Rapid Prototyping application in the aerospace sector: Windform GF and SLS Technology

1:8 Scale Wind tunnel model of the external fairing of the European TILTROTOR

Among the most interesting and significant applications in the aerospace sector, developed thanks to the collaboration of our partners, is with no doubt the wind tunnel model of the **European TILTROTOR,** realized by the Rapid Prototyping Department of **CRP Technology** for **AGUSTA WESTLAND** during the first months of the 2007. This project allowed us, once again, to highlight the perfect union between RP technology and WINDFORM materials. Thanks to the WINDFORM materials, it was possible to complete and test the model in the wind tunnel within a very short time, with excellent results and with really high-performing mechanical and aerodynamic properties.

The project related to the manufacturing of the external fairings of a wind tunnel model (1:8 scale) for the prototype of the European TILTROTOR, made by Rapid Prototyping and WINDFORM® GF material. This mock up was designed by AGUSTA WESTLAND for a research program, sponsored by the European Community whose aim is to develop the European TILTROTOR.

Goals

Agusta's main goals, and therefore the reasons why they referred to CRP Technology, were essentially the following two aspects:

- The requirement of a very short timetable, but with a very good quality, in order to manufacture the external fairings for the wind tunnel model;
- The research of materials with high mechanical and aerodynamic characteristics for these components that usually would have been made by a classical composite material (pre preg glass and curing in a specific mould).

This detail is crucial to the applied loads it has to be sustainable and therefore they can't be underestimated. In fact, the aerodynamic load by the wind in the tunnel, which reaches a speed up to 50 m/s, is very high.
The most critical aspects of the project are therefore the resistance to the loads, but also the necessity to maintain good dimensional tolerances of such a large dimensioned component (L = 2 m) under load. It is important that the components of the fairings don't deflect too much under load. In addition, even when there are no external loads, the product must have dimensional characteristics in respect of the supplied specifications.

It is important to remember that the performance of these pieces affects the final performance of the entire project, especially because the external fairings have to transfer the aerodynamic loads generated by the fuselage to the internal frame.

Historically such components would have been made by a classical composite material technology (pre-preg glass and curing in a mould). The restrictions of this technology were generally the quite long manufacturing time. The manufacturing process of these components by classical composite lamination actually would require the set up of special construction designs, which needs time. Moreover, the time to design and manufacture the mould would have to be added too.

Rapid Prototyping combined to the WINDFORM GF material has instead immediately convinced our partner, thanks to its very short manufacturing time and the high properties of the material. Obviously the cost is a variable that always has to be considered: even if it is true that the costs of the traditional technique could be slightly lower, the really short delivery time of this technique is valuable enough to justify a small increase of the price.
The only two disadvantages could be the slightly wider dimensional tolerance range compared to the classical composite lamination and the reduced surface finish. Despite this, the advantages are stronger and the client chose the RP & WINDFORM package, with extreme satisfaction.

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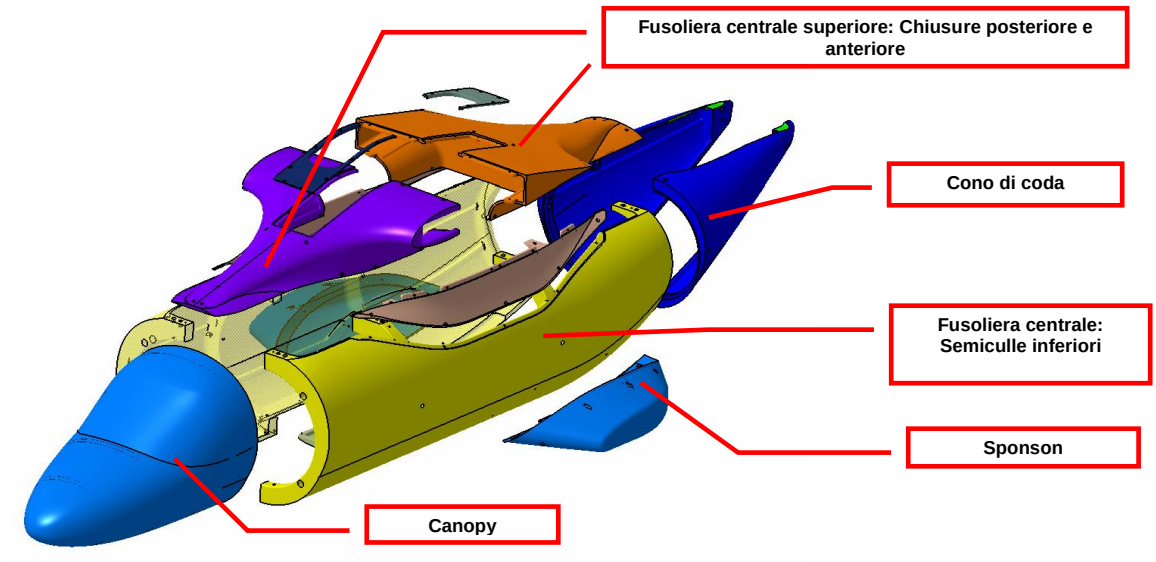
Result

The activity of our Rapid Prototyping Department has been based from the beginning on the maximisation and achievement of the requested goals.
The work started from a careful analysis of the 3 dimensional designs received from our client.
The choice of the WINDFORM® GF material was not casual, all the goals required by our partner were considered, such as the importance of a short realization time, good mechanical performances and also good dimensional characteristics.
In fact, Windform GF is a composite polyamide based material, aluminium and glass filled, appreciable for many applications such as wind tunnel, because of its high heat deflection (HDT), superior stiffness, first-rate detail reproduction (almost comparable to SLA), gleaming metallic look and the excellent surface finish. Thanks to the wide ranging experience of the department in this market and thanks to the detailed knowledge of the materials and the technology, it was possible to assist the client in the choice of the best technology and the best materials.
The first difficulties concerned the very high dimensions of the prototype: since most of the components were dimensionally much superior to the construction volume of the Rapid Prototyping machines, it was necessary to manufacture separately the single parts. The long experience and deep knowledge of this process by CRP's staff have allowed the analysis, the study and the consequent perfect creation of such a complex project without any delay or problem for the client.
From the beginning the work was focused on the designs of the components, with a correct split of the parts, considering of course the working conditions and the stress that the components would have to sustain.



Exploded view of the external fairings made in WINDFORM GF

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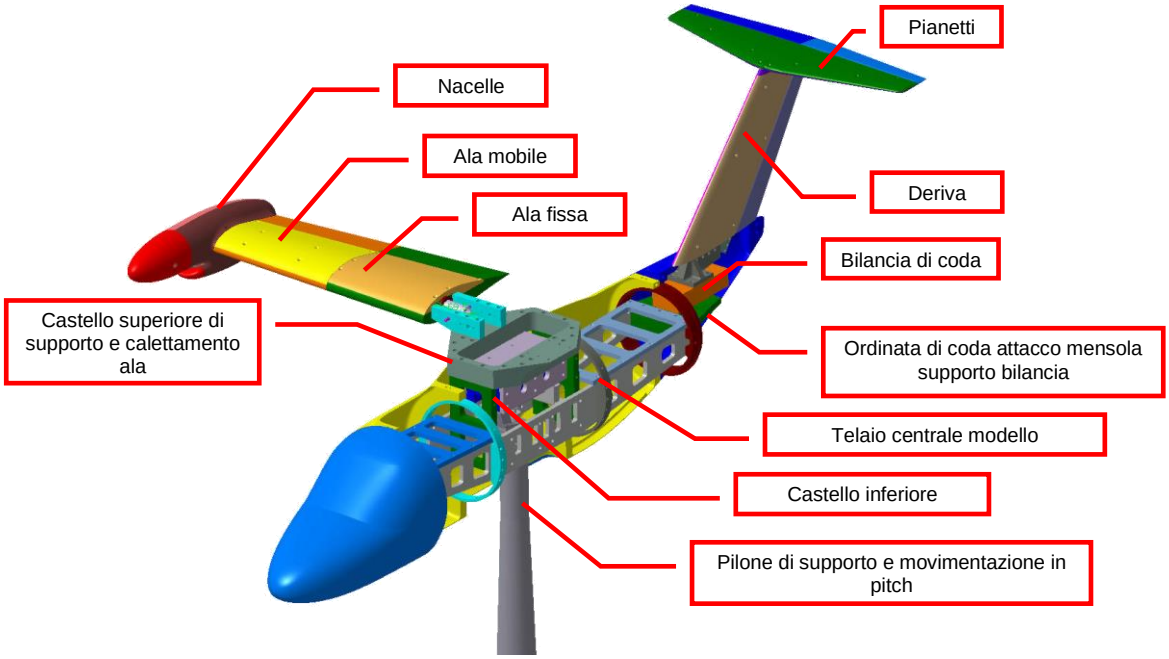

Exploded view of the entire wind tunnel model

Identifying the parts to split was an operation undertaken with the CAD, evaluating the functional measures of the working volume but also the possibility to optimize such volume and minimize the production time and costs.
The CAD cut was done with a special technique in order to maximize the contact surface in the place where the structural adhesive would be applied, thus having, also for very big parts but with relatively thin thickness, a great resistance to any kind of stress.
Therefore the unique technical characteristics of WINDFORM GF remained absolutely intact.

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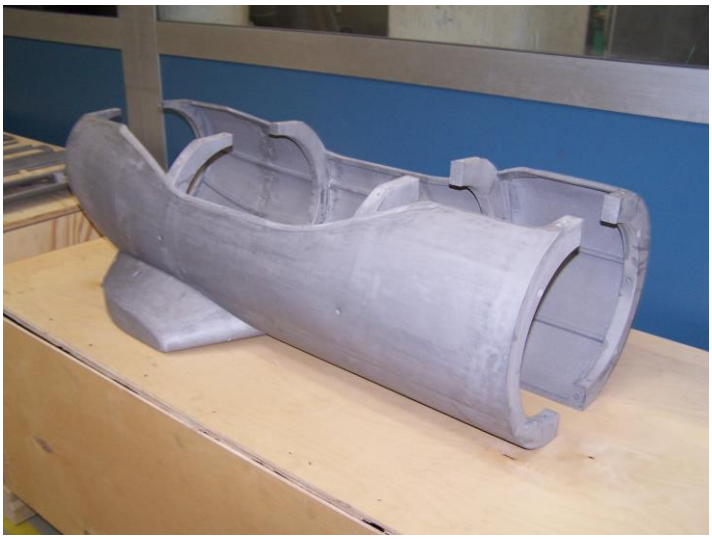
Front and rear dorsal parts of the central body fairings

Tail cones details and reset plugs made in WINDFORM GF

The creation time of the single parts was really short: not much more than one day was necessary to manufacture the Jobs to set on the RP machines and, after only 4 manufacturing days, all the various parts of the components were already physically created. These would have been then mounted thanks to a dedicated rig assembly. Different confidential efficiencies, which are an integral part of CRP's specific know-how, allowed the reduction of the delivery lead time and allowed us to minimize the normal tolerances of this technology, and eradicate any potential problem of deformation or out of tolerance.



Central body external fairings

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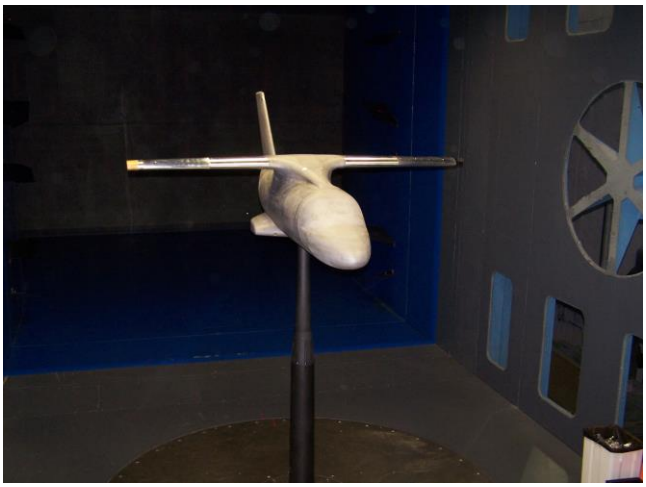
This step was also a success. The timetable was as the client had required and only three days were necessary to complete the bonding and the assembly of the model.

Final assembly of the TILTROTOR wind tunnel model

The final step was the complete model surface finishing, directly mounted on the rig assembly in order to optimize the small imperfections that could have come from the union of the single components. In this case too, CRP's know-how, that has to be maintained confidential, allowed us to execute this step in a very short time: it was therefore enough to flatten the surface of the whole model in an efficient way and treat it with a special liquid that has the double function to make it waterproof and prepare the surface to be painted without any problem.

The final result, in line with the timetable and characteristics of the part, has been tested in the wind tunnel.



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