

provide at launch. The installation of ejectable rocket motors under the wings, a technique used during the Second World War, would provide the necessary thrust at modest g forces (under 2g's) considered acceptable to human endurance. Nick Cook, "How 'Credible Sport' made SuperStol a reality," *Jane's Defense Weekly*, 9 March 1997, p. 18. *Airborne Operations - A German Appraisal*, op.cit., p 53. Devlin, op.cit, pp. 116, 125-126.

40. Night Vision: What Second World War glider pilots lacked in terms of a night vision capability, they made up with skill, determination, and bravery (not to mention fear) in carrying out exploits in pitch darkness where there was little margin to compensate for errors or ill-fortune. However, through the miniaturization of electronics and enhanced all-weather magnification, the current generation of portable night vision goggles offers a degree of safety and accuracy for executing a twilight landing. GPS: With an array of satellites encircling the globe in various orbits, hand-held receivers can compute exact geographic locations to the nearest meter. In practical terms, this means a safe touch down in a tight LZ. A precision landing GPS system in service with some civilian airports uses a series of fixed antennas installed at a designated LZ which transmits approach coordinates to incoming aircraft with onboard GPS receivers. Pathfinders or forward air controllers (FACs) outfitted with a portable version of this system could position it before the arrival of GPS-equipped gliders to permit round-the-clock precision landings in any environment and climate. Video Guidance Systems: Used to direct unmanned aerial reconnaissance vehicles, gliders outfitted with similar equipment could serve as a remotely piloted container delivery system (controlled from the tow aircraft or ground-based FACs). Early NASA space shuttle flight trials proved the idea is feasible: glide tests performed by the shuttle Enterprise in the late 1970s included a "hands off" maneuver with the orbiter on autopilot while it descended from 8,000 to 3,000 feet under the control of a ground-based microwave guidance system. Composite Materials: Light-weight, but hard-wearing tubular components not prone to disintegrating under excessive fatigue and stress (i.e., titanium, used in prosthetic arms and legs, or carbon fiber alloys), would constitute the structural frame of the fuselage. Detachable Kevlar-based bullet-proof body panels or insulation could reinforce the interior at points where personnel and cargo are most vulnerable to small-arms fire. Kevlar tow cables, as those used in the recent recovery of the Mercury spacecraft — Liberty Bell 7 — after 38 years on the ocean floor would provide the strength to prevent premature release; a frequent complaint among Second World War glider crews. The composition of the exterior components depends upon whether the model of glider selected for service used the traditional canvas on the frame or all-wood method. As mentioned earlier, the failure to immediately recover expended gliders from the battlefield rendered many permanently unusable because the canvas exterior deteriorated in the wind, rain, and humidity. Preventative measures could entail using a synthetic water- and wind-proof material such as Gore-Tex, commonly used in the manufacture of rugged outdoor clothing, to encapsulate the fuselage. Another alternative is to update the design using a fiberglass exterior, as used in contemporary civilian models, which may improve aerodynamics with less weight. Crash Protection: To overcome the shock of landing, a cargo-restraint system developed for the "Credible Sport" aircraft should be given consideration for inclusion as a standard feature. Intended for a compliment of 150 passengers, this special pallet incorporated aft-facing seats that would give "impact support" rated at 9g's on touch down. Adapting this system to those gliders mentioned above for possible reintroduction would improve upon passenger survivability and comfort during aerial retrieval. Other Features: A wide range of portable add-on options is feasible: commercial air bags, bulletproof plexiglas, drag parachutes,

and inflatable flotation devices to enable emergency amphibious landings. See "Precision landing by GPS set for take-off," *Jane's Defense Weekly*, 12 June 1996, p. 41. Kenneth Gatland, *Space Technology*, (New York: Harmony Books, 1981), p. 278. Cook, *op. cit.*, p. 21.

41. Soviet experiments in the early 1930s perfected the concept of the "glider train," for which it set a record by towing four gliders in a sausage-link configuration. Mrazek, *The Glider War*, *op.cit.*, pp. 231-234.

42. There were plans for a larger version of the ME-321 with a 60- to 70-ton cargo capacity but these never got off the drawing board. Aircraft data from Clancy, *op.cit.*, p. 161. Mrazek, *The Glider War*, *op.cit.*, p. 36.

43. 870-5a Organizational History Files XVIII Airborne Corps - Operation Just Cause, *op. cit.*

44. Jet-glider tow combinations have yet to be verified with military versions, but the space shuttle, which is also part glider, did conduct trials. From August to October 1977, the space shuttle Enterprise conducted five free flight tests with glide release occurring from atop a Boeing 747 at altitudes ranging from 17,000 to 24,000 feet and executing turns under no power. Gatland, *op.cit.*, p. 278.

45. For amphibious assaults up to 50 nautical miles offshore, Navy and Marine planners calculate a three-hour cycle as the normal turnaround time for a wave of troops landed by an MV-22B: an hour in transit in either direction, plus a half-hour on each end for loading and unloading. Amphibious-capable gliders can help to lower this cycle to under three hours for reasons associated with its light-weight mass: 1) unassembled or assembled gliders incorporating space-saving technology found on the Osprey such as folding components rather than shipped in bulk CONEX containers give amphibious-assault or aircraft carriers the capability to store enough heavy- and medium-lift versions to transport a battalion landing team in as few sorties as possible; and, 2) the quick retrieval of multiple gliders using one recover aircraft is feasible by daisy-chaining the beached fuselages together so the plane can swoop down and snatch this train. Add to this the Navy employing its fleet of small helium airships as the accompanying tow aircraft and it would bestow upon potential Marine glider units a global reach. Early experimentation by the Navy proved the feasibility of the glider-airship combination: in 1929, the USS Los Angeles successfully released a glider mated to its underside at 3,000 feet. Tom Clancy, *Marine*, (New York: Berkley Books, 1996), p. 189. Devlin, *op.cit.*, p. 21.

46. In June 1941, the Department of the Navy's Bureau of Aeronautics undertook design studies on an amphibious glider built to the following Marine Corps milspecs: capable of ferrying a fully-equipped 12-man rifle squad; [it must] "take off and land both on water and on land; transport heavy equipment; be rigged for static-line parachute jumps; and mount exterior machine guns for offensive and defensive use." Though the Navy tendered contracts for and took delivery of 12-, 24-, and 80-place amphibious glider prototypes, none entered service or saw combat, but all underwent successful flight tests, and like its Army counterparts are candidates for contemporary procurement. *Ibid.* p. 68.

47. Mrazek, *The Glider War*, *op.cit.*, p. 185.

48. Glenn A. Kent and William E. Simmons, *A Framework for Enhancing Operational Capabilities*, R-4043-AF, (Santa Monica, California: the RAND Corporation), pp. 16-30.

49. Serving on and testifying before the forum include: the Chairman, or Vice Chairman JCS on the viability of the proposed concept in enhancing capabilities in relation to the stated operational objectives; the Under Secretary for Policy on the political and strategic implications of attaining, or not attaining, the enhancement; the Under Secretary of Defense for Acquisition on the reliability of the concept, equipment, and procurement strategy; the Assistant Secretary of Defense for Program Analysis and Evaluation on whether the proposal is the best way to attain the capability and reasonable in terms of costs; and, the Comptroller as to whether or not the current fiscal budget can finance the program. The final decision though rests in the hands of the arbitrator, in this case, the Deputy Secretary of Defense. *Ibid.*, pp. 25-26.

50. Dank, *op.cit.*, p. 51.

51. Devlin, *op.cit.*, p.41.

52. This would not be the first instance of cooperation between competitive sports and the Army in the transfer of athletic skills for military applications. During the Second World War, the Army recruited famous American skiers and mountain climbers to serve as the cadre of the 10th Mountain Division along with the forest rangers and park and wildlife experts counted among its ranks. Stanton, *op.cit.*, p. 93.

53. In the United States, there is the National World War II Glider Pilots Association; Germany — the Luftland-Fleigerkameradschaft; Great Britain — the Glider Pilot's Regimental Association. Devlin, *op.cit.*, p. 375.

54. Mrazek, *op.cit.*, pp. 62-63.

55. Despite this complication, 14,612 gliders were built during the Second World War, of which a single model, the ubiquitous Waco CG-4A accounted for 13,909 or 95 percent of the total — more than any American bomber, fighter, or transport aircraft manufactured during the same time frame. Devlin, *op.cit.*, pp. 63,373.

56. Four of the 16 prime contractors had never built an aircraft before, which included a furniture and refrigeration company, and a maker of industrial exhibits and displays; only four had aeronautical experience, and of those, only two had the facilities and organizational framework for mass production: Ford Motor Company and Cessna Aircraft. Prime subcontractors were as follows: Steinway and Sons Pianos (wing and tail assemblies); H.J. Heinz Pickle Company (wings); Anheuser-Busch (inboard wing panels); and, the Gardener Metal Products Company, a former coffin manufacturer (steel fittings for connecting wing struts to the fuselage). An inquiry into why the wing of a Waco CG-4A glider broke loose in flight and crashed during a St. Louis war bond rally in 1943 that killed all on board, including, the mayor and several city council members, found that a fitting, not to up to specification, delivered by the last subcontractor mentioned was the cause. *Ibid.*, pp. 63-64.

57. Cancellation of the original tooling contract, then 40 percent complete, also put the government in the red for \$650,000 without a single glider to show for the time, energy, and dollars spent. *Ibid.*, p. 65.

58. Before it lost its contract, the Babcock Aircraft Corporation delivered to the Army Air Corps fifty-four CG-4As at \$51,000 apiece; a more sophisticated P-51 Mustang manufactured during the same period cost \$58,824. The record though went to an unnamed contractor paid \$1.7 million for a single glider delivered and later rejected due to design flaws. *Ibid.*, p. 66. Dank, *op.cit.*, p. 58.

59. Secretary of Defense Les Aspin, Report on the Bottom-Up Review, (Washington D.C.: Department of Defense, October 1993), p. 102.

60. Sir Robert Thompson, ed. *War in Peace*, updated version, (London: Orbis Publishing Ltd., 1985), p. 195. Richard K. Fickett, "Role of Infantry may expand in Future Missions," *Army Times*, 1 August 1994, p. 1. Obtained electronically from the *Army Times* database on the American Online computer information service.

61. Charles B. MacDonald, *The U.S. Army in World War II-ETO: The Siegfried Line Campaign*, (Washington D.C. Center of Military History, 1990) p. 176n6.

62. General James Gavin candidly expressed his opinion on the matter in a post-war interview: "The glider pilot problem was a very serious and troublesome one...In the American Army, the glider pilots lived and worked with the Army Air Corps...the view held...was that once they landed their job was done." Britain's foremost airborne expert General Frederick Browning vehemently criticized this policy and used it in his defense with regard to the handling and subsequent partial failure of Operation Market-Garden. Browning argued the relief of the British 1st Airborne Division at Arnhem was achievable had an assault on the Nijmegen Bridge taken place earlier. The general cites with contempt the 1,000 American glider pilots assigned to Gavin's 82nd Airborne Division, for not being organized and trained to fight as infantry. Devlin, *op. cit.*, p.73. Dank, *op. cit.*, p. 205.

63. Another early decision that paid off for the regiment in times when it lacked adequate support personnel to assemble gliders was to also cross-train the pilots as mechanics. Devlin, *op.cit.*, p. 310. Mrazek, *The Glider War*, *op.cit.*, p.85. Dank, *op.cit.*, pp. 43-44.

64. The trouble, as Matthew Allen penned it in his book, *Military Helicopter Doctrines of the Major Powers 1945-1992*, was that:

[c]ritics saw aviators [in particular, those flying helicopters] as reluctant soldiers and frustrated pilots who only barely kept in touch with the presumed realities of land warfare and who knew little about soldiering and needed an education from the infantry, armor, or other branch...Nevertheless, senior officers were aware that these criticisms had to be addressed — for political and practical reasons. They emphasized that "[Army Aviation] must not be a separate elite organization." New training schemes sought to give aviators "a comprehensive understanding of

the basic operations and, specifically, how [ground] commanders plan and conduct them...

See Matthew Allen, *Military Helicopter Doctrines of the Major Powers 1945-1992*, (Westport, Connecticut: Greenwood Press, 1993), p. 48.

65. Equal pay was the most pressing of the grievances among glider-qualified pilots and combat and support troops; not until mid-1944, two years after the inception of an official glider program, did the Army authorize the same hazardous duty pay as parachutists: \$50 a month for enlisted men, \$100 a month for officers. Devlin, *op.cit.*, pp. 126-127.

66. Tom Clancy makes reference to this in his book *Airborne— A Guided Tour of an Airborne Task Force*:

There is a bit of resentment in the 325th [Airborne Infantry] about this, and troops of the 504th and 505th [Parachute Infantry] like to kid them about "riding" into combat. Such is the mystique of the 82nd that two words, "airborne" and "parachute" can still arouse emotions five decades after the last combat glider landing.

Clancy, *Airborne*, *op.cit.*, p. 210.

67. Situated at the summit of a ridge 150 feet above the Belgian countryside, the fortress of Eban Emael presented a formidable roadblock to the Wehrmacht's blueprint for a mechanized drive through the Low Countries. Impervious to a conventional assault, its man-made and natural obstacles combined with a system of interlocking pillboxes and bunkers defended by heavy artillery and garrisoned by 850 Belgians capable of enduring a siege formed the core of its defenses. The German High Command deemed a parachute assault out of the question since Eban Emael's early warning system included sound-ranging equipment capable of identifying incoming transports' miles away. On the other hand, estimates for subduing Eban Emael by ground attack predicted a six-month siege costing 6,000 casualties before capitulation. Operation Granite, a pre-dawn raid by seventy-eight commandos in nine gliders, ended the debate. Silently landing on the fortress's grass-covered roof, sappers quickly secured this mammoth installation, using hollow-shaped charges to neutralize strongpoints, in three hours and captured a force 10 times its size while incurring only 26 casualties. James Lucas, *Kommando-German Special Forces of World War II*, (New York: St. Martin's Press, 1985), p. 53.

68. Debriefing Conference — Operation Neptune, August 1944, *op.cit.*, pp. 7-9.

69. Ahead of the foot-bound infantry, the squadron was to make a "dash" and secure both ends at once of this "prize" spanning the Rhine. However, a serial of gliders carrying a troop of 22 jeeps (one of four troops) shot-up in an ambush, brought a "flurry of rumors and misinformation." Some accounts claim the squadron could not take its objective because it lacked the jeeps to secure the bridge. Disclaiming the rumors, the squadron's commanding officer (CO) retorted: "It was not due to a lack of jeeps, but to the fact that no one had warned us that the 9th and 10th SS Panzer Divisions were in the area." John L. Lowden, *Silent Wings at War*, (Washington:

Smithsonian Institute Press, 1992), pp. 76-79. Cornelius Ryan, *A Bridge Too Far*, (New York: Simon and Schuster, 1974), pp. 113n, 226n.

70. If one embraces this "establishment" view as valid logic, as the officer who led the Eban Emael raid argued, it follows, one must abstain from launching any method of shock attack since surprise had been forever lost after its first historical introduction on the battlefield. Mrazek, *The Glider War*, op.cit., p. 65.

71. Field Marshall Albert Kesselring scoffed at this tactic stating it was not the best way of beginning an airborne operation:

The exceptionally unfavorable landing conditions should have induced them to land in a single area away from the occupied objectives with their effective defense fire, and then to capture the decisive points (airport and seaport) intact in a subsequent conventional infantry attack at the point of main effort. In doing this it would not have been necessary to abandon the use of surprise local glider landings directly into key points, the possession of which would have facilitated the main attack.

Airborne Operations — A German Appraisal, op.cit., pp. 20-21

72. T/Os for British airborne divisions authorized one glider and two parachute infantry regiments — the correct force mix for operations with the glider in attack; this is without counting the glider pilots which added the equivalent of a second infantry regiment to the total. The U.S. Airborne Command, in accordance with their interpretation of doctrine adopted the 1942 71-series airborne division T/O which grouped one parachute with two glider infantry regiments; two-and-a-half years passed before it endorsed earlier recommendations for a T/O (71T) similar to the British-style. German airborne divisions contained three parachute and one air-landing regiments. Prior to its August 1965 Vietnam deployment, the newly activated 1st Cavalry Division (Airmobile), contained a full brigade of qualified parachutists. This practice ended when the Army found it difficult to provide enough replacements for paratroopers killed in action to maintain its other two airborne brigades already in-theater, the 173rd and the 1st Brigade of the 101st, at authorized strength. John Ellis, *World War II: A Statistical Survey*, (New York: Facts on File, 1993), p. 219. Stanton, op. cit., pp. 10-11,15. Shelby L. Stanton, *The Rise and Fall of an American Army*, (Novato, CA: Presidio Press, 1985), p. 53n3.

73. Had the Clinton Administration opted for an invasion of Haiti under Operation Uphold Democracy in 1994, it would have marked the first three-brigade combat drop of an airborne division, the 82nd, since the Second World War. During Desert Storm, the 101st Air-Assault performed the largest helicopter envelopment ever mounted at once in combat moving an entire brigade 93 miles into Iraq. Tom Clancy, *Airborne*, op. cit., p. 195.

74. This design may also extend a glider capability to mechanized infantry, similar to the dramatic change in air-assault doctrine after the 1987 revision of FM 90-4: "...all infantrymen and their supporting arms counterparts must be prepared to execute air-assault operations when the situation dictates. Mechanized infantry units of the heavy division...must be proficient in the

conduct of air-assault operations [emphasis added]." FM 90-4 Air-Assault Operations, op.cit., p. 1-2.

75. Mrazek, *Fighting Gliders of World War II*, op.cit. Appendix.

76. Devlin, op.cit., p. xiii.

77. Nick Cook, "Giant airships: shifting the load of the future," *Jane's Defense Weekly*, 28 October 1995, p. 4.

78. Gavin postulated helicopters could maintain the offensive momentum on a nuclear battlefield. Allen, op.cit., pp. 4,6.

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