GLASGOW - HELICOPTER BIRTHPLACE

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Not everybody realises the important contribution that the Weir Group of Glasgow made to the development of the helicopter, or that this company built the first practical British helicopter and the world's first passenger-carrying machine. Prior to these "firsts", Weir also played an important part in autogyro development.

This paper examines the various rotorcraft built by Weir in the 1930s, both from an engineering and an historical aspect, but begins even earlier with a review of the 1907 Mumford Helicopter which was built on the Clyde by the Denny Bros. shipyard.

Whilst the Mumford Helicopter could not be considered a success, the Weir W5 and W6 helicopters certainly were. The W5, first flown on 7th June 1938 at Dalrymple, was at the time the world's smallest helicopter and logged some 78 flying hours before it was dismantled a year later. It was followed by the much larger W6, which, only days after its first flight in October 1939, was being demonstrated with two passengers aboard. This aircraft was subsequently used to flight test the revolutionary aerodynamically stabilized rotor system, before the war effort forced a stop to Weir's development programme.

The paper concludes with a brief look at Weir's later helicopter activities, including the W9 "Notar" and the three-rotor W11 Air Horse.

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IT IS almost exactly 51 years since the world's first passenger-carrying helicopter flight took place - it is 52 years since the first practical helicopter flew in Great Britain. Not everyone is aware that both these rotary-wing firsts took place here in Glasgow, more renowned for its contribution to the shipping industry than for its work in the aviation field.

Yet, as early as 1906, engineers on the Clyde were re-applying their knowledge of screw-driven ships to the theory of screw-driven helicopters. In that year, Edwin Mumford, head of the experimental department at Denny Brothers' shipyard at Dumbarton, began designing his "aerodrome". This early vertical lift machine featured six two-bladed propellers, each about 25 ft (7.62 m) in diameter and 19 ft (5.79 m) pitch, and mounted on adjustable vertical shafts with a slight forward and outward set. This outward set helped to assist stability. Steering was by a single triangular rudder aft, which was universally hinged for both horizontal and vertical use. For take-off, the rudder was adjusted so that the propeller shafts were vertical. For forward flight, rudder was used to incline the framework forward, thus accentuating the propeller angle and driving the "aerodrome" forward. The first rotors were made of silk, stretched over a bamboo framework and braced by wires from a central kingpost. Early tests however showed that the bamboo framework soaked up water and rotted, so it was initially replaced by a steel tube framework and then, in 1909, by elm, which proved much more satisfactory. The rotors turned at about 40 rpm.

The airframe and transmission shafts were manufactured from aluminium tubing. The transmission was reportedly relatively trouble-free, with very efficient bevel gearboxes connecting the vertical rotor shafts with the two parallel longitudinal shafts. These were chain-driven from a centrally-mounted 25 hp Buchet engine. Mr. Mumford calculated that he required about 3 sq.ft (0.28 sq.m) of disc area for every pound of total load, and needed 1/30th hp per pound for vertical flight. The total disc area was 2950 ft (899 m). The Mumford helicopter was assembled at the Denny Overton estate and hangared in a large marquee, close to Overton House. It was quite large - about 60 ft (18 m) long and 41 ft (12.5 m) wide, and originally sat on two long wooden skids. The original gross weight, including the pilot was 886 lb (402 kg).

The original Buchet engine was replaced in 1909 by a 25 hp four cylinder two-stroke N.E.C.. This in turn was replaced by a more powerful 40 hp V-4 N.E.C. engine in 1911. By this time the gross weight had increased to 1580 lb (717 kg), so the extra power was very necessary.

Attempts to fly the Mumford Aerodrome appear to have been punctuated with structural failures of one kind or another but, in 1912, tethered hovers to 10 ft (3 m) were achieved. However, in January 1913 a shaft failure caused two adjacent rotors to go out of sync. and collide, which wrecked the machine.

The engine and transmission were salvaged and in 1914 were incorporated in a second prototype, which was built in Denny's Leven yard. This machine was smaller and of stiffer construction than the first aircraft and mounted on a float undercarriage. The aluminium airframe was replaced by composite tubes (proving nothing is new), manufactured from paper, wood and fabric, and helping to reduce the weight to 1508 lbs (684 kg) empty. In the autumn of 1914, the Mumford Helicopter No.2 was launched on the Clyde and made a successful flight of 300 ft (91 m) at a height of 10 ft (3m), during which it operated at a gross weight of 1600 lb (726 kg) and reached a forward speed of about 15 knots (17.2 mph, 27.8 km/hr). That same night it was wrecked by a gale and, with the outbreak of war, further development was abandoned.

There was now to be a gap of some 20 years before Glasgow was to become seriously interested once again in the helicopter. In the intervening years, many designers tried and failed to conquer true vertical flight. One man above all others got nearest to it. Juan de la Cierva, the father of the rotary-wing aircraft, began developing his ideas of vertical take-off in 1920, resulting in the aircraft patented as the "Autogiro". Cierva's concept differed from the basic principle of the helicopter by using a freewheeling rotor system, power and drive being provided via a conventionally mounted propeller, with stubwings and a tail unit providing conventional fixed-wing means of control. This concept avoided the torque reaction common to helicopters, which was a major control development problem, but did mean that the "autogiro" needed a short take-off run before getting airborne. Cierva was not alone in this form of rotary-wing development. Indeed, a Scotsman from Perth, David Kay, contributed some important blade pitch control ideas with his Kay Gyroplane designs in the late 1920s and 1930s.

However, Cierva was the most active in this field and in part his success was very much due to the backing he received from a Glasgow family, whose engineering group was - and still is - a major force in the area. This was the firm of G & J Weir, founded by two brothers, George and James, at Cathcart, Glasgow in 1886. The youngest son of James Weir, James George Weir, was a keen advocate of aviation. His RAeC Aviator's Certificate, No.24, was awarded in 1910 and he owned his own Bleriot in 1911. Later he became an Air Commodore in the Auxiliary Air Force and Chairman of the Scottish Flying Club. His elder brother, William Douglas, and the first Lord Weir, who became Chairman of the company, was also interested in aviation, and was in fact Secretary of State for Air in the First World War. During that war, G & J Weir contributed to the war effort not only in the shipbuilding field but also by building aircraft at their Cathcart works.

In 1926 James George Weir put up most of the finance to form the Cierva Autogiro Company Ltd., becoming its first and only Chairman. This backing allowed Cierva to develop and refine his concept to a point where, by 1932, the Cierva C.19 Mk.V Autogiro was able to dispense with the fixed-wing control surfaces of the earlier aircraft in favour of a direct-control tilting rotor head.

Meanwhile, at a Weir board meeting in July 1932, James Weir proposed that they themselves should obtain a licence from Cierva to develop a small single-seat autogiro. In part, this proposal was probably engendered by a developing crisis within the Cierva company, which was running short of the money needed to complete development of the new technology. The Weir family decision to back James with £8000 to develop his new project, was all the more courageous in view of the fact that G & J Weir's were at that time themselves suffering from a major slump in the shipbuilding business.

The new autogiro, designated the Weir W1 was to act as a testbed for the new direct-control rotor, as well as being suitable as a private single-seat aircraft. The basic design was by Cierva, supported by Weir staff at their Cathcart factory, where the W1 was built during the winter of 1932-33. The fuselage was a plywood monocoque of oval section, with power provided by a 1200 c.c. two-cylinder horizontally opposed air-cooled engine, especially developed by Douglas Motors at Bristol. The Douglas company, incidentally, collapsed during the final stages of completing the new engine, and two of their design and engineering staff, Cyril Pullin and G.E. "Mickey" Walker, followed it to Cathcart. Pullin subsequently became the chief designer for Weir. Other members of the design team were Dr. J.A.J. Bennett, Freddie Hodgess, Ken Watson, and R. Bowyer.

The W1 was very small, only 15 ft (4.5 m) long and 7 ft 6 in (2.3 m) high. Construction of the two-bladed 28ft (8.5m) rotor generally followed that of the Cierva C19 blades (i.e. a tubular steel spar at quarter chord with light spruce ribs, a solid ash leading edge and slender spruce trailing edge, with doped fabric covering). Blade chord was 11 inches (28 cm). The tilting rotorhead embodied offset flapping hinges connected to the drag hinges by short links. The bearings of both hinges each had two phosphor bronze bushes. These were flanged at one end and, when pressed into the eyes of the link, also formed the rubbing faces. Ferodo and steel plate friction dampers, exactly the same principle as those used in later conventional helicopters completed the assembly. The head was tilted fore and aft and, in the lateral planes, by two independent push-pull rods operated by a hanging stick.

The starting sequence began by engaging a dog clutch, which spun a drive shaft topped by a small cone. This fitted under a larger conical aluminium casting lined with Ferodo, shaped like a coolie's hat, and bolted to the top of the rotor head. To engage the two cones and so start the rotor turning, the pilot simply eased the stick forward. As soon as he eased it back into the normal flying position, it disengaged.

The system wasn't perfect by any means - you needed a strong pilot for a start, and the rotor rpm achieved was not enough to substantially shorten the take-off run. Nevertheless, the W1 did fly, first of all in May 1933 at Hanworth in Middlesex, where the Cierva company was located. The pilot was de la Cierva himself. Later it was test flown from Abbotsinch in Scotland, but was written off on 21 December, when it overturned on landing. The ride was described as less than comfortable, due to vibration from the Douglas engine and the rotor system.

Only a single W1 was built, and this was followed in 1934 by the improved W2. This introduced various modifications, including a new 45 hp engine developed in house by the ex-Douglas members of the Weir team, and a toothed pinion and internal bevel replacing the conical rotor drive system. The complex tilt-control was replaced by a simple hanging stick, operating in the correct sense and having the different ratios required for fore-and-aft and lateral control of the rotor. The rotor head was also redesigned, with co-axial flapping hinges fitted to a common pin in line with the axis of rotation. Thus there was no flapping hinge offset. At the top of the pylon a rudimentary sprung trim control was introduced, which was operable from the cockpit and had the facility to considerably reduce pilot fatigue. W2 was first flown at Abbotsinch by Alan Marsh, and proved to be much more stable and controllable than the W1. About 10 hours flying was logged and design of a production version was begun. This would have been offered on the market at £355 each, but did not go ahead. W2 still survives and is on display at the Scottish Museum of Flight at East Fortune.

The next machine to be built by the Weir team was the W3, which introduced Cierva's direct take off or "jump start" system. This was achieved by angling the drag hinges so that when the blades were driven on to their forward stops, they decreased incidence to the minimum drag position. While they were held there by torque, the rotor was accelerated to some 20 percent over the normal flying rpm. On releasing the drive, centrifugal force immediately straightened the blades, thus increasing pitch and causing the autogiro to leap off the ground to a height of some 15ft (4.5m) in quite spectacular fashion. The surplus kinetic energy kept the rotor spinning, until the propeller had accelerated the aircraft sufficiently to maintain autorotation speed.

In order to obtain as rapid a change of pitch as possible it was important to reduce the friction in the angled hinge to the minimum. To do this Ken Watson of Weir invented the "inching bearing", in which the races of both the journal and thrust bearings were inched around by means of roller bearing free wheels - thus preventing the balls from brinelling due to the small angular movement of the blades.

The W3 rotorhead showed a further design advance by introducing a suspended head which could be tilted about its CG. The earlier tilting head, moved by the axle to which the hanging stick was attached, had a CG above the tilting fulcrum, causing displacement of the whole rotor and heavy loads on the controls. The new arrangement meant that the earlier single tube rotor pylon was now replaced by a four-legged open framework, which in turn led to a box section fuselage.

The blades themselves introduced several major improvements, including a plywood covering instead of fabric, magnesium instead of wood ribs, and metal spars with the gauge gradually reduced towards the tip to reduce weight and inertia. This reduction was done by controlled acid immersion - an early example of chemical milling. As a result of these changes the chordwise CG of the blade moved aft so that, to maintain a positive pitching moment, a horn balance was attached to the blade roots.

Finally W3 introduced another new Weir powerplant, the 50 hp Pixie four-cylinder in-line inverted, which weighed less than 100 lbs (45 kg). Although much smoother than the horizontally-opposed engines, it apparently caused a lot of problems. W3 first flew at Abbotsinch on 9 July 1936, piloted by Marsh, and early trials were so successful that a month later he was able to demonstrate it in front of some 20,000 spectators during a Brooklands motor race meeting.

The last of the Weir autogyros to be built was W4, which introduced a transmission redesign and a faired pylon structure. In the rotor hub, Helical splines in the rotor hub for the direct drive system allowed the torque arms to be moved into the driving position by means of a bell crank, operated by a separate control from the cockpit. On releasing the drive, the horns of the angled drag hinge links kicked the torque arms back and drove the vertical shaft down the splines. This ensured complete disengagement. A synchromesh dog clutch was used to engage the main drive shaft, and the rotor brake was moved to the bottom of the vertical rotor shaft to avoid oil or grease contamination. W4 used the developed and type-tested version of the Pixie engine and was taken to Abbotsinch for flight trials in late 1937. It never flew, being badly damaged during taxi tests, after which development was abandoned.

A major reason for abandoning the W4 was the decision by the Weir Board in December 1937 to transfer its expertise to helicopters. The company had spent a total of about £600,000 (about £1.20 million today) on autogyro development up to this point, but could see from the work being done by Focke and others that the helicopter offered far greater potential. Cierva, of course, had been killed a year earlier in an airliner crash at Croydon.

The Board decision followed some preliminary work that had already been carried out by the autogyro design team on a single-seat helicopter, the Rotorplane Type Z. This had co-axial rotor system and an engine/airframe layout based on that of the W4. Although some components were tested, Rotorplane Type Z was never built because Pullin could not overcome the risk of blade collision and control and stability problems. In addition, realizing the experimental nature of the work, it was considered wiser to adopt a layout that would allow ample disc area, in case of a need for emergency autorotation. Interestingly though, the layout was not dissimilar to Shapiro's Rotorcraft Grasshopper, built with Weir backing in the 1960s.

During 1937, the company had also approached Focke, at the request of the Ministry of Aircraft Production, to acquire an example of the FW61, but the price was too high and delivery somewhat protracted - perhaps not surprising in the light of future events.

However, in October 1937, when it became obvious that the company would have to develop their own design, Cyril Pullin followed the Focke side-by-side rotor configuration for his first helicopter, the W5, which incidentally used parts of the undercarriage and the 55 hp engine (in a reversed position and air-cooled by a special blower unit) from the salvaged W4.

The rotorhead was based on the autodynamic head used on W4, but with cyclic pitch via a swashplate with a screw jack control, instead of the tilting head principle. While hovering, control about the rolling and pitching axis was by tilting the lift vector through the application of harmonic pitch change. Subsequently, control about the rolling axis was obtained by continuous differential pitch change and about the pitching axis by harmonic pitch change. Vertical movement was controlled by aplication of engine throttle to change the rotor rpm. Normal flapping and drag hinge articulation were included, together with a freewheel on the hub to allow autorotation.

Power transmission from the engine was via a single-plate clutch to a primary gearbox, and then through universally-jointed super-critical shafts to the rotor hubs. The overall gear ratio between engine and rotors was 8.4 to 1, but anticipated torsional vibration problems did not arise, probably because of the long transmission shafts damping effect in the numerous bearings and the elastic constraint of the rotor blades in relation to the rotor hubs. The two-blade rotors were geared down to run at 410 rpm and had a diameter of 15 ft (4.6 m). For the W5, Weir introduced a new method of blade construction, using compressed wood spars and moulded synthetic resin bonded plywood skins. The blades were of constant chord throughout and untwisted, with a cruciform type of rib construction to reduce the torsional and bending flexibility. Fuselage, tail unit, and outrigger construction was also primarily of wood, with the outriggers made of box section without fairings. With pilot, fuel and oil, gross weight worked out at 840 lb (381 kg), giving a power-to-weight ratio of about 17 lb (7.7 kg) per horsepower.

Initial attempts to hover the W5 on a tether at Cathcart in early 1938 were singularly unsuccessful. According to Cyril Pullin, who made the first efforts, the aircraft "showed a rapid rate of displacement in all axis and the pilot's control lay-out was completely inadequate." Certainly the control system was very sensitive, but also there was very little dynamic stability, and no static stability whilst hovering at all. Nothing could be done about the latter, but the dynamic stability was improved by increasing the moment of inertia about the pitching axis, introducing some horizontal offset of the flapping hinges and adding five feet (1.5 m) to the tail end of the fuselage. At the same time, the angle of the side outriggers carrying the rotors was changed from 11.5 degrees to 22 degrees, and the original rocking wheel control, which combined cyclic and rudder, was replaced by a cyclic stick and rudder pedals to provide differential fore and aft cyclic control.

The result of these changes meant that hovering on short tethers in the erecting shed and outside at Cathcart, now became possible, despite marked ground interference. The horizontal offset of the flapping hinges was regarded as especially satisfactory, permitting hovering even in a light wind with hands-off the control column for some 10-20 seconds. On 7 June 1938, Ray Pullin, C.G.'s son, who learnt to fly autogyros in his mid-teens, made the first free flight under full control at Dalrymple in Ayrshire. This was the first practical flight of a British helicopter and the world's smallest. Testing continued on an almost continual basis throughout the year, with Ray Pullin encountering more than his fair share of hairy moments - like the time a rotor blade came off at about 20 ft (6 m) from the ground, sailing over the heads of some 100 RAF recruits on the airfield, fortunately without hitting anyone. This incident was traced to blade stall, following an attempt by the pilot to correct for a sudden large change of angle of attack. On another occasion, whilst testing for maximum speed, Pullin attempted a banked turn at the end of the run, but found the W5 instead in a power dive from 150 ft (46 m). Having tried everything he could to pull out, he was just waiting for the crash, when, to everyone's amazement, it levelled out into a glide - having apparently taken advantage of the ground effect. On a third occasion, whilst demonstrating the aircraft at the Weir football field, the tail wheel and oleo dropped off on the fifth circuit at 200 ft (61 m). Pullin, of course, was totally unaware of what had happened until, on landing, the helicopter came to rest at an unusually steep tail down angle.

W5 made more than 100 take-offs and landings in 1938-39 before it was dismantled in October 1939. It logged a total of some 78 flying hours. The maximum speed achieved at Dalrymple was 70 mph (113 km/hr). Rate of climb was estimated at 400 ft/sec at 30 mph (122 m/sec at 48 km/hr). Components of this historic helicopter still existed in the immediate post war period, although I know of none that exist today.

The end of testing of the W5 came about because of the advent of the W6, a much larger helicopter which Weir began developing under an Air

Ministry contract dated March 1939. Design work on this helicopter actually began in October 1938, not long after the first flight of the W5, and construction began at the end of that year in the former pattern shop at the Cathcart factory. W6 retained the same basic configuration as W5, but featured a two-seat tandem fuselage and a 200 hp Gypsy VI engine driving two three-bladed rotors of 25 ft (7.6 m) diameter. The main fuselage was an open framework of light alloy tubing, although this was replaced by steel tube in the rear bays.

Blade construction followed the same method as for W5 but, in this instance, the blades were manufactured in Glasgow by Messrs. Morris & Co., high class woodworking engineers. (The W5 blades had been made down South in the London area). In the case of W6, the transverse CG position of the blades was corrected by rolling on to the leading edge an extruded metal section, the inner end being anchored to the root fitting so as to relieve the wooden portion of the blade of the centrifugal load of the metal edging. The W6 blade was, in true Weir tradition, "Clyde-built" and, placed across two bench ends, could support the weight of two men without breaking.

The Gypsy VI engine, with its relatively long crankshaft compared to the little Pixie, led Cyril Pullin to introduce a fluid flywheel in the transmission, to overcome possible torsional vibration problems. The flywheel also doubled as a hydraulic rotor starting clutch. The low speed drag of the coupling was resisted by a brake which, when released, allowed the engine to progressively wind up the rotor. Increasing engine speed brought the coupling into full operation, with a final slip of some three percent. Blower cooling of the Gypsy VI absorbed some eight percent of the maximum power. The engine ran at 2400 rpm whilst the rotors turned at 275 rpm. Loaded weight of the W6, with pilot, passenger, fuel and oil, was about 2360 lb (1070 kg). The first W6 rotor head was based on that employed in the W5, with the cyclic and differential collective pitch mechanism all neatly enclosed within the hub and pressure lubricated. There was no damping between the blades and the rotor hub and the hinge layout, incidentally, was identical to that employed by Sikorsky in the 1950s. Each rotor was equipped with a ratchet type free-wheel, to permit autorotation and to establish the correct phasing between the rotors. New on the W6 was a Hamilton Hydromatic constant speed unit, mounted on the primary gearbox to govern the rotor revs, and using a hydraulic jack to operate the collective mechanism. This system could govern within 2 percent of the required rotor revs. and could alter blade incidence from 11 degrees to zero in half a second in the event of an engine failure, or when either of the rotor drive shafts failed to transmit the correct percentage of engine torque. Perhaps its a safety feature worth considering for todays two seat light helicopters.

On 6 September 1939, the fuselage of the W6 was towed tail first, and on its own undercarriage, behind Tom Nesbit's sports car from the Cathcart factory to a new home for the Weir Aircraft Dept. at the Group's Argus Foundry at Thornliebank. Ray Pullin carried out the first tethered flight of the W6 at Thornliebank on 20

October 1939. The prior work done with the W5 ensured relatively trouble-free progress and, on 26th, Pullin was able to complete the first free flight. On the very next day at 11.30 a.m., he took off again with Chief Engineer, Ken Watson, in the passenger seat. This was the world's first passenger-carrying helicopter flight. 15 minutes later J.G. Weir was taken up. On both flights, the passengers noted the smoothness of the aircraft, both mechanically and in terms of control. On 28 October, in a series of seven flights, the W6 flew for the first time with two passengers, carried out its first 360 degree turn and, with Tom Nesbit aboard, acted as the aerial platform for the first photograph taken from a helicopter. On 31st October, testing in gusty weather at 15-30 mph (24-48 km/hr), a port rotor blade came off. The W6 was hovering at about 50 ft (15 m) at the time, but Pullin managed to make a tail slide crash landing, which ended with him and his passenger being ejected through the bottom of the fuselage. On examination the blade was found to have broken off at the root end. Damage to the W6 was not substantial but fortified concern about the limitations of cyclic and collective pitch control. It was therefore decided to test a new rotor system known as the Aerodynamically Stabilized Rotor (ASR). In February 1940 the W6, equipped with A.S.R., was demonstrated to several military VIPs and flew both Captain Liptrot, a strong Royal Navy supporter of helicopters, and Air Marshall Tedder of the Royal Air Force, whose visions were firmly fixed-wing orientated.

In the A.S.R. system, the three rotor blades were attached to a hub, which in turn was mounted on one rotating universal joint, similar to the tilting-head philosophy used on the Weir autogyros. However, on the A.S.R. a Delta III blade coupling, or pitch change coupled with flapping displacement, was embodied. The blades were provided with drag and flapping hinges, but restrained in such a manner as to permit collective coning, but suppressing the differential flapping. Arms from the blade torsion hinges were under control of the swashplate mechanism, so that the rotor disc always followed the inclination of the swashplate. The Weir inching bearing played an important role in all this. Gust effect or differential flow would thus cause the rotor as a whole to tilt about the gimbal component, whereas the swashplate datum remained fixed. This, in effect, automatically reduced the cyclic pitch. The A.S.R. system was seen by Pullin as ideal for a multi-rotor helicopter, but not suitable for a single-rotor design because of the precessional characteristic of the disc tilt.

Trials of the A.S.R. system were substantially completed by July 1940 when, with the war situation worsening, the Air Ministry cancelled further development and the Weir aircraft Dept. closed down. The W6 had logged some 70 hours total flying by this date, all of it confined to waste land at the Thornliebank site - for security reasons and because of wartime restrictions on airfields. The machine could fly forwards, backwards, sideways, etc., under reasonable control, and had a rate of climb at 25 mph (40 km/hr) of 650 ft/sec (198 m/sec). The confined area available for testing meant that speed was only measured in a closed circuit.

Nevertheless, this was estimated at 80 mph (129 km/hr), with a calculated maximum of 90 mph (145 km/hr). Under agreements with the US, some of the Weir technology, including the A.S.R., was transferred across the Atlantic to the Cierva licensee, Pitcairn's Autogiro Company of America, where it was to prove useful to the budding American helicopter industry. Post-war, the A.S.R. was to appear on the G & A XR-9, two-seat helicopter. Back in the UK, the W6 itself was dismantled and, piece by piece, disappeared into obscurity.

In 1941, the Weir team began to attempt a revival - first with the W7, which, powered by a 600 hp Rolls-Royce Kestrel engine and with the A.S.R. system, scaled up the W6 to meet a potential fleet spotter and anti-submarine warfare requirement. It was never built.

This was followed in late 1941 by the start of a design study for a single-rotor single-seat helicopter powered by tip jets using air pressure supplied from a Rolls-Royce Vulture supercharger plus heat exchanger driven by a 205 hp de Havilland Gypsy Queen. This was W8. The following year saw the design team moving south to Thames Ditton and eventually to Eastleigh, Southampton. Although data research was to continue at Cathcart into the 1950s, by the end of 1943 helicopter development in Glasgow had effectively come to an end. Furthermore, the Weir Aircraft team had been reorganized under the banner of a revived Cierva Autogiro Co. Ltd., albeit still largely financed by the Weir Group.

After W8, six more helicopter projects were initiated with Weir designations, three of which were actually built. W9 used a powered tilting hub and featured a variable-pitch fan and jet efflux for anti-torque yaw control (shades of NOTAR), W11 was the famous three-rotored Air Hose, which fatally crashed at Eastleigh in 1950 and brought the Cierva company to an end, and W14 was a small two-seat helicopter, development of which was taken over by Saunders-Roe in 1951 and emerged later as the Skeeter.

It's a sad fact that J.G. Weir and the members of his team never really received the credit due to them. Why this is so is difficult to say. Certainly the secrecy surrounding the events in 1938-1940 played a major part but, in any case, Weir was not a flamboyant, publicity-seeking character, and the Weir Group itself kept a fairly low profile. In the United States on the other hand, the publicity machine was all ready to roll, and individuals were far less reluctant to talk about their successes.

As has already been recounted, by the end of the War, the two early Weir helicopters had been dismantled - to eventually disappear we know not where. Ray Pullin - the first British helicopter pilot - had transferred to Spitfires and became a prisoner of war. He never flew a helicopter again, but is still hale and hearty, living in High Wycombe, Bucks. Ken Watson - the world's first helicopter passenger - stayed with the helicopter industry, surviving the demise of Weir, Cierva and Saunders-Roe, before eventually retiring from Westland and taking up residence in Yeovil, Somerset - where he still lives. The others, alas, have disappeared into history, but will not be forgotten.