Changing the way we fly

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An airplane roaring down the runway and into the air is a familiar sight to most travellers today. In fact, this image has not changed much in 50 years. While significant advances have been made in terms of fuel economy, engine design and noise reduction techniques, the basic tube and wing shape of airplanes, and the material used to build these aircraft, has remained largely the same for years.

This however is not the case anymore. Like many products that have evolved dramatically in the last few years - phones for example - aircraft design is changing. Today more than ever, researchers are pushing the boundaries of the science of flight in their effort to make aircraft more efficient, quieter and greener. Future aircraft are predicted to become even more efficient and dependable. But how will they reach these goals and who is doing the important work to change the way we fly? The common misconception is that most advances come strictly from major aircraft manufactures, but the true story is more complex.

The EU-funded WASIS project is a great example of this. It is working on a composite fuselage structure based on the lattice (wafer) stiffening concept, which will improve the development of fuselage structural joints. The project's overall concept is focused on meeting stringent environmental and safety demands together with design and manufacturing cost-efficiencies. The lattice or wafer approach allows composites to obtain more efficient mechanical behaviour, reducing weight and optimising structure performance. This will be combined with specially designed semi-loop and micro-pin joining elements to facilitate innovative non-regular lattice structure manufacturing and reduced aircraft weight.

The ultimate aim of the project is to develop new medium-sized planes. While major manufacturers are concentrating on creating aircrafts that are 20% more efficient and bigger, the reality is that the world is saturated in terms of big airports. The growth of airports is limited by land space or air capacity. Fuel prices are not the only dark cloud on the horizon. Additional taxes and regulations, e.g. regarding environmental issues, (mainly noise, $CO2$ and NOx emissions), place further financial pressure on airlines, which in turn look for opportunities to reduce costs in their balance sheets.

Thus airlines are trying to lower aircraft landing charges at airports, in some cases by threatening to divert their traffic to alternative locations. The reality is that the future belongs to medium-sized planes that can service smaller airports at a low cost.

Secondary airports or smaller airports not only offer specialised services for low cost carriers, but also for other customers, e.g. business aviation, general aviation, cargo or the military, which will experience strong growth. This is exactly what this new breed of medium-sized plane is for.

The fuselage is the main body section of the aircraft, which holds the crew and passengers or cargo. In the past few decades, modern aircraft have been made out of aluminium, though recently, some airplanes have been constructed with composite materials, such as the Boeing 787 and the Airbus A350. Both fuselage and wing structures are made primarily of carbon fibre-reinforcedpolymer. The WASIS project is assessing the safety of this material through simulation and virtual testing, from the very first design stages. The developed innovative fuselage section design will then be merged with high-productive filament winding technology to reduce manufacturing cost and time. Samples will be manufactured in order to prove how the different concepts fit together. Complete testing of the samples will be applied to prove the wafer approach.

In its first year, WASIS explored the wafer structural approach and designed a new fuselage section based on the Piaggio P180. This prototype fuselage section was designed to bear the same load cases as its metallic reference structure. Sizing was initially performed analytically, followed by static and dynamic FEM simulations. These were conducted to determine stiffness, failure indexes and behaviour under different impact situations (such as emergency landing situations, hail damage, or low speed impacts). Also during this first year, demonstration pieces were designed and manufactured by consortium partners to demonstrate the feasibility of the manufacturing processes (filament winding and tape placement) at the first year review.

WASIS is currently in the final stages of its second year. Focus has been on improving the fuselage section design, and the project team has started researching the micro-pin joints and the reels that will be used on the structure to avoid cutting fibres and improve the load transfer from the metallic frame to the composite section. The design and first manufacturing trials of the attachment frames, which will be the metallic interface between the composite section and the rest of the plane, have been discussed.

Several scaled down prototypes have been designed using buckling behaviour as the reference scaling criteria. Two different size prototypes have been designed: one will be 1 m in diameter, while a second will be 0.5 m in diameter. Different manufacturing assessment trials have been conducted to make sure all the concepts can be included in the production of these prototypes. Also, different tests have been run to optimise the mandrel materials and performance. In the last year and a half of the programme, WASIS will be manufacturing prototypes and will start a testing campaign based on a constructed building block approach, to effectively demonstrate the performance of the structure and validate the developed design. The end result will be a medium sized, general aviation pressurised jet with a diameter not exceeding 3m.

More information: For more information, please visit: WASIS - www.wasis.eu/

Provided by CORDIS

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