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From the Editor:

This NSM issue is devoted to a report about the World War II Military Glider Program by **ELIOT NOYES** which was uncovered in the Museum's archives.

Eliot Noyes met Lewin Barringer in 1935 in Iran and became close friends spending evenings talking about soaring while seated among the ancient ruins of Persepolis, (see The Barringer Trophy, **NSM,** Vol. 2, Number 4). Shortly upon returning to the United States Barringer taught Noyes to fly in a Franklin Stevens glider. When Barringer went to the Pentagon as Gen. H.H. "Hap" Arnold's Special Assist. for the Military Glider Program, he asked Noyes to serve on his staff and the two men worked closely together to develop the Army's Glider Program.

This report was submitted first to the Army Air Force for review, and then, to Dr. August Raspet to be included in a proposed publication of a revised version of Lewin Barringer's **FLIGHT WITHOUT POWER**. Noyes said in a letter, . . . "It is probably the only authentic story of the wartime glider program that will ever be written, since I was fully involved in it from start to finish, and wrote this piece while it was fresh in my mind immediately after my discharge." See **SOARING**, July-August, 1944 for another article by Eliot Noyes, "Tactical Uses of Gliders".

Ideally, photos from the Museum's collections should have complimented this report. However, due to its length it was decided to publish the report in its entirety, rather than divide it between two NSM issues.

Eliot Noyes who became one of America's most distinguished architects and industrial designers continued his interest in aviation and soaring and was the architect for the National Soaring Museum, completing that task just prior to his death in 1977.

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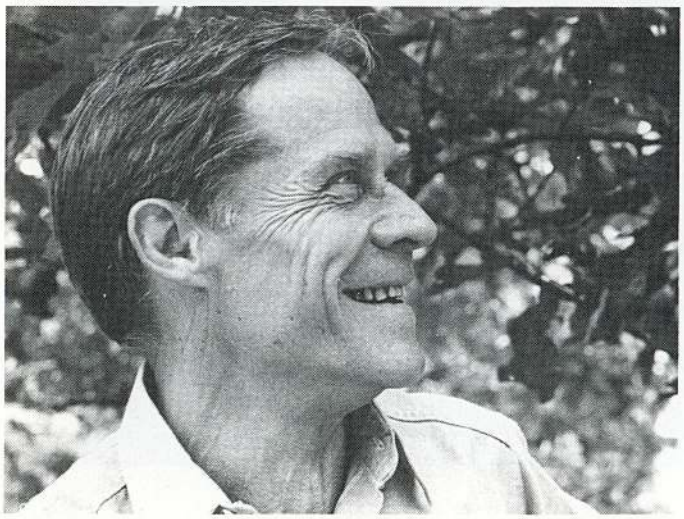
CALENDAR

Date	Event	Location
Nov. 5, 1983	10th Annual Ralph S. Barnaby Lecture and NSM Board of Trustees' Fall Meeting (Speaker: Ralph S. Barnaby)	Princeton, NJ
Dec. 16	Community Soaring Committee Luncheon (Honoring: John Gill, J. Arthur Kieffer and Frank Hurtt)	NSM
March 2, 1984	NSM Board of Trustees' Winter Meeting at SSA's International Convention	Hartford, CT

ON THE COVER:

Left, Major Lewin B. Barringer, Special Assistant to General H.H. "Hap" Arnold for the Military Glider Program and Lt. Colonel Michael C. Murphy, Director of Combat Training and flew lead glider into Normandy on D-Day.

WORLD WAR II MILITARY GLIDER PROGRAM



Eliot Noyes: 1977 photo taken by his younger daughter, Derry Noyes Craig.

One of the completely new tactical developments to emerge from the war with Germany and Japan was the airborne attack. The equipment of air warfare in the first world war never reached a stage of development to permit the launching of large scale attack from the sky and the concept of such attack was therefore slow to develop. Armies slugged it out on the ground in fixed lines until one side or the other could break through or outflank the other. The tactical effect of airborne attack on warfare has been much the same as the use of the forward pass in football. The suddenly new ability to strike from behind one's own lines deep into enemy territory and over the head of prepared lines of defense made for a more fluid type of warfare. Through air power, strategic air forces could cripple the enemy's ability to make war by destroying his factories and supply sources; tactical air forces could isolate the battlefield. Armies still had to fight it out on the ground but now air power also made it possible for ground force units to leap-frog established lines, to create airheads in enemy territory and to disrupt the entire pattern of his defenses.

The use of gliders in warfare can be understood only in relation to this new concept of airborne attack. At the be-

ginning of the war, the U.S. Army had no start to create the tools for this type of warfare. Suddenly the necessity for development of these tools became apparent.

The Army Ground Forces established special airborne units and designed special light equipment for them; large numbers of paratroops and glider borne troops were given special training; airborne aviation engineer units were organized for the constructing of airfields in enemy-held territory. The Army Air Forces, charged with carrying these ground forces into combat and keeping them supplied, began to develop the tools necessary for their operations. For different operations, different tools were designed. One such tool was the military glider. This chapter deals primarily with the part that gliders played in the airborne activites of the war.

TRAINING AND OPERATIONS

The first serious consideration given by the U.S. Army to gliders had no relation to the use of gliders as a weapon. In pre-war years, it had been urged by many that glider training would be a valuable adjunct to power training for power pilots. The Air Corps training establishments at Brooks Field, March Field and Kelly Field were asked to study this possibility. In their reports, all found no need for glider training.

In the fall of 1939, Germany blitzed into Poland, following this up in the spring of 1940 by successful, lightning thrusts into Belgium and Holland. In these campaigns, paratroops, supported by gliders carrying troops and equipment, were used for the first time in the history of the world. Spectacular use was made of gliders to land demolition teams inside the "impregnable" Fort Eben Emal in Belgium, resulting in the quick fall of the fort to the invaders. When the Germans struck at Norway, again airborne troops were the spearhead. Had the Germans attempted this move by sea alone, British naval action might well have frustrated the attempt during the battle of the Skagerrak. The major portion of the invasion force was flown into southern Norway during the first 48 hours of the operation and airborne activity was continued until all of Norway was occupied. Airborne assault as a successful method of warfare was suddenly a practical reality.

In early 1941, the U.S. Army Air Corps initiated a study of gliders for military use and General Arnold directed development of military gliders. These aircraft were to be used for the transporting of personnel and equipment and the seizing of objectives not accessible to ground forces. Two sizes were to be designed, the larger to carry 12 to 15 troops and four machine guns with 500 rounds of ammunition for each. It is interesting to note the size of the weapons desired now in relation to later requirements.

In May of 1941, first steps were taken to train army personnel in gliders. Here the Army, totally inexperienced in gliders, fell back on civilian glider groups. Arrangements were made with the Elmira Area Soaring Corporation at Elmira, New York, and with the Lewis School of Aeronautics at Lockport, Illinois, to train 12 Air Corps officers in Franklin utility gliders and in two-place Schweizer Gliders.

It was in May, 1941, that the Germans staged the world's first completely airborne invasion in capturing the island of Crete. In this invasion, gliders were used to spearhead the assault. Taking off behind JU-52's from Grecian airfields, a total of about 70 gliders landed at various parts of the island. The gliders used were DFS-230's, carrying about ten men apiece, or a total force of some 700 men. Approaching the island at several thousand feet of altitude, they released from their towplanes two or three miles off shore. The landings were disorganized and haphazard; many gliders crashed on the rocky sides of the Akrotiri Peninsula, killing all occupants. On others the steel towing cables broke and they went down at sea. However, a few gliders landed safely in a rocky river bed below the Maleme airdrome and the troops from them, with the assistance of subsequently landed paratroops and troops from transports took the airfield. Once the airfield was secure, more JU-52's with more troops landed and the island fell to this assault from the air. Although invasion forces from the sea had also attempted to land, the British Navy practically wiped them out.

This clear cut example of the effectiveness of airborne attack gave further justification to General Arnold's belief in airborne operations and in the use of gliders. However, the program was still at a very small scale and was full of confusion. It affected both Air and Ground Forces but had no single controlling authority.

In October, 1941, General Arnold took steps to correct this situation by personally summoning Lewin B. Barringer to Washington to coordinate and administer the entire program. Barringer started as a civilian but accepted a commission as Major in the spring of 1942. Through his skill and tireless effort, the scattered elements of the glider picture were brought together and the program given cohesion, direction and momentum. His leadership continued until January, 1943, when the Army C-47 in which he was flying to the European Theater disappeared between Puerto Rico and Trinidad.

During the winter and spring of 1941-42, requirements both in gliders and glider pilots were tremendously stepped up. The problem of meeting those requirements was made unusually difficult by the over-riding urgency in the power pilot and airplane programs, as a result of which, many critical materials were not available for construction of gliders, and pilot volunteers had to be found outside the regular aviation cadet program. As part of the expanding program, the Twenty-Nine Palms Air Academy had already been selected as a winter training site.

Now other new civil contract schools were opened, including those at Lemesa, Texas, and Wickenburg, Arizona. At this time, training was still given in utility gliders and sailplanes which were being built for the purpose by Schweizer, Laister-Kauffmann and Frankfort. As the training goal increased, privately owned gliders were purchased for Army use to augment those on hand. Then came another suddenly increased pilot requirement that dictated drastic action. To meet this tremendous program, contracts were let to 18 C.P.T. civil contract schools in the middle and far west to train glider pilots in light planes but with the emphasis on dead stick landings. Volunteers for this training were canvassed from all parts of the Army and from 85,000 airman certificate holders. This power course was to be the preliminary phase of glider training. As an intermediate phase between this and cargo gliders (which were not yet ready), a basic training phase was established. Since there were not enough sailplanes for this basic phase, another innovation was made by the conversion of light planes into gliders. This was done initially to an Aeronca Tandem Trainer. After removing the motor, a new nose section with a seat was bolted on. Spoilers and controls were added, the landing gear and other parts altered slightly and it became the TG-5. Similarly, the Taylorcraft became the TG-6 and the Piper, the TG-8.

It had been expected that cargo gliders would begin rolling out of production in July of 1942 and that an advanced glider course could start at once. Actually, the first CG-4A was delivered on 1 September 1942 and quantity production was still far off. It was at this point that the graduates of the basic course began to accumulate in pools, which resulted later on in a serious morale problem.

The CG-3A and the CG-4A, both Waco-designed gliders, appeared at about the same time. It became apparent at once that while the CG-3A was designed as a training glider to be a transition to larger types, in actuality, the CG-4A itself was satisfactory for training purposes. Emphasis was therefore increased on the CG-4A and relaxed on the CG-3A. Only a limited number of the latter were ever produced and few were ever used in training.

As soon as the first CG-4A's were available, a course was set up at Lockburne, Ohio, to train instructor personnel in the CG-4A and to give the glider a shake-down in operation. It was

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at this point that Lt. Col. Michael C. Murphy, then a Lieutenant in the Troop Carrier Command, first appeared in the program to develop the training curriculum and supervise the training activity.

Numerous flaws turned up in the CG-4A as is inevitable on any new aircraft which is rushed from drawings into quantity production. But basically the design seemed good for its purpose. As more and more became available, advanced schools were opened up at such places as Stuttgart, Arkansas; Lubbock, Texas; Dalhart, Texas; Victorville, California and finally Fort Sumner, New Mexico. The original course given was of fifteen hour's duration. At one point, this was cut to only eight hours in order to speed up the program and meet urgent needs. This was inadequate, however, and as changed tactical plans eased the requirements, the course was restored to fifteen hours once more.

By the fall of 1942, there were enough gliders available and enough pilots trained to take part in the Airborne Maneuver scheduled for mid-October at San Antonio, Texas. The gliders were a focal point of attention since they were making their first appearance before the eyes of Headquarters staffs of both Ground and Air Forces. The demonstration aroused considerable interest and speculation. The practicability of using gliders as a weapon of war was still subject to much scepticism.

By mid-February of 1943, the pilot procurement program had far outrun anticipated glider production with the result that there were large numbers of glider pilots in pools awaiting various phases of training. The anticipated, sudden need for pilots had not developed to the extent for which preparations had been made. Surgery was indicated and in February of 1943 the pilot program was drastically cut back, with many schools shut down.

At this point there was again no single control of the glider program since Lewin Barringer had been lost in January. The glider program coasted for about three months until the middle of April 1943. At that point General Arnold again turned to an outstanding leader of the civilian glider movement when in April, 1943, he appointed Richard C. du Pont his Special Assistant in Charge of the A.A.F. Glider Program. In this position of authority Richard du Pont was able to exert his great initiative to direct sound development of the program. His death in a glider accident in September 1943 was one of the hardest blows that the program ever suffered.

The first large scale glider maneuver took place at the end of May, 1943, near Camden, North Carolina. It was entirely a daytime meneuver and for the first time involved the use of gliders to land airborne troops and equipment in a variety of unprepared fields, while paratroops landed in other areas. The glider flying was haphazard. Pilots had been trained to perform high speed "blitz" landings on airports and had not learned a proper technique for landing in unprepared areas. Air discipline was poor and the results far from satisfactory.

Since there had been no course in tactical glider flying, Richard du Pont arranged to set up a test group at the Laurinburg Maxton Army Air Base to develop the proper techniques for combat glider flying. He put Michael C. Murphy (then a Major) in charge, and prepared to go to North Africa where action involving gliders was being prepared.

On the night of July 9, 1943, the invasion of Sicily was launched by air and sea. The American Forces elected to use paratroops but the British sent troops of their First Airborne Division in gliders. A total of 137 gliders were prepared for the initial assault, including 127 CG-4A's and 10 Horsas. The mission was flown at night against strategic points south of Syracuse. Over two thousand troops with equipment were carried in gliders which were towed by American C-47's for the most part. The plan called for releasing at some altitude off shore and gliding in to landings in the fields of Sicily. A pale moon was shining as the point of glider release was reached. As a result of an unpredicted wind which had arisen from the northwest, many gliders failed to make shore and landed in the ocean where, in many cases, occupants rode the wings until they were rescued next morning. Of the ninety or so which landed ashore, most could not find the designated landing zone but went into any field at all. The mission was clearly a technical failure; it was equally clearly a tactical success, for the troops that landed disorganized the defenses, captured pillboxes and beach positions, saved bridges, and contributed in a large extent to the successful amphibious landings which followed. The British commander credited this airborne thrust with advancing the campaign by at least a week.

At Maxton, meanwhile, Major Murphy was preparing a demonstration of the techniques which his group had developed. Lessons learned from Sicily were incorporated in the training. On the 5th and 6th of August, 1943, a large scale demonstration was staged for the Commanding General of the A.A.F. and many high ranking officers of both Air and Ground Forces who had still to be convinced of the practicability of gliders in war. The show was a smashing success. Major Murphy's men had been taught strict air discipline in formation flying and landings. The "blitz" landing technique had given way to the minimum speed glide and short field landing. By day and night these pilots demonstrated their ability to land and park gliders wing tip to wing tip in small, rough fields.

The success of the demonstration gave the glider program its biggest boost. Glider pilots had been accumulating in a pool at Bowman Field, Kentucky, following their graduation from advanced training. There they had been given intensive courses in physical conditioning and infantry tactics. Now an additional course under the First Troop Carrier Command was instituted at Maxton under Lieut. Col. Murphy to teach tactical glider flying as developed by his special group. All the glider pilots were drawn from Bowman Field to take this course and when the pool was empty, it was closed.

Meanwhile, airborne activity was beginning in the Pacific war, although gliders were not yet used. There were three main ways of carrying troops and equipment into combat by air and resupplying them: Troop Carrier units, flying C-47's, could carry paratroops and drop parabundles; or they could tow gliders to a landing zone; or they could fly airborne troops in C-47's, landing the airplanes where suitable facilities existed.

In the early phases of the Pacific war, C-47's had flown standard infantry battalions from Brisbane to Port Moresby. Over 5,000 troops were flown over the Owen Stanley mountains to the front at Buna and Gona. In addition, some 20 C-47's had carried a weekly average of 2,000 tons of supplies of all sorts. Troop Carrier in this theater quickly becme important as the only means of supply for advanced and widely separated units.

On the 5th of September, 1943, the first extensive use of paratroops by our forces in the war took place in an unopposed landing in the Markham Valley of New Guinea. The 1,700 paratroops captured the Nadzab air strip with no difficulty. Gliders had been made ready to take part in this mission but were not needed.

Through the fall of 1943, the emphasis was on the tactical training of glider pilots, the standardization of techniques, and the making of as many improvements as possible in the equipment. No one knew what the deadline would be for this intensive activity but the invasion of "Festung Europa" had been promised and no one doubted the importance of the role gliders would play.

It was in the China-Burma-India theater that produced the next glider activity, however. In one of the most dramatic actions of the war, 54 CG-4A's loaded with U.S. Airborne Aviation Engineers and a force of Wingate's Raiders were double-towed over the China Hills and landed on the night of March 5th in a rutted jungle clearing 100 miles behind Japanese lines. This field was dubbed "Broadway". For twenty-four hours after the landing, the engineers worked frantically to prepare an air strip, which enabled U.S. and British transport planes to land. Another glider team went in nearby at "Chowringhee" and by the sixth day after the initial landings, 9,052 troops, 175 ponies, 1,183 mules and

509,083 lbs. of supplies had been brought in, undetected by the Japanese.

This was a new kind of airborne operation. In this case, an airhead was established behind enemy lines and the entire assault force moved in by air. As distinguished from the Sicily landing, which was diversionary in intent, this was a new type of attack, particularly suited to sparsely held territory and almost impossible to prevent except by alertness and overwhelming air superiority on the part of the defenders. In this operation, gliders were the only key to success. In no other way could the bulldozers and engineering equipment have been successfully landed on ragged terrain.

While this exciting activity was going on in Burma, intensive preparations were under way in England for the invasion of the continent. Lieut. Col. Murphy had been summoned to England by General Eisenhower to help organize the glider phase of the assault. The airborne attack on Normandy was originally planned to be a daylight landing. As the day approached, a German panzer outfit was reported to be moving up into the area where the gliders were to land. Despite anticipation of heavy losses, it was considered important enough to revise the plan and make the landings at night. The best available fields were not very large and almost all were bordered with high trees. The assault was launched on the night of June 6, 1944. Lieut. Col. Murphy piloted the first of the 512 gliders into Normandy. Of all glider missions to date, this was the most critical, since the communication lines back of the beaches had to be cut to assist the landing of troops from the sea. Although the hazards were tremendous, the glider landings succeeded brilliantly, with unusually light losses. Three fully equipped divisions were deposited squarely across the German communication lines and the battle field area was cut off by the airborne troops until seaborne troops had made the beach-head secure.

Two months later, between the 14th and 16th of August, while the Allied forces were slugging their way through Northern France, another airborne landing was made on the continent. Taking off from Italy, some 9,000 paratroopers and 408 gliders landed in Southern France on the high ground which controlled the land approaches to the points of seaborne attack. While the airborne troops severed communication lines, large forces slogged ashore from landing craft and started the drive which eventually tied up with the northern armies.

Recognition of these successes came in the form of the announcement of the creation of the First Allied Airborne Army under the command of Lieut. General Lewis H. Brereton. This was a logical outgrowth of experience. Up to now, the air and ground elements of airborne attack had been welded together only prior to a specific planned mission. Now, under a single command, these were merged. The Troop Carrier elements with C-47's and gliders were under the same organization as the combat teams and supply units of the ground force. Both British and American units were included. The very existence of such an Army constituted an ever-present menace to the enemy who could only guess where and when the lightning thrust might strike.

There was not long to wait. On the 17th of September 1944, the Allied armies attempted an end run through Holland and across the lower branches of the Rhine. During a week of operations, a long spearhead was thrown up to Nijmegen and Arnhem. Although it was not possible to hold the farthest point reached, the airborne forces opened the way for a long advance by ground troops. This was the largest airborne show of the European War. Over 2,600 allied gliders were used, of which 1,900 were CG-4A's. Nearly 40,000 troops were landed from planes and gliders and over 4,500 tons of supplies delivered.

The final airborne operation in Europe took place during the Rhine crossing. This mission was more in the nature of a reinforcing blow than vertical envelopment of the enemy. Ground troops had surged across the Rhine before the gliders and paratroopers made their landing which was only a very short distance in advance of the ground units.

Little further use was made of gliders in the Pacific. A few had been used in New Guinea to land in a remote valley where an air strip was needed but logistical problems in this theater made the use of gliders very difficult. The final operation in which they were put to use was the mopping-up on northern Luzon in the Philippines in the spring of 1945. There an unopposed landing was made against the Japanese who had fled northward in the earlier part of the campaign. It is possible that a more extensive role might have been found for gliders had an invasion of the Japanese home islands of Kyushu of Honshu been necessary.

DEVELOPMENT OF GLIDERS

U.S.A.

The first two cargo glider designs to be built for the U.S. Army were the CG-3A and the CG-4A.

The CG-3A had a span of just under 74 feet and was designed to carry nine troops or about 2,100 lbs. including pilot and co-pilot. With a wing loading of around 7 lbs. per square foot, it was intended to provide a transition between two-place trainers and the larger cargo gliders. It had a fixed landing gear designed for rough student landings and the same general wing and flying characteristics as the larger CG-4A.

The first CG-4A's began to appear in advance of CG-3A's and it was soon found that no transition phase of training would be needed for this glider. Tests were run with some typical students who were soloed in the CG-4A easily after two hours of instruction.

The CG-4A became the standard U.S. combat glider. It had a span of about 84 feet and carried fifteen fully equipped troops including pilot and co-pilot, or up to about 4,000 lbs. of useful load. The entire nose was hinged at the top with all control cables running through the hinge point. When the nose was opened, clear access was afforded to the interior space which was about 6 feet wide, 6 feet high and 13 feet long.

This gave room for a jeep, which could be carried with 6 men, and a special cable device enabled the jeep (or other self-propelled vehicle) to open the glider nose automatically as it drove forward on the way out. Normally the nose was raised and latched open by hand. Other important items which could be carried were the 37 mm. anti-tank gun, the 75 mm. pack Howitzer, the airborne 105 mm. Howitzer M-3 and a variety of airborne engineer equipment such as bulldozers, tractors, scrapers and so forth. The CG-4A was originally designed with three types of landing gear. One, a fixed type with oleo shock strut, was to be used for training and became known as the "training" gear. For combat, it was believed that the glider would need to land on the heavy wooden skids which were fixed to its bottom, so a simple pair of wheels on a rigid axle was designed for takeoff on such missions. This, known as the "tactical" gear, was to be jettisoned, to float down on a parachute after takeoff. In practice, it was soon found that the landing on skids was not satisfactory since on wet ground there was no adequate braking method and it was impossible to control the glider on the ground after it had touched. With the so-called training gear, however, the glider could be parked very neatly at any desired point since it could be steered and stopped by the brakes. It could also be ground to an emergency halt by forcing the nose skids into the ground. There was one disadvantage to the training gear in that it put the glider floor too far off the ground for vehicles to unload until the tail was raised, but a system was quickly worked out which largely overcame this objection. The tactical gear was soon eliminated for these reasons and the training gear became standard.

The CG-4A had many admirable characteristics and not a few bad ones. It could carry many important pieces of equipment but not all that were needed. It could fly fully loaded at 65 to 70 miles an hour and land at 55 to 60, with a ground

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roll of 150 to 400 feet depending on the terrain. Its wing had tremendous drag but good stall characteristics and it would fly at very high angles of attack which made it suitable for combat landings. The fuselage, of steel tube construction, acted as a steel cage and protected the occupants in crash landings which demolished the wooden wings. In general, it was a good glider for the first try and while its boxlike appearance made it the butt of many irreverent jests and uncomplimentary comparisons, glider pilots liked it and felt confident in their ability to make it perform. There was never a moment during the war when some modification was not under way on the basic design. On occasions, desirable improvements could not be incorporated because of the urgency of the production program. However, a good many changes were made, the most important of which was a crash protection device on the nose to deflect the glider over or to the side of large obstacles and to protect the pilots against any type of landing obstructions.

Much study was given to the other paraphernalia which were necessary parts of glider activity. Nylon rope was developed very early in the program. This has a quality known as hysteresis; the rope stretches generously when a sudden load is applied but returns to its original length slowly. Tow ropes of nylon helped make for quicker mass takeoffs, therefore, since the tug could accelerate from a standstill with less care than if hemp rope were used. Furthermore, flying in turbulent air became easier since surge loads were taken up by the rope.

CG-4A's were originally equipped with SCR 585 radios, known as handy-talkies. These were to be used in the air to talk to the towplanes and were to be removed from the glider after landing for use in combat. However, the comparatively short battery life of this set, the difficulty of communicating with the towplane and the need for radio silence in combat areas dictated a need for another solution. Since the nylon tow rope stretched, one solution was the stringing of a telephone line in loops along it, with plugs at towplane and glider. A later and more satisfactory solution was a development which permitted weaving the intercommunicating line inside the towrope despite its stretching.

Tactical use of the CG-4A soon indicated the need for other new equipment such as some device to permit towing under instrument conditions, some way to increase the rate and angle of sink, and a method to arrest the glider as quickly as possible on the ground. Completely satisfactory answers for these problems may be a long way in the future but continuous study was applied to all of them. Various "angle of dangle" methods were tried for blind towing; the trailing parachute which is released from the tail had partial success in overcoming excess altitude and the danger of overshooting a landing; numerous braking methods on the ground were tested.

One common objection to gliders was the inflexibility of their use. Having landed in a small field, they were expended. The pickup system, invented by Richard du Pont and developed for the Army by du Pont and Barringer, seemed to provide an answer, since in this way gliders could be recovered even from very restricted areas. The Model 80 pickup unit mounted in a C-47 proved able to pick up fully loaded CG-4A's.

Other uses for gliders in conjunction with pickup immediately suggested themselves. A program to develop so-called "utility" uses for gliders was begun. Since the glider could both land in and be flown out of areas which were inaccessible to other aircraft, it seemed practicable to prepare various utility loads such as a weather station, a field kitchen, a radar set, a field medical station, and repair shops for gliders, armament and so forth. A special trailer was built for the CG-4A which would carry most of these loads and which could be towed around on the ground by a jeep. A special installation was also made for litters, so that wounded could be evacuated directly from combat areas to the rear. Considerable use of this device was made in Burma.

The possibility of improving the CG-4A was apparent throughout the war as well as the need for new gliders to carry larger equipment. Most of the lessons learned from combat operation with the CG-4A were put to use in designing its successor, the CG-15A, which was basically the same glider. To increase the rate of descent and improve the flying qualities on tow, the wings were shortened to about 62 feet and electrically operated flaps were added to replace the spoilers of the CG-4A. The entire nose was redesigned to reduce drag and to provide a much better cockpit arrangement with escape doors for pilot and co-pilot. Many other refinements were also incorporated in the CG-15A, such as built-in crash protection, and after the usual, necessary, initial modifications, it appeared to be a definite improvement over the CG-4A from all points of view. It was unfortunately not available in time to be used in combat during the war.

Experimental development of larger gliders had been under way since early 1942 and the first to reach completion was another in the Waco family, the CG-13A. Originally designed as a 30-place glider, this was soon modified to take 42 troops or a 10,000 lb. payload. It was very similar in appearance to the CG-4A, having the same wing and only two feet longer span, but incorporated split-trailing edge flaps instead of spoilers. It had a hydraulic system for opening the nose, and eventually a tricycle landing gear. It carried several pieces of equipment important to the Ground Forces, such as the standard 105 mm. Howitzer M-2 or the 1½ ton 6 by 6 truck which served as a prime mover for the gun. Its far higher wing loading resulted in higher stalling and landing speeds than the CG-4A, however, and the ground run was considerably longer. Furthermore, the drag at gross weight made it a difficult load for a C-47. While the C-46 or a four-engine airplane such as the B-17 or C-54 could tow it easily, such aircraft were not assigned to Troop Carrier Commands. Although C-46's were eventually given to Troop Carrier units, the CG-13A was dropped in favor of new gliders which were being developed.

An interesting attempt was made in the CG-16 to create a glider with a 10,000 lb. payload which could be towed efficiently behind a C-47. This glider was an aerodynamic and aesthetic improvement over the CG-13A but also had serious drawbacks. Its design was started before the importance of carrying bulky equipment was fully realized. Its cargo compartment was split by the pilot's and co-pilot's compartment and it could carry nothing larger than jeeps or the standard 105 mm. Howitzer. Furthermore,its design cleanness did not begin to pay off until speeds above 150 m.p.h. were reached and the C-47 could not tow it at such speeds without excess use of power. Also, visibility for pilot and co-pilot was far too restricted for tactical operations with other gliders. This design, therefore, remained in the experimental stage and never went into production.

Another attempt to develop a "clean" glider was made in stripping a C-47 of engines and any other unnecessary equipment. This glider was the CG-17 and carried a large payload but was not practical to investigate further. Though it would hold three jeeps, the loading and unloading of such equipment was very difficult; no very bulky items could be carried. It would also have been impossible to crash land in combat without structural modification of the nose. In addition, the cost of the airframe of a C-47 was considerably higher than for any other glider in production.

A more promising design that any other large glider was the CG-10A, designed and built by the Laister-Kauffmann Aircraft Corporation. This was the largest glider yet developed by the Army Air Forces, having a span of 105 feet, and it had many outstandingly good characteristics. It could carry important items such as the 2½ ton 6 x 6 truck, or the M-22 tank, or the 155 mm. howitzer. Even with this great load, it had comparatively slow stalling speed and seemed to provide a definite possibility for combat use. This was the first U.S. glider to provide access to the cargo compartment from the rear, a feature which had many advantages in combat landings. Although originally designed to be towed by a C-47, the performance of the CG-10A behind this tug was marginal. However, by the time the enlarged CG-10A was

ready, Troop Carrier Command was beginning a transition to C-46 airplanes, which were easily able to tow the fully loaded glider. The main drawback to this design was the fact that it was constructed almost entirely of wood. This was because at the time it was engineered, metal was critically scarce and could not be used to any large extent in the glider program. Experience with wooden gliders in theaters during the war indicated clearly that more durable materials should be used.

British

Four types of glider were developed by the British during the war. Of these, one was a trainer, one never produced, and two saw considerable use in combat.

Hotspur: The Hotspur was the first British glider to appear. It was designed of wood and intended for limited use in training. Its sailplane antecedents were responsible for its initial large span and low wing loading. In subsequent models, some 14 feet were clipped from the span, bringing it down to 48 feet. It carried 8 troops or a payload of about 2,000 lbs., corresponding roughly to the CG-3A.

Hengist: The Hengist was to be the equivalent of the CG-4A, carrying 15 troops or about 4,000 lbs. of payload. It had an 80 foot span. Although experimental models were built and flown, this design never was put into production.

Horsa: The Horsa became the mainstay of the British glider program. This glider carried 25 troops or a payload of nearly 7,000 lbs. It was entirely of wood and had a long, cigar-shaped fuselage which was circular in cross-section. It sat very high off the ground and at the beginning had to be loaded through a large door on the left hand side of the fuselage forward of the wing. This could be reached only by long ramps. Once the jeep or gun had been pushed up the ramps, it had to be turned nearly 90° to enter the fuselage. All this made loading difficult enough but the prospect of unloading under combat conditions was even more critical. Various experiments were made with cordite for blowing the tail off and with systems of hinging the tail and nose. Most of the gliders used in combat depended on unbolting the tail section and running the vehicle down ramps to the rear. The Horsa was towed by a yoke with a release on the under side of each wing. It was equipped with tremendous split-trailing-edge flaps which were operated by hydraulics and permitted this glider to descend at a much steeper angle than any other glider. A short flare-out was necessary just above the ground because of the extreme nose-down attitude during approach and this became somewhat hazardous if the ground could not be seen clearly. Many pilots preferred the CG-4A which flew nose-high in a minimum glide and would land itself in that attitude.

Hamilcar: The largest glider to see combat was the British Hamilcar, which was designed specifically to carry a small tank. At the time, it was the largest wooden aircraft ever constructed, having a span of 110 feet and a gross weight of 36,000 lbs. It had the comparatively heavy wing loading of 21.7 lbs. per square foot and required a four-engine towplane, usually the Halifax. Its cargo area was reached through the nose which was hinged at the side. It was capable of carrying such important items as the M-22 airborne tank, two Bren gun universal carriers, or a D-4 tractor. Actually, the tank was its most important load and over twenty of them were landed from Hamilcars in Normandy where they had a startling success. Hamilcars were also use at Arnhem in the airborne thrust into Holland.

German

German activity with gliders started long before the American or British programs. The first German glider to be used in combat was the DFS-230 which, like many of the first British and American designs proposed, was an overblown sailplane. It was a high wing, strut-braced design with a span of 72 feet. It carried about ten men in its slender fuselage. This glider was used in the airborne invasion of Crete.

The DFS-230 was succeeded by the Gotha 242, a very successful design of about the size of the American CG-4A. The Gotha 242 had a number of innovations. It made use of rear loading with twin booms holding the empennage. It had provisions for wheels or skids as landing gear and machine gun positions for the crew. This glider was used extensively for supply across the Mediterranean to Rommel's fast moving army to trapped armies in the Ukraine, in Tunisia and at Stalingrad. Powered versions of this glider were made and used to augment the dwindling supply of JU-52's or other transport planes.

The largest glider built during the war was the Messerschmitt 321 which was so difficult to tow and operate that it was soon developed into the Me-323 by the addition of six Gnome-Rhone engines with a total of 5,790 H.P. The Me-323 carried loads of up to 40,000 lbs. or 120 fully equipped troops for ranges of up to 500 miles at speeds between 135 to 190 miles per hour. Rockets were needed for assistance on takeoff, however. Many of these were used by the Germans in shuttle service between Sicily and Tunisia in the closing days of that campaign.

Japan

When the Allied troops captured Manila, a great haul of enemy aircraft was taken. Among them was the Japanese transport glider, KU-8, or "Gander", which resembled the CG-4A. It had a 66 foot span and was designed to carry about 15 troops or the Jap equivalent of a jeep. Its nose was hinged at the side for loading purposes.

From the beginning, the use of gliders in war was a costly operation and was justified and continued only because there was no other way of accomplishing the desired end. For the glider was basically the largest container which could be delivered with troops or equipment to unprepared fields in enemy territory.

The expense and difficulty of mounting a glider mission stemmed from many things. First of all, the gliders were not inexpensive and the majority of those used on an assault were expended, despite the use of pickup when possible. A glider mission could not be staged without large scale preparation and training. This involved the use of large numbers of towplanes over a long period of time and in a theater that usually meant that the towplanes and crews had to be withdrawn from vitally needed supply missions. The problem of the glider pilot was also acute. Trained at great expense, he was restricted to flying gliders or liaison aircraft. Since towplanes were not generally available for routine maintenance of flying proficiency, glider pilots in theaters either flew liaison planes occasionally, acted as co-pilots in C-47's, or did not fly at all. The effect of this was to lower their flying proficiency and their morale, and they often languished on the ground for long stretches. When a specific mission was planned, intensive training was begun, of course, but the use of gliders was intermittent. Few, if any, glider pilots ever flew more than five combat missions during the course of the European war.

There was also a difficult problem in the gliders. Since they could not fly to theaters, it was necessary to crate and ship them. Each CG-4A, when crated, occupied five large boxes, so a tremendous amount of shipping space was needed to transport enough gliders for sizable airborne operations. Once the crates had arrived in the theater, it required vast work areas and large crews to assemble the gliders, which then occupied valuable space at airdromes and could not be moved without towplanes. Furthermore, the process of shipping, unloading and assembly was time consuming. It was possible to overcome these difficulties in the European war since England stood as an advance base for us to ship to and from which the missions could be run. In the Pacific war, with the greater distances involved, the

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constant progress of the war from island to island and the lack of facilities for unloading and assembly, the difficulties were so great that extensive use of gliders was out of the question. Furthermore, every airfield or landing strip had to be put to most efficient use, with fighters and bombers having top priority. Beyond that, the theater was heavily dependent on constant use of the Troop Carrier Command planes for daily supply and transport operations from which they could not be spared for glider training or airborne activity.

In recognition of these difficulties, steps were taken at an early stage in the glider program to investigate ways of overcoming the inflexibility of gliders. Packaged power units of various horsepowers were tried on the CG-4A to see if the gliders could not at least be ferried from factories under their own power after which the engines might be removed. With two 200 H.P. engines, the CG-4A became the PG-2A, a wallowing, overgrown Cub which could, however, take off and fly carrying a jeep. Investigation was also begun early on higher horsepower engines applied to the CG-15A, which was called the PG-3A. As tests progressed, it was believed by many that these powered gliders might find a place in combat operations. But outstanding as a possibility was the potential use of powered gliders for training, since this would obviate the need for towplanes. They could take off with the power units; with the power cut off, they became gliders once more for landing practice. Except that there would be fire hazard in crash landings, normal glider training activity could proceed in this way. Further experimentation along these lines seemed to be logical.

By the closing months of the war, an important change was made in the glider pilot program. Up till this point, this program had been entirely separate from the Army's power training program and had produced pilots who were excellent in quality as long as their flying proficiency could be maintained. This, however, had proved difficult both in theaters and in the U.S. As the newer gliders were larger and had heavier wing loading, the glider pilot's job and his responsibility became greater. Tests showed that regular power pilots who had received glider training were better able to handle this larger equipment than men trained only in gliders and light planes. For this reason and in order to insure more usefulness for the glider pilot, the Army determined to stop further training of men only as glider pilots and to make a transition to power pilots, who would be assigned to glider training after completing the standard Army flying course for twin-engine aircraft. This would also enable these pilots to fly either gliders or towplanes thus eliminating long periods of inactivity and the other resulting difficulties. This change was announced and put into effect in the spring of 1945. With this move and with the investigation of power units for gliders, the four years of a separate glider program seemed to be ended. No longer would there be a separate rating of Glider Pilot and only further development would tell whether a new type of aircraft might not replace entirely the need for gliders.

The problem still remained, however. Unless the atomic bomb had made all ground warfare obsolete, it was necessary for the Army to plan for possible airborne operations. A major change in this program had occurred during the war, however. While in 1942, airborne operations had been conceived as consisting of specially trained troops using specially designed light weight weapons and equipment, by the end of the war it had been determined that standard infantry troops could be landed by air and that they needed just as heavy artillery as their enemy. The problem was therefore to provide the means to move standard Army units with all their regular equipment. In recognition of this, the policy was established to study the design of all new Army equipment with a view to making it transportable by air. What means may be found for the transporting of these troops and this equipment will someday provide the sequel to this chapter, even though it may not appear in a book on gliders.

Eliot Noyes, Sept. 1945