



Autogyros: The First Rotorcraft

WITH an unpowered rotor made to spin by aerodynamic forces, autogyros were the first successful rotary wing aircraft to fly. Although not widely accepted at the time, they were very important in the development of the helicopter which due to its ability to hover, drew attention and funding away from autogyro development. More recently, particularly thanks to recreational aviation, autogyros are becoming popular amongst the aviation community – but where did it all begin?

Autogyros were invented by the Spanish Engineer, Juan de la Cierva. In 1903 he was only 8 years old when the Wright brothers first left the ground. Cierva was intrigued and decided to build his own which he did in 1912, with a Sommer biplane as the basis. His design was considered to be the first Spanish built aeroplane. His second design was a monoplane which crashed in 1913 and was abandoned. In 1918 a Spanish military competition was announced and he entered a new design in the bomber category. This was a large tri-motor plane that he completed in 1919 and which flew well. However in an early test, the pilot flew too slowly and stalled, escaping without injury but wrecking the aircraft.

Cierva was disappointed and resolved to think of a better way to fly at low speeds. He came up with the idea of the 'autogiro'. His first three designs were the C.1, the C.2, and the C.3, all powered by a conventional engine and propeller at the front of the aircraft. The first utilised two counter rotating rotors with a vertical control

surface above the rotors for lateral control and a conventional rudder and elevators on a tail. However aerodynamic interactions between the two rotors meant that it never flew – though it did demonstrate the principles of autorotation while taxiing on the ground.

The C.2 design would only have one rotor with 5 blades, but this was initially abandoned for the three-bladed C.3 which incorporated collective pitch variation on the blades (to change the pitch of all blades simultaneously), while retaining a rudder and elevator for yaw and pitch control. The C.3 achieved brief low hops off the ground but did not prove to be a practical design.

Cierva returned to his C.2 model which was completed in 1922 but still could not maintain sustained flight.

Cierva's eventually realised his main problem was that his rotor was affected by unbalanced lift due to the increased relative wind flowing over the advancing blade, compared to the retreating blade. He was watching an opera when he came up with the solution. One of the props for the opera was a windmill that had hinged blades and Cierva came upon the idea to use hinges on his rotor blades to allow the blades to rise and fall depending on the direction in which they were moving. The advancing blade (with the higher relative airflow) would rise due to the higher lift, but this would also serve to decrease its angle of attack. The opposite would happen for the retreating blade. This combination of rising and falling came to be



The Cierva C.4 was the first rotorcraft to make a controlled flight. Picture courtesy Dr. Bruce Charnov.

known as flapping and the increase and decrease this had for lift on either side of the aircraft served to balance the forces.

Cierva's next design incorporated these hinged rotors and was designated the C.4. It had outrigger mounted ailerons on the sides of the aircraft with yaw and pitch control from a conventional rudder and elevators. On January 17, 1923 the Cierva C.4 flew, marking the first controlled flight of an autogyro.

Three days later, Cierva's new design went into a steep nose-up attitude after an engine failure at about 30 feet. In a conventional airplane this would have resulted in an unrecoverable stall but the autogiro simply descended and landed without damage. This incident was an able demonstration of the safety of the design in low speed flight. Later, in 1916, a subsequent model, the C.6, lost power while climbing through 200 feet. In this case the pilot turned the aircraft and still landed safely with only minor damage, a manoeuvre that could not easily have been achieved in an aeroplane.

For autorotation to be self-sustaining, airflow over the rotor blades is required, however they must be turning fast enough to maintain rigidity before autorotation can be achieved. A mechanism was required to get the blades turning at this minimum speed while still stationary on the ground. Early efforts involved spinning the rotor by hand (if it was small enough) and on bigger rotors, spinning it by a team of horses or a mechanical driveshaft connected to a ground based engine such as a car. Such methods didn't allow the autogiro to operate independently of ground based support and a better solution was needed. Cierva tried designing the tail of the autogiro to deflect propwash into the rotor which did turn the rotor but not fast enough to allow takeoff without further building up the rotor speed by accelerating down a runway of reasonable length.

Cierva was several designs down the track by this time and in 1930, his C.11 model utilised a driveshaft connected to the autogiro engine via a clutch. The initial version added so much weight that it wouldn't fly but by 1931 the approach was being used successfully by Harold Pitcairn in his PCA-2 'autogyro'. Pitcairn had acquired the United States licensing rights for Cierva's invention. In 1932 Cierva successfully incorporated the system into his own design, by now the C.19.

Autogyros still required a short take-off roll however, until in 1933, on his C.30 design, Cierva again incorporated cyclic pitch variation in the rotor system. On the ground the rotors would be spun up to beyond flying speed with a neutral pitch setting. The spin-up mechanism could then be disengaged to eliminate the torque reaction and then pitch applied to the rotors which would launch the autogiro vertically off the ground. This became known as the jump take-off. The C.30 also provided the pilot with a direct means to tilt the rotor head for directional control. A relatively simple and refined rotorcraft was now available and more than 180 of them were manufactured.

In the late 1930s, helicopter development was proceeding apace and by 1941 Igor Sikorsky had flown his first successful design which led to an order of 400 of these new aircraft by the U.S. Army. Although helicopters had a smaller speed

envelope than autogyros of the time, they could hover, and funding flowed into Sikorsky's company. Helicopters had also been under development for a long time by then (about as long as airplanes), and the general public could understand the concept of a powered rotor much more so than an unpowered one which they didn't necessarily trust (even if it provided a much safer way to fly than either airplanes or helicopters).

In 1936 at the age of just 41, Cierva was killed in a DC-2 commercial plane crash. He had been one of the driving forces behind the autogiro movement. Further commercial autogyros were produced (a future article in KiwiFlyer perhaps) but the movement never recovered from the near simultaneous loss of Cierva and the birth of the helicopter.

Thanks to jefflewis.net for some of the information used in this article.

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