Less is more: Clean Sky’s advanced manufacturing techniques conserve resources and minimise wastage

To maintain competitive advantage, and to address an annual 5% growth in air travel, Europe’s manufacturing environment needs to accelerate the pace of aircraft production. Innovative tools and processes under development within Clean Sky 2’s EWIRA consortium (part of the Regional-IADP) are turning to additive manufacturing (AM) and jig-less manufacturing techniques (beside others) to bring new efficiencies, minimise material wastage, and reduce cost during the assembly and integration of aircraft structures.

“Airframe manufacturers’ order books are filled up for the next eight or nine years, so there’s a strong focus on how to improve production rates” says Ruud Den Boer, Project Officer at Clean Sky.

But manufacturing and assembly in the aeronautical industry are laborious processes that consume time and resources. Added to that, global forces are at play — a concern that’s not lost on Europe’s aeronautical manufacturers:

“Aircraft manufacturing is getting increasingly competitive with more competitors appearing all across the world. It’s key for European industries to maintain leadership in aviation, therefore it’s essential to maintain an innovative technological approach to reduce the development cycle of new aircraft types while keeping or increasing quality standards. This will enable European industry to respond faster to commercial needs and concentrate resources in other innovations” says Jorge Martínez San Martín, Programme Manager at the Engineering & R+D Division at Acturri, the Burgos, Spain-based company leading the EWIRA consortium, which, with the combined expertise of the Manufacturing Technology Centre (MTC) and Caetano Aeronautic, aims to streamline production timeframes and reduce environmental footprint.
To accomplish these goals, Aciturri has created a jig-less assembly concept which cuts the timescale and cost of assembly tooling in aircraft structures, and by reducing or eliminating some of the tooling manufacturing activities, factories can reduce their CO₂ emissions.

"In order to validate this innovative assembly concept, Aciturri carried out two technology demonstrators in 2017 and 2018 to confirm its applicability for the assembly of the ailerons of the Regional Flight Test Bed 2 (FTB#2) demonstrator aircraft, led by Airbus Defense & Space" says Martínez.

"The first demo was a small scale wing box structure manufactured using fast prototyping techniques, while the second was a full scale section of the FTB#2 aileron which was assembled using an important part of the final assembly jig. This philosophy worked very well as it was possible to 'learn by doing' and solve implementation difficulties of the technology before its application to the final component, saving cost and time impacts, and also identify other potential applications increasing the outputs of the innovation line".

The conclusions following the second demonstrator proved that it was possible to reduce tooling costs by 25%. And moving forward, Aciturri expects to further mature its jig-less assembly concept in order to assess potential benefits in assembly time.

Supporting this jig-less process, some of the components of the project have been manufactured entirely using minimum quantity lubrication (MQL) technology in a collaborative development between Aciturri and Caetano Aeronautics, reducing environmental impact and metal machining activities costs, while improving efficiency.

Another significant factor that underpins the EWIRA project is the use of a type of additive manufacturing technology known as electron beam melting (EBM) being undertaken by the National Centre for Additive Manufacturing, part of The MTC in Coventry, UK.

"The additive manufacturing work package of EWIRA has been focused on re-design, manufacture and validation of an aileron hinge bracket, whilst reducing the component weight and waste material" says Dr. Nick Cruchley, Advanced Research Engineer - Additive Manufacturing at the MTC.

"Through utilising the benefits of additive manufacturing such as being able to produce components with increasing complexity, the hinge bracket can be re-designed allowing 13% weight and 90% waste material savings. The conventional bracket is machined from a solid block of aluminium alloy, incurring a large amount of waste material. For additive manufacture of the bracket the material selected is Ti-6Al-4V, which is twice as dense as the aluminium alloy. However, due to a complex strut based design (only possible through the benefits of additive manufacturing) the component can still be lighter by 13%".

The EBM technique involves selectively melting a bed of powder in a layer-wise fashion. The process occurs in a vacuum, providing protection to environmental gases such as oxygen and nitrogen which titanium is susceptible to picking up at high temperatures. By melting only the powder necessary to make the component, and with the ability to re-use any leftover powder from the process, waste is dramatically reduced.

"A large test programme is currently underway in this project to evaluate the EBM process variables and material properties of Ti-6Al-4V" says Cruchley. "This information will be key in validating the component design and maturing the EBM technology for upcoming flight test programmes".

As for the social and environmental benefits, Aciturri’s Martinez anticipates that the EWIRA project’s technological advances will "directly drive a reduction of the CO₂ footprint of the manufacturing and assembly activities through tooling simplification, task time reduction and waste material reduction". Additionally, he says "reducing water consumption and non-biodegradable lubricants use, thereby leading to reduction of the environmental impact of metal manufacturing techniques. And a further positive outcome will be the reduction of CO₂ emissions in aircraft operations through parts and components weight reduction".

From the Clean Sky perspective, Project Officer Ruud Den Boer adds that "This jig-less integration of components is very promising and there’s a lot of ongoing research at Aciturri which will provide Airbus Defence & Space with some tools to improve the production process. The project focuses not just on increased production rates but also on the quality — for instance, on alignment of hinges for ailerons and flaps — and also on reducing the costs. It’s estimated at this stage that jig-less will save between 20 and 25% of the recurrent and non-recurrent costs".

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