A demountable composite wing box for private planes

The quest for lower environmental impact throughout an aircraft's service life along with increasingly stringent passenger safety requirements are leading to extensive research in the design of new airplane models.

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The E-Fan project for the first all-electric, all-composite stunt plane was initiated by Aéro Composites Saintonge (located in France's south-western Charente region) and financed by Poitou Charentes department, Fedex, Aquitaine region, Frensh State and Airbus. Under the project, Rescoll and the Institut Pprime physics and engineering research laboratory worked together to design the E-Fan's wing unit and monitor its test validation. Validated by the French civil aviation authority DGAC, the composite wing, which was inspired by Colomban[1], or classic, architecture, demonstrated that it is possible to build an electric private plane – the first step towards the potential future use of the technology for very large transport aircraft.

Neofac wing tested up to 13G on Rescoll's benches

The Neofac project

As a follow-up to the E-Fan project, SRC Rescoll (located in Bordeaux and Rochefort) and the Institut Pprime research laboratory (which is affiliated with the National Higher School of Mechanics and Aeroengineering ISAE-ENSMA and the University of Poitiers) decided in 2015 to continue their research on the development of innovative aeronautical structures. The partnership of stakeholders from the Nouvelle Aquitaine region initiated the 2½-year-long Neofac project, which was 50% financed by the European regional development fund FEDER, out of a global budget of about €500,000. "*The Neofac project consisted of designing, fabricating and testing the full-scale prototype of a demountable composite wing box for a private plane, subject to Section 23 of Federal Aviation Regulations (FAR).*

Focus

The **Association des Structures de Recherche sous Contrat** (ASRC, an association of contract research organizations) unites some forty private R&D organizations from all over France. These are recognized by the French public investment bank Bpifrance for their capacity to provide companies with innovative solutions in a number of sectors, including health, food processing, energy, materials, transportation, logistics, NITC, defence, and safety. ◻

www.asrc.fr

(1) For French aeronautical engineer Michel Colomban, who designed the world's smallest twin-engined airplane in the 1970s.

Neofac profil

Rescoll and ISAE ENSMA carried out numerical simulations that enabled them to come up with a structural design and to optimize it even beyond the initial requirements for private planes, so that it is able to support the 12G (1) required to obtain DGAC certification for aerobatics. Mechanical tests on semi-structures were used to make the numerical models more reliable and predictive, and to carry out a reliable virtual optimization," said Anne-Sophie Andreani, project manager at Rescoll in Rochefort.

While the composite wing box is a structure that dates back to the 1990s, it has been used primarily on fighter aircraft, using very high-tech manufacturing processes.

"A demountable wing with a wing-box architecture is less run-of-the-mill, and transferring that architecture to private planes required adapting to the manufacturing means of smaller businesses," Ms Andreani went on to explain. Pika, a company in Bayonne, took up that challenge under the Neofac programme and made the prototype. The composite wing box consists of a single part in the form of a hollow, compartmented box with web along the entire length. This new architecture was created in a one-shot autoclave process. The advantage is that by reducing the number of manufacturing steps, tools and consumables, the manufacturing cost is also reduced. The wing box must be able to support all exterior loads to which it is subject. Compared to a wing of standard design, the loads are carried entirely by the skin and web, rather than through spars. Reducing the number of parts (ribs, spars) reduces the areas for weight, and the new architecture helps optimize the wing's mechanical performance. The adaptable thickness of honeycomb sandwich, which is developped by Pika, skins also provides better buckling resistance without additional weight. Ultimately, the wing box has 23% more bending stiffness with no torsional phenomena at wing tip, and 10% less weight compared to a composite wing of standard design.

Validation

In its structural characterization laboratory in early November 2017, Rescoll tested the full-scale demountable wing box according to the protocol recommended by the DGAC. The test programme proved that the wing as designed is able to support the 12G (rupture occurred at 13G), i.e. 40% more than the wing design under the E-Fan project. These full-scale assessments confirm the results that were previously obtained with Rescoll's and Institut Pprime's predictive design. *"This technical success encourages us to continue with our development and validation work on innovative aeronautical structures,"* concludes Mr. Nicolas Vetel. The Neofac II project under preparation will involve creating a full-scale demonstrator that includes the fuselage. ◻

More information:
www.ensma.fr/lisae-ensma-en-exclu-sur-facebook-et-youtube
www.youtube.com/playlist?list=PLBM-LrjCs0B9IJ06Jp-S76-pjUCDHmzv
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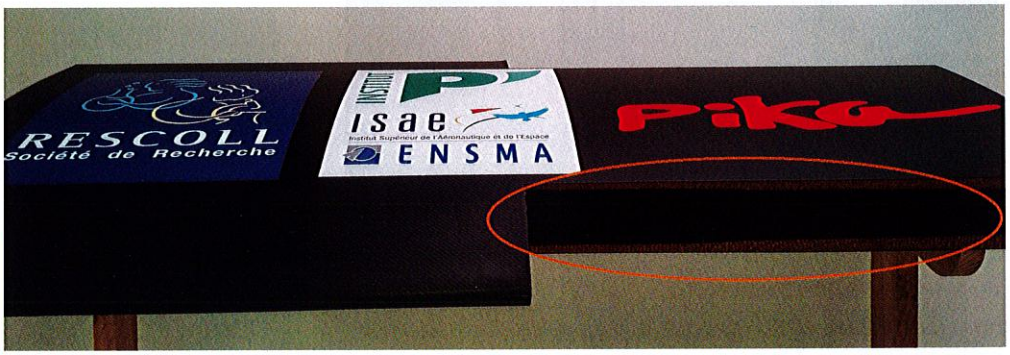
Institut Pprime – UPR CNRS3346 is an in-house lab of the French national research centre CNRS. It was created in 2010 in partnership with the National Higher School of Mechanics and Aeroengineering ISAE-ENSMA and the University of Poitiers, and brings 600 people together. ◻
www.pprime.fr

Focus

Rescoll is a contract research company that specializes in technical innovation studies in the field of industrial applications for polymmaterials like composites, resins, adhesives and coatings. ◻
www.rescoll.fr



Adaptative thickness of honeycomb sandwich, made by Pika