Duo Discus Aerodynamic Study

(Translation from Tomahawk Aviation website, https://tomahawk-aviation.com/eu/)

The basic concept from which we started for choosing the perfect airfoil for the Duo Discus (DD), was the glider had to be **exciting and enjoyable**. According to Tomahawk Aviation philosophy, this means designing a **fast glider**.

As it was not intended to be used for any specific competition class, there was no reason to change the overall geometry. In addition, for a non-competitive use, we considered appropriate and useful to remove the air brakes and to extend flaps until the inner part of the wings. Flaps chords were fixed at 25% of the wing chord. Furthermore, in order to have efficient flaps, their chord was increased with respect to the scaled original glider (around 17%). Initially, the first version of the Duo Discus was designed without winglets, since in the fast flight they do not bring any benefit. Later, also removable winglets were developed being sure they did not slow down the response of the model in flight.

The airfoil was not simply selected among the available ones. On the contrary it was generated using a calculation software. By means of a multi-criteria algorithm (according to a Pareto logic), some design parameters were identified like e.g. (in addition to the airfoil itself) the wing twist. A 3D-panel model, in which a 2D model is embedded for the calculation of the viscous drag and a specific structural calculation, has provided numerous parameters to predict the overall behaviour of the model like the optimum gliding angle or the max efficiency flight speed for the horizontal flight and for manoeuvres. By analysing the solutions of the different iterations with a statistical approach, again with a Pareto logic, different possible solutions were defined. Finally, the best one was selected manually.

The convenience of this multi-criteria optimization approach is, it is not necessary to decide in advance between different performance criteria. With the coupling of 2D and 3D aerodynamic calculation models, it is possible to evaluate the airfoil behaviour together with the wing geometry. In this way, it is possible for instance to verify if the glider has critical flight characteristics and their impact on the model performances.

At the end of this simulation and selection process, the airfoil geometry resulted to be like an RG-15. Nevertheless, due to the fact the Duo Discus is a scale glider and not a F3F class model, the airfoil showed to be a bit more performant in the thermal flight with respect to an RG-15. Some data:

- the wing-root airfoil has a thickness of 8.88% with a 1.76% camber;
- the wing-tip airfoil has a thickness of 8.41% and camber 2.84%;
- the airfoil thickness at the wing root has been then increased (11.39%), in order to have the space for installing an electrical connector for cables and to increase the structural stiffness.

The wing also has a geometrical twist. Thanks to the increased airfoil camber at the wings tip, structural resistance is improved and at the same time the lift distribution at high-speed flight has been considered. Therefore there will be not any anti-aesthetic drop of the wing tips during the fast flight. This precise set-up cannot be obtained manually but it requires mandatorily modern numerical calculation methods. The manual revision of the results and a second check with a separate and independent tool, ensure the validity of the project also from an engineering point of view. The wing is installed on the fuselage with an angle of 1.20°, the horizontal tailplane has an angle of 0.62° with respect to the wings. That means, the horizontal stabilizer has an angle of 0.58° with respect to the wings. The stabilizer setting has not been optimized for the best gliding rather for a high speed flight, so that the Duo Discus does not have to fly nose-down in high speed flight. The adjustment of the elevator during thermal flight is reduced by means of the modification of the wing camber (acting on flaps). The optimization algorithm calculates a flap rotation of around 7° (around 8 mm at the wing root).