ROYAL AERONAUTICAL SOCIETY
Loughborough Branch

21 November 2017

Designing the e-Go light aircraft

Giotto Castelli – designer and founder
e-Go Aeroplanes

In 2007 the Civil Aviation Authority (CAA) introduced legislative relaxations with the intent to encourage the design and development of aircraft in a new category – single-seat deregulated (SSDR). This would be a microlight which was likely to be operable almost as a light aircraft. A summary of the main design requirements is:

- Single-seat
- Maximum empty weight 331lb (150kgs)
- Max all-up weight 660lb (300kgs)
- Stall speed <35kts
- Private flight use, by day, in VFR, and only over non-congested areas
- Pilot must be in possession of an appropriate microlight licence

Our speaker explained how it influenced him to exploit the opportunities he believed were offered by the new design category.

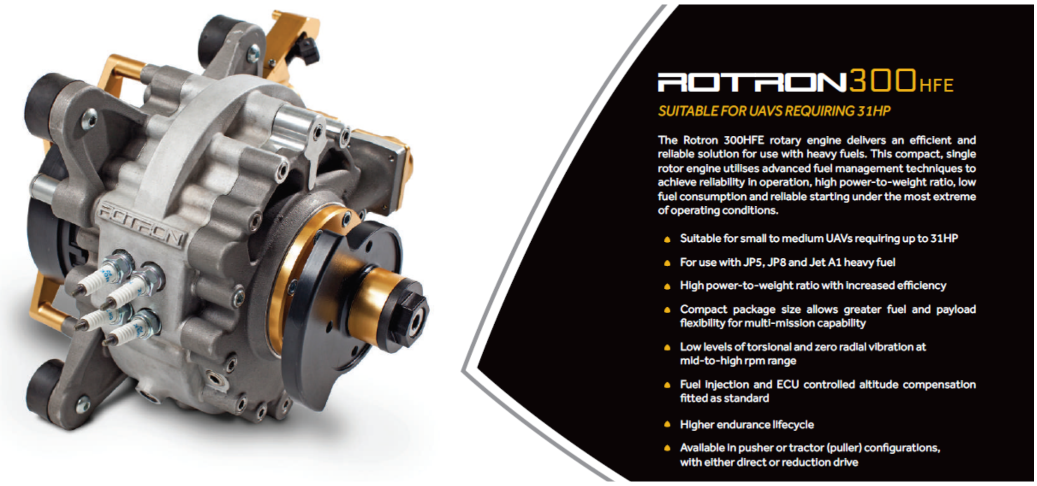
He was already well-versed with design, having taken a BSc in Aeronautical Engineering, and an MSc in Aircraft Design. He also had a light aircraft pilot's license. He became a contractor design engineer and worked for several years on the conversion of configuration data into detail component designs for companies such as Pilatus, Airbus and Raytheon. In these roles he became familiar with procedures for meeting certification and design authority requirements, and whilst it was design experience it did not stimulate the designer talents that he believed lay dormant.

Hence, when the Light Aircraft Association (LAA) launched a design competition in 2007, specifically seeking designs that applied the new CAA rules, Giotto Castelli's leap of courage was to present an innovative submission and his E-Plane (later to be called e-Go) concept was declared the winner.

The e-Go concept is based on a simple and compact configuration

With support, both technical and financial, in September 2011 he set about converting the design concept into a flyable example, and his presentation was a deep explanation into how he proceeded through various design stages, the manufacture of a prototype, and the outcomes of the testing phase. He also highlighted several significant changes to the design.

His starting point was configuration. The selection of a canard design was an intuitive choice, his main rationale being that over-the-nose visibility was of paramount importance, and by adopting a layout where the engine could be behind the pilot and the foreplane could be low on the fuselage he met this requirement. It was compatible too with a fully-enclosed cockpit within a low wetted area fuselage. The layout provided comfortable accommodation for the pilot, and full protection against the elements when flying.



The engine is an innovative package in itself – a flight-cleared rotary cylinder (Wankel) engine with water cooling

He chose a Rotron 300 single rotor (Wankel) engine with 300cc capacity, capable of delivering 30hp and driving a 3-bladed 3ft 11in (1.2m) diameter propeller. The compact engine is located behind the pilot's seat, and the installation includes neat small cooling radiators in the mainplane roots and directly adjacent to the engine bay. There is a 6 Imp gall (27 litre) fuel tank and the fuselage rear section profile presents relatively undisturbed flow to the pusher propeller, and ensures good propulsive efficiency. The landing gear comprises two flexible main gear struts and the nose gear unit is, similarly, a low-weight composite material unit located in line with the canard surface.

Simplicity and elegance do not come without forethought – this rear view shows the clean and efficient lines of the fuselage, the radiator installations and the effort devoted to ensuring minimal disturbance of air coming towards the propeller

The canard is an unswept surface with a rectangular plan, and the mainplane has modest sweepback and is tapered. The canard is set lower than the mainplane on the nose, and the mainplane is at shoulder-level on the rear section – total fuselage length is only12ft 9in (3.9m). The canard surface carries the elevators, and the mainplane has ailerons. There is a fin at each wing tip each incorporating a rudder. The aircraft does not have flaps or airbrakes/spoilers.

He described the relationship that affects pitch moments between lifting surfaces and the aircraft centre of gravity (CG). The configuration assures little CG change with pilot and fuel mass variations, and there is no tendency for the aircraft to pitch nose up when the pilot climbs out (as has happened on many 'tandem-wing' designs). In steady level flight the canard surface tip vortex passes below the wing, but in high-incidence flight conditions this is not always the case. He illustrated surface flow interactions using photographs of the canard and mainplane from wind-tunnel tests on which flow-visualisation techniques showed regions of clean and disturbed flow regions at different flight conditions. He discussed the options he considered to moderate the impact of flow interactions on handling qualities. The prognosis was that impact was minimal, and that was probably a fact attributable to the low wing-loading demanded by the certification requirements. He was confident of positive longitudinal pitch stability but showed how the aircraft, in initial trials, had a very low stick force/g characteristic. This was deemed too 'light' and the desirable increase was achieved through modifications introduced during flight trials which changed the slot geometry of the foreplane elevators.

Directional and lateral control was positive, and a tendency for directional control to deteriorate at very low speeds was counteracted by changing the wing-tip located fin design – initially adding area below the wing surface and later by having a slight increase in the sweepback angle of the upper portion of the fin. He described these characteristics and showed films of flight trials.

The prototype e-Go was first flown on 24 October 2013, and trials conducted using a number of test pilots. Confidence was high, and by the time of the LAA annual meeting at Sywell in 2016 a very spirited display was conducted. The agility of this relatively low power and lightweight aircraft, viewed from within and from ground cameras too, was impressive to say the least. The aircraft was looped and rolled – always positive-G he noted - and an enviable turn rate was evident. He said this approximates to a 360^0 turn in 7 seconds (i.e.: over 50^0/sec). This is turn rate to envy, and indicative of what an aircraft at low speed and with low wing loading can attain. A remarkable comment was that the aircraft L/D is about 18, a high value, much of which he attributed to the effective span improvement of the wing-tip fins.

Overall, the aircraft was showing its paces as a 'sport aircraft' that would thrill the adventurous, and it has too the capacity to support the ambitions of the more mundane who would relish its 90kts cruise speed and 3.5 hour endurance. It was difficult to deny that the designer had moulded design requirements and operator desires into a configuration that is technically and operationally well-suited to its proposed market.

Production plans for the design were suspended in November 2016, but there are plans for re-capitalisation, and the speaker was hopeful of a positive outcome, with sufficient funding to attain steady production in the near future.

When answering questions he confessed that the price will not fall as low as many potential customers have wished to see, and he made clear that it would be manufactured using mainly existing tooling. The prototype has been a one-off and production techniques were investigated when building a second aircraft for a client. Now some parts of the internal structure are being re-designed for production, and he was hopeful that a competitively priced product would be attainable.

The aircraft in the foreground is the second example built, and the prototype in the background shows the modified wing-tip fin that will be adopted for production.

The presentation was largely technical, but delivered with a degree of passion that revealed the speaker's deepest and most genuine desires to achieve outcomes that trials subsequently proved to be well founded. There was a delightful sense of restraint when he showed a picture of himself being strapped into the e-GO to conduct his first flight in the type: clearly it was an emotional experience, and a designer/pilot attainment to cherish for a lifetime.

Attendance was approximately 100 people, and the enthusiasm of the light aircraft elements was clearly heard in questions and in the vote of thanks, and then measurable in terms of the considerable number of people who wanted to discuss his work before leaving.

Lecture notes by Mike Hirst