Operation Market Garden and Modern Airborne Insertion: The Strategic Cost of Airborne Operations

A Monograph

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Operation Market Garden was the largest airborne insertion of World War II. Using an integrated air plan, the Allies launched thousands of aircraft to insert over thirty thousand soldiers via parachute and glider landings. Although the overall operation failed, the airborne component succeeded, but at what cost? The airborne's success offers lessons for modern airborne planners as does the cost.

Gleaning those lessons means assessing what Operation Market Garden required of the air component in terms of aircraft missions, capabilities, and numbers, and how that relates to modern airborne insertion. Through historical study of the air component's role in Operation Market Garden, this study determines the needed capabilities and limiting factors for a large-scale airborne insertion. It then compares those findings to a notional modern scenario using three different delivery options for the airborne force.

Based on the analysis, conducting a large scale airborne operation against a peer adversary will cripple the Air Force's ability to provide aircraft for other operations. In other words, a division size airborne mission is strategically unfeasible in almost any imaginable scenario. Therefore, military planners must accurately and realistically consider the balance of costs and rewards when creating airborne plans and making suggestions to decision makers.

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Abstract

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Operation Market Garden was the largest airborne insertion of World War II. Using an integrated air plan, the Allies launched thousands of aircraft to insert over thirty thousand soldiers via parachute and glider landings. Although the overall operation failed, the airborne component succeeded, but at what cost? The airborne's success offers lessons for modern airborne planners as does the cost.

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Acronyms

AFB	Air Force Base
AFI	Air Force Instruction
AFTTP	Air Force Tactics, Techniques, and Procedures
CRAF	Civil Reserve Air Fleet
DTR	Defense Travel Regulation
ETO	European Theater of Operations
FM	Field Manual
GRF	Global Response Force
JFE	Joint Forcible Entry
JP	Joint Publication
OPLAN	Operation Plan
RAF	Royal Air Force
SHAEF	Supreme Headquarters Allied Expeditionary Force
TCC	Troop Carrier Command
TR. CARR	Troop Carrier
USAF	United States Air Force

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Introduction

> Execution of MARKET as an airborne operation was almost flawless. The units involved carried out their several missions, according to plan as modified by weather and enemy reaction, in such a manner as to clear the way for Gen. Dempsey's armor provided it came through close to schedule. Tactical air preparation was adequate and thorough. Troop carrier operations, depending heavily on available radar and radio aids and conducted for the first time in broad daylight, were precise and determined: IX TCC experience in other operations was utilized fully and paid great dividends.
>
> —Headquarters Army Air Forces, "Report of Observations of Airborne Operations in ETO"

The fog covering England on the morning of Sunday, 17 September 1944 dissipated as the sun rose to expose a clear sky.[1] Starting at 1025 local time, aircraft launched from twenty-two bases spread throughout the island nation, filling the clear morning with 1,544 British and American airlift aircraft towing 478 gliders.[2] As they headed toward mainland Europe, 503 pursuit aircraft joined them to provide protection from German aircraft and ground-based defenses.[3] Bomber and pursuit aircraft from the far reaches of the European Theater of Operations (ETO) joined the fight. Not counting the pursuit aircraft attached to the airborne package, another 512 fighters and 1,474 bombers also supported the first day of Operation Market Garden.[4] On that day, the Allies dedicated 26.3 percent of their operational bombers and 32.2 percent of their operational fighters available in the European Theater to this one mission.[5] By the

[1] Headquarters, First Allied Airborne Army, "Narrative of Operation Market," 9 October 1944, Air Force Historical Research Agency, Maxwell Air Force Base, Folder 545.452A 1944, 2.

[2] Ibid.; Headquarters, IX Troop Carrier Command, "Air Invasion of Holland: IX Troop Carrier Command Report on Operation Market," Air Force Historical Research Agency, Maxwell Air Force Base, Folder 546.452K-1 25 September 1944, 2-8, 64-66.

[3] Headquarters, IX Troop Carrier Command, "Air Invasion of Holland Annex No. 5: Air Support Activity in Connection with Operation 'Market,'" Air Force Historical Research Agency, Maxwell Air Force Base, Folder 546.452K-1 25 September 1944, i.

[4] Ibid., i-ii.

[5] Wesley R. Craven and James L. Cate, *The Army Air Forces in World War II*, vol. 3 (Washington, DC: Office of Air Force History, 1983), accessed 24 August 2016, http://media.defense.gov/2010/Nov/05/2001329888/-1/-1/0/AFD-101105-007.pdf, 596.

time Operation Market Garden ended on 26 September, 13,388 aircraft sorties had launched along with 2,598 gliders.[6]

The armada sought to insert an airborne landing force tasked with securing key locations and infrastructure ahead of the land component forces advancing toward Germany.[7] As a result, the Allies committed a significant portion of their air assets to support this one mission in an expansive theater during World War II. Allocating the combat aircraft to Market Garden had strategic implications for the rest of the fight in Europe, and the large numbers of troop carrier aircraft committed to the operation influenced the movement of supplies and personnel across the entire theater. However, the amount of air assets available and their capabilities allowed strategic level decision makers to make that choice without crippling operations in other areas.

Today's American military and political leaders do not have the luxury of overwhelming numbers of aircraft. If US land forces requested a large scale airborne Joint Forcible Entry (JFE) operation in a war against a peer competitor, it will not be strategically feasible to commit the numbers and types of aircraft required for a successful operation. A study of the air component used in Operation Market Garden offers lessons regarding the types of air missions needed for airborne operations in a contested area. Applying these lessons to a modern scenario shows that a division size airborne insertion will cripple the ability to perform other missions during the operation. By analyzing modern JFE through this lens, important planning factors concerning strategic allocation of air assets emerge that show the true cost of employing airborne insertion. Furthermore, this examination exposes the limitations of America's current airlift fleet in order to promote the creation and use of realistic planning assumptions in terms of aircraft availability and capabilities.

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[6] Craven and Cate, *The Army Air Forces in World War II*, 610.

[7] Headquarters, First Allied Airborne Army, "Narrative of Operation Market," 1.

Currently, the US military practices JFE during exercises multiple times per year. These exercises involve dropping from 200 to 1,400 paratroopers in one lift. Current plans involve dropping higher numbers, usually a brigade combat team or approximately 2,000 personnel. Many of these exercises involve only airlift aircraft, although two times per year combat aircraft practice with mobility air assets at the US Air Force Weapons School's Joint Forcible Entry vulnerability window ("vul") event.[8] These exercises, while valuable, do not replicate the full extent of dropping a brigade and fall far short of showing the requirements needed if America drops a division-size force in near peer or peer combat.

Figure 1. Paratroopers Load onto a C-130J. DeAndre Curtiss, Swift Response 16 [Image 30 of 36], June 7, 2016, Defense Video Imagery Distribution System, accessed December 31, 2017, https://www.dvidshub.net/image/2641662/swift-response-16.

Near peer adversaries exist, and the foreign affairs arena remains unstable. China, Russia, and North Korea continually expand power in multiple realms, especially military and economic. If America must engage in combat operations against a threat of this type, it should expect a war involving large units maneuvering against high numbers of enemy forces with modern weapons. Presenting that type of adversary with multiple dilemmas requires US forces to perform military

[8] Vulnerability window refers to a scheduling factor for Weapons School events. The school now refers to each event as a "vul." The term is derived from the time an aircraft is away from home station and, thus, vulnerable to harm.

actions not executed in current and recent conflicts. A division-size airborne envelopment may become necessary in order to seize key terrain to enable the continued advance of US land forces.

As the United States does not practice airborne operations of this size, planners and leaders must extract lessons from past events to inform decisions made when designing future operations. Operation Market Garden offers these lessons. Specifically, Operation Market, the airborne portion of the overall operation, shows what the air component must do to permit the insertion of large numbers of paratroopers in near peer battle.[9] Analyzing the air missions performed, the numbers of aircraft needed, and the aircraft capabilities necessary for Market Garden, reveals lessons for large scale modern airborne operations. Using these lessons and applying them in modern terms to educate operational and strategic level planners and decision makers facilitates a better understanding of airborne Joint Forcible Entry. Furthermore, these lessons will show the strategic cost of an operation of this size.

After gleaning the lessons of Operation Market Garden, it is essential to apply them in a contemporary context. By exploring what occurred in the past and investigating how the modern military conducts that type of operation, a narrative develops showing whether or not today's US Air Force can perform a similar operation. Furthermore, applying the scale of Market Garden to current context shows the number of strategic resources required. For this analysis, the modern application is limited to one division, instead of the two American divisions and one British division dropped by the United States during Market Garden, because the United States Army no longer contains multiple airborne divisions.

Other differences between Operation Market Garden and the modern scenario must exist to account for the changing tools of warfare. Modern aircraft are more capable in their roles, with some performing multiple roles, than World War II aircraft with similar mission sets. This results

[9] Two operations existed under the overarching Operation Market Garden, Operation Market and Operation Garden. Operation Market consisted of the airborne insertion and follow-on actions conducted by airborne personnel. The advance by ground forces through the areas secured by the paratroopers comprised Operation Garden.

in a situation that does not allow the use of Market Garden's aircraft numbers in a one-to-one comparison. Instead, this study makes assumptions concerning the effects produced by each aircraft compared to those produced in the historical study. Furthermore, the improvements of ground based defensive systems, such as radar guided surface to air missiles, influence the assumed need for certain aircraft roles. The modern scenario also considers new aircraft roles that did not exist during Market Garden. For instance, radar guided threats created a need for aircraft optimized to counter those threats.

Although the number of aircraft used in Market Garden will differ from those required for a modern airborne operation, numbers are still important. The number of aircraft used relates to the strategic cost of this type of operation, especially when those numbers are broken down by mission type. The use of 4,632 aircraft and gliders on one day for one operation had significant strategic cost.[10] A higher strategic cost comes with the use of each aircraft today considering that as of 30 September 2015 the US Air Force only had 2,763 fighter, bomber, and airdrop capable mobility aircraft in its inventory.[11] In other words, the modern Air Force has a much smaller total number of the types of aircraft used in Market Garden, and in World War II those aircraft were only a portion of the aircraft available in that one theater.

Since counting the aircraft used in Market Garden and using that number for modern use is not sufficient, the analysis of the operation focuses more on aircraft mission sets and principles concerning air component integration during a large-scale airdrop operation. This exposes the enduring lessons learned during the operation that remain valid despite technological advancement. It also provides planning assumptions for use when considering an airborne

[10] Headquarters, IX Troop Carrier Command, "Report on Operation Market," 64-66; Headquarters, IX Troop Carrier Command, "Annex No. 5," i-ii.

[11] Brendan McGarry, "USAF Almanac 2016: The Air Force in Facts and Figures," *Air Force Magazine* 99, no. 5 (May 2016): 33, accessed 1 September 2017, http://secure.afa.org/joinafa/AFMag0516/files/downloads/attachments/0516fullissue.pdf.

insertion option related to support requirements for the airlift package that should be preserved in doctrine.

Applying the information, or lack thereof, in modern doctrine to the study performed, shows whether or not the knowledge exists for US forces to perform a large-scale airborne operation. If the lessons collected from Market Garden, as applied to modern operations, are not included in doctrine, an awareness shortfall exists. Examining operational and strategic level doctrine while considering this possible lack of understanding will show if the US Military truly absorbed Market Garden's lessons.

In the end, this study will produce important planning considerations to influence future missions. These factors will address the Joint Forcible Entry capabilities of the Air Force. More importantly, the Air Force's limitations will be revealed as well as how the use of the assets required to perform a division-size airborne drop influences and limits concurrent missions.

Operation Market Garden

> The accomplishment of our mission required, above all else, precise and accurate troop carrier delivery, as well as aggressive, determined action on the ground. The D Day parachute landings, without exception, were the best in the history of this Division. The accuracy, altitude and speed during drop were considered ideal by all participants.
>
> —James M. Gavin, Letter to IX Troop Carrier Command dated 25 September 1944

Following Operation Overlord, Allied forces fought their way across France and Belgium. Operation Market Garden aimed to continue the advance rapidly through the Netherlands in order to position forces to take the conflict into Germany while denying Germans in Western Holland an avenue of retreat and bypassing the defenses on the Siegfried Line.[12] Allied commanders intended to employ their strategic reserve, airborne forces, and mass resources toward the Northern Group Armies fighting in the European Theater.[13] The operation

[12] Charles B. MacDonald, *United States Army in World War II, The European Theater of Operations: The Siegfried Line Campaign* (Washington, DC: Center of Military History, 2001), 119-120.

[13] Ibid.; Headquarters, First Allied Airborne Army, "Narrative of Operation Market," 1.

consisted of two parts: Operation Market, airborne soldiers seizing bridges and securing a corridor for advancing conventional troops, and Operation Garden, the Second British Army's advance through the secured corridor.[14]

Operation Market Garden did not succeed as the Allies did not secure all planned river crossings, outflank the Siegfried Line, or isolate the enemy forces in the area.[15] However, the airborne insertion did succeed.[16] The commanders of the American airborne forces agreed with this assessment. Then-Major General Maxwell Taylor, 101st Airborne Division Commander, commented, "Parachute drop superbly executed," and then-Brigadier General James Gavin, 82nd Airborne Division Commander, called it "an excellent drop in face of hostile fire."[17] Therefore, Operation Market serves as an example of how to properly plan and execute a large-scale airborne insertion. The fact that the overall mission did not succeed does not degrade Market's value as a positive case for air component operations.

Three key aspects stand out about the air operations of Market: first, the portion of aircraft available in the ETO required for the mission; second, the different missions performed by the aircraft; and third, the ability to generate the crews and airplanes for the mission in a short amount of time. These aspects highlight the strategic cost of large air operations during a war, the air support roles required by airborne operations, and the impact of force structuring decisions on operational tempo.

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[14] Headquarters, First Allied Airborne Army, "Narrative of Operation Market," 1; MacDonald, 120.

[15] MacDonald, *United States Army in World War II, The European Theater of Operations: The Siegfried Line Campaign*, 198.

[16] Headquarters, Army Air Forces, "Report of Observations of Airborne Operations in ETO," 30 October 1944, Air Force Historical Research Agency, Maxwell Air Force Base, Folder 506.452A 30 October 1944, 2-3.

[17] Headquarters, IX Troop Carrier Command, "Report on Operation Market," 77.

Planning and Gathering Resources

Planning for Market Garden happened quickly. Lieutenant General Lewis Brereton, the First Allied Airborne Army Commander, received notification of the mission at 1430 on 10 September 1944.[18] Brereton briefed the airborne commanders at 1800 that evening and their staffs started planning a mission less than a week from execution.[19] For comparison, Operation Neptune, the airborne portion of Overlord, inserted 17,262 troops via airdrop and glider after four months of planning and Operation Dragoon, the invasion of southern France, landed 7,019 troops with almost seven weeks to plan.[20] During Market 30,481 troops arrived via aircraft and glider.[21] These numbers underscore not only the size of Market compared to previous airborne operations but also the complexity. The size differential equated to a need for more aircraft. When considered in conjunction with the short planning timeline, the air service performed a herculean task in assembling the aircraft and crews needed to make Market a success.

Before requesting the aircraft, planners first determined the numbers and types of aircraft needed based on the air support roles required for the operation. Intelligence estimates of enemy forces, the size of the transported ground force, and available assets were key factors in the calculation. The size of the ground forces needing transport dictated the number of troop carrier aircraft needed for delivery. This number then influenced the amount of pursuit aircraft necessary as the transports required protection from pursuit aircraft. More airlift aircraft meant a physically longer formation to cover and more time to suppress threats near the objective areas to ensure a

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[18] MacDonald, 128-129; John C. Warren, *USAF Historical Studies: No. 97, Airborne Operations in World War II, European Theater* (Maxwell AFB, AL: Air University Press, September 1956), 88.

[19] Warren, *USAF Historical Studies: No. 97, Airborne Operations in World War II, European Theater*, 88.

[20] Headquarters, IX Troop Carrier Command, "Report on Operation Market," 63; US War Department, "Reduction of Time Factor in Launching an Airborne Operation," staff memorandum, 11 July 1946, General Staff G-3, War Department General Staff Training Division, Combined Arms Research Library, Fort Leavenworth, KS, N-13686, Tab I.

[21] Headquarters, IX Troop Carrier Command, "Report on Operation Market," 63.

safe drop. Estimates of the enemy's disposition also influenced the plan for pursuit aircraft while also shaping the number of planned bomber aircraft.

The composition of the troop carrier piece of the air package was the easiest to compute. Allied leadership tasked the troop carriers of the IX Troop Carrier Command, with support from the Royal Air Force (RAF) 38 and 46 Groups, to carry the American 82nd and 101st Airborne Divisions, the 1st British Airborne Division, and the 1st Polish Parachute Brigade.[22] This meant airlift planners knew the quantities of paratroopers and equipment for transport. Furthermore, the planners knew the number of aircraft available. The American troop carriers made 1,274 C-47s and 2,264 gliders available, and the RAF groups had 485 powered airlifters and 885 gliders at their disposal.[23] The final plan ordered the use of 1,067 aircraft to drop paratroopers and 478 aircraft towing one glider each.[24] In total, the Allied troop carriers planned to use only 15 percent of their gliders but 88 percent of their powered aircraft. This put essentially the entire troop carrier force at risk and removed a standing, highly flexible threat, the First Allied Airborne Army, from the German strategic calculus.[25]

Planning for other air missions during the operation was not as straight-forward as the airlift plan. The roles other assets needed to fill depended on the enemy and accurate intelligence gathering. Furthermore, the air support for the troop carriers and airborne forces depended on the aircraft available in the various organizations under both the US Army Air Forces and the RAF supporting the operation. American Eighth Air Force fighters filled the escort role and suppressed

[22] Headquarters, IX Troop Carrier Command, "Field Order No. 4 for Operation Market," 13 September 1944, Air Force Historical Research Agency, Maxwell Air Force Base, Folder 546.327 September 1944, 1.

[23] Ibid., 2.

[24] Headquarters, IX Troop Carrier Command, "Report on Operation Market," 64-66; Headquarters, 38 Group, "No. 38 Group Operation Order No. 526 for Operation Market," 12 September 1944, Air Force Historical Research Agency, Maxwell Air Force Base, Folder 546.01 September 1944 V2, 2.

[25] Headquarters, Army Air Forces, "Report of Observations of Airborne Operations in ETO," 3-4.

antiaircraft artillery near the objective areas.[26] Close air support for the paratroopers came from the US Ninth Air Force and Second Tactical Air Force, which also provided photographic reconnaissance aircraft for the operation.[27] The Air Defense of Great Britain performed escort and antiaircraft artillery suppression duties once the troop carriers reached mainland Europe until the Eighth Air Force took over responsibility.[28] The RAF's Coastal Command and Bomber Command acted as diversions when the Coastal Command performed a raid and the Bomber Command dropped parachute dummies and bombed enemy positions.[29] Finally, the Eighth Air Force airdropped supplies to ground forces on the second day of Market Garden to supplement the troop carriers' exhausted resources.[30]

With missions allocated to the assorted commands, detailed planning started based on the enemy's expected actions. Allied intelligence estimated three hundred German fighter sorties and between fifty and seventy-five fighter-bomber sorties during the first day of Market Garden.[31] Estimates also included up to 280 sorties of night fighters and bombers.[32] The aircraft supplemented the German ground-based air defenses. In the area of operations for Market Garden, intelligence reported one antiaircraft company and two flak battalions supporting the

[26] Headquarters, IX Troop Carrier Command, "Preliminary Report on Operation Market," 3 October 1944, Air Force Historical Research Agency, Maxwell Air Force Base, Folder 546.327 September 1944, 7.

[27] Ibid.

[28] Ibid.

[29] Ibid.

[30] Ibid.

[31] Headquarters, IX Troop Carrier Command, "Field Order No. 4 for Operation Market," 4-5; Headquarters, First Allied Airborne Army, "German Air Defense of Eastern Holland and Northwest Germany," 12 September 1944, Air Force Historical Research Agency, Maxwell Air Force Base, Folder 545.452A 1944, 2.

[32] First Allied Airborne Army, "German Air Defense of Eastern Holland and Northwest Germany," 2.

main German ground forces.[33] The Germans also set up static antiaircraft defenses in the three main areas of Market Garden: Arnhem, Nijmegen, and Eindhoven. In total, these included sixty-nine heavy antiaircraft artillery positions, 254 light positions, and one balloon barrage.[34] These numbers followed an increase of eleven heavy positions and 160 light antiaircraft guns from 7 to 11 September 1944.[35] Furthermore, photographic reconnaissance indicated a large and increasing amount of flak in the area, including both fixed positions and mobile flak batteries.[36] This intelligence assessment showed a German Air Force that was not a large threat but could contest the air domain for short durations in localized areas. More importantly, the reports indicated ground-based air defenses capable of inhibiting airlift operations if positioned correctly and not suppressed using friendly air assets.

To counter the German defenses, the Allies committed two thirds of their airpower to supporting Operation Market Garden.[37] This essentially halted the operations of the Allied Armies in the Central Group in order to support an offensive by British General Bernard Montgomery, Commander of the 21st Army Group, and the Northern Group of Armies.[38] American General Dwight Eisenhower, Supreme Allied Commander of the Allied Expeditionary Force, approved the unbalanced allocation of resources based on the belief that Market Garden would secure the route across the Rhine River used to drive into Germany against a disorganized and retreating enemy army.[39] In essence, Eisenhower and Montgomery planned to commit the

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[33] Headquarters, IX Troop Carrier Command, "Field Order No. 4 for Operation Market, Annex No. 6 (Intelligence)," 13 September 1944, Air Force Historical Research Agency, Maxwell Air Force Base, Folder 546.327 September 1944, 4.

[34] Ibid., 5.

[35] Ibid.

[36] Ibid; Headquarters, First Allied Airborne Army, "Enemy Situation on Second Army Front," 15 September 1944, Air Force Historical Research Agency, Maxwell Air Force Base, Folder 545.452A 1944, 1-2.

[37] Headquarters, Army Air Forces, "Report of Observations of Airborne Operations in ETO," 3.

[38] Ibid.

[39] MacDonald, *United States Army in World War II, The European Theater of Operations: The Siegfried Line Campaign*, 120-121.

strategic reserve because they saw an opportunity to exploit success and finish off the German forces in the area.[40] The Allies believed Market Garden's outcome would allow victory over the Germans to follow soon after the operation. With this belief influencing planning, using the majority of available air assets to support the mission was reasonable. Furthermore, leadership committing the airborne forces, the strategic reserve, meant that Market Garden was a bold attempt to employ all available power in a final blow to ultimately end the war.[41]

Market Garden's strategic implications acted as one influencing factor for air planners. This influence combined with imprecise intelligence regarding enemy air defenses led to plans for large formations employed against any enemy forces found in the area to protect friendly aircraft, airborne personnel, and ground forces.[42] Put another way, the belief that Market Garden would cause the German forces to collapse granted a freedom in planning because it allowed the commitment of all available air assets while still meeting higher leadership's intent.[43] Therefore, planners built the air support for Market Garden using the enemy to determine the missions needed but based the number of aircraft used on availability instead of suspected enemy actions. When finalized, the plan called for twenty-six American bomber groups, twenty-two American fighter groups, thirty British bomber squadrons, and thirty-one British fighter squadrons just for escort and threat suppression.[44] These 134 bomber squadrons and 119 fighter squadrons do not account for units assigned to the ground support role from the Second Tactical Air Force and

[40] MacDonald, *United States Army in World War II, The European Theater of Operations: The Siegfried Line Campaign*, 119-121.

[41] Ibid., 119; Headquarters, Army Air Forces, "Report of Observations of Airborne Operations in ETO," 2.

[42] Headquarters, Eighth Air Force, "Special Report of Operations in Support of First Allied Airborne Army 17-26 September 1944," Air Force Historical Research Agency, Maxwell Air Force Base, Folder 520.452A 17-26 September 1944, 2-7.

[43] Headquarters, Army Air Forces, "Report of Observations of Airborne Operations in ETO," 6.

[44] Headquarters, Eighth Air Force, "Special Report of Operations in Support of First Allied Airborne Army 17-26 September 1944," 8-11.

Ninth Air Force, units flying photographic reconnaissance missions, or units conducting deception missions.[45]

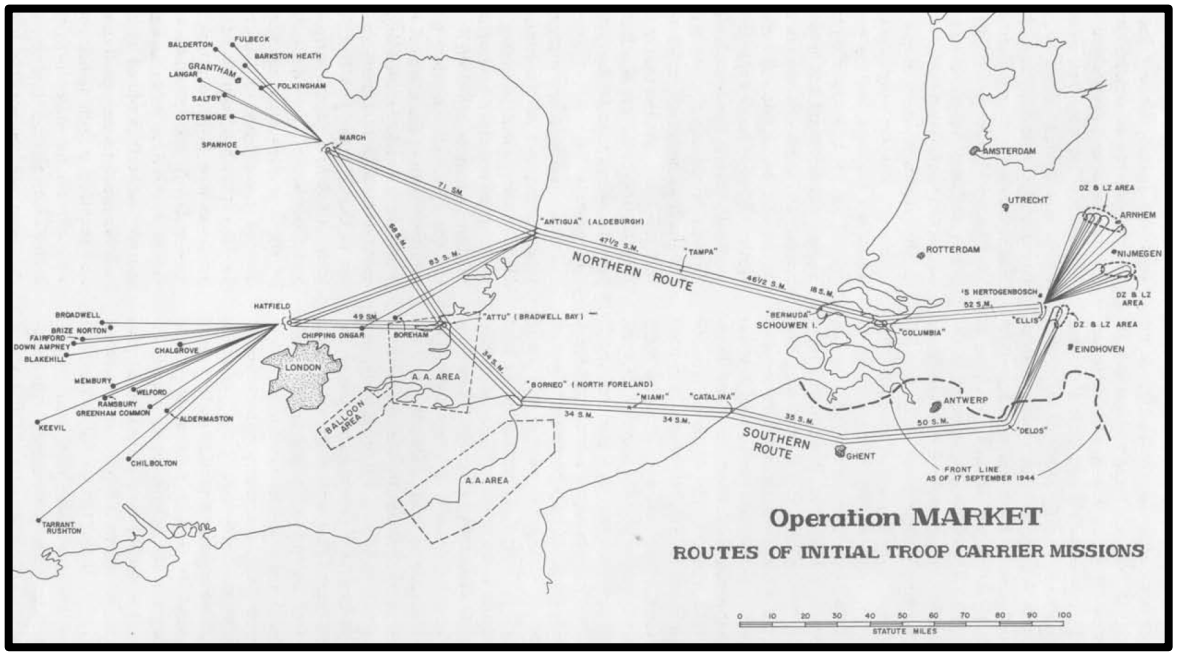

Figure 2. Operation Market Troop Carrier Plan. John C. Warren, *USAF Historical Studies: No. 97, Airborne Operations in World War II, European Theater* (Maxwell AFB, AL: Air University Press, September 1956), 92.

Initial Air Operations of Market Garden

The RAF's Bomber Command initiated Operation Market Garden on the night of 16 September using 282 bombers to target flak positions and four German airfields likely to launch fighter aircraft.[46] Five American and six RAF aircraft supported the first bombers using radio countermeasure equipment to jam German detection assets.[47] Before the sun rose, in the early

[45] Headquarters, IX Troop Carrier Command, "Annex No. 5," ii-iii; Headquarters, Eighth Air Force, 12.

[46] Headquarters, Eighth Air Force, 7-8; Headquarters, First Allied Airborne Army, "Airborne Operations in Holland, September-November, 1944 (Market)," 22 December 1944, Air Force Historical Research Agency, Henry Harley Arnold Papers, Box 81, Folder 3, 15.

[47] Headquarters, Eighth Air Force, "Special Report of Operations in Support of First Allied Airborne Army 17-26 September 1944," 8.

hours of 17 September, six Eighth Air Force B-17s conducted a bombing mission on a fifth airfield.[48] For the air component, Market Garden had started.

Daylight brought with it one of the largest air armadas ever assembled. The RAF Bomber Command continued their effort with one-hundred bombers escorted by fifty-three Spitfires attacking coastal defense.[49] The US Eighth Air Force contributed a strike package of 821 B-17s escorted by 153 P-51s assigned to destroy 112 targets along the Troop Carriers' planned route, most of them flak positions.[50] The Air Defense of Great Britain fielded 371 fighters for escort and anti-flak patrol missions and the Eighth Air Force added 550 fighters in the same roles.[51] The American Ninth Air Force supplied an additional 166 fighters positioned to provide protection for airlift aircraft and close air support for the paratroopers near the drop zones and glider landing zones.[52]

[48] Headquarters, First Allied Airborne Army, "Airborne Operations in Holland, September-November, 1944 (Market)," 16; Headquarters, First Allied Airborne Army, "Narrative of Operation Market," 2.

[49] Headquarters, First Allied Airborne Army, "Airborne Operations in Holland, September-November, 1944 (Market)," 15.

[50] Headquarters, Eighth Air Force, "Special Report of Operations in Support of First Allied Airborne Army 17-26 September 1944," 8; Headquarters, First Allied Airborne Army, "Narrative of Operation Market," 3.

[51] Headquarters, First Allied Airborne Army, "Airborne Operations in Holland, September-November, 1944 (Market)," 16-17; Headquarters, First Allied Airborne Army, "Narrative of Operation Market," 3.

[52] Headquarters, First Allied Airborne Army, "Airborne Operations in Holland, September-November, 1944 (Market)," 17; Headquarters, First Allied Airborne Army, "Narrative of Operation Market," 3.

Figure 3. C-47s Prepared for Operation Market Takeoff. Headquarters, 314th Troop Carrier Group, "Historical Record 1 September 1944-30 September 1944," Air Force Historical Research Agency, Maxwell Air Force Base, Folder GP-314-HI (TR. CARR) September 1944.

Beginning at 1025 troop carrier aircraft and gliders started taking off from airfields in England.[53] Over the next one hour and thirty minutes 1,544 airplanes and 478 gliders took off carrying the largest airborne force ever used in combat.[54] As the Troop Carriers flew over the European coast, they split to take two different routes. The aircraft transporting the 82nd Airborne Division and 1st British Airborne Division followed the northern route and the troop carriers carrying the 101st Airborne Division took the southern route.[55] By taking two courses, the troop carriers avoided causing aerial conflicts within their formation and decreased the length of the formation for escorts to cover, but their split also forced the escorts to cover two geographic areas. From first drop until the last paratrooper and glider landed one hour and twenty minutes passed.[56] This is a short amount of time to deliver 19,820 troops and over one million pounds of

[53] Headquarters, First Allied Airborne Army, "Airborne Operations in Holland, September-November, 1944 (Market)," 16; Headquarters, First Allied Airborne Army, "Narrative of Operation Market," 2.

[54] Ibid.

[55] Headquarters, First Allied Airborne Army, "Narrative of Operation Market," 2-3.

[56] MacDonald, *United States Army in World War II, The European Theater of Operations: The Siegfried Line Campaign*, 139.

supplies and equipment.[57] Still, the time over the drop zone necessitated multiple waves of fighters to cover the entire operation due to the short endurance of that type of aircraft.[58]

Although considered a success, the mission was not perfect. Support aircraft destroyed three hundred ground targets, including 107 antiaircraft positions, and damaged 117 targets, thirty-two of them antiaircraft positions.[59] Even with this success, the troop carriers lost thirty-five aircraft and thirteen gliders and an additional 291 aircraft were damaged.[60] The Eighth Air Force lost two B-17s, seventeen fighters, and 112 B-17s were damaged.[61] Other commands fared better than the Troop Carriers and Eighth Air Force, but there were other losses. The RAF lost two Bomber Command Lancasters and the Ninth Air Force lost one fighter.[62] These losses did not lead to failure of the airborne insertion, but they did leave the Allies with fewer resources for future missions.

[57] Headquarters, IX Troop Carrier Command, "Report on Operation Market," 64-66; Warren, *USAF Historical Studies: No. 97, Airborne Operations in World War II, European Theater*, 226-227.

[58] Warren, *USAF Historical Studies: No. 97, Airborne Operations in World War II, European Theater*, 102-103.

[59] Headquarters, IX Troop Carrier Command, "Annex No. 5," i.

[60] Headquarters, First Allied Airborne Army, "Narrative of Operation Market," 3; Warren, 226-227.

[61] Headquarters, First Allied Airborne Army, "Narrative of Operation Market," 3; Headquarters, Eighth Air Force, "Special Report of Operations in Support of First Allied Airborne Army 17-26 September 1944," 9-10.

[62] Headquarters, First Allied Airborne Army, "Narrative of Operation Market," 2-3; Headquarters, Eighth Air Force, "Special Report of Operations in Support of First Allied Airborne Army 17-26 September 1944," 8.

Figure 4. Resupply Drop on D plus 3. Headquarters, IX Troop Carrier Command, "Air Invasion of Holland: IX Troop Carrier Command Report on Operation Market," Air Force Historical Research Agency, Maxwell Air Force Base, Folder 546.452K-1 25 September 1944, 36.

Follow-on and Resupply Air Missions

Air missions supporting Operation Market Garden did not end on 17 September 1944, but the remaining days contained far smaller air efforts. The troop carriers flew missions almost daily from 18 September though Market Garden's end on 26 September in order to keep the airborne forces supplied.[63] The resupply effort began on 18 September because the paratroopers jumped with only one day of supply.[64] On the first day, 252 B-24s from the Eighth Air Force executed supply drops in order to supplement the troop carriers and allow them to recover from the previous day's effort.[65] After 18 September, troop carriers flew all resupply missions.

[63] Headquarters, IX Troop Carrier Command, "Report on Operation Market," 64-66.

[64] James M. Gavin, *Airborne Warfare* (Washington DC: Infantry Journal Press, 1947), 82-83.

[65] Headquarters, IX Troop Carrier Command, "Annex No. 5," ii; Headquarters, Eighth Air Force, "Special Report of Operations in Support of First Allied Airborne Army 17-26 September 1944," 16.

The resupply flights required continued support from fighter and bomber aircraft. This kept those aircraft committed to Market Garden and in danger as the Germans flew more fighter sorties to counter the Allies' actions.[66] When Market Garden ended, bombers had flown 7,781 sorties and lost 104 aircraft.[67] Another sixty-six sorties supported the operations performing photographic reconnaissance, weather reconnaissance, and radio countermeasures.[68] The Allies lost five aircraft during these missions.[69] However, they enabled the troop carriers to fly 7,747 sorties delivering 30,481 troops and almost 13.6 million pounds of supplies and equipment while losing 170 aircraft.[70]

Strategic Implications and Lessons Learned

While the number of missions flown and troops delivered are important, the actions not accomplished because of Market Garden may be more significant. The operation prevented the use of a significant amount of air assets better suited for other missions. This was especially true of the Eighth Air Force's resources. During the ten days of the operation, Eighth Air Force bombers only acted in their normal strategic role on three days.[71] On the remaining seven days the Eighth performed none of their usual missions on three, had limited actions on three, and had restricted range on one.[72] The number of bombers employed for Market Garden only caused this limitation on one day; the use of Eighth Air Force fighters limited strategic bombing capabilities more than the diversion of bombers.[73] Diverting the fighters to support Market Garden placed

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[66] Headquarters, Eighth Air Force, "Special Report of Operations in Support of First Allied Airborne Army 17-26 September 1944," 13-39.

[67] Ibid., 40.

[68] Ibid.

[69] Ibid.

[70] Headquarters, IX Troop Carrier Command, "Report on Operation Market," 63-67.

[71] Headquarters, Eighth Air Force, "Special Report of Operations in Support of First Allied Airborne Army 17-26 September 1944," 43.

[72] Ibid.

[73] Ibid; Headquarters, Army Air Forces, "Report of Observations of Airborne Operations in ETO," 4.

them in roles for which they were not well suited or well trained. This was particularly true of the Eighth Air Force P-47s used for antiaircraft suppression, placing the aircraft and pilots at higher risk.[74] In all, then-Lieutenant General James "Jimmy" Doolittle, Commander of the Eighth Air Force, estimated that his command's deviation from normal operations cost six strategic bombing missions.[75]

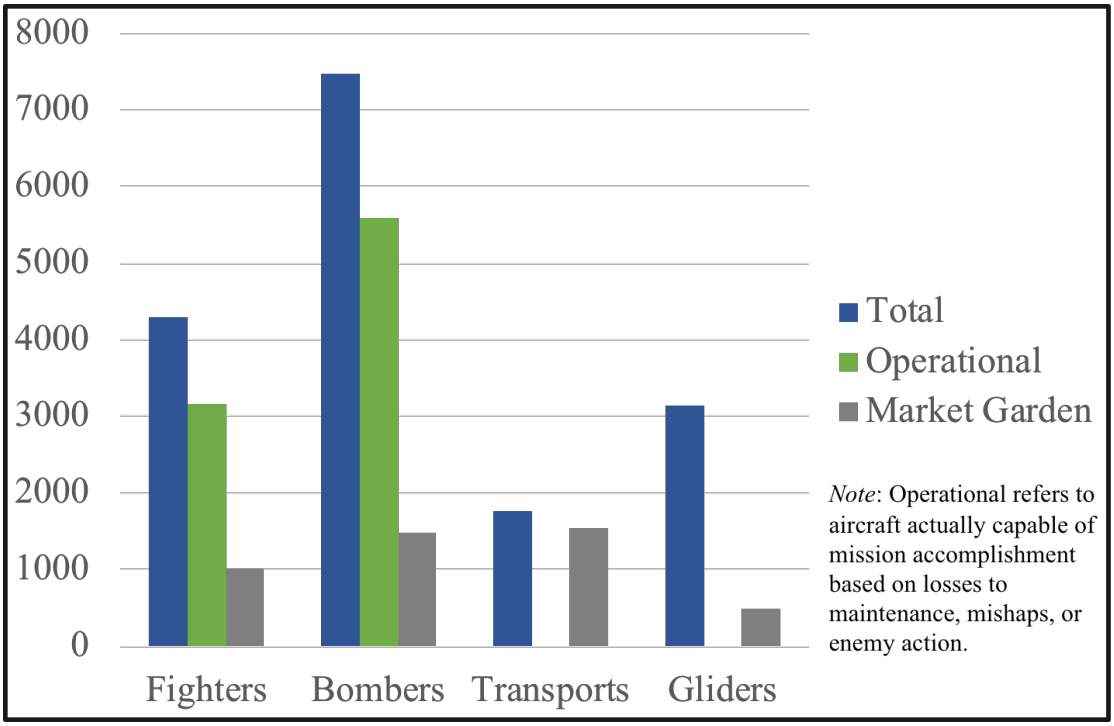

Figure 5. Aircraft Available in ETO and Used in Operation Market Garden. Data from Headquarters, IX Troop Carrier Command, "Air Invasion of Holland: IX Troop Carrier Command Report on Operation Market," Air Force Historical Research Agency, Maxwell Air Force Base, Folder 546.452K-1 25 September 1944, 64-66; Headquarters, IX Troop Carrier Command, "Air Invasion of Holland Annex No. 5: Air Support Activity in Connection with Operation 'Market'," Air Force Historical Research Agency, Maxwell Air Force Base, Folder 546.452K-1 25 September 1944, i-ii; Headquarters, IX Troop Carrier Command, "Field Order No. 4 for Operation Market," 13 September 1944, Air Force Historical Research Agency, Maxwell Air Force Base, Folder 546.327 September 1944, 2. Headquarters, 38 Group, "No. 38 Group Operation Order No. 526 for Operation Market," 12 September 1944, Air Force Historical Research Agency, Maxwell Air Force Base, Folder 546.01 September 1944 V2, 2; Wesley R. Craven and James L. Cate, *The Army Air Forces in World War II*, vol. 3 (Washington, DC: Office of Air Force History, 1983), accessed 24 August 2016, http://media.defense.gov/2010/Nov/05/2001329888/-1/-1/0/AFD-101105-007.pdf, 596.

[74] Headquarters, Eighth Air Force, "Special Report of Operations in Support of First Allied Airborne Army 17-26 September 1944," 43-44.

[75] Headquarters, Army Air Forces, "Report of Observations of Airborne Operations in ETO," 4.

The troop carrier aircraft and crews used in Market Garden are another example of strategic resourcing decisions that began much earlier than the operation. Troop carrier aviation split from strategic airlift when Lieutenant Colonel Ray Dunn, General Henry "Hap" Arnold's executive officer, signed an order creating the I Troop Carrier Command in the summer of 1942.[76] Arnold, hesitant to commit the resources demanded to support airborne operations, fired Dunn when he returned from a trip and found the order in place.[77] A lack of plans for extensive employment of airborne forces created Arnold's apprehension.[78]

The debate about using transport aircraft in the specialized troop carrier role did not end when the troop carriers separated from the Air Transport Command, and continued until and after Operation Market Garden. The dispute caused strain in the Supreme Headquarters Allied Expeditionary Force (SHAEF) in the days prior to Market Garden's launch. The ground forces advancing through Europe and the airborne forces preparing for the operation competed for the use of IX Troop Carrier Command C-47s.[79]

Beginning on 1 August 1944, the First Allied Airborne Army and IX Troop Carrier Command attempted to halt supply flights to focus on training.[80] After intervention from SHAEF, the Combined Air Transport Operations Room, the agency responsible for air transport coordination, agreed training was the troops carriers' primary focus, and the aircraft would only be used for emergency transport operations.[81] Under this agreement, the IX Troop Carrier

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[76] Charles E. Miller, *Airlift Doctrine* (Maxwell Air Force Base, AL: Air University Press, 1988), 81; Robert C. Owen, *Air Mobility: A Brief History of the American Experience* (Washington, DC: Potomac Books, 2013), 30.

[77] Owen, *Air Mobility: A Brief History of the American Experience*, 30.

[78] James A. Huston, *Out of the Blue: U.S. Army Airborne Operations in World War II* (West Lafayette, IN: Purdue University Studies, 1972), 58.

[79] Headquarters, Army Air Forces, "Report of Observations of Airborne Operations in ETO Tab H: Army Supply and Airborne Training," 30 October 1944, Air Force Historical Research Agency, Maxwell Air Force Base, Folder 506.452A 30 October 1944, 1.

[80] Ibid.

[81] Ibid., 2.

Command flew limited supply operations throughout August and until 15 September when army supply halted for Market Garden.[82] Army supply missions restarted on 22 September as Market Garden neared completion.[83] During September, the Troop Carriers hauled twenty-thousand tons of supply.[84] If preparation, execution, and standby for Market Garden had not used so many aircraft, the IX Troop Carrier Command could have delivered an estimated forty-five thousand to eighty-thousand tons.[85]

Although Market Garden failed to achieve its main objective, the airborne and troop carrier forces succeeded, and the air component learned valuable lessons concerning aircraft availability. The most prominent lesson learned is that these missions require enough supporting air assets to provide air superiority and suppression of enemy ground threats.[86] Market Garden also showed the importance of having enough troop carrier aircraft for two purposes. First, pre-mission training requires the availability of a large number of planes, and the airborne and troop carrier training enabled success during Market Garden.[87] Second, the complexity of airborne insertions and need for air support necessitate accomplishing no more than one lift per day.[88] Furthermore, troop carriers should deliver all the forces and equipment needed for accomplishment of mission objectives on the first day.[89]

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[82] Headquarters, Army Air Forces, "Report of Observations of Airborne Operations in ETO Tab H: Army Supply and Airborne Training," 2-12.

[83] Ibid., 12.

[84] Headquarters, Army Air Forces, "Report of Observations of Airborne Operations in ETO," 4.

[85] Ibid; Warren, *USAF Historical Studies: No. 97, Airborne Operations in World War II, European Theater*, 86.

[86] Headquarters, IX Troop Carrier Command, "Report on Operation Market," 80; Headquarters, First Allied Airborne Army, "Narrative of Operation Market," 14; Headquarters, Army Air Forces, "Report of Observations of Airborne Operations in ETO," 6.

[87] Headquarters, IX Troop Carrier Command, "Report on Operation Market," 80; Headquarters, First Allied Airborne Army, "Narrative of Operation Market," 14-15.

[88] Headquarters, IX Troop Carrier Command, "Report on Operation Market," 80.

[89] Headquarters, Army Air Forces, "Report of Observations of Airborne Operations in ETO," 6.

The air component also learned about the ability of airdrop to enable ground operations during Market Garden. After the mission, the Army Air Forces determined that airdrop is not a reliable method of supply for long-term operations due to the uncertainty of weather and enemy defenses.[90] To supply an airborne operation by air, ground forces must seize an airfield to enable delivery of the required amount of supplies.[91] Even if airland delivery is possible, leadership should reserve troop carriers for emergency airlift operations and support to airborne forces, and the decision authority for allocating troop carriers for transport or training should rest in the theater commander.[92]

During Operation Market Garden, the air component enabled the largest airborne insertion in the history of military aviation. It did so by employing five mission sets: airlift, escort, on-call air patrol, ground threat suppression, and reconnaissance. Support aircraft suppressed the enemy using kinetic strikes and electronic means, pre-invasion bombing raids, and interdiction strikes. To do this, the Allied forces assembled a massive air fleet, costing them the ability to continue strategic bombing and aerial supply operations elsewhere. The concentration of air assets in one area of a global war cost the Allies the ability to exploit opportunities in other areas. Because Operation Market Garden failed to meet its overall objectives, the Allies wasted ten days of airpower.

Modern Airborne Insertion

Could America perform a modern Operation Market Garden? Exploring the current implications of the lessons learned during Operation Market Garden requires a framework. The characteristics of Market Garden that shaped the nature of the operation were that it was against a near peer enemy, was not the initial invasion of Europe, involved almost all available airborne

[90] Headquarters, Army Air Forces, "Report of Observations of Airborne Operations in ETO," 6.

[91] Ibid., 7.

[92] Ibid.

forces, and relied entirely upon air for supply until the ground advance reached the landed airborne forces. These factors shaped the enemy capabilities suppressed, the amount of people and equipment needing transport, and the amount of continued air operations after the initial entry.

Based on the characteristics of Market Garden and attempting to apply realistic assumptions, the modern scenario develops. First, it assumes an operation into the same geographic region as Market Garden against a near peer enemy. The first part of this assumption has a negligible effect on the study. It mainly defines the distances required for transport, but many of the lessons are applicable to any region if sufficient basing is available within range of the objective area. The second part is an important factor in the assessment as it drives the type of defensive weapons faced by the air component. As a near peer competitor, the fictional enemy possesses fighter aircraft, electronic warfare and jamming capability, radar and infrared surface to air missiles, radar and optically-guided air defense artillery, radar early warning, and advanced intelligence capabilities. The next assumption drives the number of these systems available.

Second, the situation is not the beginning of the war. Because Market Garden took place 103 days after Operation Overlord, this scenario uses a one hundred day timeline. One hundred days into the war means there should be some conventional ground forces available to move inland and link up with the airborne forces as planned for Market Garden. Furthermore, it assumes that at least one hundred days of air operations have occurred, influencing the remaining threat systems and friendly assets available.

Third, the scenario assumes the delivery of America's 82nd Airborne Division. While recent use of airborne forcible entry in Operations Just Cause, Uphold Democracy, and Iraqi Freedom used brigade-sized elements or smaller, this study assumes the use of the entire 82nd.[93]

[93] John Gordon IV, Agnes Gereben Schaefer, David A. Schlapak, Caroline Baxter, Scott Boston, Michael McGee, Todd Nichols, and Elizabeth Tencza, *Enhanced Army Airborne Forces: A New Joint Operational Capability* (Santa Monica, CA: RAND Corporation, 2014), 7.

Requiring the larger force assumes a strategic setting like that of Market Garden when airborne employed in its entirety to exploit some type of success achieved previously. Although other parachute units exist such as the 173rd Airborne Brigade and the United Kingdom's Parachute Regiment, this study uses a division-size element. This choice enables a large enough sample to drive certain planning factors that a brigade-size scenario does not entail. Furthermore, the findings are scalable up or down to fit planning for larger or smaller parachute operations.

The final major assumption for this study is that the objective area includes an airfield. Although Market Garden did not make extensive use of an airfield, engineers built landing zones for glider recovery.[94] Furthermore, the Army Air Forces recommended seizing airfields in future operations.[95] In modern scenarios, an airborne operation that does not involve seizing an airfield is implausible as follow-on forces need access though an airfield or port.[96] Modern doctrine also promotes the establishment and expansion of a lodgment to bring in follow-on forces via air or sea lines of communication.[97] Therefore, the discussion includes seizing an airfield as a primary objective although this was not part of Operation Market Garden.

Based on the above assumptions, planning for the air component begins, like Market Garden, with an assessment of the mission. Airlift forces must deliver the 82nd Airborne Division via airdrop and airland insertion to northern Europe against a near peer enemy. The 82nd Airborne Division currently contains three infantry brigade combat teams, division artillery, an

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[94] Headquarters, IX Troop Carrier Command, "Report on Operation Market," 57.

[95] Headquarters, Army Air Forces, "Report of Observations of Airborne Operations in ETO," 7.

[96] Christopher G. Pernin, Katharina Ley Best, Matthew E. Boyer, Jeremy M. Eckhause, John Gordon IV, Dan Madden, Katherine Pfrommer, Anthony D. Rosello, Michael Schwille, Michael Shurkin, and Jonathan P. Wong, *Enabling the Global Response Force: Access Strategies for the 82nd Airborne Division* (Santa Monica, CA: RAND Corporation, 2016), 33-35.

[97] US Department of Defense, Joint Staff, Joint Publication (JP) 3-18, *Joint Forcible Entry Operations* (Washington, DC: Government Printing Office, 2012), IV-5-IV-7; US Department of the Army, Field Manual (FM) 3-99, *Airborne and Air Assault Operations* (Washington, DC: Government Printing Office, 2015), 1-3-1-4.

aviation brigade, a sustainment brigade, and a headquarters battalion.[98] The infantry brigade combat teams employ under the Global Response Force (GRF) model and prepare to fight in echelons as large as the full brigade.[99] To retain as much familiarity as possible for the larger operation, the units will deploy using the GRF model, but do so with all three brigades simultaneously instead of just one brigade combat team deploying. Under that model, one brigade requires the delivery of 1,900 people and twenty-eight pieces of equipment via airdrop with 1,110 people and 144 pieces of equipment delivered via airland.[100] Therefore, the airlift force must deliver 5,700 paratroopers and eighty-four heavy equipment airdrop loads, and then airland 3,330 soldiers and 432 pieces of equipment.

With the airborne force's size determined, planning turns to the size of the airlift force. There are two airlift assets capable of airdrop in the US Air Force inventory, the C-130 and the C-17. There are two categories of C-130 in use, the C-130H and the C-130J. All three aircraft types have different delivery capacities. For airdrop, the C-130H can deliver sixty-four paratroopers or up to 42,000 pounds of equipment, the C-130J drops ninety-two jumpers or 42,000 pounds of equipment, and the C-17 can drop 102 people or 110,000 pounds.[101] If delivering via airland, capacity increases for personnel to ninety-two for the C-130H and 128 for the C-130J.[102] Cargo capacity during airland employment for all three aircraft varies based on the fuel load.[103]

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[98] "82nd Airborne Division," U.S. Army Fort Bragg: Home of the Airborne and Special Operations Forces, accessed October 12, 2017, https://www.bragg.army.mil/index.php/units-tenants/xviii-airborne-co/82nd-airborne-division.

[99] Pernin et al., *Enabling the Global Response Force: Access Strategies for the 82nd Airborne Division*, 8.

[100] Jonathan Dixon, "EMP396A: GRF Concepts" (PowerPoint presentation, US Air Force Weapons School, Little Rock Air Force Base, AR, May 4, 2017), 34.

[101] U.S. Air Force, "Tactical Airlift Planning Factors" (Pamphlet, US Air Force Weapons School, Little Rock Air Force Base, AR, September 12, 2017), 4; U.S. Air Force, "C-130 Hercules," last modified May 2014, accessed October 12, 2017, http://www.af.mil/About-Us/Fact-Sheets/Display/Article/104517/c-130-hercules/; U.S. Air Force, "C-17 Globemaster III," last modified October 2015, accessed October 12, 2017, http://www.af.mil/About-Us/Fact-Sheets/Display/Article/104523/c-17-globemaster-iii/.

[102] U.S. Air Force, "C-130 Hercules."

[103] U.S. Air Force, "Tactical Airlift Planning Factors," 4.

Therefore, planning the cargo during the airland follow-on depends on the distance from takeoff to landing at the next field with fuel available. The space available in the aircraft limits capability more than weight for the airdropped cargo. Equipment sizes vary, but as a planning rule both C-130s can drop two heavy equipment pallets and the C-17s can drop three or eight if using the Dual Row Airdrop System.[104] Therefore, a much smaller number of airlifters than used during Market Garden can now perform a comparable mission.

Table 1. Airlift Aircraft Airdrop Capabilities

Aircraft	Personnel	Heavy Equipment Pallets	Equipment Weight (lbs.)	Container Delivery System Bundles
C-130H	64	2	42,000	16
C-130J	92	3	42,000	24
C-17	102	3/8	110,000	40

Sources: "C-130 Hercules," U.S. Air Force, last modified May 2014, accessed October 12, 2017, http://www.af.mil/About-Us/Fact-Sheets/Display/Article/104517/c-130-hercules/; "C-17 Globemaster III," U.S. Air Force, last modified October 2015, accessed October 12, 2017, http://www.af.mil/About-Us/Fact-Sheets/Display/Article/104523/c-17-globemaster-iii/; Jonathan Dixon, "EMP396A: GRF Concepts" (PowerPoint presentation, US Air Force Weapons School, Little Rock Air Force Base, AR, May 4, 2017), 64; "Tactical Airlift Planning Factors" (pamphlet, US Air Force Weapons School, Little Rock Air Force Base, AR, September 12, 2017), 4.

Table 2. Airlift Aircraft Airland Capabilities

Aircraft	Personnel	Cargo Pallets	Cargo Weight (lbs.)	Litter Patients
C-130H	92	6	50,000	74
C-130J	128	8	54,000	97
C-17	102	18	170,900	36

Sources: "C-130 Hercules," U.S. Air Force, last modified May 2014, accessed October 12, 2017, http://www.af.mil/About-Us/Fact-Sheets/Display/Article/104517/c-130-hercules/; "C-17 Globemaster III," U.S. Air Force, last modified October 2015, accessed October 12, 2017, http://www.af.mil/About-Us/Fact-Sheets/Display/Article/104523/c-17-globemaster-iii/; Jonathan Dixon, "EMP396A: GRF Concepts" (PowerPoint presentation, US Air Force Weapons School,

[104] Dixon, "EMP396A: GRF Concepts," 64.

Little Rock Air Force Base, AR, May 4, 2017), 64; "Tactical Airlift Planning Factors" (pamphlet, US Air Force Weapons School, Little Rock Air Force Base, AR, September 12, 2017), 4.

Like the troop carriers in World War II, the airlift element requires additional air support. During Market Garden the component flew four missions in addition to airlift: escort, combat air patrol, threat suppression, and reconnaissance. Although technology has changed drastically, these are the same missions needed for a modern airborne insertion. Like airlift, these missions require a much smaller number of aircraft than used for Market Garden. Unlike Market Garden, the majority of the aircraft used depend on aerial refueling.

The combat air forces for this mission depend on the threat to determine exact numbers needed. This study does not require that detail. Instead, it handles air support in general terms and assumes air support does not limit the operation. The mission requires fighter aircraft for suppression of enemy air defenses, escort, and combat air patrol. Bomber usage is not as robust as Market Garden because they also require fighter protection in the modern arena. The reconnaissance assets should not limit operations either.

This analysis uses a conversion method to assess the number of fighters and bombers needed in the operation in order to create a general understanding of the amount of aircraft needed. Trying to quantify the improved capability of aircraft able to target enemy assets from World War II to modern times is nearly impossible. Therefore, this paper explores the matter using a four to one conversion rate based on the easily quantifiable advances in mobility aircraft.[105] Furthermore, it communicates in terms of Combat Air Forces squadrons. A squadron consists of approximately twelve aircraft today, just as during World War II. Also, modern

[105] The diversity of fighter and bomber aircraft and their specialized roles make a completely accurate quantitative analysis an endeavor beyond the scope of this paper. Therefore, the analysis uses an approximated conversion rate of four to one based on improvements in airlift assets. A discussion of modern mobility aircraft capability is above. Averaging the capability of the airdrop capable modern aircraft gives a capacity of eighty-six paratroopers. The C-47s used during Market Garden carried approximately twenty paratroopers. This equates to a four and three tenths to one ratio. Using four to one simplifies the mathematics and accounts for a higher number of combined C-130Js and C-17s as compared to C-130Hs available to the Air Force.

fighters or bombers can fill the roles of both bombers and fighters during Market Garden excluding the need for fighters to counter air threats and provide escort. Therefore, this paper examines fighters and bombers in terms of numbers of combined fighter and bomber squadrons.

During Market Garden, Allied forces used 134 bomber squadrons and 119 fighter squadrons or 253 Combat Air Forces squadrons in modern terms.[106] This equates to sixty-three and one quarter squadrons necessary for the modern operation. Although the contemporary scenario assumes a smaller number of paratroopers, the combat aircraft needed does not decrease at the same rate because the requirement is based on geographic area. Also, this calculation does not account for specialized aircraft, but it demonstrates the extreme number of resources needed even after considering modern technological advances.

The challenges for these missions lie more in the tactical planning and determining how to allocate modern assets built for multiple roles than in the sheer number of aircraft required. Like Market Garden's use of P-47 pilots not trained for ground attack, fighter pilots may fly missions with little familiarity and training in that role.[107] Still, it is reasonable to assume the availability of assets necessary to conduct a mission if strategic level leadership has decided on this course of action.

For the airlift mission numbers are important. Accomplishing the personnel drop requires ninety C-130Hs, sixty-two C-130Js, or fifty-six C-17s. The equipment drop needs forty-two C-130s, twenty-eight C-17s, or eleven C-17s with the Dual Row Airdrop System.[108] This study examines three options for the delivery: departure from America using C-17s, departure from England using C-17s, and departure from England using a mix of C-130s and C-17s.

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[106] Headquarters, Eighth Air Force, "Special Report of Operations in Support of First Allied Airborne Army 17-26 September 1944," 8-11.

[107] Ibid., 43-44.

[108] These numbers change slightly in actual practice due to cargo too large for drops from C-130s and cargo requiring more pallet positions than other cargo. However, the point illustrated, airlift requirements for airborne insertion, does not change by not using specific sizes of airdropped equipment.

Figure 6. Paratroopers Exit a C-130J. Leslie Keopka, US Takes Partnerships to New Heights [Image 1 of 4], July 7, 2015, Defense Video Imagery Distribution System, accessed December 31, 2017, https://www.dvidshub.net/image/2053498/us-takes-partnerships-new-heights.

Option One: Delivery from Fort Bragg to Holland

The most rapid option for delivery is for all personnel and equipment to load from the 82nd Airborne Division's home base and fly to the objective area without stopping. This method requires a large number of C-17s and tankers. Delivering the airdrop portion of the inserted force, known as the alpha echelon, requires a minimum of sixty-seven C-17s. The bravo echelon requires an additional 195 C-17 sorties.[109]

This plan requires the aircraft to receive fuel from a tanker to reach the objective area. This requires one KC-10 to refuel two C-17s or one KC-135 to refuel one of the airlifters.[110] This

[109] Dixon, "EMP396A: GRF Concepts," 34; Pernin et al., *Enabling the Global Response Force: Access Strategies for the 82nd Airborne Division*, 38-39.

[110] Dixon, "EMP396A: GRF Concepts," 69.

constrains the supporting aircraft at the objective area, especially the fighters due to their limited endurance. The tanker requirement increases further if there is not a suitable landing field within one thousand miles of the objective due to weight restrictions that limit the amount of fuel on board for C-17s during personnel airdrops.[111] In this option, tankers quickly become a valuable resource and limiting factor.

Having a base within range of the C-17s post drop is vital for this plan to succeed. These bases also help other aircraft stage near the fight. This decreases tanker need and increases the time on station for supporting aircraft. Maximizing their capability is important because the airlift assets need the air superiority and threat suppression they provide. Furthermore, the fighters supply close air support for the airborne forces on the ground. The assumption that this plan is not the initial action of the war makes it more likely that fighter aircraft are in theater and established bases exist.

Option Two: Delivery from England to Holland Using Only C-17s

The option requiring the smallest number of aircraft for the airdrop involves using intermediate staging bases in England as used during Operation Market Garden. This option employs seventy-seven C-17s, sixty-seven C-17s for the alpha echelon and an additional ten to allow airland operations to begin as soon as possible.

For this course of action, delivery of the airdropped personnel and equipment drives the airlift requirement, assuming aircraft losses remain low, because the same aircraft can fly missions occurring after the initial assault. This is true because of the short distances from England to the objective; during Market Garden the longest routes were under three hundred

[111] Pernin et al., *Enabling the Global Response Force: Access Strategies for the 82nd Airborne Division*, 122.

miles.[112] The short distance removes the need for tanker support to airlift, freeing all available tankers to provide support for supporting aircraft.

In this plan, basing is the limiting factor. The requirements include fields with high enough capacity to host the aircraft and store the equipment. Additionally, it requires facilities to house the airborne personnel and quarters suitable for aircrew crew rest. Perhaps the most important factor in choosing the base or bases from which to launch is similar to the limiting factor in the previous option, fuel. However, this plan's fuel concern is not from tankers but from the ground. The ability to supply gas or, even better, having an existing Defense Logistics Agency fuel contract eases planning in this scenario.[113]

The issue of transport to the staging base also exists. This can be done using strategic airlift assets, like C-5s, the Civil Reserve Air Fleet (CRAF), or sealift, but it still absorbs assets surely in high demand during this type of conflict. Also, modern intelligence gathering capabilities remove the element of surprise once the move begins. The added time needed to transport to the staging base then remarshal and launch gives the enemy time to prepare defenses for the coming operation.

Option Three: Delivery from England to Holland Using C-130s and C-17s

A slight adjustment to the second option adds the use of C-130s. By mixing the assets, planners can use the resources more efficiently. For example, the C-130s can transport the personnel and the C-17s can deliver the equipment. This would reduce time over the drop zone, which helps reduce the time needed for fighter cover.[114] Furthermore, the C-17 personnel

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[112] Warren, *USAF Historical Studies: No. 97, Airborne Operations in World War II, European Theater*, 92.

[113] Pernin et al., *Enabling the Global Response Force: Access Strategies for the 82nd Airborne Division*, 45.

[114] Dixon, "EMP396A: GRF Concepts," 63; U.S. Air Force, "Tactical Airlift Planning Factors," 12, 15. The fifty-six ship C-17 formation dropping personnel requires forty-eight minutes and fifteen seconds over the drop zone. To drop the same amount of personnel the ninety-ship C-130H formation needs fourteen minutes and fifty seconds. The sixty-two C-130Js need ten minutes and ten seconds.

formation length is ninety-six and one half nautical miles long, a massive area for fighter coverage.[115] A formation of C-130Js dropping the same amount of personnel is only twenty and one third nautical miles long.[116]

This option also benefits logistics. C-130s burn approximately one fourth of the fuel burned by a C-17.[117] A lower overall fuel requirement eases one concern for logisticians. The gas not used for the airlift can then go to aircraft filling other roles. It also may allow the use of a staging base with a smaller fuel storage capacity than other available bases. Moreover, C-130s use less ramp space, allowing more aircraft to use a base than if staging C-17s.

Another benefit of this course of action is that it frees C-17s for use in strategic airlift. Because C-17s have a longer range and higher cargo capacity then C-130s, using them for long-range airland missions helps maximize the use of available resources. C-17s can deliver personnel and equipment to the staging base. C-130s then transport the loads to the final destination in conjunction with C-17s.

The disadvantages of using C-130s relate to the increased number of aircraft. Using more aircraft requires more crews and, therefore, more accommodations at staging bases. Also, C-130Hs use a crew of six while C-130Js and C-17s both use a crew of four.[118] Mobilization is also a concern for C-130Hs as few remain assigned to active duty squadrons. Finally, the Air Force apportions fewer aircrews for each C-130 compared to crews assigned per C-17.[119] Therefore, mobilizing enough crews for continuous operations is a factor.

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[115] Dixon, "EMP396A: GRF Concepts," 82.

[116] U.S. Air Force, "Tactical Airlift Planning Factors," 15.

[117] Ibid., 4.

[118] U.S. Air Force, "C-130 Hercules;" U.S. Air Force, "C-17 Globemaster III."

[119] US Department of the Air Force, Air Force Instruction (AFI) 65-503, *US Air Force Cost and Planning Factors* (Washington, DC: Government Printing Office, 4 February 1994, Incorporating Change 1, 23 February 2017), Table A36-1, "Authorized Aircrew Composition-Active Forces."

Follow-on and Supply Operations

All of the above options require continued support to airborne forces after the initial insertion. During Operation Market Garden the resupply effort lasted ten days.[120] For a modern operation, US forces retain the seized airfield as a base with continued operations until the end of hostilities or longer.[121] This helps reduce the supply burden seen at Market Garden because it allows airland delivery of supplies. Airland delivery maximizes cargo capacity, allows the aircraft to move people and equipment out of the forward field, and decreases the risk of damaged loads, among other benefits. Having the field also helps as a protected area to accumulate supplies. Therefore, ground forces do not need to rely on daily resupply operations as seen during Market Garden. This reduces the risk of supply issues due to weather.

Aircraft sourcing for the follow-on airlift requirements is not an issue. The highest number of aircraft needed is on the first day. Unless the enemy action renders the aircraft unusable, or the aircraft leave the theater, they can perform the ensuing missions. However, this does not allow the aircrafts' use in other areas. Keeping C-17s for intratheater airlift fails to maximize use of the assets.

The most concerning issue for continued operations is the enemy. If American forces cannot create enduring air superiority, the resupply efforts require a supporting air package almost as large as needed for the initial insertion. The need to suppress enemy threats for resupply increases planning complexity and limits airlift windows to times when fighter aircraft are available. This hinders emergency airlift capabilities for time-critical missions such as aeromedical evacuation.

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[120] Headquarters, IX Troop Carrier Command, "Report on Operation Market," 64-66.

[121] Pernin, et al., *Enabling the Global Response Force: Access Strategies for the 82nd Airborne Division*, 48.

Differences and Similarities of Market Garden and the Modern Operation

Although the air component performs the same missions for a modern airborne insertion as it did during Market Garden, the nature of today's military operations changes certain aspects of the operation. The size of the forces needed in terms or airplanes and paratroopers decreases. However, the equipment delivered increases in size and amount. Also, the airborne objective changes the nature of the follow-on airlift mission.

The airborne requirements and modern aircraft capabilities drastically reduce the numbers needed for the air component. Today's one-division alpha echelon contains 28.8 percent of the paratroopers delivered on the first day of Market Garden.[122] Airlift aircraft also carry many more people and much more cargo than Market Garden's troop carriers. Airdrop capabilities now allow supply of weapons and vehicles without the use of airland delivery, done in Market Garden using gliders. Fighter and bomber aircraft now employ in smaller formations and deliver more capable weapons. This all leads to a much smaller mission to achieve similar objectives.

The expected objective for today's airborne operations is seizing an airfield to establish a lodgment.[123] This also aids the follow-on airlift and changes the nature of that mission. In Market Garden the troop carriers airdropped the majority of follow-on people and equipment.[124] In today's fight very little or no follow-on deliveries use airdrop.

Although appearing very different, modern airborne insertion contains the same basic missions and principles as Operation Market Garden. The air component must airlift an airborne force and its equipment. To enable the effort, other aircraft suppress enemy ground and air threats, provide escort and combat air patrol, and conduct reconnaissance. The airborne force size and enemy composition drive the air component's size. In essence, the air component during an

[122] Headquarters, IX Troop Carrier Command, "Report on Operation Market," 64-66.

[123] US Joint Staff, JP 3-18 (2012), IV-5-IV-7; US Army, FM 3-99 (2015), 1-3-1-4.

[124] Headquarters, IX Troop Carrier Command, "Report on Operation Market," 65.

airborne insertion is the same as its World War II predecessor, it just uses more capable equipment to accomplish the same missions more efficiently.

Conclusion

Although the modern air component is more efficient than the past, the question remains whether or not America has the ability to perform this mission. To answer this, three areas require consideration. First, do the numbers of aircraft and crews exist to support this mission? Second, does doctrine exist that supports the capability? Third, does the strategic will exist to conduct an airborne operation on this scale? The answers to these questions show whether or not a large-scale airborne operation is possible today. Furthermore, this examination offers considerations for strategic decision makers to contemplate when considering this type of operation. Finally, the discussion proposes improvements to modern practices and doctrine.

The resources required to conduct the modern airborne insertion scenario involve both aircraft and aircrews. Today's US Air Force contains sixty-four combat coded squadrons.[125] These include all active, Air National Guard, and reserve component fighter, attack, and bomber squadrons. The scenario called for just over sixty-three of these squadrons. Therefore, the aircraft exist to perform the roles needed to support the airlift mission. This assumes that these squadrons' aircrew members maintain their combat readiness and adequately train to perform the missions needed during the operation.

The airlift requirements are more nuanced. The current Air Force contains 244 C-130Hs, 105 C-130Js, and 222 C-17s.[126] These include aircraft assigned to training and test units that are not normally available for real-world operations. The figures, like those for the Combat Air Forces, include all service components. The options in the modern scenario call for as many as 262 C-17s in the first option and as few as seventy-seven for the second option. The third option

[125] *Air Force Magazine*, "Defense Budget at a Glance," 99, no. 5 (May 2016): 14, accessed 1 September 2017, http://secure.afa.org/joinafa/AFMag0516/files/downloads/attachments/0516fullissue.pdf.

[126] McGarry, "USAF Almanac 2016: The Air Force in Facts and Figures," 33.

requires fewer C-17s but adds C-130s. Therefore, the first option is not feasible based on existing C-17s. Enough aircraft exist for the second and third options, but the operation uses a higher percentage of available aircraft than these numbers initially show. Even if able to use aircraft assigned to training units and other non-operational squadrons, maintenance factors into the equation. Aircraft availability averaged 62 percent for the C-130H, 74 percent for the C-130J, and 72 percent for the C-17 over the past ten years.[127] This also assumes the operation has the highest priority for global airlift missions and no attrition has occurred due to enemy action. Consequently, the aircraft exist for the operation, but the mission uses an extremely high percentage of useable mobility aircraft.

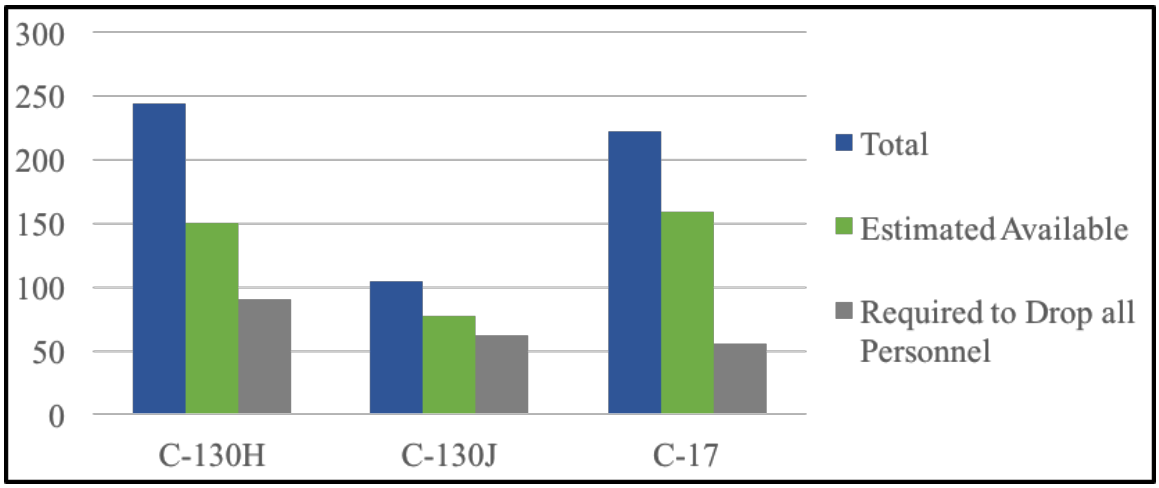

Figure 7. Availability and Requirements Estimates for Airlift Aircraft. Data from Brendan McGarry, "USAF Almanac 2016: The Air Force in Facts and Figures," *Air Force Magazine* 99, no. 5 (May 2016): 33, accessed 1 September 2017, http://secure.afa.org/joinafa/AFMag0516/files/downloads/attachments/0516fullissue.pdf; Wilson Brissett, "Air Force World," *Air Force Magazine* 100, no. 6 (June 2017): 25, accessed 13 November 2017, http://secure.afa.org/joinafa/AFMag2017/AFMag0617/mobile/index.html#p=1.

The numbers seem clear, but assembling the appropriate aircrews requires more attention than the same endeavor for the Combat Air Forces. For the C-130s, the issue does not exist as the community trains all crewmembers to conduct formation and airdrop operations.[128] The C-17

[127] Wilson Brissett, "Air Force World," *Air Force Magazine* 100, no. 6 (June 2017): 25, accessed 13 November 2017, http://secure.afa.org/joinafa/AFMag2017/AFMag0617/mobile/index.html#p=1.

[128] Gordon et al., *Enhanced Army Airborne Forces: A New Joint Operational Capability*, 45.

community, on the other hand, only trains a portion of their crews for airdrop. According to one study, approximately 10 percent of the C-17 crew force maintains airdrop qualification.[129] Based on this number fewer than sixty airdrop crews exist in the C-17 force.[130] Ongoing worldwide operations make gathering these crews an issue because no system exists to track airdrop capable C-17 crews. Additionally, if the conflict requires an airborne insertion, planners should assume an already increased operations tempo.

One other air component role in the operation limits capability. Although not a part of Market Garden, tankers now provide vital range extension for the Air Force. The Air Force uses two tankers, the KC-135 and the KC-10. They support almost all aircraft types in the current inventory including US Navy, US Marines, and partner nation aircraft. Fifty-nine KC-10s and 396 KC-135s comprise the Air Force's current tanker fleet.[131] The KC-10 averaged 70 percent aircraft availability over the last ten years, and the KC-135 averaged 68 percent over the same period.[132] These numbers limit the size of the air component because without tanker support some airframes have prohibitive range limitations. Furthermore, tanker availability may force the use of an intermediate staging base.

Joint doctrine does not capture the large pull of resources required to accomplish this mission. Furthermore, it only vaguely addresses strategic level considerations for choosing to conduct an airborne assault. Joint Publication (JP) 3-18, *Joint Forcible Entry Operations*, mentions the need for specialized forces to conduct the mission, but does not further specify the skills necessitated.[133] The same document advises considering the forces available when planning

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[129] Gordon et al., *Enhanced Army Airborne Forces: A New Joint Operational Capability*, 48.

[130] Gordon et al., *Enhanced Army Airborne Forces: A New Joint Operational Capability*, 48; McGarry, "USAF Almanac 2016: The Air Force in Facts and Figures," 33; US Air Force, AFI, 1994, Table A36-1. Number based on 222 C-17s, two and one-half crews per aircraft, and 10 percent of crews airdrop qualified.

[131] McGarry, "USAF Almanac 2016: The Air Force in Facts and Figures," 33.

[132] Brissett, "Air Force World," 25.

[133] US Joint Staff, JP 3-18, (2012), III-2.

the operation.[134] However, it does a poor job expressing the needed air component by merely commenting on the need for some "degree of air superiority and protection in the operational area" and mentioning the "availability of airlift assets" as a limiting factor for airborne forces.[135] This manual does not express factors for consideration before opting to conduct a Joint Forcible Entry. Rather, it assumes a higher authority ordered planning to begin.[136] This leaves the strategic leadership with no guidance or considerations of what an airborne insertion of ground forces might actually require.

Joint Publication 3-17, *Air Mobility Operations*, does offer some items to consider for an airborne insertion, but it frames them under the context of general airlift operations. This publication only briefly references the cost, vulnerability, and scarcity of air mobility assets.[137] It also discusses required air support for mobility missions and mentions Suppression of Enemy Air Defenses and fighter escort as specific possible support roles.[138] However, it does not tie these requirements to an airborne insertion operation. The JP 3-17 does contain a three-page section for airborne assault planning considerations. These mainly focus on the choice between fixed-wing or rotary-wing airlift assets, efficiency, objective area selection, and pre-departure planning.[139] The section makes no mention of possible air support mission sets required for the operation.[140]

The considerations contained in modern doctrine hint at some of the lessons learned in Operation Market Garden, but they fail to fully communicate them to leaders considering a similar mission. To capture the lessons learned, modern guidance should add considerations for

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[134] US Joint Staff, JP 3-18, (2012), III-3.

[135] Ibid., I-3, B-1.

[136] Ibid., III-2.

[137] US Department of Defense, Joint Staff, Joint Publication (JP) 3-17, *Air Mobility Operations* (Washington, DC: Government Printing Office, 2013), I-13-I-14.

[138] Ibid., III-10.

[139] Ibid., IV-25-IV-27.

[140] Ibid.

leadership contemplating an airborne assault. Based on the lessons learned in Market Garden, these considerations should include the ability to provide supporting aircraft for air superiority and suppression of enemy ground threats. Furthermore, the guidance must highlight the need to provide adequate numbers of airlift aircraft for pre-mission training and the operation. The publication must make it clear that delivery of all forces and equipment required to successfully meet the airborne force's mission objectives must occur on the first day, that no more than one lift each day is highly desired, and that these factors drive the airlift force's size requirements.

Assembling a force this size incurs a strategic cost similar in nature to that of Market Garden, but much more impactful due to the higher portion of existing aircraft required. Based on the modern scenario involving a mix of airlift aircraft, assume mission planners request sixty-two C-130Js for the personnel insertion, twenty-eight C-17s to drop equipment, and sixty-four fighter and bomber squadrons for support. Ignoring aircraft availability rates and aircraft not assigned to operational squadrons, these numbers account for 59 percent of the C-130Js, 13 percent of the C-17s, and virtually all fighters and bombers in the Air Force inventory. Additionally, this scenario requires approximately half of all C-17 airdrop qualified crews. Furthermore, the operation demands a significant portion of the tanker fleet.

If approved, the requested aircraft would cease all other missions requiring fighter or bomber support, to include homeland defense, and severely impact tanker operations. By using these assets, the operation jeopardizes the ability to use airpower's flexibility to respond to emerging crises. It also removes the air component's capacity to provide strategic effects elsewhere, much like the use of Eighth Air Force bombers during Market Garden. Finally, it removes the threat of air strikes from the enemy's dilemmas.

The use of large numbers of air mobility assets is, perhaps, more damaging to strategic capability than the fighter, bomber, and tanker impact. Airlift aircraft fly diverse mission sets all over the world daily. The request for these assets to conduct the airborne insertion competes with

other intertheater and intratheater movements requirements supporting the ongoing conflict.[141] Furthermore, these aircraft perform missions including aeromedical evacuation, presidential support, humanitarian operations, and disaster relief.[142] Any aircraft committed to the airborne operation limits America's capacity to conduct missions vital to national interest both related and unrelated to the war effort. In other words, a domino effect occurs if the airborne operation moves to the top of the priority list, and all Services' requests receive less or no support. The same is true for all types of air assets that are both allocated to the airborne insertion and requested for support.

To help with allotment of lift assets, US Transportation Command uses a prioritization system that ranks mission types competing for assets. The Chairman of the Joint Chiefs of Staff suggests the system's rankings, which the Secretary of Defense then approves.[143] Depending on the nature of the airborne operation, its priority would be 1A2, 1B1, or 2A1, the second, fourth, and seventh prioritization categories.[144] A mission as described by the modern scenario falls into priority 1B1. Therefore, the strategic allotment of airlift assets could make the operation impossible if certain other events occur simultaneously.

Market Garden required a strategically significant amount of aircraft for success. This took place with much higher numbers of aircraft available and a dedicated troop carrier force. Today's Air Force does not have the same luxury of numbers, and a portion of mobility aircraft reserved for airborne support is now fiscally unrealistic. To cripple worldwide air operations for a mission impacting one relatively small objective area requires high level decision makers with the will to take that strategic gamble. Whether or not that will exists depends on leadership at the

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[141] US Joint Staff, JP 3-17 (2013), IV-1-IV-3.

[142] Ibid., IV-3.

[143] US Transportation Command, Defense Transportation Regulation (DTR) 4500.9-R, *Individual Missions, Roles, and Responsibilities* (Washington, DC: Government Printing Office, 2017), 5.

[144] US Transportation Command, Defense Transportation Regulation (DTR) 4500.9-R-Part I, *Passenger Movement* (Washington, DC: Government Printing Office, 2017), I-A-1-I-A-2.

time the decision is made, but it is difficult to imagine an opportunity worthy of that amount or commitment and risk.

Additionally, a smaller Air Force is less capable of absorbing losses. During Market Garden, the massive numbers of aircraft available made each loss less damaging. Also, America produced 10,123 C-47-type aircraft during World War II.[145] For comparison, Lockheed Martin only delivered twenty-four C-130Js, the currently produced variant, in 2016.[146] They delivered thirty-three, thirty-four, twenty-five, twenty-four, and twenty-one each year from 2011-2015.[147] Furthermore, new C-17s cannot remedy the lack of aircraft as production of the aircraft ended in 2015.[148] This creates a situation in which leadership must carefully assess risk as producing replacement aircraft is a challenge.

Risk is not the only consideration when choosing to conduct a large-scale airborne insertion. Strategic-level leadership should consider a number of factors concerning the air component for this operation. These include: ongoing worldwide operations requiring combat aircraft, ongoing non-combat operations requiring airlift aircraft, time needed for rehearsals, and

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[145] Robert Jackson, *The Encyclopedia of Military Aircraft* (London: Parragon Publishing, 2002), 124.

[146] Lockheed Martin Corporation, 2016 Annual Report, Securities and Exchange Commission Form 10-K, February 9, 2017, accessed December 1, 2017, https://www.lockheedmartin.com/content/dam/lockheed/data/corporate/documents/2016-annual-report.pdf, 4.

[147] Lockheed Martin Corporation, 2011 Annual Report, Securities and Exchange Commission Form 10-K, February 23, 2012, accessed December 1, 2017, https://www.lockheedmartin.com/content/dam/lockheed/data/corporate/documents/2011-Annual-report.pdf, 33; Lockheed Martin Corporation, 2012 Annual Report, Securities and Exchange Commission Form 10-K, February 28, 2013, accessed December 1, 2017, https://www.lockheedmartin.com/content/dam/lockheed/data/corporate/documents/2012-Annual-report.pdf, 4; Lockheed Martin Corporation, 2013 Annual Report, Securities and Exchange Commission Form 10-K, February 14, 2014, accessed December 1, 2017, https://www.lockheedmartin.com/content/dam/lockheed/data/corporate/documents/2013-Annual-Report.pdf, 4; Lockheed Martin Corporation, 2014 Annual Report, Securities and Exchange Commission Form 10-K, February 9, 2015, accessed December 1, 2017, https://www.lockheedmartin.com/content/dam/lockheed/data/corporate/documents/2014-Annual-Report.pdf, 4; Lockheed Martin Corporation, 2015 Annual Report, Securities and Exchange Commission Form 10-K, February 24, 2016, accessed December 1, 2017, https://www.lockheedmartin.com/content/dam/lockheed/data/corporate/documents/2015-Annual-Report.pdf, 5.

[148] Tiffany Pitts and Felix Sanchez, "Final Boeing C-17 Globemaster III Departs Long Beach Assembly Facility," Boeing Media News Releases/Statements, November 29, 2015, accessed December 1, 2017, http://boeing.mediaroom.com/2015-11-29-Final-Boeing-C-17-Globemaster-III-Departs-Long-Beach-Assembly-Facility.

opportunities lost due to aircraft unavailability. These planning considerations account for the strategic impact of this large of an air operation better than the considerations currently found in doctrine. Including these with the planning factors in current doctrinal publications directs attention toward strategic concerns when contemplating an airborne option. Also, their inclusion encourages planners to accurately assess the cost of each aircraft requested.

The hypothetical modern scenario of a division-sized airborne operation appears strategically impossible based on the aircraft needed and high cost of the mission. However, the most well-known contemporary airborne employment concept only calls for airdropping echelons as large as a brigade.[149] Using an air component one third the size of the one in the discussed scenario still involves a large strategic cost. Therefore, the lessons of Market Garden and proposed planning considerations apply to it as well.

Considering the strategic impact of a large-scale airborne operation produces more realistic assumptions for Operation Plans (OPLANs) containing airborne insertions and plans involving the GRF. Improving these plans hastens their implementation and enables more accurate Joint planning. GRF planners assume a ninety-six hour timeline.[150] More consideration should be given to planning and assembling the required air package in that time. For example, ignoring the friction sure to exist, gathering the airlift force in ninety-six hours is possible.[151] However, this ignores the time to plan air operations. Furthermore, if the operation occurs one-hundred days into a conflict as per the scenario, these assets will be spread all over the world. Finding, recalling, and flying them to the assembly base will take time. A final consideration is finding the limited airdrop qualified C-17 crews and recalling them, a task made extremely difficult because no system exists to track them. Namely, finding available aircraft and crews is

[149] Pernin et al., *Enabling the Global Response Force: Access Strategies for the 82nd Airborne Division*, 8.

[150] Ibid., 11.

[151] Dixon, "EMP396A: GRF Concepts," 56.

extremely time consuming and may delay the ability to launch an airborne force. The troop carriers made this a non-factor during Market Garden, but as previously mentioned no such force exists or is likely to be built today.

Also, airborne planners should consider integrating with already planned air missions. By attaching the airborne insertion to a strike mission already employing the needed support aircraft, leadership can accomplish more while not needing large numbers of additional fighter and bomber aircraft. This allows the air package to provide more effects for less cost than launching a strike mission on one day and the airborne insertion on another.

Future research may produce remedies to address some of the issues with airborne plans and the number of aircraft available. The ability of partner nations to provide aircraft may exist as an option. However, on initial assessment it appears unlikely as no partner nations have large numbers of airlift assets. For example, the RAF owns twenty-five C-130Js and seven C-17s and the Royal Australian Air Force flies twelve C-130Js and eight C-17s.[152] Still, a coalition effort adds other types of aircraft that may amount to a more significant contribution similar to the British air assets used in Market Garden.

Cross domain effects offer another possible method of freeing aircraft for operations or reducing the number of aircraft necessary for the mission. If effects provided from cyber and space assets can affect enemy air defenses, the air component benefits while paying no cost. This falls in line with the Army's emerging concept of Multi-Domain Battle. The concept promotes Joint forces exploiting cross domain capabilities to create advantages.[153] It also mentions using

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[152] Royal Air Force, "C-130J Hercules," 2017, accessed December 2, 2017, https://www.raf.mod.uk/equipment/Hercules-130j.cfm; Royal Air Force, "99 Squadron," 2017, accessed December 2, 2017, https://www.raf.mod.uk/organisation/99squadron.cfm; Royal Australian Air Force, "C-130J Hercules," accessed December 2, 2017, http://www.airforce.gov.au/Technology/Aircraft/C-130-Hercules/?RAAF-EPzAnXmgjWuyTq8XSZbcAUaUIYIcntiB; Royal Australian Air Force, "C-17A Globemaster III," accessed December 2, 2017, http://www.airforce.gov.au/Technology/Aircraft/C-17A_Globemaster/?RAAF-h0719xJ/eXjMFO8eLULT2D7U+C9pXnFB.

[153] US Department of the Army, "Multi-Domain Battle: Evolution of Combined Arms for the 21st Century 2025-2040," ver. 1.0, October 2017, accessed December 2, 2017, http://www.tradoc.army.mil/multidomainbattle/docs/DRAFT_MDBconcept.pdf, 21.

Joint integration across domains to weaken or eliminate an enemy's integrated air defense system.[154] Any non-air domain methods employed to accomplish these effects significantly aids the air component's ability to succeed.

Successful air operations rely on massing air effects. Airborne insertions are no different. Technology changed the way airpower adheres to this principle with amount of effects equaling mass instead of numbers of aircraft.[155] The ability of small numbers of aircraft to provide versatile effects sometimes leads to a desire to divide airpower and remove its ability to mass.[156] Obeying the airpower tenet priority helps prevent this from occurring, but Joint service leaders must understand this concept to realistically assess the ability to use large numbers of aircraft.[157]

Operation Market Garden is an example of when America could afford to commit a significant portion of its airpower to a singular event. The operation showed that conducting a large scale airborne insertion requires aircraft able to perform diverse missions for a substantial amount of time. Leaders should, therefore, consider the impact on other operations and opportunities lost when deciding on the mission's value in comparison to cost. Modern numerical limits to airpower increase the strategic value of each committed asset.

America cannot afford to commit the air assets necessary to ensure the success of a large-scale airborne operation against a near peer opponent. The Air Force does not have enough resources to do so. The operation would absorb aircraft in numbers that make massing elsewhere impossible. It would shut down worldwide air mobility operations and place aircraft at risk that are difficult or impossible to replace. Furthermore, the operation would prevent the Air Force from providing effects on strategic targets. In all, the size of the Air Force limits its ability to

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[154] US Department of the Army, "Multi-Domain Battle: Evolution of Combined Arms for the 21st Century 2025-2040," 28.

[155] US Department of the Air Force, Air Force Doctrine Volume I, *Basic Doctrine* (Washington, DC: Government Printing Office, 2017), 54.

[156] Ibid., 31.

[157] Ibid., 74.

offer large numbers of aircraft to one operation. Doing so requires the opportunity to exist for vast strategic gains. Military planners must consider this cost-reward balance in order to produce realistic plans and properly advise decision makers.

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