill issued a 6 June 1940 directive to the War Office, Air, and General Staffs requesting the formation of a vertical envelopment corps of 5,000 parachute troops. The Luftwaffe's vertical envelopment combat successes in Holland and Eben Emael drove the British

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[14] Air League of the British Empire, "Air League Young Pilots Fund," 1935 press release. Royal Air Force Museum Archives.

[15] Edward Chamier, *Letter to Lord Brabazon*, 2 January 1935. Royal Air Force Museum Archives.

[16] Edward Chamier, *Letter to the Air Ministry*, 19 November 1937. AIR 2/2716. United Kingdom National Archives.

[17] "Air Cadets in London County Council Schools Refused," *The Times* 4 May 1939, p. 10.

[18] Author unknown, "High Schools Train Aviation Mechanics," *The Clearing House* 13, no. 5 (1939): 287.

Prime Minister's tasking.[19] Churchill emphasized commencing training as soon as feasible. The joint RAF-British Army Central Landing School (CLS) opened 19 June 1940 to establish vertical envelopment doctrine and training. Its original manning comprised fifteen total RAF and Army officers.[20] The CLS Army staff realized, Churchill's parachute decree notwithstanding, that the glider was the preferred vertical envelopment asset for numerous reasons: troops landed in a cohesive group instead of scattered under the airplane's line of advance, heavier weapons landed with their crews and ammunition, and mobility assets arrived intact.[21] Their RAF brethren envisioned gliders, due to their lack of noise once released, as the first stealth bombing platform.[22] The British Army prevailed, CLS analysis proved that gliders corrected the inherent weakness of parachute units: a lack of mobility, heavy mortars, and medium artillery. These elements constituted the lethality of an infantry unit.[23]

Prime Minister Churchill inquired 10 September 1940 on the parachute brigade headway. Britain's 1940 war needs created a non-conducive environment for vertical envelopment testing. The Army focused on defending the British Isles against the perceived eminent German invasion, while the RAF centered on fighting the Battle of Britain. Parachuting and gliding remained confined to the CLS think tank. General Hastings Ismay, the Chief of the Imperial General Staff, informed Churchill that the lack of operational aircraft and aircrews to conduct parachute drops made it impossible to train 5,000 men so rapidly to a combat ready standard.

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[19] Winston Churchill, *Provision of Airborne Forces and Policy Minute*, 6 June 1940.

[20] F. A. M. Browning, "Airborne Forces," *Journal of the Royal United Services Institution* 89 (February 1944): 351.

[21] Air Ministry, *Airborne Forces* (London: H. M. Stationery Office, 1951), 3.

[22] Ibid.

[23] Browning, "Airborne Forces," 354-355.

Ismay further explained the glider tests demonstrated they were the preferred method of vertical envelopment. Ismay informed the Prime Minister that the CLS was developing troop-carrying and light tank capable gliders. CLS subsequently expanded into the Central Landing Establishment (CLE) and encompassed the Parachute Training School, Airborne Tactical Development Section, and Glider Training Section. The War Office and Air Ministry tackled the next problem, developing a codified joint interoperability doctrine.[24]

The RAF received Britain's highest strategic priority the latter half of 1940. Their operational commands fought U-boats in the Atlantic's sea lines of communication and commerce, kept the Suez Canal open, and held back the entire weight of the Luftwaffe. After the British Army's rescue at Dunkirk, RAF Bomber Command was the only offensive punch available to Great Britain. The RAF designated the nearly outdated Whitley bomber and the emerging Ablemarle as towplane platforms, when not required for bombing duty. Ergo, in late 1940 forming a large airborne contingent resulted in two strategic views: one by the War Office and one by the Air Ministry.[25]

The Army stated that bombing could not unilaterally win the war. An amphibious assault integrated with large vertical envelopment into France was the first step in defeating Germany. Thus, the Army argued for significant quantities of readily available aircraft and aircrew for vertical envelopment advanced training, despite impacts on Bomber Command. The RAF countered that operational plan was not feasible until 1943, at the earliest. The current logistical and strategic situations limited a British airborne force to commando-esque raids. Therefore, focus should shift to slowly codifying major airborne operational doctrine and tactics,

[24] Air Ministry, *Airborne Forces*, 4-6.

[25] Ibid., 5.

techniques, and procedures with whatever aircraft and aircrews that Bomber Command could spare. The RAF 1940 position won approval as the way forward.[26]

The Air Ministry also refused to build or design airframes solely for the purpose of dropping paratroopers or towing gliders in 1940. They wanted cross-functionality out of airframes, owning to Britain's 1940 industrial resources. CLE doctrine had submitted, and gotten approved, that the RAF administratively owned all pilot training. This included gliders. However, the Army operationally owned the glider units and pilots. The RAF had responsibility to tow the gliders to release points. Army glider pilots then flew into the designated landing zones. Different towplanes presented different flight handling characteristics, ranges, and towplane weight configurations. These factors contributed to frequent policy and doctrine changes. The CLE staff continued formulating a codified doctrine defining how to train and implement vertical envelopment forces for when the logistical and strategic situations allowed glider operational implementation.[27]

First, they requested definition on how planners intended to use an airborne force and what size it required to accomplish its mission(s). The Vice Chief of Air Staff and Vice Chief of the Imperial Generals Staff issued a manning document on 5 September 1940. This initial airborne force consisted of three 1000-man maneuver elements fully manned, trained, and equipped by spring 1941. Paratroop infantry numbered 100 per element while the remaining 900 personnel consisted of glider borne troops and glider pilots. The British staffs modified the basic manning document by adding 200 Royal Engineer parachutists as demolition saboteurs. The final airborne force manning was 500 paratroopers and 2,700 glider troops, 360 of which were

[26] Air Ministry, *Airborne Forces*, 6.

[27] Ibid.

glider pilots. The parachute infantry served primarily as pathfinders (personnel trained to identify proper glider landing zones and guide gliders into them) and scouts for local reconnaissance, while the glider borne troops provided the main firepower.[28]

The CLE army cadre then determined that, with two-week familiarization training immediately prior to a mission, standard British infantry formations sufficed as glider troops. The RAF CLE component applied the same methodology to towplane aircrews. The staff designated one crew from each bomber squadron in No. 4 Group to rotate through the CLE supporting vertical envelopment training, then return to their squadron and pass on the lessons learned to their squadron. It failed to function once put into action. Bomber Command's casualty rate was extremely high, therefore squadron personnel had high change over. The bomber crews that survived their tours posted to other duties, typically to recover physically and mentally, so no single squadron ever obtained full readiness in vertical envelopment capability. This differed tremendously from the German method in two critical ways. First, the Luftwaffe insisted on using Fallschirmjager paratroopers exclusively for glider operations. Second, the Germans contained vertical envelopment inside the Luftwaffe. There were no inter service rivalries to overcome. Fallschirmjager units did not have to beg for aircraft as the Fliegerkorps had transport groups readily dedicated for training and operations.[29] Britain's foundational airborne manning document drove the glider procurement requirements. This staff action exemplified how to produce military change effectively, it was based off the requirement. Germany had utilized similar methodology for its glider procurement.

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[28] Air Ministry, *Airborne Forces*, 6-7.

[29] Ibid.

Great Britain still failed to meet the spring 1941 deadline for the airborne brigade. There was a massive delay in producing both gliders and glider pilots. The initial glider design carried eight troops with one pilot. The 360-man glider pilot requirement initiated an October 1940 order for 400 one pilot/eight troop gliders to the Ministry of Aircraft Production (MAP). CLE experimented with a fifteen troop, twenty-five troop, and light tank carrying capable glider in late 1940.[30]

MAP and the Air Ministry adamantly mandated that glider manufacturing was not to interfere with powered aircraft production. Britain's 1940 limited wartime resources forced a totally wooden glider design. MAP had to contract furniture companies that retooled their machinery to produce gliders.[31] This caused significant delay in glider delivery: 50 eight seaters were available in January 1941 and only two twenty-five seaters would be ready by August 1941. The British furniture industry deemed 400 too small for total focus on glider production. [32] The British inter service rivalry also contributed to the glider delay. The Royal Air Force saw no reason to push for greater glider production with no codified doctrine or operational plan written to use them. However, the CLE, War Office, and Air Ministry staffs had drafted no plans to implement gliders because no gliders were available for TTP testing.[33]

British glider acquisition ramped up in 1942. Britain designed, developed, and fielded World War Two's leading military gliders. They accomplished this as a nation totally mobilized for war. Great Britain utilized its political, economic, technological, and industrial bases with

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[30] Air Ministry, *Airborne Forces,* 7.

[31] Mrazek, *Fighting Gliders of World War II,* 60-63.

[32] Air Ministry, *Airborne Forces,* 7-8.

[33] Ibid., 8.

maximum efficiency, driven by necessity owing to limited resources. British industry fabricated all its gliders solely from wood, yet they outperformed Luftwaffe and American steel tubular counterparts.

The Hotspur held seven troops and one pilot. It landed infantry solely and had no capacity for equipment or vehicles. The Hotspur fuselage had a lid configuration. The passengers threw off this lid in a few seconds following landing and egressed by climbing out of the boat shaped lower half.[34] Conceptualized and designed following CLE's 1940 analysis to use gliders vice Churchill's paratroopers as the primary vertical envelopment asset, the Hotspur cast off from the towplane at a high altitude and distance from the landing area. It utilized stealth from noiseless approach, preventing towplane noise from comprising the tactical initiative. The Hotspur required a shallow dive angle, medium to low speeds, and excellent gliding aerodynamic characteristics for this procedure. It resulted in single use only utility. These design variables rendered the Hotspur's structure not robust enough to repair after a combat landing.[35]

Intelligence gathered from Luftwaffe glider pilots prisoners of war after Crete resulted in a TTP change for British gliders. CLE decided that towplanes would approach landing zones in close proximity and low altitude. This necessitated a steep approach and reversed CLE's initial glider design requirement. This TTP required a more resilient glider airframe and less focus on gliding distance performance qualities. The Hotspur became the initial training glider for the British. The designers had made the flight controls rudimentary and easy to master, as British

[34] Air Ministry, *Airborne Forces*, 245.

[35] Ibid.

doctrine dictated enlisted soldiers as the primary source of glider pilots. It made no operational flights. General Aircraft Company built 948 Hotspurs and delivered them all by May 1942.[36]

The Horsa Mark I and Mark II gliders emerged from the British glider TTP insertion change. They met the requirement for increased durability and the twenty-five-passenger requirement stated by CLE in 1940.[37] MAP reached an agreement with the Harris Lebus Furniture company to deliver 400 beginning in 1942. The Imperial Chiefs of Staff formulated a Middle East airborne force and MAP awarded Tata Manufacturers of Mumbai, India a contract for 400 Indian built Horsa gliders for delivery by July 1943.[38]

The Horsa Mark I and II had wing spans of eighty-eight feet and sixty-seven feet lengths. Two pilots sat above and forward of the fuselage compartment. The Mark I and II carried twenty-seven fully loaded combat troops or 6,900 pounds of military cargo or mobility vehicles.[39] The original mobility vehicle requirement consisted of solo and/or combination (sidecar) motorcycles for localized reconnaissance/communication operations. CLE discovered during field testing and TTP refinement that a jeep loaded inside a Horsa with minimal modifications. Glider troop ground mobility and firepower greatly increased with Horsa delivered jeeps. Jeeps provided greater range, endurance, and speed in reconnaissance roles. Furthermore, jeeps outfitted with heavy machine guns substantially increased glider infantry combat lethality. [40]

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[36] Air Ministry, *Airborne Forces*, 246.

[37] Ibid., 7.

[38] Ibid., 14.

[39] Ibid., 252.

[40] Ibid., 247.

The Horsa Mark I had a rectangular cargo loading door aft of the nose on the fuselage's left side. It measured seven feet, nine inches by five feet and was hinged at the bottom. Equipment loaded and unloaded through this door. Troops exited via two passenger doors on either side of the fuselage. Maneuvering equipment and mobility vehicles round the cargo door's corner was laborious and lengthy: not ideal in a tactical environment landing under fire. The RAF Transport Technical Unit formulated two methods to overcome this liability. The first consisted of a band of pre-staged and dual primed detonation cord used to explosively sever the Horsa I tail section. The second improvisation made the tail section a detachable piece bolted to the fuselage by eight uniquely fabricated bolts with quick-release nuts. They immediately spun loose when actuated and the tail section fell away. The RAF dubbed the explosive tail Horsa I's Red Horsas and the mechanical released versions White Horsas.[41]

The Horsa Mark II overcame the vehicle egress constraints with a hinged nose. Located directly underneath the pilots, it allowed straight loading and egress, similar to the United States Air Force's modern C-5 Galaxy transport jets. The nose section, however, of any combat glider was particularly susceptible to damage upon landing. Therefore, all Horsa IIs incorporated the explosive removal tail feature.[42]

Horsa Mark I and II took off of wheels like the Luftwaffe DFS-230 but did not jettison them like the Germans. They conducted wheeled, not skid, landings. This technique increased the landing run length but allowed the pilots greater control when landing and enabled Horsas to maneuver on the landing zones. This provided two critical tactical advantages over all other World War II gliders. One, it allowed a large quantity of Horsa gliders to park compactly and

[41] Air Ministry, *Airborne Forces*, 247.

[42] Ibid.

avoid blocking landing zones for follow on waves.[43] Two, it allowed the glider borne troops to fight as cohesive tactical sub-units (platoons) or as consolidate as company sized elements within five minutes.[44]

The British, again using intelligence gathered from Crete, adopted the Luftwaffe technique of parachuted arrested landings for the Horsa. This effort enabled the use of shorter landing zones. Twin fourteen-foot parachutes deployed from under the tail just before touchdown. A completely loaded Horsa, 15,750 total pounds, stopped in less than 100 yards with this technology.[45]

Britain's wartime industrial base produced 5,000 Horsa Mark I and II's by the war's conclusion. It's remarkable to note that British furniture companies retooled lathes and manufacturing lines from couch, table, and dresser production to successful airframe fabrication with rapid success. The RAF made the first Horsa test flight 10 September 1941 and 1 Glider Training School conducted its first student training flight June 1942. Horsas flew in North Africa, the Mediterranean, Europe, India, and Burma operations.[46] It possessed a great cargo capacity yet light enough that all Allied (British and American) towplanes had the capability to pull it.[47]

The Hamilcar represented British technological supremacy in glider design and aeronautical engineering. One hundred technical draftsmen and twenty aeronautical engineers allocated to this 1941 project produced an airframe that carried nearly its own entire weight in

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[43] British Army, *Airborne Operations Pamphlet No.1- General* (London, U.K.: The War Office, 1943): 27.

[44] Ibid., 5.

[45] Air Ministry, *Airborne Forces,* 248-252.

[46] Ibid., 248.

[47] Ibid., 268-69.

military load. No other Second World War aircraft, powered or unpowered, came close to replicating the Hamilcar's performance feature. Its unloaded weight was 18,600 pounds and the Hamilcar carried 17,400 pounds of cargo for a maximum load of 36,000.[48]

CLE doctrine drove the Hamilcar requirement. Again, CLE used the lessons learned from analyzing the Battle of Crete and intelligence gathered from German prisoners of war. The captured Germans attested they sorely lacked glider delivered armored vehicles.[49] CLE wrote doctrine for the Hamilcar requirement to carry light tanks, armored vehicles, tracked vehicles, and heavy engineering equipment. The load was modified for the tactical situation(s) and configuration included but was not limited to: (1) a Tetrarch or Locust light tank, (2) two armored scout cars, (3) seventeen-pound anti-tank gun with tractor, (3) twenty-five-pound howitzer with tractor, (4) self-propelled 40 millimeter Bofors gun system, (5) Bailey pontoon bridging equipment, (6) variety of road graders, scrapers, and bulldozers. Hamilcar troop carrying capacity was forty fully laden combat troops. This acquisition design represented military technology change implementation driven by doctrinal precepts.[50]

The Hamilcar was a high-winged monoplane, 68 feet long with a 110-foot wingspan. The pilots sat in a cockpit completely above the storage compartment. It had a nose-opening door for loading and unloading. The Hamilcar landed on a permanent skid undercarriage that incorporated high-pressure oil shock absorber struts. Hamilcar's cleared the landing zone using their speed and steerage controls. Once stopped, the high-pressure oil released, and the struts telescoped allowing the skid to sink under the Hamilcar's weight. The nose opened and the

[48]Air Ministry, *Airborne Forces*, 252.

[49] Ibid., 248.

[50] Ibid., 249-252.

vehicles rolled right out. This feature alleviated the need for any special ramps. The Hamilcar fuselage had special exhaust tubes that allowed the vehicles to start during the final stages of descent without causing carbon monoxide poisoning. These two features enabled Hamilcar borne motorized assets to depart within fifteen seconds of landing and reaching a full stop.[51]

The CLE incorporated the principle operational performance requirement for any combat glider into the Hamilcar: the flight characteristics had to minimize the time exposed to enemy ground fire between towplane release and landing. Like the Horsa, it had to make high speed, steep angle dives with, given the size and weight, survivability for the cargo and personnel when landing. Britian's Royal Aircraft Establishment and the British National Physical Laboratory conducted structural analysis and wind tunnel testing before operational experimentation with a half-scale flying model to solve this problem.[52] They ascertained that using large surfaced wing flaps powered by servo-pneumatic controlling systems allowed the Hamilcar to successfully conduct precision landings, fully loaded by high-speed, steep angle dives in constrained landing zones on their skid undercarriages.[53] The Hamilcar glider progressed from design to testing and acceptance in twelve months. General Aircraft, Limited delivered the first Hamilcar in early 1942. The British design team reduced the Hamilcar's final weight by eight hundred pounds

[51] Air Ministry, *Airborne Forces,* 249.

[52] Ibid.

[53] Ibid., 248. This was another first in aeronautical engineering by the British leveraging their societal and technological bases in glider developments. Servo-pneumatic controls provide multiple times the force capability of an electromechanical actuator of a similar body size. Without these, the Hamilcar pilots had no chances of controlling such a large, heavily laden glider on these combat insertions without fatally crashing.

from original estimate.[54] The Hamilcar's drawback was that its immense size and capability reduced it to one towplane, the four-engine Handley-Page Halifax heavy bomber.[55]

Designs tested and approved, the British Air Ministry and War Staff delivered the Ministry of Air Production their glider quotas. On 4 March 1942, a jointly issued order requested 1,375 Horsa and 87 Hamilcar gliders by 1 May 1943. Furthermore, they wanted another 600 Horsa and 40 Hamilcar ready one month later.[56] MAP concurred but warned in a 27 March 1942 communication that any further increases in glider program production required a nine-month notice. Britain's logistical and resource base, in 1942, simply did not have the ability to increase glider production quantities once codified and underway.[57]

Britain further codified its airborne force by assigning a two star (Major General) to command what had been a brigade-sized element and was a division in 1942. General Frederick A. M. "Boy" Browning assumed the duties as General Officer Commanding (G.O.C.) of 1ST Airborne Division: a parachute brigade, airlanding brigade, and support units comprising 10,000 troops.[58] Browning assigned a one star (Brigadier General) to command each brigade. Brigadier Richard Gale commanded the parachute brigade while George Hopkinson commanded the glider (airlanding) brigade.[59]

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[54]Air Ministry, *Airborne Forces,* 249.

[55] Ibid., 269.

[56] War Cabinets Chiefs of Staff, 4 March 1942, *Committee Meeting Minutes,* CAB 79-19-2, United Kingdom National Archives.

[57] War Cabinets Chiefs of Staff, 27 March 1942, *Committee Meeting Minutes,* CAB 79-19-27, United Kingdom National Archives.

[58] Air Ministry, *By Air to Battle: Official Account of the British First and Sixth Airborne Divisions* (London, U.K.: His Majesty's Stationery Office, 1945), 20.

[59] Ibid.

Browning was an infantry officer from the Grenadier Guards. The Grenadier Guards had earned the reputation of being His Majesty's best physically conditioned, highest disciplined, and cross trained troops. The men landed had to be great soldiers, in the mold of the Grenadier Guards. He reversed the CLE's earlier recommendation that standard British infantry units, with two weeks familiarization training, sufficed as airlanding troops.[60]

Browning formed the 1ST Airlanding Brigade by converting the 31 Independent Brigade. It had just returned from India and originally trained for mountain warfare. The 31 Brigade soldiers already possessed high levels of individual physical conditioning, were well-disciplined, and used to sustaining operations based off what they carried. Mountain infantry, due to topography, had to rely on the supplies carried by the individual soldier. Like airborne troops, they had limited organic mobility assets.[61]

The brigade was based around four standard British Army infantry battalions: First Battalion Border Regiment (the Borders), First Battalion Royal Ulster Rifles Regiment (RUR), Second Battalion Oxfordhamshire and Buckinghamshire Light Infantry (OBLI), and Second Battalion South Staffordshire Regiment (the Staffords). They each totaled 36 officers and 809 enlisted at full strength. Each battalion was comprised of four rifle companies, a support company, a pioneer platoon, a signals platoo, and a Battalion headquarters section. The British rifle company was the primary maneuver element and had four platoons. Each platoon consisted of one officer and thirty-six enlisted distributed in four sections: (1) seven-man HQ element with one Lieutenant, the platoon sergeant, radio operator, runner (messenger who literally ran verbal and written orders), and a three-person 51-millimeter light mortar team. British infantry platoon

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[60] Air Ministry, *By Air to Battle*, 20.

[61] War Cabinets Chiefs of Staff 9 October 1942, *Committee Meetings on Airborne Forces Volume I June 1940-January 1943* CAB 121/97, United Kingdom National Archives.

TTPs centered on the three, ten-man maneuver sections comprised of the Bren light machine gun squad (one Bren gun and operator, assistant gunner who carried extra .303 ammunition magazines, and a lance corporal as its leader), and seven riflemen.[62]

The support company wielded heavy weapons divided across six platoons. Two anti-tank platoons operated eight six-pound (57 millimeter) quick-firing guns. Each of the two heavy mortar platoons provided indirect fire from six 81-millimeter mortars. Two heavy machine gun platoons had four Vickers HMGs each.[63] The brigade rounded out with a jeep reconnaissance squadron, brigade signals detachment, field ambulance unit, anti-aircraft battery of eighteen 40-millimeter Bofors guns, anti-tank battery of sixteen 6-pound guns, and brigade howitzer battery of eight 20-pound guns. With six hundred glider pilots added, the total fighting strength numbered 7,000.

Bomber Command had to dedicate towplanes for the British glider force and the RAF had to produce glider pilots. The RAF had originally allocated the CLE 38 Wing for airborne development with only six antiquated Whitley bombers. The 3,200-troop airborne brigade requirement had grown 38 Wing by January 1942 to two squadrons: 296 Glider Exercise Squadron (26 Whitleys) and 297 Parachute Exercise Squadron (16 Whitleys). 38 Wing further expanded with the airborne doctrine increasing from a brigade to a division. In April 1942, the Air Ministry ordered 38 Wing increased to four squadrons by August 1942.[64] 295 Squadron had

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[62] H. F. Joslen, *Order of Battle Organization of British 1ST and 6TH Airborne Divisions, Second World War, 1941-1945* (London, U.K.: Her Majesty's Stationary Office, 1960): 4-7. The Bren gun did not operate from belt fed ammunition. It received ammunition from thirty round magazines that attached to the top of the LMG. These never exceeded twenty-eight actual rounds to prevent magazine spring failure that could lead to a malfunction. Every member of the three maneuver sections carried nine extra Bren magazines. The three Bren's provided the greatest firepower in the British infantry platoon.

[63] Ibid.

[64] Air Ministry, *38 Group Progress Reports April Report* 18 May 1942 AIR 8/1386, United Kingdom National Archives.

30 Whitleys allocated while 298 Squadron possessed 20 Whitleys and 10 Halifax heavy bombers for towing the tank capable Hamilcar.[65]

Glider pilots received their flight training from the Royal Air Force but belonged administratively and operationally to the British Army. This was per the CLE doctrine approved by the War Cabinet. Browning stipulated that the glider pilots must be highly proficient infantry who had the ability and flight training to conduct precision glider landings. They must also possess cross-functionality to serve as anti-tank gunners or indirect fire (mortar) crewmen.[66] They organized as the Glider Pilot Regiment (GPR) in 1942. The British Imperial General Staff envisioned three airborne divisions each with a six hundred strong glider pilot battalion: one in the Home Islands, the Middle East, and India.[67]

Browning assigned Major (later Brigadier) George Chatterton the task of raising the GPR. Chatterton embodied the perfect candidate to commission such a unit. He served as a RAF pilot from 1930-35 until grounded from head injuries suffered in a crash. Recalled in the British mobilization following the 1938 Munich accords, the RAF transferred Chatterton to the British Army who placed him in the 5TH Infantry Battalion of the Queen's Royal Regiment.[68] This provided Chatterton with the operational experiences of both a pilot and an infantryman, fundamentals that proved crucial to his success in forming a unit with the uniqueness of the Glider Pilot Regiment.

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[65] Air Ministry, *Airborne Forces,* 44-45.

[66] Air Ministry, *By Air to Battle*, 22.

[67] War Cabinets Chiefs of Staff 10 March 1942, *Committee Meeting Minutes Army-air co-operation March 1942-September 1945* CAB 121/96, United Kingdom National Archives.

[68] Chatterton, *The Wings of Pegasus,* 6-12.

Browning delivered his standards and performance expectations for the airlanding brigade and the GPR. Chatterton replied that to create a glider pilot that fit Browning's required skillsets demanded men that had high esprit de corps instilled in them coupled with exacting discipline. Chatterton requested Browning provide him with Command Sergeant Majors (CSMs), the senior most enlisted ranks in His Majesty's army, from the Guards regiment to run the GPRs ground combat training program. Browning told Chatterton, with zero hesitation, that he would personally pick and assign two Grenadier Guards CSMs for that very purpose.[69]

Great Britain lacked the aviation and glider culture prevalent in the German military age males. Unlike the Luftwaffe, they could not leverage British society and directly draft personnel as glider pilots. The Glider Pilot Regiment consisted purely of volunteers, with applicants coming from every regiment in His Majesty's Army.[70] A six-week pre-flight screening course designed by the Guards CSMs centered on intense physical training. Candidates conducted daily five-mile ruck runs (running with a full combat load in boots) prior to breakfast.[71] Exacting personnel and equipment inspections brought physical conditioning exercised for minor infractions. The training induced physical and mental stress with high washout rates, some classes averaged sixty-seven percent attrition. Infantry training centered on proficiency in all individual and crew served weapons in the airlanding brigade inventory.[72] Those who graduated received promotion to corporal and reported to an RAF Elementary Flight Training School (EFTS).

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[69] Chatterton, *The Wings of Pegasus*, 21-22.

[70] Air Ministry, *By Air to Battle*, 23.

[71] Martin Sugarman, "Six of Our Jewish Glider Pilots: Last Voice of Our Eagles Who Landed," *Jewish Historical Studies* 46 (2014): 209.

[72] Ibid., 215.

The RAF conducted glider pilot selection panels at EFTS in-processing using their standards for bomber and fighter air crew. Education levels received the utmost scrutiny with an emphasis on mathematical knowledge and writing comprehension.[73] The RAF allowed one Army representative to serve on these selection boards. Those glider pilot candidates deemed lacking the academic acumen for EFTS received the option of returning to their original unit or to the rifle, anti-tank, or light artillery units within the combat arms of the airlanding brigade.[74]

A GPR candidate received sixty hours flying hours on light powered aircraft in EFTS' first phase. A modified course of ground instruction overlapped this phase with modules on basic navigation, map reading, and flight theory.[75] This hybrid curriculum lasted for twelve weeks. Two glider specific courses followed it. The first taught gliding fundamentals on the Hotspur at Nos. 1 or 2 Glider Training School (GTS). The final GPR pipeline school taught Horsa and/or Hamilcar flying at a Glider Operational Training Unit (GOTU).[76] Five individual units dedicated to the glider pilot training requirement stood up in March 1942: (1) No. 16 EFTS shifted to solely producing glider candidates, (2) Nos. 1 and 2 GTS conducted Hotspur familiarization training, and (3) Nos. 101 and 102 GOTU delivered Horsa/Hamilcar instruction.[77]

Britain's glider force made huge strides in 1942 toward obtaining operational capability. The British industrial, political, and scientific bases had produced viable glider designs that entered production. The military and political oversight hierarchies established a doctrinal requirement, deconflicted British Army-RAF rivalries in an emerging military technology

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[73] Dank, *The Glider Gang*, 43.

[74] Air Ministry, *Airborne Forces,* 15.

[75] Ibid.

[76] Ibid.

[77] Ibid., 37-39.

change implementation and expanded 38 Wing to four full towplane squadrons. The 1ST Airlanding Brigade had achieved full manning, the GPR candidates had a codified training pipeline, and General Browning worked diligently at refining airlanding TTPs. In mid-October 1942, the fledgling British airborne forces received their first operational tasking. This mission evolved into the only Allied glider assault conducted in 1942.

Nazi Germany had worked diligently toward weaponizing the power of the atom. Their program relied on deuterium oxide (heavy water) to convert common uranium into weapons-grade plutonium. Germany received its heavy water from the Norak Hydro Plant in German occupied Vermork, Norway. Heavy water was laborious to produce and a successful raid that eliminated the Vermork plant would substantially delay the Nazi atomic bomb timetable.[78]

Geographical and topographical factors made the plant a difficult target. The Norwegian coast's closest point of approach from a British airfield was 280 miles. Vermork lies sixty miles inland from this point. The Germans situated the plant in a deep valley with thick forested sides that rose to 3,000 feet. Gaustal Fjell Mountain overlooked the valley's end at 5,400 feet. The plant sat on a rock shelf 1,000 feet up from the valley floor. The RAF attempted a bombing strike in early 1942 to neutralize the facility. That effort failed as the topography protected the factory from air strikes. Britain's Headquarters, Combined Operations removed this course-of-action (COA) from future consideration. The valley contained a substantial civilian populace that aligned with the Norwegian resistance, and the Allies, in close proximity to the Vermork plant.[79] Combined Operations developed two COAs going forward: attack from the ground by British

[78] Air Ministry, *Airborne Forces,* 71.

[79] Ibid.

vertical envelopment troops or arming local Norwegian resistance saboteurs with the necessary explosives to accomplish the mission.[80]

In mid-October 1942 Headquarters, Combined Operations decided to use the first COA. Major General Browning and RAF Group Captain Nigel Norman received direction to plan an airborne operation to neutralize the installation as soon as possible. Their operational planners deduced that a parachute option was not militarily feasible for three critical reasons: (1) the intrinsic nature of dispersion from parachuting, (2) the quantity of demolitions necessary to neutralize the plant would be attached to the individual jumpers and exceed safe paratrooper jump weight, and (3) the topographical and meteorological conditions did not favor parachute insertion. These factors drove the British airborne military decision-making process to select a glider insertion as having the greatest chance of success.[81]

The staff solicited volunteers from jump qualified (paratrooper) Royal Engineers, not combat engineers attached to the airlanding brigade's pioneer detachments. They divided thirty-two men into separate sixteen-man elements. These elements individually carried enough demolitions and manpower to accomplish the mission alone. 38 Wing assigned two Horsa gliders and three Halifax bombers with their respective air crews to the operation. The Royal Engineer assault elements split between the two Horsa airframes and the third Halifax served as a backup in case of mechanical issues prior to mission launch. The British built redundancy into the mission plan to ensure that enough assets reached the target.[82]

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[80] Air Ministry, *Airborne Forces,* 72.

[81] Ibid., 73.

[82] Ibid.

This task-oriented mission closely resembled the Luftwaffe's Operation Granit assault on Eben Emael. Parachute pioneer elements, scaled in size to the task, using glider vertical envelopment, had to neutralize a strategic target with demolitions. The British Royal Engineer paratroopers, unlike their Fallschirmjager peers, had no reinforcements to relieve them. They planned to escape overland to neutral Sweden or embed with the Norwegian resistance and hope for a later extraction. They commenced hard physical conditioning, demolition practice on Vermork plant mockups, and practice with snowshoes and winter equipment familiarization. 38 Wing air elements practiced long distance night tows with equivalent mission weight gliders and the Horsa crews refined precision landings replicating the time, distance, and approaches to the Vermork landing zone.[83]

The combined force transferred to an aerodrome at Skitten, Scotland on 17 November 1942. Combined Operations designated the night of 19-20 November as launch day, or the first suitable weather night during the moon period. The 19-20 November meteorological conditions proved acceptable, but not ideal. The forecast predicted a strong possibility of weather deterioration over the moon period; therefore, Operation Freshman proceeded as planned.[84]

38 Wing engineers had installed the new guidance technology Rebecca-Eureka radar homing devices on the Halifaxes. Rebecca attached to an aircraft and Eureka operated from the ground. H. Q. Combined Operations had Eureka's covertly inserted by the Special Operations Executive to the Norwegian resistance prior to the operation, informed their agents of the landing zone and provided code words for the mission launch date(s). The first Halifax departed with its Horsa at 1750 (5:50 PM) with the second aloft at 1810. They flew separate, individual flight

[83] Air Ministry, *Airborne Forces*, 72-73.

[84] Ibid., 74.

paths across the North Sea to avoid compromise. Skitten received a signal from the second Halifax at 2341 requesting a return course. Radio direction finding (RDF) plotted their position over the North Sea. No further communication occurred with this aircraft. The second Halifax reported at 2355 that its glider released into the sea. RDF plot ascertained their location over southern Norway. A precise post-mission navigation check confirmed this position when the aircraft arrived back at Skitten.[85]

The first Halifax accomplished the North Sea transit. It made landfall and proceeded toward the landing zone. Their Rebecca set failed right before crossing the Norwegian coast. The aircrew navigated by map reading alone and failed to recognize the designated Horsa release point. They made a second attempt and flew into deteriorating visual flight conditions forty miles north-west of Vermork. The Halifax and Horsa both began accumulating ice that caused them to rapidly lose height and strained the tow rope.[86]

The tow rope completely iced over and parted over Stavanger, Norway 114 miles southwest of the landing zone. The Halifax returned to Skitten and landed dead-stick on zero fuel. The Norwegian resistance agents reported via coded wireless radio message hearing the aircraft directly above the landing zone on what was its first run. They did not know the status of the Horsa. The unproven Rebecca set's technical fault caused the mission failure of this assault element.[87]

The Horsa from the first Halifax crashed thirteen miles east of Stavanger on a snow-covered peak above Lysefjord. Meteorological conditions consisted of high winds, limited

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[85] Air Ministry, *Airborne Forces,* 74

[86] Ibid.

[87] Ibid.

visibility, and increasing snowfall. The Horsa pilot and co-pilot died on impact along with six Royal Engineer paratroopers; four sustained serious injuries and five received no injuries. The Gestapo captured these nine men before they could maneuver off the crash site. A Gestapo medical officer murdered the four injured British paratroops by lethal injection. The five injured Royal Engineers died by firing squad on 18 January 1943 after two months of imprisonment and interrogation.[88]

The second Halifax and Horsa crashed in the mountains north of Helleland after making landfall near Egersund. The Horsa crash-landed four kilometers west of the tow plane. The Halifax crew died instantly. The glider crew suffered three dead on impact and one severely injured. Two British soldiers left the glider and found the local sheriff who contacted elements of the resistance at 0300. The resistance leader assembled stretchers, bandages, five reliable Norwegian resistance men, and the local doctor's wife, who was a nurse, and proceeded to the damaged Horsa. The British officer-in-charge, a Lieutenant, asked the resistance leader how far it was to Sweden, and requested help with their wounded. A twelve-man German patrol captured the British twenty minutes after the Norwegians arrived. The Germans burned the Horsa and took the British to the German base camp at Slettebo near Egersund. One day later, Saturday 21 November 1942, the Germans summarily executed these men, with no trial, under Hitler's 18 October 1942 Commando Order.[89]

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[88] J. S. Wilson to H. A. Nutting, 13 March 1944, *Memorandum from Translated Information About the Fate of Glider Parties That Crashed in Southern Norway 1942: Translation of Report Received from Norwegian Authorities German Shooting of British Prisoners,* 5-7, United Kingdom National Archives, FO 371/42997-0021.

[89] Ibid. This was an order issued by Hitler and disseminated by the OberKommandoWehrmacht (OKW), the German High Command, that stated all Allied commandos captured in Europe and Africa receive immediate execution without trial even if in proper uniform or surrendering. Any single commando, group of commandos, agents, or saboteur not in an official uniform were to be handed over to the Sicherheitsdienst (SD) the intelligence agency of the Schutz-Staffel (SS) and the Nazi Party. The British participants in Operation Freshman all wore uniforms with rank insignia.

These outcomes remained completely unknown until the British embassy in Stockholm, Sweden debriefed an escaped Norwegian high ranking resistance leader in March 1944.[90] This agent, code named ARNE LIMA, did not personally witness any of the events and was not in the geographical areas. Separate sets of eyewitnesses, vetted as loyal and highly reliable Norwegian resistance members, provided him direct testimonies. ARNE LIMA evaded German capture and made it to Sweden, where he sought out the British embassy for asylum. He debriefed the Foreign Office personnel on what he knew of these events.[91] The Foreign Office London headquarters passed this information to the War Office. In May 1945, the 1ST Airborne Division entered Norway and verified ARNE LIMA's report. They exhumed the bodies and buried them with full military honors at Oslo and Stavanger. Using sources from ARNE LIMA's network, British authorities successfully prosecuted the German officials responsible as war criminals.[92]

The American military hierarchy had intransigence to gliders, an apathy dating back to 1930. In 1930, the National Glider Association had invited the Air Corps to participate in a competitive meet at Elmira, New York. The Assistant Secretary of War responded with a terse letter stating that no officer, active or reserve, would attend this militarily insignificant sporting event. Secretary of War Patrick Hurley told them in 1931 that glider flying held negligible, if any, potential military value. Hurley issued a mandate prohibiting all Army personnel from

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[90] J. S. Wilson to H. A. Nutting, 13 March 1944, *Memorandum from Translated Information About the Fate of Glider Parties That Crashed in Southern Norway 1942: Translation of Report Received from Norwegian Authorities German Shooting of British Prisoners,* 5-7, United Kingdom National Archives, FO 371/42997-0021.

[91] J. S. Wilson to H. A. Nutting, 13 March 1944, *Memorandum from Translated Information About the Fate of Glider Parties That Crashed in Southern Norway 1942: Translation of Report Received from Norwegian Authorities German Shooting of British Prisoners,* 5-7, United Kingdom National Archives, FO 371/42997-0021.

[92] Air Ministry, *Airborne Forces,* 74.

participating in glider flights.[93] This attitude permeated the Army Air Corps and War Department through the end of the 1930s.

The United States War Department Intelligence Directorate (G-2) delivered its own 6 June 1940 declaration, derived from military attaches in the British and Hungarian embassies, that Germany had used gliders to seize Eben Emael, frequently conducted glider assault training exercises at German and captured Polish airfields, and that its aviation industry had produced vast quantities of troop carrying and tank capable gliders.[94] The Luftwaffe's demonstrable successes increased U.S. civilian glider interest, but the Air Corps faced a situation synonymous with Great Britain's: a sharply increased demand for powered aircraft, pilots, and aircrews.[95] There was no room for gliders in the American mindset. The Americans combined national level neglect on powered and unpowered aviation; driven by isolationism, armament reductions, and Great Depression financial austerity, had caught up to them. Army Air Corps Chief of Staff General Henry "Hap" Arnold eventually ordered a glider feasibility study. American analysis of Luftwaffe glider operations and what Arnold dubbed increasing intelligence received from abroad predicated this order. Two Classified Technical Instructions, CTI-198 (24 February 1941) and CTI-203 (4 March 1941), written by Arnold's personal staff, directed procurement design studies for 8- and 15-man gliders.[96] The Americans initiated glider capability research simply off

[93]Paul M. Davis and Amy C. Fenwick, *Development and Procurement of Gliders in the Army Air Forces, 1941-1944* (Washington, DC: Army Air Forces Historical Study 47, Headquarters Army Air Forces March 1946), 2.

[94] Ibid., 4.

[95] Ibid., 5.

[96] Ibid., 6.

General Arnold's personal directive, with no stated unit organization, capability, or doctrine directing how to implement them into U.S. maneuver warfare doctrine.[97]

The American and British military hierarchies contrasted in glider development during this period. Arnold, as the senior most Air Corps officer, directed glider research from the top-down, he even mandated the initial specification parameters. The British used a bottom-up approach, immaterial of Churchill's paratrooper decree. They delegated the task to a small, multi-service staff (CLS/CLE) and allowed it to test concepts and form designs using objective analysis. This difference arose from personality, circumstances, and structure. Arnold was impatient and America was not yet at war. The RAF and British Army were separate services, overseen by the Air Ministry and War Office, respectively, which produced interservice rivalries concerning gliders. The American Army Air Corps existed as a branch inside of the United States Army; Arnold had total autonomy. Arnold did not derive his glider methodology from a doctrinal requirement. He embodied a do-it-right-now leadership technique.[98] The British CLE staff first developed the doctrine and the requirement, a do…it…right meticulous approach.[99] Military leaders throughout history have used both techniques for change implementation, resulting in positive and negative outcomes. The Allied initial glider programs proceeded on separate, unique paths partly due to their military leadership's change implementation process.

America's fledgling glider program suffered from material procurement and personnel shortage problems in 1941. On 16 May 1941, the Air Corps requested conceptual designs for eight two-person gliders, one eight-person glider, and one fifteen-person glider from four aircraft

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[97]Clayton Bissell, *USAAF Historical Studies No. 1 The Glider Pilot Training Program 1941-1943* (Washington, D.C.: Headquarters Army Air Forces, 1943), 4-10.

[98]Bissell, *USAAF Historical Studies No. 1 The Glider Pilot Training Program 1941-1943,* 10.

[99] Air Ministry, *Airborne Forces,* 4-7.

corporations. Two civilian agencies received contracts for training six Air Corps officers each in glider piloting. The funding covered three weeks of training for the Lewis School of Aeronautics at Lockport, Illinois and the Elmira Soaring Corporation of Elmira, New York.[100] The Judge Advocate General Corps delayed this training. It duly informed General Arnold's staff that former War Department Secretary Hurley's 1931 order banning all Army personnel from glider training was still in effect. The bureaucratic process took till 5 June 1941 to rescind this ten-year-old directive.[101]

The Air Corps had its first twelve glider pilots, but Arnold's approach led to an absolute absence of future program direction. Air Corps planners had no organization established for the first twelve pilots. These pilots had no military capable gliders to continue training: they had trained on two seat and one seat sport gliders. The Army had failed to dedicate any Army Air facilities, logistics, towplanes, or ground crew personnel to a glider program. Air Corps training commands had no approved curriculum for glider training, as Arnold's change implementation had no doctrine and had yet to approve any glider designs for acquisition.[102]

The United States Army Air Corps' Material, Plans, and Training and Operations Divisions disputed the glider way ahead in mid-1941. Lacking a defined doctrine, they took opposing, compartmentalized positions. Material Division needed glider pilots to conduct research, test, and experimental evaluation on the civilian designs. On 14 June 1941, it requested that Plans and Training and Operations formulate, and get approved, a clearly defined Army glider pilot training program that leveraged the civilian school contracting process, specifically

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[100] Bissell, *USAAF Historical Studies No. 1 The Glider Pilot Training Program 1941-1943*, 4.

[101] Ibid., 5.

[102] Ibid., 6.

one that used the Elmira Soaring Corporation solely. Material division's experimental glider testing plan needed a large volume of rapidly delivered glider pilots that the Army organically could not train and provide.[103]

Training and Operations essentially balked at Material's way forward. They concurred that any future glider pilot expansion required the knowledge, skills, and abilities of the civilian glider schools. Their 17 June 1941 correspondence to Plans, copied to Material, stated that without any validated, doctrinal requirement for how the Army would use gliders, they could not concur on any course of action. Furthermore, without any hard due date from Plans for glider full mission capability attainment, any monetary and time expenditures on civilian schooling were premature.[104]

Plans vehemently disagreed with Training and Operations. On 23 June 1941, they formally requested that the Chief of Staff Army Air Forces order Training and Operations to design and promulgate a definitive army glider training program that met the needs of Material and the nascent glider units. General Arnold's staff concurred with this recommendation and on 25 June 1941 directed Training and Operations to develop an official Army glider pilot training curriculum.[105]

Training and Operations realized that the first need was for a cadre of military glider officer instructors. These powered aircraft officer pilots had to complete civilian glider courses, then transition through military gliders. The Army Air Corps assigned them to glider training units (GTUs) as instructors and training supervisors, initially, and with experience garnered at

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[103] Bissell, *USAAF Historical Studies No. 1 The Glider Pilot Training Program 1941-1943*, 6.

[104] Ibid.

[105] Ibid.

the GTUs rotated them to glider operational commands to serve as operations, planning, and readiness officers. They also allocated a number to the Material Division for experimental testing plan requirements. The Air Corps had to utilize the civilian school contracting system at this stage, with ten to fifteen powered officer pilots assigned per class until enough cadre existed to establish the military GTUs.[106]

The Training and Operations Division decided that enlisted personnel should comprise the bulk of operational glider pilots. The Army Air Corps had enlisted motorized pilots called rated flight sergeants. Rated meant those enlisted were equivalent pilots and received the same benefits as commissioned officer pilots: better quality rations in their mess, guaranteed down time after flights, flight pay, higher life insurance payouts, and monthly commissary (PX) allowances equal to an officer's in alcohol and cigarettes. Training and Operations lobbied, and received approval, that these enlisted glider pilots received direct promotion to staff sergeant and rated status, like their motorized enlisted peers.[107]

With the War Department reversal of the glider training ban lifted, the next twelve officers, in two classes of six, conducted their training at the Elmira Soaring Corporation. They graduated 20 September 1941 and helped draft the first official Army Air Corps glider course of instruction. This curriculum was flexible and open to revision as the TTPs of U. S. military gliding emerged and evolved with field testing. The cadre designed it not to exceed four weeks in length to transition powered aircraft officer pilots into glider instructors/supervisors. This was a marked departure from the Training and Operations Division's recommendation to use enlisted soldiers, with practically no flight experience, as the primary operational glider pilots.

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[106] Bissell, *USAAF Historical Studies No. 1 The Glider Pilot Training Program,* 6-7.

[107] Ibid., 7.

Furthermore, General Arnold displayed his impatience and change implementation inconsistency when he issued a 21 August 1941 directive ordering 150 officer pilots trained as glider instructors and the establishment of one advanced Army glider school. He directed these pilots attend contract civilian gliding schools in the Southern and Western portion of the United States to mitigate winter weather impacts at the Elmira, New York school.[108]

Arnold made these changes in a vacuum and without collating the memorandums he had already signed. 1941 ended with the United States Army Air Corps failures to: (1) form an official glider doctrine, (2) designate any official units as glider units, (3) issue a definitive organizational document delineating the manning of glider units, or (4) conduct preliminary experimentation. This period in American glider development was rudimentary at best. This was partly due to the pre-Pearl Harbor state of most U.S. military programs: the Air Corps lacked training equipment, money, gliders, towplanes, and fuel. Army Ground Forces (AGF) command had neither instituted a glider infantry regiment into operational doctrine nor issued a manning, training, and organization document.[109] Arnold's do-it-right-now staffing approach, without a meticulous analysis that defined a doctrine-based requirement, did little more than fund 150 officer glider pilots' training at civilian schools.[110] Arnold operated outside of Army regulations for training organization. The United States Army stated training and doctrine had a synergistic, inseparable relationship. Furthermore, Army policy said they could not be compartmentalized from tactical organization. Doctrine defined proper operational employment of personnel and

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[108] Bissell, *USAAF Historical Studies No. 1 The Glider Pilot Training Program,* 8.

[109] United States Army, *Field Manual 100-5: Field Service Regulations Operations* (Washington, DC: War Department Government Printing Office, 1941): 241.

[110] Bissell, *USAAF Historical Studies No. 1 The Glider Pilot Training Program,* 9-10.

equipment assets; therefore, training was intrinsically an extension of doctrine.[111] In General Arnold's defense, the AGF delayed promulgating a glider infantry regiment organizational doctrine until 15 October 1942.[112] Arnold, however, never requested AGF to produce a glider doctrinal organization document. Therefore, the Army Air Corps had no glider unit end-state basis on which to make decisions, subsequently their glider capability had miniscule advancements in 1941.

The United States Air Corps designated the Material Division at Wright Field, Dayton Ohio the agency responsible for glider acquisitions. The Material Division delegated it to their Aircraft Laboratory Department. They delegated it, subsequently, to the Experimental Engineering Section (ESS).[113] Lacking a doctrine driven requirement, the ESS in early 1942 steered toward testing training gliders. This kept with Arnold's notional requirement of producing 150 powered officer pilots trained as glider pilots.

ESS, through their chain-of-command to Material Division, decided to follow the Civil Aeronautics Administration's (CAA) guidelines for sailplane certification(s) for awarding training glider acquisition contracts. CAA had glider design parameters that ensured air worthiness and public safety for sport flights, not military tactical applications.[114] The Material Division established contracts for experimental training gliders at a fixed price. This safeguarded the contracts to prevent waste, fraud, and abuse. However, it limited bidders to inexperienced and small companies. It also failed to capitalize on America's emerging economic and aviation

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[111] United States Army, Center of Military History Publication 2-1 *Army Ground Forces Organization of Combat Troops* (Washington, DC: War Department Government Printing Office, 1947), 267.

[112] United States Army CMH Pub 2-1, *Army Ground Forces Organization of Combat Troops,* 341.

[113] Paul M. Davis and Amy C. Fenwick, *Development and Procurement of Gliders in the Army Air Forces, 1941-1944* (Washington, DC: Headquarters Army Air Forces Historical Office, 1946): 7.

[114] Ibid., 9-10.

technology instruments of power.[115] These factors severely hindered America's glider program across the entirety of World War II.[116]

ESS tested and approved seven different production models from thirteen bids for training gliders in 1942. Commercial sport glider manufacturers with CAA design certifications rapidly delivered training gliders within weeks or months after contract authorization.[117] They consisted of two and three-seat trainers. Frankfurt Sailplane Company of Joliet, Illinois provided the first training glider, the TG-1A, in March 1942. Light airplane manufacturers Aeronca, Taylorcraft, and Piper removed the engines and made compensatory aeronautical changes on their cub type planes. Army powered pilots had already trained in these airframes, including making dead-stick, or unpowered, landings. Aircraft making dead-stick landings performed as gliders, and the ESS readily authorized these training platforms.[118] The Material Division procured 1,086 training gliders in 1942, 753 of them converted light aircraft.[119] The development and acquisition of tactical gliders proved more daunting.

America's political system inhibited the United States Army Air Force glider program inception. The established U. S. aircraft companies in 1942 had accelerated designing, testing, and production to meet the increasing demand for powered aircraft in the European Theater of Operations. The War Production Board (WPB) issued an executive regulatory directive that authorized glider manufacturing to only those companies not engaged in metal and combat

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[115] Davis and Fenwick, *Development and Procurement of Gliders in the Army Air Forces, 1941-1944,* 10.

[116] Ibid., 10-11.

[117] Ibid., 20.

[118] Ibid., 18.

[119] Ibid., 73.

aircraft fabrication.[120] The U.S. Air Corps' Material Division contacted eleven companies requesting Arnold's eight- and fifteen-person cargo glider prototypes for experimental testing by the ESS. Only four replied favorably: Bowlus Sailplanes, Inc., Frankfurt Sailplane Company, St. Louis Airplane Corporation, and the Waco Aircraft Company.

Frankfurt Sailplane delivered the first two experimental cargo airframes in January 1942: the eight seat XCG-1 and fifteen seat XCG-2. The XCG-1 failed at 63% of the design load during structural testing at Wright Field. Due to this substantial failure, the ESS denied the XCG-2 testing and they terminated Frankfurt's cargo glider design contract on 31 March 1942.[121] Waco provided the eight seat XCG-3 and fifteen seat XCG-4 on 31 January 1942. These airframes passed structural and flight tests in February 1942 and Material Division awarded Waco a quantity production contract in April 1942.[122] The XCG-4 performed so admirably that Material Division immediately cancelled the Bowlus Sailplane and St. Louis Aircraft fifteen seat models, the XCG-6 and XGC-8.[123]

Wright Field tested St. Louis Aircraft and Bowlus Sailplane eight-seat cargo glider models. St. Louis' XCG-5 produced a serious failure during structural tests at the 90 percent load. St. Louis received time to correct the engineering discrepancy, but it replicated during an October 1942 towed flight and Material Division cancelled it.[124] The Bowlus XCG-7 failed a structural test as well on 10 February 1942. Bowlus did not complete repairs until late June. The

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[120] Davis and Fenwick, *Development and Procurement of Gliders in the Army Air Forces, 1941-1944*, 22-24.

[121]Ibid., 24.

[122] Ibid., 25.

[123] Ibid., 28-29.

[124] Ibid., 28.

XCG-7 failed a towed test at 40% of the rated load and Material Division cancelled their contract.[125]

The Waco cargo gliders incorporated high-wing monoplane construction with strut braces, welded steel tube fuselages, wooden wings, droppable landing gear for tactical operation and fixed gear for training. A pilot and co-pilot flew both designs. Material Division ordered 200 CG-3As (the X prefix dropped after moving out of the experimental phase) and 300 CG-4As from Waco in March 1942.[126] Waco designed the CG-4A from inception to carry 13 combat troops or a jeep and six personnel. The entire nose section, including the aircrew cockpit, swung upward creating an aperture large enough that a jeep could drive directly out. The Air Laboratory airborne towed a fully jeep loaded Waco from Wright Field in Dayton, Ohio to Chanute Field in Rantoul, Illinois and back (220 round trip miles). This performance impressed the Air Corps so much they cancelled the CG-3A program with Waco and shifted those funds into 500 CG-4As.[127]

The Air Corps awarded eleven other companies contracts to fabricate a total of 640 CG-4As in 1942. Only four possessed any aeronautical production experience: Waco, Ford, Cessna and Timm Aircraft Company. Furthermore, only Cessna and Ford organically possessed the facilities and organizational structure of a prime aviation contractor.[128] Ergo, the 1942 cargo glider procurement suffered from abysmal production rates. Colonel L. M. Johnson of the Army's Inspector General Department investigated the considerable delays in production. He found shoddy workmanship, non-compliant manufacturing standards, and general inefficiencies

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[125] Davis and Fenwick, *Development and Procurement of Gliders in the Army Air Forces, 1941-1944*, 29.

[126] Ibid., 90.

[127] Ibid.

[128] Ibid., 91.

at the companies that had no previous aviation experience.[129] This trend perpetuated into 1943-44 and the paper will cover the corrective actions taken in Chapter Four.

The War Department realized in 1942 that fighting and winning World War Two required amphibious, mountain, and vertical envelopment units.[130] America's vertical envelopment requirement(s) emerged from contingency, operational plans for the European Theater of Operations. Operation Sledgehammer called for a joint American and British 1942 invasion of northern France if the strategic situation in the Soviet Union portended a Russian collapse. Sledgehammer consisted of a simultaneous amphibious and vertical envelopment assault that would draw enough Luftwaffe assets away from the eastern front to alleviate pressure on the Russians.[131]

American concurrence to Sledgehammer drove Chief of Staff General George Catlett Marshall's order for the formation of one American airborne capable division. He directed General Leslie McNair, the head of AGF, to develop the size, manning, composition, and training for America's first vertical envelopment infantry division. McNair emphasized that special-type trained army units (mountain, amphibious, parachute, glider) tended to sacrifice core infantry proficiency training for what McNair defined as mere unique mobility skill sets. He advocated back to Marshall that those mobility skills be accomplished only when two specific milestones were reached: (1) an approved operation that actually required the unique mobility

[129] Davis and Fenwick, *Development and Procurement of Gliders in the Army Air Forces, 1941-1944*, 102.

[130] United States Army CMH Pub 2-1, *Army Ground Forces Organization of Combat Troops,* 339.

[131] War Cabinet Chiefs of Staff 8 April 1942, *Committee Meetings Operation Sledgehammer,* CAB 79-56-21. United Kingdom National Archives.

and (2) conducted in the geographical theater of the operation to best simulate the topographical conditions encountered.[132]

Marshall heard McNair's position and informed him of his strategic view that a larger amphibious-airborne invasion than Sledgehammer attack western Europe in 1943. This was Marshall's Operation Roundup. It required two American airborne divisions. McNair's AGF drafted a Table of Organization proposal for these divisions, the 82ND 101ST, and the War Department approved them in August 1942.[133]

The U.S. vertical envelopment division implemented in 1942 comprised one parachute infantry regiment and two glider infantry regiments. The 325TH and 326TH GIR belonged to the 82ND, while the 327TH and 401ST GIR received assignment to the 101ST. The glider infantry regiments (GIRs) numbered 1,605 with the standard American infantry regiment totaling 3,000.[134] Each GIR had two infantry battalions assigned with three rifle companies, a battalion-level weapons company that had six 81 millimeter heavy mortars and eight .30 caliber machine guns, a jeep borne reconnaissance platoon, and a battalion headquarters company that possessed a signals platoon, medical platoon, an additional weapons company equivalent of .30 caliber machines guns and 81 millimeter mortars plus three 37 millimeter anti-tank guns.[135]

The glider infantry rifle company contained a headquarters platoon, weapons platoon, and three rifle platoons. The weapons platoon had two squads of .30 caliber machine guns and three 60-millimeter mortar teams. A glider rifle platoon had three squads of twelve men lead by a

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[132] United States Army CMH Pub 2-1, *Army Ground Forces Organization of Combat Troops,* 340.

[133] Ibid., 341.

[134] Ibid.

[135] Ibid.

sergeant or staff sergeant. Their firepower was ten M-1 Garands, one 1903 Springfield sniper rifle and one Browning Automatic Rifle (BAR). The GIR rounded out with the combat service company (chemical, signal, military police, medical, and combat engineers platoons) and the regimental headquarters company that possessed the anti-tank detachment of nine 2.36-inch bazooka teams and nine 37-millimeter anti-tank guns.[136]

1942 saw substantial, and chaotic, growth in the U.S. glider pilot training program. The U.S. Air Corps established the Flying Training Command (FTC) on 23 January 1942. This organization owned all United States Army flight education. Arnold directed Flying Training Command in April 1942 to train 4,200 glider pilots by a 1 July 1943 deadline. This order coincided with the U.S. commitment to Operation Sledgehammer and General Marshall's formation of the two airborne divisions.[137] Arnold further stipulated that 2,000 be qualified by 31 December 1942. FTC had inherited one established military glider school, a civilian run facility at Twenty-Nine Palms, California. This sudden surge forced them to immediately contract three additional sites at La Mesa, Texas, Elmira, New York, and Wickenburg, Arizona. The rapid expansion did not allow time for a curriculum review and these sites planned their training designs around the powered instructor officer pilot program.[138]

The additional glider pilot trainees, by directive had to come from within the Army Air Forces. The selection criteria mirrored those for rated pilots. Glider pilot volunteers had to meet four parameters: (1) 18-32 years old, (2) pass a Class I flight physical, (3) documented flying

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[136] United States Army CMH Pub 2-1, *Army Ground Forces Organization of Combat Troops,* 341.

[137] Bissell, *USAAF Historical Studies No. 1 The Glider Pilot Training Program,* 15.

[138] Ibid., 16.

experience with powered or sailplanes, civilian or military, and (4) volunteers could not have failed aircrew training in the Army or Navy aviation pipelines.[139]

Arnold increased the glider pilot output thirty-eight days later from 4,200 (with 2,000 by 31 December 1942) to 6,000 by 31 December 1942 with 3,000 due on 1 September 1942. Flying Training Command had only gotten seven students into the 4,200-glider pilot pipeline. An FTC internal review deduced that this new requirement required funding eighteen civilian contracted schools, modifying the standards for entry, and two unique training paths implemented, but Arnold's 3,000 1 September 1942 goal was feasible.[140] On 11 May 1942, Arnold approved their plan and its criteria that included: (1) Military applicants remained restricted to USAAF personnel, (2) the age limit was raised to 35, (3) the flight physical was lowered to Class II, (4) previous flight experience not required provided the applicant held a CAA. Airman certificate or higher, and/or (5) had an invalidated CAA pilot license, (6) enlisted applicants with no flight time had to score 110 or higher on the Army General Classification Test, and (7) a civilian procurement process instituted.[141]

These changes forced Flying Training Command to implement pipelines for students with flight experience and those with flight classroom fundamentals but no actual flying time. They sought and received approval to take military flight school washouts provided those personnel had obtained at least fifty military flying hours. The FTC established a Class A and Class B glider student training path. Class A students had previous flight experience and

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[139] Bissell, *USAAF Historical Studies No. 1 The Glider Pilot Training Program,* 17.

[140] Ibid., 18-19.

[141] Ibid., 21-24. The CAA Airmen certificate was the basic, minimum knowledge level gained from a ground school that covered the academic portions of federally approved flight programs. These programs had the students conduct cockpit familiarization and pass academic tests and ground checks. This level of qualification came with zero actual flight time.

received four weeks of the preliminary block: light aircraft flying with all landings made dead stick. Two seat glider advanced training block one followed for a week duration. Flying Training Command funded and scheduled a one-week advanced block two landing the CG-4A Waco.[142]

Class B students completed an elementary flight training block that was five weeks in duration. Its design followed the CAA's for initial pilot training and gave light aircraft flying with powered landings. Graduates proceeded to a preliminary phase where they conducted two weeks of light aircraft flights with all dead stick landings. Class B glider candidates then completed the same two advanced block(s) and their Class A counterparts.[143] This was the standard glider pilot pipeline from 15 June to 14 September 1942.

The War Department leveraged the Civil Aeronautics Administration to contact eighty-five thousand Airmen or higher certificate holders in the civilian populace. They mailed a USAAF approved recruiting circular encouraging these Americans to volunteer for glider pilot training. If accepted for enlistment, they went to one of seventeen Army Air Force bases for processing and testing. Candidates had to score either a 110 on the Army General Classification Test or 65 on the Aviation Cadet Mental Screening Test (this was fifteen points below the standard cutoff score for powered military aviation training). Those with the aptitude score(s) took the Class II flight physical and if found fit enlisted in the USAAF glider pilot Class B pipeline.[144]

Civilian recruitment and the Army Air Force simply could not meet the 6,000 qualified glider pilot deadline. The glider pipeline contained 228 students on 4 June 1942, was one week

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[142] Bissell, *USAAF Historical Studies No. 1 The Glider Pilot Training Program,* 23.

[143] Ibid., 23-24.

[144] Ibid., 24.

behind in instruction milestones, and short 1,100 candidates for the currently funded class quotas. Flying Training Command reported on 6 June 1942 that it was unable to reach 2,000 glider pilots by 1 September. The CAA notified the War Department's G-1 (administrative branch commanded by the Adjutant General) in June 1942 that a large volume of personnel meeting the glider pilot pre-requisites existed in the Army Combat Arms (infantry, armor, artillery) and supporting branches (military police, signal corps, chemical, supply). General Marshall signed an order that stated all Army units shall read the glider pilot recruiting circular to every soldier. Furthermore, Marshall's order directed the immediate transfer of those men, officer and enlisted, which met the prerequisites and volunteered into the USAAF glider pilot program.[145]

Flying Training Command proposed another procurement change on 12 June 1942: opening glider pilot applicants to those with no classroom or actual flying experience, provided they met all the other prerequisites. They advocated that this change, coupled with the Army wide recruitment effort, would enable them to achieve the original 1 September 1942 goal of 2,000 glider pilots by 28 September. This course of action received immediate approval. By 13 July 1942, FTC reported 3,800 trainees in the glider training system.[146]

Arnold raised the glider pilot quantity from 6,000 to 7,800 on 10 August 1942. He ordered them to be operationally ready by 1 March 1943. The American gliding program however was at a standstill. 3,800 glider pilot candidates had, or were close to, completing the elementary training blocks. None could progress into the advanced portions flying the CG-4A for two primary reasons: (1) no quantity of Waco CG-4As had arrived at the training schools, and

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[145] Bissell, *USAAF Historical Studies No. 1 The Glider Pilot Training Program,* 24.

[146] Ibid., 25-28.

(2) no towplane assets had been assigned to support glider operational training. The War Production Board's executive order limiting aviation companies from Waco building now limited the Material Division's ability to support training glider pilots. Flying Training Command had requested sixty C-47 Dakotas from Air Transport Command. The Air Transport Command (ATC) responded that a written, standing order from General Arnold directed all C-47 squadrons to supporting only tactical commitments, therefore they could not allocate any Dakotas for glider training.[147]

Major General Barton Yount demanded a 21 August 1942 conference with his ATC counterpart Major General Harold George and Hap Arnold at USAAF Headquarters in Washington, DC. Yount resolved to solve the glider quagmire and his command's inability to receive any transport support, despite Arnold's constant increase in glider pilot demand. Arnold had failed to realize that his own edicts, with no analysis, had countermanded themselves and handcuffed his functional commanders. Yount and FTC received an allocation of thirty-nine C-47s from the 61ST Troop Carrier Group. The Flying Training Command staffers notified Arnold, through General Yount, that this quantity would only support the qualification of 4,800 pilots. Arnold acquiesced from the 7,800 by 1 March 1943.[148]

Yount also requested a modification to the training curriculum. The attrition rates had increased with the change from qualified powered pilots exclusively to a huge pool of volunteers that had no flight experience. Flying Training Command recommended that Class A students complete a fourteen-week pipeline in which a candidate received: (1) four weeks elementary light plane flying with dead stick landings, (2) four weeks of two-seat glider basics, (3) four

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[147] Bissell, *USAAF Historical Studies No. 1 The Glider Pilot Training Program,* 33-37.

[148] Ibid., 37-43.

week of two-seat glider advanced, and (4) two weeks on the CG-4A. Class B students received eighteen weeks with four weeks of preliminary light plane flying school prior to the elementary, dead stick landing block. Arnold concurred and this pipeline went into effect 14 September 1942.[149] Noticeably absent in the American glider pilot pipeline was any allocation for ground combat skill training.[150] The British and the Germans had placed tremendous emphasis on a glider pilots' abilities to integrate as combat infantrymen. Chapter Four will address this training gap and the resultant second and third order effects.

The American glider program ended a tumultuous, rapidly changing 1942 with a codified, robust glider pilot training curriculum designed by Flying Training Command. America's political system had totally inhibited military cargo glider production efforts and denied the United States Army Air Forces ability to maximize the U.S. civilian aviation technological and industrial basis. General George Marshall's strategic view for the European Theater of Operations had cemented the Glider Infantry Regiment into the United States Army's vertical envelopment doctrine. 1943 provided the Allies their first large-scale glider vertical envelopment assault opportunity.

[149] Bissell, *USAAF Historical Studies No. 1 The Glider Pilot Training Program*, 45.

[150] Ibid., 44-45.

Chapter Four

Allied Glider Force 1943 Through Post War

Allied political and military leaders met for the Anfa Conference in Casablanca, Morocco in January 1943. Churchill, Roosevelt, and their respective military chiefs of staff discussed the strategic way forward. In the European Theater of Operation (ETO), General Marshall lobbied hard to direct the next combined effort in a cross-channel attack from England to northern France. Marshall posited this would both draw German pressure off Russia and provide the most direct route to taking the fight into Germany. British leadership, both political and military advocated strongly against this plan. First, they correctly stated that the Allies did not possess the inventory of landing craft for such a large amphibious assault. Second, Churchill felt that Italy's political and military instruments of power had weakened. The Allies could force a quick Italian capitulation by taking Sardinia or Sicily, then invading the Italian mainland. This had the ability to split the Axis politically, hamper German morale at home, and force the OKW to weaken the Russian front by shifting units to Italy. Roosevelt concurred with the British. The combined staffs determined Sicily as the target and that Allied vertical envelopment forces land simultaneously with amphibious forces. The July 1943 favorable moon period was the desired invasion date(s), code named Operation Husky.[1]

Browning received orders shortly after the Anfa Conference to move the 1ST Airborne Division immediately to North Africa and prepare by midsummer for Operation Husky.[2] The Husky plan centered on the Allied airborne forces striking Italian and German beach

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[1] Map Room Papers, Anfa Meeting Minutes Volume 1 18 January 1943. *Presidential Trips – Anfa Conference (Casablanca Roosevelt Administration)*, 13-31, accessed 23 August 2023, U.S. National Archives and Records Administration.

[2] The Air Ministry, *By Air to Battle: The Official Account of the British First and Sixth Airborne Divisions* (London, U.K.: His Majesty's Stationery Office, 1945), 50.

fortifications from the rear and seizing key topographical features which provided Allied ground units freedom of maneuver. The operation had to launch from austere North African bases captured during Operation Torch. The airborne element initially planned for three British brigades and two American brigades (regiments). British planners integrated two parachute brigades, infantry elements of the airlanding brigade, and divisional artillery and engineers.[3] Sir Law Bernard Montgomery, assigned as the Allied ground forces component commander for Husky, was still engaged fighting the Afrika Korps in Tunisia. He and his staff would not have the time to provide Browning any detailed commander's intent for planning purposes until the German defeat in Tunisia.[4]

Browning and his Allied counterparts had significant obstacles to overcome. Despite the 1942 allocations to 38 Wing for towplanes and the Horsa-Hamilcar productions, Britain severely lacked towplanes and had a presupposition that the Horsa could not be air delivered to North Africa. The flying distance encompassed 1,400 miles from England and only the Halifax heavy bomber, still in low production quantities, had the range and endurance to potentially make the tow. The British planners realized that the tow distance from North Africa's bases to the glider release point was 350 miles. This factor made the American CG-4A Waco more feasible for operational success for two critical reasons: (1) The Waco design allowed for disassembly, shipping, and reassembly whereas the Horsa once assembled could not, (2) The Allies had

[3] General Sir Alan Brooke Memorandum to the Allied Chiefs of Staff, 24 February 1943, *A/Policy/Army-Air: Airborne Forces Volume II January 1943-July 1945*, accessed 23 August 2023, 407, United Kingdom National Archives, CAB 121/98.

[4] De Guingand, *Operation Victory*, 269-270. Eisenhower was the overall theater commander and British General Harold Alexander was his deputy commander. Montgomery did not write to Alexander until 10 April 1943, after Allied victory was asured in North Africa, to receive input for the final planning for Operation Husky. Eisenhower, Brooke, Marshall, Browning, all had been planning and moving logistics into North African bases for Husky starting in later January 1943.

greater quantities of smaller tow planes than those required for the Horsa, and (3) American industry could provide the Waco quantities necessary by Husky's launch date(s). Browning's early planning determined that the airlanding brigade required 200 Waco's for Husky. Brooke put this requirement into official correspondence to the British prime minister. Churchill leveraged the political-diplomatic instrument of power he'd fostered with Roosevelt to divert 200 CG-4As from USAAF glider training to the British airborne division for Operation Husky.[5]

The combined Allied airborne planners ascertained during COA development that Husky required 800 transport planes to deliver the vertical envelopment forces in one lift. Delivering half of just the British 1ST Airlanding Brigade at once needed 500 aircraft. Britain's 38 Wing possessed a combined 80 Albemarle and Halifax towplanes (the antiquated Whitley now relegated to training only) in early 1943. Britain diplomatically convinced the Americans to shift tactical control of the USAAF's 51ST Troop Carrier Group from Twelfth Air Force to Husky. This provided 312 C-47 Dakota I's to supplement 38 Wing's lift assets.[6]

The Allied vertical envelopment forces arrived by the end of April 1943. The U.S. Army's 82ND Airborne Division had undergone a reorganization: the 326th GIR shifted to the new 13TH Airborne Division and the 505TH Parachute Infantry Regiment (PIR) replaced them. The division retained the 325TH GIR, the 319TH Glider Field Artillery Battalion (GFAB), and the 320TH GFAB. The Husky plan placed the American glider units as reserve assets due to the marked shortage of trained U.S. glider pilots.[7]

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[5] Winston S. Churchill to Franklin D. Roosevelt Official Correspondence, *A/Policy/Army-Air: Airborne Forces Volume II January 1943-July 1945*, accessed 23 August 2023, 409-11, United Kingdom National Archives, CAB 121/98.

[6] Ibid., 4 March 1943, 394-396. For the clarification of the reader: the historian assembled this source in reverse chronology; 1945 was placed at the beginning and the end of the book was where 1943 began.

[7] Ibid., 27 April 1943, 387.

Browning recognized that the American Dakota pilots lacked operational towplane experience and his recently arrived Glider Pilot Regiment knew nothing about the Waco, dubbed the Hadrian by the British.[8] The GPR brought all qualified pilots and those in the final stages of Horsa-Hamilcar training to prepare operationally for Husky. Joint training operations began in April 1943. The Hadrian, however, could not hold the British anti-tank gun and its jeep mobility asset. Two Hadrian's had to carry them in divided loads; with an impossibility of assurance that both arrived intact, on time, and the right location to be combat effective.[9] The British planned to insert glider artillery and anti-tank guns one hour prior to a seaborne assault near Syracusa. Their primary task, along with elements of the Staffords GIB, was to seize and hold a vital bridge over the Anapo River. This bridge allowed the British to expand the beachhead and conversely, if not held, enabled German armor and mechanized forces to assault the landing forces.[10] The Dakota did not have the ability to pull an artillery laden Horsa from North Africa to Sicily. 38 Wing had to tow Horsas into North Africa for Husky to succeed.[11]

The Horsa I and II did not disassemble like the Hadrian. Its total wooden design was not conducive to shipping on transport ships. Furthermore, this method occupied valuable cargo space due to the Horsa's size. In April 1943 the RAF experimented with the feasibility of towing the Horsa's 1,400 miles, a capability thought uncertain two months earlier. A bold proof-of-concept test flight series, conducted around the British Isles, had a Halifax tow a cargo-free Horsa the required distance, altitude parameters, and still land with a small fuel reserve. This

[8] Air Ministry, *By Air to Battle*, 50-52. British protocol named gliders after historical characters that started with the letter "H".

[9] Ibid.

[10] De Guingand, *Operation Victory*, 285.

[11] Air Ministry, *By Air to Battle*, 52.

demonstrated again how the British glider technology changed in response to doctrinal requirement(s).[12]

The RAF issued 38 Wing orders to deliver thirty Horsas (steered by a pilot and co-pilot) and Halifax towplanes to General Browning's 1ST Airborne Division staged at Kairouan, Tunisia in three stages.[13] The first leg had them travel to Sale, Morocco. This segment of the flight was highly dangerous. These flights navigated within one hundred miles of German airfields in occupied France. A Halifax did not have the range to swing out over the Atlantic pulling a Horsa. The Halifaxes carried extra fuel outside of their self-sealing tanks, in their bomb bays, to make it to Morocco. 38 Wing aircrews conducted these sorties in daylight. Nighttime towing over water was too risky; if the towrope parted from turbulence, the Horsa's invaluable GPR aircrew would be unrecoverable. The British only lost two Halifaxes and three Horsas in this phase, with two GPR aircrews rescued.[14]

From Sale, they proceeded to the airfield at Froha, Algeria. Weather conditions forced this 350-mile flight to depart at midday: early morning low clouds forced a later launch. This resulted in towing through turbulence and high desert winds. Two gliders suffered towrope failures and landed in the desert. The RAF salvaged one Horsa and saved both GPR aircrews.[15]

The final flight required the 38 Wing and GPR pilots to cross mountains at an altitude of 9,000 feet. The climb was laborious, at one hundred feet a minute, and full of turbulence over the peaks at midday. One Horsa crew reported immediately dropping 1,300 feet when initially

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[12] Air Ministry, *By Air to Battle*, 52-53.

[13] Air Ministry, *Airborne Forces*, 88.

[14] Air Ministry, *By Air to Battle*, 53.

[15] Ibid.

entering a turbulent period. This flight resulted in them losing 3,000 feet in ten minutes and laboring to prevent the Horsa crashing. The first Horsa reached Kairouan on 28 June 1943. Hard landings rendered seven inoperable for Husky.[16] The 38 Wing-GPR aircrews had accomplished a task thought unachievable. They had overcome distance, weather, and enemy aircraft to deliver nineteen mission critical Horsas, from Great Britain to Tunisia by towing, for the invasion of Sicily.[17]

Browning realized that Britain was attempting an unprecedented vertical-amphibious double envelopment. While the CLE and Britain's War Cabinet had devised a doctrine of what gliders should accomplish, no definitive manual guided ground commanders, who were not airborne, how to integrate gliders into an operational plan. Furthermore, the Army and Air Force responsibilities needed further expansion and clarification. Browning and his staff worked diligently to produce the first Allied airborne doctrine manual for Husky planners. The Chief of the Imperial General Staff signed *Airborne Operations Pamphlet No. 1* and promulgated it as an official doctrine in May 1943.

This manual covered both parachute and glider planning and operations. It spelled out critical glider implementation considerations such as: (1) air landing troops have the greatest hitting power, (2) gliders have the ability to land in restricted areas, (3) glider forces shall be employed in a concentrated brigade and battalion taskings with rare company sized operations.[18] *Pamphlet No. 1* delineated how landing zone selection was a joint Army-RAF responsibility. The Army required relatively flat landing zones with a slope not to exceed 1-in-15 with close

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[16] Air Ministry, *Airborne Forces*, 88.

[17] Air Ministry, *By Air to Battle*, 53.

[18] British Army, *Airborne Operations Pamphlet No.1-General 1943*(London: The War Office, H. M. Stationery Office, 1943), 5-7.

proximity to the mission objective. RAF towplane pilots had to fly avenues of approach with highly recognizable, particularly in low visibility night conditions, topographical aids to navigation.[19] It covered all military aspects for vertical envelopment operations from initial planning phase to post-mission troop remobilization.

The British airlanding brigade conducted intensive training in the Tunisian desert leading up to Operation Husky. Their objectives, code named Operation Ladbroke, had expanded beyond the Ponte Grande bridge over the Anapo River.[20] They also had tasking to seize a coastal artillery battery that overlooked part of the landing beaches and launch a diversionary attack on Syracuse's western outskirts.[21] The final plans required 109 Dakotas from 51ST Troop Carrier Group and 28 Albemarle and 7 Halifaxes from 38 Wing to tow 127 Hadrian and 10 Horsa gliders.[22] 1ST Airlanding Brigade's ground component comprised one infantry battalion each from 1ST Border Regiment and 2ND South Staffordshire Regiment, 9TH Field Company Royal Engineers, and the 181ST Airlanding Field Ambulance Company.[23] Browning had a strong supposition that transport pilot training deficiencies might hamper Allied vertical envelopment force success in Husky.[24] Therefore, he had these units conduct 1,800 full mission profile, joint night training lifts between 26 May and 8 July 1943.[25]

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[19] British Army, *Airborne Operations Pamphlet No. 1*, 14-16.

[20] De Guingand, *Operation Victory,* 285.

[21] Air Ministry, *By Air to Battle*, 54.

[22] Air Ministry, *Airborne Forces,* 89.

[23] Air Ministry, *By Air to Battle*, 55.

[24] De Guingand, *Operation Victory,* 290.

[25] Air Ministry, *Airborne Forces,* 89.

The Dakota, Albemarle, and Halifax had different tow speeds relative to their own engine performance and the glider load(s) they pulled. The RAF staff had to meticulously calculate and stagger their take-offs to compensate for speed differences to enable precise timed arrival at the release point. This also inhibited the towplanes from formation flying. They had to individually navigate an indirect route from Tunisia: due east to Malta's southeast corner, north to Capo Passero on Sicily's southeast corner, then up the eastern Sicilian coast to the release point.[26]

The first Allied towplane-glider combination got airborne at 6:48 PM on 9 July 1943. The aircrews received a weather briefing to expect winds at 30 miles per hour enroute to the release point, but they encountered southeasterly gales up to 45 miles per hour after Malta. This forced a number of towplanes severely off course. German radio direction finding capabilities forced them to fly the Malta to Sicily leg at a low altitude.[27] This made topographical navigation, emphasized in the British doctrine by *Airborne Operations Pamphlet No. 1,* difficult to impossible. Furthermore, low altitude approach did not allow any margin to correct for course deviation from the increased wind speeds or over water navigation errors to the release point.[28]

Browning's apprehension manifested as reality. Sixty-nine of the 137 gliders landed in the sea due to towplane navigational failures in reaching the proper release point. Heavy anti-aircraft artillery (flak), something American transport pilots had yet to endure, was a contributing factor. Fifty-six gliders scattered across southeastern Sicily in erroneous landings. Only twelve managed to alight on the correct landing zone.[29]

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[26] Air Ministry, *Airborne Forces,* 90.

[27] Air Ministry, *By Air to Battle,* 56.

[28] Air Ministry, *Airborne Forces,* 90.

[29] Ibid.

Horsa glider No. 133 in the Ladbroke order of battle by a GPR staff sergeant landed within 300 yards of the Ponte Grande bridge. Lieutenant L. Withers and his full South Staffordshire infantry platoon captured the bridge in less than thirty minutes. They took no casualties and lacking any Royal Engineers, Withers and five volunteers swam the bridge and removed all preset demolitions. Three other Horsas landed within two miles and the glider troops maneuvered toward the bridge. Seven officers and eighty enlisted men arrived at 6:30 AM to reinforce Withers. Lieutenant Colonel Walch assumed command from Withers.[30]

This force's armament consisted of one 81-millimeter mortar, one 51-millimeter mortar, four Bren LMGs, and rifles and sidearms. They repelled numerous counterattacks in the morning and early afternoon including one with three armored cars. The enemy switched to continuous mortar fire, which the South Staffords could not counterfire due to a scant quantity of their own mortar rounds. By 4:00 PM on 10 July 1943, only fifteen British glider troops remained uninjured when an Italian-German combined infantry assault overran them. Six managed to escape toward the beaches where they ran into lead elements of a Royal Scots Fusiliers brigade. The Scots moved up rapidly and retook the bridge by 4:40 PM.[31]

This action proved the highwater mark for the 1ST Airlanding Brigade in Operation Husky. Some small unit improvisational successes occurred, attributed to Browning's insistence that glider troops, including the aircrews of the GPR, undergo intense physical training and discipline drills commensurate with those of the Grenadier Guards. Glider No. 10, a Hadrian, carried a detachment of the Brigade Headquarters staff. It landed off target but near a coastal artillery battery protected by substantial barbed wire. The senior man in Glider No. 10 was

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[30] Air Ministry, *By Air to Battle*, 58.

[31] Ibid., 59-60.

Brigade Deputy Commander Colonel O. L. Jones. He decided it was worth taking out but too protected to assault at night. Jones led a mixed bag of staff officers, signalers, and glider pilots in overwhelming the garrison, destroying five artillery pieces, and blowing up the battery's ammunition reserve. Hadrian Glider No. 7 crashed 250 yards from shore with elements of the 2ND South Staffordshire. Three officers, a medical officer, his enlisted aide, and signaler made it out of the glider prior to sinking and swam to shore. They marched ten miles to rejoin their battalion by the evening of 10 July 1943. They managed to capture two pillboxes, three machine guns, 21 Italian prisoners, and an anti-tank gun along the way.[32]

Montgomery deemed the glider assaults as successful. Taking and holding the Ponte Grande bridge allowed for expansion of the beachheads and opened the drive north up the Sicilian coast.[33] General Freddy De Guingand served as Montgomery's Deputy Commanding General and head planner for Husky. He stated that the airborne assault had been the only part that was not a total success, only partially satisfactory.[34] The material cost in gliders and men was substantial but the scattered landings and actions served to confuse the Italian and German defenders into thinking a much larger force was landing.[35]

Browning held an after-action report conference focused on Husky's vertical envelopment force performance. The 21 July 1943 meeting had British Army, RAF, Royal Navy and their equivalent American counterparts capture the lessons learned to develop a way forward for Allied airborne operations. Browning assigned equal fault to both sides' airborne ground

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[32] Air Ministry, *Airborne Forces,* 90.

[33] Air Ministry, *By Air to Battle,* 60.

[34] De Guingand, *Operation Victory,* 290.

[35] Air Ministry, *Airborne Forces,* 92.

forces and transport units for errors: he stated no single branch or nation carried more or full blame. De Guingand and Montgomery deployed the British Air Landing Brigade, towed primarily by U.S. Dakotas, with full anticipation of high material loss. The Ponte Grande bridge was vital enough to accept the risk. Browning and the senior RAF officer, Air Marshal Tedder, felt Husky demonstrated that glider troops should replace parachute infantry in future airborne operations. This was due to German armor nearly overrunning the American's 504TH PIR near Catania, Sicily. Furthermore, they suggested Allied doctrine state that no parachute mission occurred without glider accompaniment carrying artillery and anti-tank guns.[36] Eisenhower embraced this doctrinal concept for the Allied airborne and issued a 2 August 1943 training memorandum stating that glider borne troops held a great advantage over parachute troops because: (1) they carry more heavy weapons and ammunition, (2) are compact units ready for action, and (3) fulfill the principle of massing force as they can land in a concentration quickly. Eisenhower addressed the necessity of parachute-glider integration: parachute troops shall train to secure glider landing zones and protect the gliders during their landings. The Allies had not yet operationally achieved this standard. It became the task and condition to which American airborne forces had to train. General Marshall and the War Department concurred and issued this as America's first official comprehensive vertical envelopment doctrine in War Department Training Circular No. 113 on October 1943.[37]

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[36] Colonel John L. Lewis, Commanding Officer 325TH Glider Infantry Regiment, *Regarding Reactions to Airborne Operations Conference North African Theater of Operations Briefing 21 July 1943,* 1-3, United States Amry Heritage and Education Center, accessed 20 May 2023.

[37] General Dwight D. Eisenhower to General Marshall, *A/Policy/Army-Air: Airborne Forces Volume II January 1943-July 1945*, accessed 23 August 2023, 172-179, United Kingdom National Archives, CAB 121/98.

Britain's glider program continued with GPR training and Horsa-Hamilcar production through 1943. Britain's MAP guaranteed that Airspeed and the converted furniture manufacturers would produce 1,370 Horsa I and II's and 100 Hamilcar gliders by the end of the year. This did not include those assets moved to Tunisia for Operation Husky. The RAF reported that the glider pilot pipeline would matriculate 500 completely trained aircrew to the Glider Pilot Regiment, adding to those who survived the Ladbroke operations in Sicily.[38]

Operation Ladbroke's joint interoperability training and Eisenhower's doctrinal glider decree combined to drive American interest in large gliders. Lieutenant General Jacob Devers was responsible for the material buildup of American forces in the ETO. American airborne commanders noted the Horsa carrying capability during the desert workups and requested Devers approach the British War Cabinet about acquiring Horsas and Hamilcars. Devers, based in London, forwarded an official request on 12 October 1943 for 300 Horsas and 50 Hamicars.[39]

The War Cabinet appointed British Brigadier L. C. Hollis the point of contact for this proposal, and he replied expeditiously that British industry could meet the American request provided that America contributed the material resources necessary beyond Britain's own procurement. This included: (1) 234,000 cubic feet of spruce harvested from American forests, (2) 3,700 cubic feet of American Douglas fir, and (3) 6,207,000 square feet of plywood. Devers supplemented this request with a 14 November 1943 increase to 500 Horsas. This requirement evolved from the early planning of Operation Overlord. Devers also stated that if the Overlord

[38] Ministry of Aircraft Production and RAF Flight Training Command to War Cabinet, *A/Policy/Army-Air: Airborne Forces Volume II January 1943-July 1945*, accessed 23 August 2023, 409, United Kingdom National Archives, CAB 121/98.

[39] Lieutenant General Devers to the War Cabinet Committee Meeting, *A/Policy/Army-Air: Airborne Forces Volume II January 1943-July 1945*, accessed 23 August 2023, 239, United Kingdom National Archives, CAB 121/98.

plan dictated a need for glider borne engineers to build an austere airfield in Normandy, it would require 225 Horsas and 175 more Hamilcars by 1 March 1944.[40] The British Vice Chief of Staff for Air replied four days later that British industry could produce the 500 Horsas. It could not, however, meet any glider production beyond the 500 Horsa-50 Hamilcar, even with American material supplementation.[41]

The USAAF Material Division used the War Department's Training Circular No. 113 vertical envelopment doctrine and the feedback on Britain's Horsa to begin 1943 testing on thirty, thirty-two, and forty-two seat troop carrier gliders. The Glider Branch and ESS rejected seven different designs until Waco's XCG-13A passed initial testing and met AAF requirements. It had an 86-foot wingspan, was 54 feet long, with a welded steel tubular fuselage and wooden wings. The XG-13A had a gross weight of 15,000 pounds and carried 8,000 pounds of cargo at 174 miles per hour tow speed with a maximum altitude of 12,000 feet.[42] It represented American industry's answer to the Horsa evidenced in that the Horsa: (1) had an 88-foot wingspan and 67-foot length, (2) carried 27 troops, and (3) had a cargo capacity of 6,900 pounds.[43]

The USAAF ordered the CG-13A for production quantities. On 9 June 1943, Classified Technical Instruction 1358 awarded contracts to two companies that had proven CG-4A manufacturing processes: Northwestern Aeronautical and Ford. Material Division paid Waco Aircraft Corporation as the design contractor to provide the engineering specifications while

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[40] Lieutenant General Devers to Brigadier L. C. Hollis, *A/Policy/Army-Air: Airborne Forces Volume II January 1943-July 1945*, accessed 23 August 2023, 209, United Kingdom National Archives, CAB 121/98.

[41] Vice Chief of Staff for Air Ministry to Lieutenant General Devers, *A/Policy/Army-Air: Airborne Forces Volume II January 1943-July 1945*, accessed 23 August 2023, 204, United Kingdom National Archives, CAB 121/98.

[42] Davis and Fenwick, *Development and Procurement of Gliders in the Army Air Forces, 1941-1944*, 38-45.

[43] Air Ministry, *Airborne Forces*, 252.

retaining proprietary blueprint rights. The contracts directed Ford and Northwestern to deliver fifty CG-13As each. Northwestern began construction earnestly, but Ford refused to take on any additional aviation work in 1943. The Material Division had tasked Ford with an expanded contract on B-24 Liberator Pratt and Whitney engines. Ford stated they could commence CG-13A work in 1944 and the USAAF concurred with a later delivery.[44]

The American glider program had tried to proceed for almost two years without any coordinated planning and doctrine. By 1943, the USAAF had 10,294 glider students awaiting different phases in training. Their morale had deteriorated severely as the Army Air Force had guaranteed them robust, exciting training with accelerated advancement and privileges. They could not progress toward glider qualification with the lack of both towplanes and cargo gliders. The glider volunteers also suffered numerous administrative problems, particularly in lost pay records, as they left their original units and endured mismanagement of their service records.[45]

The War Department finally established an official airborne force structure in 1943. This codified the number of airborne divisions and glider infantry and artillery battalions needed to prosecute World War II. It increased the number of airborne divisions from two to five. The U.S. Army activated the 11TH, 13TH, and 17TH Airborne Divisions in 1943. The 11TH Airborne received the 187TH and 188TH GIRs with the 674TH and 675TH GFABs. The 326TH GIR shifted from the 82ND and along with the 88TH GIR, 676TH and 677TH GFABs joined the

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[44] Davis and Fenwick, *Development and Procurement of Gliders in the Army Air Forces, 1941-1944*, 137-139.

[45] Bissell, *USAAF Historical Studies No. 1 The Glider Pilot Training Program,* 52-59.

13TH Airborne. 193RD and 194TH GIRs, 680TH and 681ST GFABs rounded out the 17TH Airborne Division.[46]

This doctrinal requirement codification resulted in the Army Air Force convening an official review board for the glider pilot training program. This board of officers defined the final quantity of required glider pilots as 4,054. The Chief of Staff of the USAAF approved this final number and ordered the Flying Training Command to only continue training those students that had graduated Class A or B basic pipelines. The excess glider students received reclassification into undermanned branches in the Army and Army Air Force.[47]

The glider unit finalized end state resulted in advanced training site consolidation and curriculum overhaul. On 9 July 1943, South Plains Army Airfield in Lubbock, Texas became the single point manager for CG-4A advanced TTP instruction. The glider curriculum(s) had centered on individual safe and proficient operations concerned with landings on improved airfields. This methodology ensured glider material condition preservation but was not a tactical reality. Flying Training Command ordered a revision that mission-oriented glider TTP training commence to include: (1) low approaches over simulated obstructions to a landing zone, (2) only conducting precision spot landings, (3) formation flying in echelons of two or more, (4) minimum altitude navigation, and (5) flying at maximum full combat loads including at night.

The USAAF conducted the Laurinburg-Maxton Maneuvers in North Carolina, August 1943. This was a two-week field exercise with nine towplanes and CG-4As. Flying Training Command was implementing the lessons learned from British gliders in Operation Ladbroke and

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[46] Committee on the Revision of the Military Program to General George Marshall, Chief of Staff United States Army, Memorandum 7 June 1943, United States Army Century of Military History, accessed 31 August 2023.

[47] Bissell, *USAAF Historical Studies No. 1 The Glider Pilot Training Program,* 61-65.

assessing the South Plains advanced glider school's curriculum training. It culminated with tactical towing and glider flights under simulated combat conditions with night landings, formation flying, and emergency water landings. Full mission profile training followed with the Kershaw maneuvers. Held near Kershaw, South Carolina, CG-4As and C-47s towed and landed elements of the 101ST Airborne's GIRs, GFABs, and combat engineers. The Waco aircrews had orders to deliberately land in bushes, scrub trees, and barbed-wire fences. This demonstrated survivability of the CG-4A airframes, glider troops, and equipment in austere landing zone insertions.[48]

The neglect of tactical training was a second order effect caused by the scarcity of gliders and towplanes. However, by late 1943, CG-4As began to finally arrive from the manufacturers. The Lockheed C-60 Lodestar, allocated by Air Transport Command for glider pilot training, arrived in substantial quantities. This returned the C-47 Dakotas to operational Troop Carrier Commands and corrected a marked training deficiency. 3,001 glider pilots progressed through advanced glider training in 1943, transferred to Troop Carrier Commands, and commenced operational training.[49]

The Allied airborne forces had evolved for the purpose of spearheading the invasion of Hitler's Festung Europa (fortress Europe). By late 1943, the strategic and material conditions had shifted to make this an operational possibility. Allied planners assigned vertical envelopment forces' key roles in Operation Neptune, the initial assault phase(s) of Operation Overlord schedule for May-June 1944. American and British airborne forces had the responsibility of landing behind German beach defenses, capturing key terrains features, and holding strategic

[48] Bissell, *USAAF Historical Studies No. 1 The Glider Pilot Training Program,* 82-84.

[49] Ibid., 93-95.

points to prevent German mechanized and armor units from striking the amphibious landing areas.

American and British airborne forces both initiated leadership, doctrine, technology, and organizational design changes for Operation Neptune. The U.S. created the 9TH Air Force to align tactical air support functions under a separate command from 8TH Air Force. 8TH Air Force conducted all strategic level air operations, particularly long-distance bombing, against Germany. 9TH oversaw the training and integration of the IX Troop Carrier Command with the 82ND and 101ST Airborne Divisions for Neptune. On 4 October 1943, Arnold assigned Major General Lewis H. Brereton to command Ninth Air Force.[50] Brereton built on Eisenhower's 1943 airborne training circular by signing a combined vertical envelopment doctrine directive between 101ST Airborne Division and IX Troop Carrier Command. IX Troop Carrier Command's C-47s and CG-4As transported the glider assets and paratroopers into enemy territory. Brereton and the 101ST Commanding General William C. Lee concurred that airborne forces and troop carrier aircrews had to foster mutual confidence and coalesce to overcome emergent problems.[51]

Britain made airborne organizational changes based off lessons learned from Husky and the scope of Operation Neptune's plans. On 26 December 1943, the War Office created the Headquarters Airborne Troops under General Montgomery's Twenty-First Army Group. They also raised Browning's rank to Lieutenant General (three stars). This act made Browning, technically, a senior officer to his American airborne counterparts.[52] Montgomery's Twenty-First Army Group had operational control over all Allied ground forces for Neptune. Twenty-First

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[50] Brereton, *The Brereton Diaries,* 216.

[51] Ibid., 218-221.

[52] Air Ministry, *Airborne Forces,* 101-102.

Army Group's deputy commander, General Frederick De Guingand, suggested consolidating all Operation Neptune Allied airborne assets into a unified command under Browning. Brereton and the Americans concurred in the design, provided an American commanded it. The U. S. leadership tactfully advocated this position because the American airborne divisions outnumbered the British and without America shifting C-47 airframes to Britain, the British airborne missions would not be feasible. Montgomery declared this unacceptable and implemented policy that each respective Allied nation control their own respective airborne operations.[53]

The British authorized a second airborne division after Husky and the 1ST Airborne Division's use in the Italian campaign as conventional infantry. The War Office authorized the 6TH Airborne and chose its numerical designation for security and deception to German intelligence.[54] Britain also made a change to the size of the 6TH Airlanding Brigade. The 6TH contained three glider infantry battalions vice four GIBs in the 1ST Airlanding Brigade. These battalions were the 2ND Oxfordhamshire and Buckhinghamshire Light Infantry, 1ST Royal Ulster Rifles, and 12TH Devonshire Infantry.[55]

Transport plane quantities drove this change. The British shifted more emphasis on additional parachute battalions. A glider battalion inserted by Hadrian (CG-4A) and C-47, like in Operation Husky, required 95 C-47s and fifteen minutes of air space. 48 C-47s dropped a parachute battalion within four minutes.[56] Britain's industry simply could not match America's in

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[53] Brereton, *The Brereton Diaries,* 227-228.

[54] Air Ministry, *Airborne Forces,* 103.

[55] H. F. Joslen, *Order of Battle, Second World War 1939-1945* (London, U.K.: Her Majesty's Stationary Office, 1960), 4.

[56] James M. Gavin, *Airborne Warfare* (Washington, DC: Infantry Journal Press, 1947), 97.

terms of transport plane construction. Therefore, the British vertical envelopment doctrine adjusted its unit composition to match transport lift capability. Browning's Headquarters Airborne Troops requested two major changes to Britain's air transport assets for Operation Neptune. First, that 38 Wing expand from four squadrons to a nine squadron Group. Two, that Twenty-First Army Group have 46 Group of RAF Transport Command operationally assigned for Neptune's airborne operations. The Combined Chiefs of Staff concurred on 1 February 1944.[57]

38 Wing grew to 38 Group with upgraded airframes and additional squadrons. The RAF removed Whitley bombers from operational status. Original 38 squadrons 295, 296, 297 and the newly added from Bomber Comber 570 received Albemarle planes. 298 squadron remained the only Halifax (Hamilcar glider capable) squadron. 299 squadron, another original, and 190, 196, and 620 (all formerly of Bomber Command) outfitted with the Stirling. The Stirling airplane was obsolete for bombing because of its low airspeed; however, it remained a considerable advance over the Whitley. The Air Ministry authorized twenty airframes each per squadron, with total wing strength at 180.[58]

46 Group was comprised of five squadrons outfitted with 30 C-47 Dakotas each. The RAF Transport Command retained administrative control while operationally releasing them to General Browning. Squadrons 48, 233, 271, 512, and 575 had to train under their American counterparts first in C-47 transition and then in towing operations under the oversight of 38 Group. By 6 March 1944, 46 Group was training on Neptune's vertical envelopment plans.[59]

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[57] Air Ministry, *Airborne Forces,* 104-107.

[58] Ibid., 105.

[59] Ibid., 122.

Allied airborne forces trained for Neptune with a high degree of reciprocal exchange. This happened despite the earlier General Officer-level dispute over forming a unified airborne force for the invasion. The Americans planned to use the British Horsa in their landing zones for its ability to bring in artillery pieces and prime movers on one glider. The British aircrews and troopers trained on the C-47 pulling Horsas. Furthermore, the British had combat experience from Husky with the Hadrian (Waco). The Americans had yet to conduct a combat glider assault. In a true display of teamwork and commonality in purpose, the British trained with American aircrews and the Americans learned from their counterparts on the Horsa.[60] On 24 April 1944, IX Troop Carrier Command, 38 and 46 Group took the entire 6TH Airborne Division aloft and inserted it on an exercise.[61] IX Troop Carrier Command, 38 Group and 46 Group conducted over 30,000 hours of night and day airborne exercises in April and May 1944.[62]

The Allies assembled an enormous air fleet for Operation Neptune. The British 38 and 46 Group had a combined 362 towplanes with 650 Horsa (mix of I and II models) and 70 Hamilcar gliders.[63] U.S. assets included 1,022 C-47 Dakotas, 2000 CG-4A Waco and 200 British Horsa gliders.[64] A British Albemarle from 38 Group got airborne at 2303 5 June 1944 for France.[65] The first American C-47 destined for Normandy pulled a Waco aloft at 0119 6 June 1944.[66] D-Day and the assault on Hitler's Fortress Europe had begun.

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[60] Gavin, *Airborne Warfare,* 47.

[61] Air Ministry, *By Air to Battle*, 70.

[62] Brereton, *The Brereton Diaries,* 262.

[63] Air Ministry, *Airborne Forces*, 123.

[64] Gavin, *Airborne Warfare,* 42.

[65] Air Ministry, *Airborne Forces,* 125.

[66] Brereton, *The Brereton Diaries,* 277.

American doctrine utilized the glider in Neptune to support the parachute infantry by delivering mobility, GIBs, anti-tank, artillery, and engineering assets. Parachute infantry inserted between 0100-0310 with orders to seize the key terrain features necessary in their sector, behind Utah Beach on the right flank (western edge) of the invasion. Glider flights immediately followed with the rest of the GIRs, but these scattered badly in the dark due to heavy German flak and suffered serious casualties. Fifty percent failed to insert on the proper landing zone.[67] Plans called for the 82ND and 101ST to receive 52 and 58, respectively, gliders at dawn 6 June 1944 on landing zones within their area of responsibility. The force flow dictated 150 additional gliders at dusk 6 June 1994 inside the 82ND's area. Both divisions expected 50 gliders each at dawn and dusk on 7 June 1944.[68] The daylight glider landings 6-7 June 1944 proved successful.[69]

The British leveraged gliders to conduct coup de main, commando assaults and primary vertical envelopment attacks. Six Halifax-Horsa combinations (three each from 298 and 644 squadrons) delivered D Company of the 2ND Oxfordhamshire and Buckinghamshire Light Infantry (OBLI or Ox and Bucks) and Airlanding Brigade engineers onto landing zones X and Y.[70] X was the bridge over the Caen Canal at the village of Benouville. Y was the Orne River bridge, a few hundred yards to the east. These bridges, if held by the British glider troops, secured the eastern most position of the invasion from German mechanized forces centered around Caen. The Ox and Bucks landed in three Horsas at each target. The Caen Canal forces landed within forty-seven yards of the bridge, overwhelmed the German defenders, and

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[67] Gavin, *Airborne Warfare,* 57-62.

[68] 1ST United States Army, *First United States Army Report of Operations 20 October 1943-1 August 1944* (First United States Army Headquarters, 1944), 117.

[69] Gavin, *Airborne Warfare,* 62.

[70] Air Ministry, *Airborne Forces,* 126.

ascertained there were no demolition charges within fifteen minutes.[71] The Orne River bridge assault force landed one Horsa 150 yards from target and a second 400 yards away. The third Horsa made a blind release from its tug and landed eight miles west.[72] These glider troops secured this bridge without firing a single shot. Howard consolidated his forces at the Caen Canal to strengthen his position being closest to the beach and because the British plan had paratroopers dropping within half an hour to occupy the Y target area.[73] The glider borne Ox and Bucks plus some 200 paratroopers held out all day against German counterattacks until reinforced by the British commando 1ST Special Service Brigade arriving from Sword Beach led by Brigadier General Lord Lovat.[74]

The remainder of 6TH Airlanding Brigade arrived by glider in daylight insertions. This constituted the first daytime, major glider insertion of any magnitude. The U.S. airborne planners deemed it too risky due to German flak and the potential of Luftwaffe fighter interference. The British calculated those risks against nighttime collisions, crashes, navigational difficulties and wide dispersion potential. With air superiority provided by RAF Fighter Command's No. 11 Group, British vertical envelopment assets landed 246 of a total 256 gliders on their correct landing zones on 6 June 1944.[75]

The narrative scope cannot cover the Allied Neptune glider operations in complete detail. Neptune provided lessons learned that the Allies incorporated into doctrine and future mission planning. The British proved unequivocally that all factors being equal, glider borne operations

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[71] Air Ministry, *By Air to Battle*, 76-77.

[72] Air Ministry, *Airborne Forces*, 126.

[73] Air Ministry, *By Air to Battle*, 78.

[74] Ibid., 78-80.

[75] Air Ministry, *Airborne Forces*, 132-134.

conducted in daylight had tactical advantages over nighttime insertions. Vertical envelopment full mission profile training rehearsals proved instrumental. The Allied airborne planners stressed the need to thoroughly conduct them prior to any future operation(s).[76] The U.S. Army revised Field Manual 100-5: Operations, incorporating glider forces into operational planning doctrine. The 1941 version only mentioned parachute troops. The 15 June 1944 manual stated how vertical envelopment forces are theater of operation forces. The theater commander retained direct control and planning to implement them as strategic level assault assets. The ground commander assumed control only when they landed on their targets. Based off British Neptune gliders successes, the U.S. emphasized that daylight navigation for mass glider landings. Additionally, the airborne commander selected the overall airborne operating area. The troop carrier commander, not the airborne commander, selected the specific glider landing zones within the operating area.[77]

General Eisenhower reinitiated the discussion of a unified Allied airborne force, originally tabled by the British prior to Operation Neptune. Eisenhower championed the concept from Field Manual 100-5: the theater commander planned strategic impact airborne missions. He wanted the Allied airborne army utilized in ways that brought about maximum destruction on Germany's war capabilities in western Europe.[78] This Allied airborne army's order of battle would consist of one American and one British corps. The American units notionally included were the 17TH, 82ND, and 101ST Airborne plus IX Troop Carrier Command. British contributions designated were the 1ST and 6TH Airborne plus the 52ND Scottish Lowlander

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[76] Air Ministry, *Airborne Forces,* 136-137.

[77] United States Army, Field Manual 100-5: *Field Service Regulations, Operations* (Washington, DC: War Department Printing Office, 1944), 290-294.

[78] Brereton, *The Brereton Diaries,* 308.

Infantry division. 38 Group and 46 Group provided the British airlift contribution. Eisenhower designated Lieutenant General Brereton as Commanding Officer with Lieutenant General Browning as Deputy Commander.[79] The British concurred and on 7 August 1944, Eisenhower's Supreme Headquarters Allied Expeditionary Force (SHAEF) established First Allied Airborne Army.[80]

The Americans conducted an invasion of Southern France that used airborne forces. Allied planners designed this operation to align with the main advance in Normandy. This invasion intended to prevent the Wehrmacht from using units in the area to reinforce or counterattack the Allies in Normandy. Operation Dragoon was a double envelopment, amphibious and airborne assault.[81]

Operation Neptune consumed most of the troop carrier airlift assets, particularly gliders, and glider trained combat units in the ETO. Therefore, the 50th, 51st, and 53rd Troop Carrier Wings, 35 Horsas, and 413 Wacos shifted to Corsica for pre-invasion training. The Wacos arrived completely broken down, per their design, only twenty days prior to the established invasion date. The American glider aircrews completely assembled all the CG-4As and made final preparations on the Horsas within ten days.[82]

Operation Dragoon's planning called for daylight glider landings, per the new Field Manual 100-5 and the British success in Neptune. The first wave comprised 103 Wacos and all

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[79] Air Ministry, *Airborne Forces,* 142-143. The 52ND Scottish Lowlander Infantry Division was neither parachute nor glider infantry. They landed via transports plane on an airfield secured by vertical envelopment troops.

[80] Brereton, *The Brereton Diaries,* 325.

[81] Air Ministry, *Airborne Forces,* 140.

[82] Major Patrick Mulcahy to Allied Force Headquarters Mediterranean, 4 September 1944, *Report Regarding Airborne Operation Dragoon*, G-3 Allied Forces Headquarters Mediterranean, United States Army Heritage and Education Center, 3-4, accessed 5 September 2023.

the Horsas, all scheduled to land between 8:14 AM and 8:22 AM. Planners designated this glider echelon to reinforce parachute infantry scheduled to land between 4:12 and 5:10 AM. The plan scheduled the second glider element of 310 CG-4As landing between 6:10 and 7:00 PM.[83]

An improvised glider course taught elements of the 36TH Infantry Division the fundamentals of combat loading and unloading. These units included the 602ND Pack Field Artillery Battalion, the anti-tank company from the Japanese American 442ND Regimental Combat Team, a combat engineer company, and 36TH Division ordnance and medical battalions. Once the glider crews assembled the Wacos, these personnel underwent several orientation flights followed by one assault training insertion on a simulated landing zone.[84] Dragoon's glider envelopments proved highly successful.; on D-day 15 August 1944, 407 gliders made successful daylight landings.[85] The American glider forces dedicated to the 35 Horsas achieved a defining moment in Allied glider joint interoperability. British GPR aircrews flew non-airborne designated Americans in British Horsas, towed by American Dakotas, on an American operation.[86]

Despite Eisenhower's establishment of the First Allied Airborne Army, SHAEF in coordination with 21ST Army Group, planned and cancelled eighteen different vertical envelopment operations in the forty days since Brereton assumed command. Allied rapid ground advances partly caused this situation. However, the misuse of IX Troop Carrier Command

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[83] Major Patrick Mulcahy to Allied Force Headquarters Mediterranean, 4 September 1944, *Report Regarding Airborne Operation Dragoon*, G-3 Allied Forces Headquarters Mediterranean, United States Army Heritage and Education Center, 3-4, accessed 5 September 2023.

[84] Ibid., 4. Pack artillery was artillery light enough for horse or mule teams to pull. This unit had been used in the hills of Italy before being operationally assigned for Dragoon.

[85] Ibid., 9.

[86] Air Ministry, *By Air to Battle*, 93.

created the primary obstacle that blocked the First Allied Airborne Army's implementation during this period: SHAEF used them as a logistical mobility asset to resupply the highly mobile ground forces.[87]

Cherbourg's deep-water harbor remained ineffective as a logistical flow point due to German destruction before Cherbourg's surrender. Furthermore, the complete loss of artificial Mulberry harbor Alfa in a 19 June 1944 channel storm slowed the supply situation down to the point truck hauled logistics could not meet demand. The lines of communication and supply lengthened with the ground advances. IX Troop Carrier Command, 38 Group and 46 Group shuffled supplies from depots in the United Kingdom to austere, forward landing strips across France. The airborne ground forces trained diligently for each potential operation's ground phases. However, conducting an airborne operation without proper troop carrier-ground force interoperability training was not militarily feasible. SHAEF refused to pull the transport planes from logistical resupply duties while making great ground advances.[88] Airlift alone did not keep the Allied armies replenished. The U.S. First Army consumed an average of 5,752 tons daily in August 1944. By 1 September First Army fell sixty percent below total daily requirements. The quartermasters had 4.4 days' worth of rations on 1 September 1944, reduced to 0.7 days' by 8 September 1944. U.S. Third Army suffered worse. In the same time period, they absolutely stopped all advancement due to an acute lack of gasoline.[89]

The British 2ND Army crossed the Seine River, drove through Belgium, and penetrated into Holland by mid-September 1944. The lead corps, XXX Corps, accomplished this by having

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[87] Brereton, *The Brereton Diaries,* 339-343.

[88] Air Ministry, *Airborne Forces,* 144-147.

[89] Gavin, *Airborne Warfare,* 69.

2ND Army divert all transport assets to its advance. This left the remaining corps unsupplied, immobile, and fixed in their last positions. The Wehrmacht retained one defensive position between Germany's northwestern frontier and the British. Three rivers: the Meuse (Maas), Waal, and the banks of the Lower Rhine provided a topographical defense with single point bridges along one road to Germany.[90]

Sir Bernard Law Montgomery approached Eisenhower with a daring plan to finally use the First Allied Airborne Army. He envisioned the American airborne forces landing and securing the key bridges running south to north along this single road over those rivers: Eindhoven-Veghel-Grave-Nijmegen. The British XXX Corps, under General Brian Horrocks, would launch a mechanized drive up the road. The 101ST had the Eindhoven-Veghel-Grave sector and the 82ND Grave-Nijmegen area. The British 1ST Airborne Division had refitted following operations in the Mediterranean (the 6TH unavailable from Neptune and post-Neptune fighting) and would drop and seize the northern most bridge at Arnhem. Arnhem bridge afforded access over the Rhine and into Germany's key military industrial production zone, the Ruhr. Eisenhower readily agreed. The mission received the code name Operation Market-Garden and was set for Sunday, 17 September 1944.[91]

Bridge seizure represented the Market phase operational center of gravity. Surprise comprised the most critical failure in this mission set. The British had vast proven experience in nighttime glider landing bridge seizures from the Ponte Grande, Caen Canal, and Orne River successes. Allied planners knew, from photo reconnaissance and Dutch resistance reports, that the Wehrmacht maintained the Market bridges ready for demolition. Yet, Allied planners

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[90] Air Ministry, *By Air to Battle*, 94-96.

[91] Air Ministry, *By Air to Battle*, 97-98. The code name Market detailed the airborne phases. Garden represented Horrocks' mechanized overland advance.

prepared all the Market phases for daytime. Horrocks' XXX Corps received orders that emphasized the airborne could not hold the bridges, especially the northern most at Arnhem, for more than two days and two nights.[92]

The World War II glider represented the first stealth technology. It was undetectable at night, with proper moon conditions, when cast off from its towplane. The British proved that at Ponte Grande, Caen Canal, and the Orne River bridges. British Neptune daylight landings did have a tremendous success rate but occurred on landing zones already secured by previous vertical envelopment forces. General Brereton ordered daylight operations for two primary reasons. First, the Americans lacked glider night navigational proficiency.[93] Second, Brereton thought daylight landings leveraged Allied air supremacy and close air support would enable Horrocks' columns to reach the airborne forces within the allotted 48 hours.[94]

This decision completely negated the stealth advantages of gliders. The First Allied Airborne Army leadership violated all their respective doctrines formulated from operational lessons learned and German POW vertical envelopment human intelligence. The real culprit was not daylight versus nighttime navigation. It was time. All Allied doctrine stressed the importance of training time for vertical envelopment preparation. The two months old U.S. revised Field Manual 100-5 stated how planners must allot time for joint training and practice operations to culminate in a full rehearsal of the operation on terrain and condition(s) closely approximating the target for airborne operations.[95] The British doctrine emphasized the same criteria by clearly

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[92] Air Ministry, *By Air to Battle*, 96-97.

[93] Air Ministry, *Airborne Forces,* 153.

[94] Brereton, *The Brereton Diaries,* 345.

[95] United States Army, Field Manual 100-5: *Field Service Regulations, Operations*, 294.

delineating that nighttime operations were preferable for achieving surprise and exploitation.[96] Furthermore, their airborne doctrinal publication mandated that prior to any vertical envelopment operation of magnitude being initiated, an extensive period of preparation and rehearsal was necessary as special training for pilots towing gliders shall be required.[97]

The Market portion of Operation Market-Garden was the greatest airborne assault ever conducted. Yet, Eisenhower did not authorize its 17 September 1944 execution until 10 September 1944.[98] The British trained exhaustively for months in the Tunisian desert prior to Operation Ladbroke.[99] Allied airborne forces replicated this intensive preparation for their respective Neptune objectives.[100] With the towplane assets dedicated to logistical duties and one week warning prior to execution, SHAEF had effectively circumvented and disregarded all established vertical envelopment pre-mission doctrine. No time existed to conduct Market task-oriented, interoperability training.

The glider insertions proved highly successful on 17 September 1944. IX Troop Carrier Command, 38 and 46 Group delivered 478 gliders between 12:03 and 2:05 PM.[101] The next day, they towed 1,203 gliders to facilitate the second Market echelons.[102] 84.6% of American glider columns reached their objectives in accordance with the Market-Garden timelines.[103] The British

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[96] War Office, *Airborne Operations Pamphlet No.1-1943,* 6.

[97] War Office, *Airborne Operations Pamphlet No.1-1943,* 6.

[98] Brereton, *The Brereton Diaries,* 341.

[99] Air Ministry, *Airborne Forces,* 89.

[100] Brereton, *The Brereton Diaries,* 262.

[101] Ibid., 345.

[102] Gavin, *Airborne Warfare,* 87.

[103] James M. Gavin and Maxwell Taylor, *Report of Airborne Phase 17-27 September 1944 Operation Market,* 4 December 1944, 9, United States Army Heritage and Education Center, accessed 2 September 2023.

utilized a parachute drop, vice a glider assault, to secure the Arnhem bridge. The Luftwaffe airfield at Deelen (a suburb of Arnhem) and Arnhem itself had heavy flak fortifications that made direct glider insertion at the bridge precarious.[104] Therefore, British planners designated the 1ST Airlanding Brigade to secure four drop-landing zones beyond the enemy flak range, the farthest being eight miles from the target bridge. 38, 46 Group, and GPR aircrews landed 88.9% of their gliders on the correct landing zones.[105] British paratroopers and glider borne reinforcements had to land and maneuver off these zones to reinforce the bridgehead.[106]

Market-Garden's success depended on three key factors: (1) how long the Germans took to recover and respond to the Allied surprise, (2) Horrocks' XXX Corps speed of advance, and (3) the meteorological conditions to facilitate aerial reinforcement and resupply; especially the Arnhem forces.[107] Fierce German attacks on XXX Corps' flanks and stiff German resistance at the bridgeheads delayed Horrocks' advance. The British paratroopers succeeded in securing the north side of Arnhem's bridge and held it for three days before German armor eventually pushed them into a western suburb, Oosterbeek. The airlanding brigade resisted German assaults on the landing zone perimeters. Horrocks reached the American bridgeheads, but German defense delayed XXX Corps at Nijmegen from penetrating through to Arnhem. The 1ST Airborne Division held its positions until the night of 25-26 September when its Commanding General, Roy Urquhart, left his wounded with volunteers of the Royal Army Medical Corps and escaped with those who could from the Arnhem perimeter. Urquhart began Operation Market with 8,969

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[104] Air Ministry, *By Air to Battle,* 97.

[105] Air Ministry, *Airborne Forces,* 172.

[106] Air Ministry, *By Air to Battle,* 99.

[107] Ibid.

troops and 1,126 aircrew from the Glider Pilot Regiment. Britain lost 7,605 killed, wounded, and missing airborne personnel that held on four times longer than the planned forty-eight hours.[108]

The British Glider Pilot Regiment's training doctrine vindicated itself. The GPR aircrews' intense combat training directly enabled the British perimeter to hold for so long. Pilots from No. 1 and No. 2 GPR Wings formed the mainline of defense at Oosterbeek. A wounded Brigadier Hackett turned over to Lieutenant Colonel Ian Murray, the GPR second-in-command, who assumed the brigade ground commander role for the perimeter defense. GPR Regimental Sergeant Major Tilley assumed command of a parachute battalion. The 1,000 U. S. glider pilots in the Nijmegen area had no military combat training from their pipeline. Therefore, American leadership could not utilize them for offensive or defensive roles.[109] Browning and Gavin later concurred that had the American glider pilots received GPR level ground combat training, Gavin could have leveraged them to seize Nijmegen bridge faster or maneuvered them up the road to reinforce the British at Arnhem. Gavin declared how American glider pilots without GPR equivalent combat skills became a liability to the airborne commander.[110]

One 1944 Allied glider operation occurred in the Pacific theater, specifically in the China-Burma-India (CBI) area. British General Orde Wingate formed Operation Thursday to isolate the Japanese 18TH Division in northern Burma. He audaciously planned a nighttime glider landing 250 miles behind Japanese lines to carve out an expeditionary airfield. The glider force package consisted of Army engineers with British and Gurkha ground forces to hold and

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[108] Air Ministry, *By Air to Battle,* 116-128.

[109] Chatteron, *The Wings of Pegasus,* 188-206.

[110] James M. Gavin and Maxwell Taylor, *Report of Airborne Phase 17-27 September 1944 Operation Market,* 4 December 1944, 49, United States Army Heritage and Education Center, accessed 2 September 2023.

develop the airfield. C-47s would then land three brigades of British and Indian infantry to maneuver against the Japanese rear, while a simultaneous assault enveloped them from the front.[111]

The lift required twenty-seven American C-47s towing fifty-four CG-4As from the U.S. 5318 Provisional Troop Carrier Squadron.[112] The operation launched the night of 5-6 March 1944 from airbases in the Chin Hill mountains. This forced the pilots to conduct a rapid climb, coupled with double tows, resulting in multiple mission aborts due to overheating engines and excessive fuel consumption.[113] Only thirty-seven gliders arrived at the landing zone to discover that aerial reconnaissance had failed to identify dozens of large tree trunks camouflaged by high grass. Only three Wacos survived unscathed. Nevertheless, the American engineers carved out the airfield while the British-Gurkha forces held a perimeter.[114] Wingate proceeded to land 12,000 troops from the 77TH and 111TH brigades by 11 April 1944 and catch the Japanese in an effective double pincer. Allied planners had originally deemed glider vertical envelopment impossible in northern Burma's mountainous topography.[115]

Great Britain continued to refine its glider and airborne doctrine in 1945. They integrated the lessons learned from 1944's operations into *Army/Air Operations Pamphlet No.4-*

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[111] Louis Mountbatten, *Report to the Combined Chiefs of Staff by the Supreme Allied Commander Southeast Asia 1943-1945* (London, U.K.: His Majesty's Stationery Office, 1951), 39.

[112] Air Ministry, *Airborne Forces,* 222. The C-47 shortage in the CBI theater forced the Waco's to be double towed by each Dakota.

[113] Mountbatten, *Report to the Combined Chiefs of Staff by the Supreme Allied Commander Southeast Asia 1943-1945,* 40.

[114] Dank, *The Glider Gang,* 99.

[115] Mountbatten, *Report to the Combined Chiefs of Staff by the Supreme Allied Commander Southeast Asia 1943-1945,* 40-42.

Airborne/Air Transported Operations. The Arnhem bridge lessons learned reinforced that gliders served as the primary commando/coup de main vertical envelopment platform.[116] British Army/RAF joint interoperability for glider landing zone selection was reemphasized.[117] Airlanding troop and glider pilot combat training standards had to be maintained to the highest possible standards in: (1) instilling extreme levels of physical fitness and individual initiative, (2) cross-functionality in individual and crew-served infantry weapons, (3) ability of the GPR to perform as anti-tank and artillery crew, and (4) when time permits, day and night full mission training profiles with live ammunition must be executed replicating every detail of the operation.[118] The Americans maintained their 15 June 1944 Field Manual 100-5 and 1943 Training Circular No. 113 as solid doctrine.

1945's Operation Varsity represented World War Two's most intricate ground-airborne coordinated envelopment. 21ST Army Group and First Allied Airborne Army planners designed a final strike to open the heart of Germany. The American 17TH and British 6TH Airborne divisions would serve as the vertical envelopment forces. Lesson learned from Neptune and Market played critical roles in how this operation developed.[119]

Market required the British airborne forces to move eight miles from a landing zone to secure the bridge and hold forty-eight hours until relief arrived. Varsity place them across the Rhine at Wesel, but never out of the range of 21ST Army Group medium artillery. Furthermore, the Allied airborne forces arrived after the land forces penetrated over the Rhine. Unlike Market,

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[116] British Army, *Army/Air Operations Pamphlet No.4-Airborne/Air Transported Operations* (London, U.K.: The War Office, 1945), 7.

[117] Ibid., 14.

[118] Ibid., 35-38.

[119] Gavin, *Airborne Warfare,* 121-123.

Allied planners allocated sufficient training time for full mission profile preparation. Intensive interoperability training commenced in February 1945. Brigadier Chatterton's Glider Pilot Regiment reconstituted starting in October 1944 with a high percentage of RAF pilots who expeditiously transitioned to non-powered flying. They became hardened combat infantryman through the GPR combat skills course.[120]

6TH Airlanding Brigade received tasking to conduct the coup de main bridge seizures using glider envelopment. This switched from Arnhem's use of parachute infantry back to original British airborne doctrine. These bridges restricted German reinforcement abilities by denying the bridges at Ringenberg and Hamminkeln over the River Issel. Furthermore, the remainder of 6TH Airlanding Brigade received orders to secure two major landing zones that denied Germany the high ground overlooking 21ST Army Group's advance. 38 and 46 Groups' towplanes planned to deliver these forces in 321 Horsa and 34 Hamilcar gliders in daylight landings.[121]

The 17TH Airborne Division drew responsibility to land on the British right. This protected the entire British right flank, sealed off the Wesel pocket, and opened up the ability to drive east into the industrial Ruhr. The entire airborne arm would drop in a single lift: in Neptune and Market multiple day lifts had been necessary that weather had impacted. This required twenty-six airfields: every available transport field in England, Belgium, and northern France. IX Troop Carrier Command used 314 single-tow and 296 double-tow CG-4As pulled by 610

[120] Air Ministry, *By Air to Battle,* 135-139.

[121] Air Ministry, *Airborne Forces,* 188-190.

aircraft.[122] The RAF launched 439 towplane-glider combos, of which 425 reached their target(s).[123]

Despite heavy German flak, all Allied airborne units reached their operational areas. 17,122 troops, 614 jeeps, 286 artillery pieces and required logistics had landed in two hours via vertical envelopment.[124] The Royal Ulster Rifles and Ox and Bucks coup de main elements reached their respective bridges in a combined fifteen Horsa gliders. They rapidly overwhelmed the German defenders. History's final glider envelopment assault was an operational success.[125]

[122] Gavin, *Airborne Warfare,* 123-124.

[123] Air Ministry, *Airborne Forces,* 193.

[124] Gavin, *Airborne Warfare,* 125.

[125] Air Ministry, *By Air to Battle,* 142.

Conclusion

Great Britain pre-eminently conducted glider technology implementation in the Second World War. This happened because of how their civilian industrial base, political, and military leadership leveraged their instruments of power and managed the change process. Throughout the hostilities that concluded in 1945, landing cohesive fighting units by the overhead flank was vertical envelopment's desired goal. No nation's military had applied this technology, either by parachute or glider, in combat. World War Two reflected the societies and cultures that waged it. Technological change reciprocated these societies' variables. Comparatively analyzed by PEST and DIME, the British emerged ahead of both her ally and foe in glider applications.

Britain utilized patience, methodology, and staff analysis to first define how they would integrate gliders into their military objectives. This established an adjustable doctrine as tactical, strategic, and logistical external contingencies affected material resources, TTPs, and manufacturing. Prior to even beginning a glider design, they defined how to integrate gliders into the British military. Doctrine became a consistent paradigm, a datum point that the aforementioned variables adjusted around.

Churchill and the British Combined Chiefs of Staff remained engaged in glider procurement until the war's end. Although not micromanaging the process, the British civilian and military political leadership ensured the Ministry of Aircraft Production, and their industrial basis, coordinated to achieve the government's stated objectives.[1] Churchill used his diplomatic and political rhetoric to overcome obstacles and deficiencies to Britain's glider initiatives. He acquired C-47 Dakota towplanes, Hadrian (Waco) gliders, and natural resources from America's

[1] War Cabinet Chiefs of Staff 10 July 1945, *Combined Committee Meetings Horsa Glider Production,* CAB 79-27-22. United Kingdom National Archives.

arsenal of democracy to correct British shortfalls. The American War Production Board hindered the U.S. glider development by executive decree that prohibited aircraft manufacturers from glider construction. The War Department's General Staff displayed aloofness toward the glider problem. Germany's political machine, going back to the Weimar Republic, used international political policies to encourage gliding in the German populace. The NSDAP combined Allied political intransigence with totalitarianism to openly harness glider schools for future military application.

Glider technological change, integrating non-powered aircraft with towplanes and ground forces, needed a fusion cell between aviation design, aviation manufacturing, ground force components, and air components. Civilian political oversight forced the British War Office, Air Ministry, and Ministry of Aircraft Production to coalesce in a unified effort. Their decision making ultimately derived from requirement(s) set in doctrine. This doctrine adjusted from combat experiences, but it remained the foundation for British glider technology.

The United States glider program initiated purely from the hubris of General Henry Arnold. Arnold unilaterally dictated glider design, procurement, and training before the Army Ground Forces established any vertical envelopment doctrine or units. American industry glider production quota codification did not occur until the airborne division requirements of 1943. Arnold's non-doctrine-based declarations wasted two full years of American glider development potential.[2]

Germany possessed an aviation obsessed populace, advanced aeronautical engineering technology, and political climate favorable for glider military application. In the 1930s, the Nazis shuffled massive economic resources into military aviation development. They succeeded in

[2] Bissell, *USAAF Historical Studies No. 1 The Glider Pilot Training Program,* 88-90.

conducting both the first glider combat mission and purely airborne assault. However, that very political instrument of power which enabled huge glider technology advancement ultimately ended its continuous doctrinal refinement. Hitler forbade any further airborne operations after Crete. They had not developed massive vertical envelopment doctrine. The lessons learned from Crete instead found their way from German prisoner of war intelligence into the emerging Allied doctrine(s).

The research findings examined how three different nations approached and handled emerging military technology in the form of World War Two glider borne forces. Key things separated Britain: (1) the emphasis on doctrinal foundation and continuous refinement of that doctrine, (2) identifying the strengths and weaknesses in their instruments of power, (3) taking measures to mitigate/correct those weaknesses for glider success, and (4) fully using the combat potential of glider capabilities. Foundational requirements defined how the technology incorporated into Britain's tactical and strategic objectives.

Clausewitz stated how war was a reflection of the societies that waged it. This applies across the national spectrum analyzed with the tools of PEST and DIME. The British glider doctrine drove what actions their industrial, technological, socio-cultural, and political bases took to integrate that doctrine with defense strategy. The modern military commander in acquisitions, intelligence assessments, or combat development can apply this change methodology in the modern era. Arguably, it is more important today to codify proper doctrine for emerging technology. The warfighting commander requires rapid TTP adjustment with the rate of technology proliferation, both for kinetic strikes, understanding an adversary's capability(ies), and to quickly end hostilities thus minimizing casualties on all sides. Establishing doctrine for new technology also prevents expensive cost overruns on weapons systems acquisitions.

The U.S. Navy's Littoral Combat Ship, U.S. Army's Stryker Mobile Gun System and Marine Corps Osprey V-22 programs are modern examples of how undefined doctrinal requirements drove military technology acquisitions that have dubious performance records. Historical review of how these programs came to fruition can shed a modern interpretation and lessons learned on military technology change practice. In terms of vertical envelopment, the post-World War II United States Marine Corps advocated for research and development in using gliders with amphibious landings. The budget reductions and material drawdown hampered this initiative. Military historians need to investigate this effort for several reasons: (1) what doctrinal concepts they devised, (2) what results came about and how they might have influenced the rotary wing growth of both the U.S. Army and the Marine Corps (to bring about the Marine Air-Ground Task Force or MAGTF), (3) how it might have influenced the Osprey concept, and (4) what technological innovations that civilian industry might have contributed.

Bibliography

Primary Sources

Air League of the British Empire. *The Air League Bulletin* 3, no. 53 (1925).

_____. "Air League Young Pilots Fund." Press release, 1935. Royal Air Force Museum Archives.

Air Ministry. *Airborne Forces.* London: His Majesty's Stationery Office, 1951.

_____. *A/Policy/Army-Air: Airborne Forces Volume I June 1940-January 1943*. United Kingdom National Archives. CAB 121/97. https://discovery.nationalarchives.gov.uk

_____. *A/Policy/Army-Air: Airborne Forces Volume II January 1943-July 1945*. United Kingdom National Archives. CAB 121/98. https://discovery.nationalarchives.gov.uk

_____. *By Air to Battle: The Official Account of the British First and Sixth Airborne Divisions.* London: H.M. Stationery Office, 1945.

_____. *38 Group Progress Reports April Report.* 18 May 1942. United Kingdom National Archives. AIR 8/1386. https://discovery.nationalarchives.gov.uk

Army, British. *Airborne Operations Pamphlet No.1-General,* 1943. London: The War Office, H. M. Stationery Office, 1943.

_____. *Army/Air Operations Pamphlet No.4-Airborne/Air Transported Operations.* London, U.K.: The War Office, 1945. Archived at the Netherlands Airborne Museum. https://vriendenairbornemuseum.nl

Army, United States. Army, 1st. *First United States Army: Report of Operations, 20 October 1943-1 August 1944.* Volume 2.

_____. Center of Military History Publication 2-1. *Army Ground Forces World War II Organization of Ground Combat Troops.* Washington, DC: War Department, Government Printing Office, 1947.

_____. Field Manual 100-5. *Field Service Regulations: Operations.* Washington, DC: War Department Government Printing Office, 1941. Archived at the United States Army Command and General Staff College. https://cgsc.army.mil

_____. Field Manual 100-5. *Field Service Regulations: Operations.* Washington, DC: War Department Government Printing Office, edited 1944. Archived at the United States Army Command and General Staff College. https://cgsc.army.mil

_____. Ordnance Corps. "Gliders Away." *The Military Engineer* 36, no. 225 (July 1944): 246-47.

Author unknown. “High Schools Train Aviation Mechanics.” *The Clearing House* 13, no. 5 (1939): 287.

Bassett, James A. “Past Airborne Employment.” *Military Affairs* 12, no. 4 (Winter 1948): 206-216.

Bissell, Clayton. *USAAF Historical Studies No. 1 The Glider Pilot Training Program.* Washington, D.C.: Headquarters Army Air Forces, September 1943. Archived at Air Force Historical Research Agency. https://afhra.af.mil

Brancker, William Sefton. “Commercial Aviation.” *Journal of the Royal Society of Arts* 73, no. 3785 (June 1925): 649-663.

Brereton, Lewis H. *The Brereton Diaries.* New York: William Morrow, 1946.

Browning, F. A. M. “Airborne Forces.” *Journal of the Royal United Services Institution* 89, (February 1944): 349.

Caldwell, Norman W. “Political Commissars in the Luftwaffe.” *The Journal of Politics* 9, no. 1 (1947): 59-79.

Cammack, I. I. “Aviation in the Public Schools.” *The Journal of Education* 104, no. 23 (December 1926): 599.

Carruthers, Bob. “World War II From Primary Sources: Through German Eyes the Balkans, Greece, and Crete 1941.” Directed by Paul Dunn. Black and white; 60 minutes. Pen & Sword Digital DVD, 2012.

Chamier, Edward. *Letter to Lord Brabazon*. 2 January 1935. Royal Air Force Museum Archives.

_____. *Letter to the Air Ministry*. 19 November 1937. United Kingdom National Archives. AIR 2/2716. https://discovery.nationalarchives.gov.uk

Chatterton, George. *The Wings of Pegasus.* London, U.K.: Macdonald & Co., 1962.

Confidential Print: First World War: General Correspondence [Part XI] 1917-1918. Foreign Office. United Kingdom National Archives. FO 438/11. https://discovery.nationalarchives.gov.uk

Churchill, Winston S. *Munitions Possibilities of 1918.* 21 October 1917. United Kingdom National Archives. CAB 24-30-36. https://discovery.nationalarchives.gov.uk

_____. *Provision of Airborne Forces and Policy Minute.* 6 June 1940.

_____. *The Second World War: The Gathering Storm*. Boston, MA: Houghton Mifflin, 1948.

Davis, Paul M. and Amy C. Fenwick. *Development and Procurement of Gliders in the Army Air Forces, 1941-1944.* Washington, DC: Army Air Forces Historical Study 47, Headquarters Army Air Forces Historical Office, March 1946. Archived at the United

States Air Force Historical Division, Archives Branch, Building 914, Maxwell Air Force Base, Montgomery, Alabama.

De Guingand, Francis W. *Operation Victory.* London, U.K.: Hodder & Stoughton, 1947.

Ehrig, Generalleutant Werner, and Oberst Freiherr von der Heyte, Generalfeldmarschall Albert Kesselring, General der Fallschirmtruppen Eugen Meindl, Generalleutant Max Pemsel, Generalmajor Hellmuth Reinhardt, Generaloberst Kurt Student. *Airborne Operations: A German Appraisal.* Washington, DC: United States Army Center of Military History Publication 104-13, 1951. Archived 1989. https://history.army.mil/htma;/bookshelves/resmat/ww2earnet.html#GermanPerspective

Ellis, Jr. John T. *Army Ground Forces Study No. 25, The Airborne Command Center.* Washington, DC: Historical Section, Army Ground Forces, 1946. Archived at the Ike Skelton Combined Arms Research Library. https://carlcgsc.libguides.com/AGF

Emmart, A. D. "A Secret Weapon: Some of the Possibilities Suggested by The Fall of Eben Emael and Germany's Dark Reference to a New Instrument of Attack." *The Baltimore Sun*, 13 May 1940, p. 10.

England, E. C. Gordon. "Soaring Flight: Its Function in Aviation." *Journal of the Royal Society of Arts* 80, no. 4143 (1932): 530-546.

Federal Statistical Office, Swiss. "Germany's Military Expenditures in 1929 and 1932." In *Statistiches Jahrbuch 1935*, 423-427. Neuchetal, Switzerland, 1935.

Fokker, Anthony H. G. "Air Transportation." *The Annals of the American Academy of Political and Social Science* 131 (1927): 182-187.

Gavin, James M. *Airborne Warfare.* Washington, D.C.: Infantry Journal Press, 1947.

Genske, Walter. *Nurnberg Document Schwerin-Krosigk # 324.* Unpublished Reich budget accounts taken by affidavit from Walter Genske, former official of the Reich Finance Ministry. Nurnberg, Germany: 1947.

Gerth, Hans. "The Nazi Party: Its Leadership and Composition." *American Journal of Sociology* 45, no. 4 (1940): 517-41.

Goering, Herrman. *Germany Reborn.* London: Elkin Mathews & Marrot, 1934.

Gompertz, A. V. "The Battle of the Somme." *Professional Memoirs, Corps of Engineers, United States Army, and Engineer Department at Large* 10, no. 50 (March-April 1918): 229-252.

Groves, P. R. C. "The Influence of Aviation on International Affairs." *Journal of the Royal Institute of International Affairs* 8, no. 4 (July 1929): 289-317.

Hartshorne, E. Y. "The German Universities and the Government." *The Annals of the American Academy of Political and Social Science* 200 (November 1938): 210-234.

Hoff, N. J. "A Short History of the Development of Airplane Structures." *American Scientist* 34, no. 3 (July 1946): 370-388.

Hoetzsch, Otto. "The German View of Disarmament." *International Affairs (Royal Institute of International Affairs 1931-1939)* 11, no. 1 (1932): 40-54.

Kandel, I. L. "Education in Nazi Germany." *The Annals of the American Academy of Political and Social Science* 182 (1935): 153-63.

Kleiman, Robert. "The Secret of Eben Emael: New Weapon is Explosive, Gas, or Propaganda Weapon Experts Believe." *The Washington Post,* 13 May 1940, p. 1.

Klemin, Alexander. "Learning to Use our Wings." *Scientific American* 137, no. 1 (July 1927): 72-89.

_____. "Learning to Use our Wings." *Scientific American* 139, no. 4 (October 1928): 374-376.

Kronfeld, R. "Gliding and Soaring." *Journal of the Royal Society of Arts* 87, no. 4523 (28 July 1939): 949-965.

Lewis, Colonel Henry L., Commanding Officer 325th Glider Infantry Regiment. *Regarding Reactions to Airborne Operations Conference North African Theater of Operations Briefing 21 July 1943.* Archived at United States Army Heritage and Education Center. https://emu.usahec.org/alma/multimedia/1442205/20184120MNBT1036/350179F000000654551012.pdf

Loening, Grover. "Ships Over the Sea: Possibilities and Limitations of Air Transport in War." *Foreign Affairs* 20, no. 3 (April 1942): 489-502.

Memorandum from Translated Information About the Fate of Glider Parties That Crashed in Southern Norway November 1942: Translation of Report Received from Norwegian Authorities German Shooting of British Prisoners, 13 March 1944. Foreign Office British Embassy Stockholm, Sweden. United Kingdom National Archives. FO 371/42997-0021. United Kingdom National Archives. https://discovery.nationalarchives.co.uk

Memorandum on the Revision of the Current Military Program, 7 June 1943. Committee on the Revision of the Military Program for Chief of Staff General George C. Marshall. Unites States Army Center of Military History. Accessed 31 August 2023. https://history.army.mil/agf

Miksche, Major F. O. *Paratroops.* New York: Random House, 1943.

Mooney, James E. "A National Survey of Aeronautical Education." *Social Science* 8, no. 1 (January 1933): 53-55.

Mountbatten, Louis. *Report to the Combined Chiefs of Staff by the Supreme Allied Commander Southeast Asia 1943-1945.* London, U.K.: His Majesty's Stationery Office, 1951,

Nations, League of. *Armaments Yearbook.* Geneva, Switzerland: 1935.

_____. *Armaments Yearbook.* Geneva, Switzerland: 1938.

Office, War. *Notes on the German Army No. 38: XI Corps and The Attack on Crete.* London, U.K.: The War Office, 20 March 1942. Archived at the Imperial War Museum, London. Catalogue number LBY WO 1920.

Presidential Trips-Anfa Conference (Casablanca Roosevelt Administration) Volume 1 Minutes. Map Room Papers. Anfa 2ND meeting. 18 January 1943. U. S. National Archives and Records Administration. Accessed 23 August 2023. https://catalog.archives.gov

Piercy, N. A. V. "The Present Position in Aeronautics: Lecture III." *Journal of the Royal Society of Arts* 79, no. 4114 (25 September 1931): 945-956.

Poppel, Martin. *Heaven and Hell: The War Diary of a German Paratrooper.* Translated from German by Dr. Louise Willmot. Kent, U.K.: Spellmount Limited, 1988.

Report of Airborne Phase 17-27 September 1944 Operation Market. 4 December 1944. United States Army Heritage and Education Center. Accessed 2 September 2023. https://emu.usahec.org

Report Regarding Airborne Forces Operation Dragoon, 4 September 1944. Archived at Unites States Army Heritage and Education Center, 1-13. Accessed 5 September 2023. https://emu.usahec.org

Spaulding, Robert H. "Aviation and the Public School Curriculum." *Junir-Senior High School Clearing House* 4, no. 2 (October 1929): 116.

Special Bulletin No. 35 G-2 Battle of Crete. Washington, DC: War Department Military Intelligence Division, 15 October 1941. Archived at United States Army Heritage and Education Center. https://emu.usahec.org/alma/multimedia/1369034/20184812MNBT//95059245F00000000162270I001A.pdf

Stone, Shepard. "The Rearming of Germany." *Current History (1916-1940)* 39, no. 3 (1933): 295-301.

The Allied and Associated Powers and Germany. Treaty of Peace signed at Versailles. 28 June 1919.

Tinker, Clifford Albion. "Aeronautical Diplomacy." *The North American Review* 219, no. 820 (March 1924): 336-342.

War Cabinet Chiefs of Staff Committee Meeting Minutes 4 March 1942. United Kingdom National Archives. CAB 79-19-2. https://discovery.nationalarchives.gov.uk

_____. 10 March 1942. United Kingdom National Archives. CAB 121/96. https://discovery.nationalarchives.gov.uk

_____. 27 March 1942. United Kingdom National Archives. CAB 79-19-27. https://discovery.nationalarchives.gov.uk

_____. 8 April 1942. United Kingdom National Archives. CAB 79-56-21. https://discovery.nationalarchives.gov.uk

_____. 10 July 1945. United Kingdom National Archives. CAB 79-27-22. https://discovery.nationalarchives.gov.uk

Way, Greg. *Fallschirmjager!: A Collection of Firsthand Accounts and Diaries by German Paratrooper Veterans From the Second World War.* Warwick, U. K.: Helion & Company Limited, 2019.

Wilson, Woodrow. *The Fourteen Points: Address to a Joint Session of Congress.* 8 January 1918.

Woody, Thomas. "Principles of Totalitarian Education." *Proceedings of the American Philosophical Society* 82, no. 1 (23 February 1940): 39-55.

Secondary

Ambrose, Stephen A. *D-Day June 6, 1944: The Climatic Battle of World War II.* New York: Simon & Schuster, 1994.

_____. *Pegasus Bridge: June 6, 1944.* New York: Simon & Schuster, 1985.

Annussek, Greg A. *Hitler's Raid to Save Mussolini: The Most Infamous Commando Operation of World War II.* Cambridge, MA: Da Capo Press, 2005.

Dank, Milton. *The Glider Gang: An Eyewitness History of World War II Glider Combat.* Philadelphia: J.B. Lippincott, 1977.

Greenacre, John W. *Churchill's Spearhead: The Development of Britain's Airborne Forces During World War II.* London, U.K.: Pen & Sword Aviation, 2010.

Joint Chiefs of Staff. *Joint Doctrine Note 1-18: Strategy.* Washington, DC: United States Department of Defense, 2018.

Joslen, H. F. *Order of Battle Organization of British 1ST and 6TH Airborne Division, Second World War 1941-1945.* London, U.K.: Her Majesty's Stationary Office, 1960.

Kennedy, Robert M. *The German Campaign in Poland (1939).* Washington, DC: United States Army Center of Military History, Publication 104-20, 1956.

Lloyd, Alan. *The Gliders: The Story of Britain's Fighting Gliders and the Men Who Flew Them.* London, U.K.: Leo Cooper, 1982.

Marine Corps, United States. *Air Assault Operations,* Marine Corps Tactical Publication 3-01B. Washington, DC: Department of the Navy, Headquarters Marine Corps Combat Development and Integration, 2019.

Marshall, S. L. A. *Night Drop: The American Airborne Invasion of Normandy.* Boston: Little Brown, 1962.

McRaven, William H. *Spec Ops Case Studies in Special Operations Warfare: Theory and Practice.* Novato, CA: Presidio Press, 1996.

Mrazek, James E. *Fighting Gliders of World War II.* New York: St. Martin's Press, 1977.

Secondary Source Articles

Bednarek, Janet R. "The American Combat Glider Program, 1941-1947: Damned Fool Idea!" *Air Power History* 43, no. 4 (1996): 38-50.

Eells, Richard. "Aeronautics." *Quarterly Journal of Current Acquisitions* 6, no. 4 (August 1949): 37-49.

Fritzsche, Peter. "Machine Dreams: Airmindedness and the Reinvention of Germany." *The American Historical Review* 98, no. 3 (1993): 685-709.

Gavin, James M. "Airborne Armies of the Future." *Marine Corps Gazette* 31, no. 4 (April 1947): 44-51.

Guttman, Robert. "Costly Assault Vehicle." *Aviation History* 16, no. 6 (July 2006): 38-58.

Heilmeier, George G. "Guarding Against Technological Surprise." *Strategic Studies* 2, no. 2 (1978): 80-86.

Horn, Bernd. "The Airborne Revolution." *MHQ, The Quarterly Journal of Military History* 17, no. 4 (2005): 62-72.

Sugarman, Martin. "Six of Our Jewish Glider Pilots: Last Voices of Our Eagles Who Landed." *Jewish Historical Studies* 46 (2014): 203-242.

Tate, James H. "Airborne Training." *Ordnance* 39, no. 208 (1955): 561-64.

Wilkinson, Stephan. "One Way to Hell." *Military History* 27, no. 2 (July 2010): 24-35.

Wyckoff, Don P. "Super Soldiers." *Marine Corps Gazette,* 47, no. 11 (November 1963): 26-28.