PROUD

Precision Outer Wing Assembly Devices

State of the art – Background

Actually assembly processes in aeronautic structures confront several main challenges;

-How accurate we can be?
Today's limits of cost effective accuracy are aligned with the 1 mm max in big structures assemblies due to the high cost that could involve to reduce that limit and to the usually handcraft condition of the aeronautic structure assembly process.

-What is the real added value of tooling accuracy in the assembly process?
The impact of process on parts, the proper tool deformations due to the weight of tool and parts the manual positioning methods and the required measuring process makes the decision on the tooling accuracy to be based on past experiences or to the dividing factor of three, means the total tolerance will be divided in equal parts between the part manufacturing, the assembly tool and the manual assembly process. We need to have concrete data to understand the impact of all factors at the final product tolerance and be able to make it cost effective.

-What level of automatic procedures can we apply to positioning?
The action of positioning parts is manual actually; the idea of the use of robots will avoid the mechanical positioning references that are a problem for accuracy and for time also the chance of parts recognizing will let us study the multi program use of an automatic tool.

-Could we have a continue measuring and control system?
The fact of the use of cameras and image processing in the industry is everyday more usual, the application of this technology to control and measure "during process" assembly could allow the productions lines to avoid measure check stops and keep assuring the correct tolerance on parts assembly during the assembly.

Objectives

- Demonstrate technical viability of manufacturing high precision tooling that will impact directly at the aircraft assembly;
- Research on tooling manufacturing affordable limits to achieve the very high precision assembly;
- The study of the real specimen own deformation impact on the final assembly process;
- The study and demonstration of the robot positioning implementation technologies at high accuracy structure assemblies;
- The study and demonstration of alternatives imaging measuring ways to be correlated with the latest laser measuring technology;
- The new study of the complete assembly process to evaluate new technology insertion and its impact;
- Economic viability study of the implementation of new technologies based high precision assembly added with photogrammetric and automat zed portioning systems;
- As the end goal of the project, the demonstration of these different advances at the complete wing;

Clean Sky

Description of work

The project approach innovative solutions for the design and manufacturing of the tooling needed for the assembly of two different kinds of configuration for the outer wings within a smart fixed wing aircraft.

PROUD understand that the main requirement for this wing structural part is based on their high dimensional stability and tight geometrical tolerances to compliance with surface quality for a natural laminar flow condition, and therefore stability control and manufacturing precision over the integration tools to be designed and manufactured shall be strict.

PROUD (Precision Outer Wing Assembly Devices) project of Clean Sky program, SERTEC has worked on two different parts:

- High precision new concept tools for wings assembly and panels positioning with precisions of less than 0.1mm.
- Robotic and automatic wing assembly of parts; the goal of this project has been to be able to work in an aircraft wing assembly with anthropomorphic standard robots for the positioning, drilling, riveting, sealing and checking all the different parts of the assembly.

With respect to the high precision tooling, the project has achieved innovative solutions for the design and manufacturing of the tooling of two different kinds of configuration for the outer wings. The tools main requirement was based on a high dimensional stability and tight geometrical tolerances to compliance with surface quality for the natural laminar flow condition for the BLADE test. Stability control and manufacturing precision have been the two main characteristics that have been taken in account by the skilled and qualified aeronautical tooling designers and manufacturing engineering team involved in the project jointly with our main partner AERNNOVA and their high experienced wing assembly team.

Two Main Jigs (12 meter length by 4 meters high by 4 meters wide) have been manufactured and measured under diverse conditions and the goal to be able to manufacture such big structures with precisions under 0,1mm have been achieved. On top of these massive and precise structures is still left the assembly of mechanical locators to be able to install the different parts of the wing. Those locators have been manufactured with new innovative assembly technologies to assure the tight tolerance gap we maintain for this type of project.

With respect to robotic and automatic wing assembly, huge structures and aeronautical products are assembled in an automatic manner. But, in small parts or limited assemblies, the human based assembly process remains as the only way to go, forcing subcontractors to move to lower cost countries to achieve costs reductions in the process. SERTEC has developed a new way, using intelligent systems and high precision robots to accomplish small parts assembly automatically (or with low human interaction).

We have designed and built a one-of-its-kind technological demonstrator, in order to test new systems, and to achieve the full automatic assembly stage. Our goal has been to obtain the «best fit» position of several wing parts (ribs and spars) of a 1:1 scale dummy.

Thanks to high accuracy robots and to flexible grippers, combined with high accuracy computer vision feedback systems, we have achieved the goal of best fit automatic assembly. In the future, we will move forward from assembly to other operations like drilling or riveting.

Results

a) Timeline & main milestones

The main project final result is all jigs and tooling have been designed and manufactured, it allow to assembly aircraft wing. We have applied technology innovations to obtain quality and accuracy requirements, it has force us to have a high quality control, following all activities during life-cycle Project.

We have place more emphasis to allow the best precision and quality in assembly superficial wing parts. All main jig sub-groups have been designed to facilitate the most precision as possible. For example, in blades components, we have reproduced theoretical wing surface with an 5mm offset, machining blade contour in a high precision CNC centre and checking this with measurements systems as DEA or laser. Also we have used and vacuum sucker system to keep upper and lower panel position during assembly operations.

This blades support upper panel during assembly operations, so it has been very important during assembly. The most main jig sub-group have been designed as static element, it are not disassemble in this way we got reduce minimal deviations produces during this operations.

The followed sequence has been:

Lower panel sling:

Design and manufacture this sling have been the first milestone, because this are the first manufactured part and used to start wing assembly. This sling allows move lower panels from storage to main jig. It has two hoist point and four planar contacts with clamps. This is a welded steel structure and it weight are over 2.000Kg, it can support only Lower panel or fully product too. It is very strong to avoid aircraft part deformations.

Main Jig:

It is the main assembly jig, we have RH and LH. Here the most aircraft part are assembly as Lower Panel, LE, Wing box Ribs, panels, Trailing Edge, Ailerons, Hinge Line, etc. The main structure is welded steel, the blade system for panels is made in Aluminium and the most of the other sub-group are made in steel too. This complete structure weight over 13.000Kg each one. The most of sub-groups are removable and we assembly when as needed, various can be assembled at same time but other are not compatible between them.

Finished product sling:

It is the same than panel sling but with different assy fitting. It allows move finished product to different position main jig, complementary jig and storage box. This is a strong structure to avoid deformations in final product, the assy weight over 4.000Kg and can moved easily by facilities.

Complementary jig:

The aircraft wing needs to be placed in horizontal positions to finish any assembly task. This jig has four static jacks that support sling + aircraft wing in horizontal position. Two of them allow rotating assy from vertical position to horizontal. Once on horizontal position operator can work in required tasks.

Jacking Points Fittings:

When aircraft wing are in complementary jig to finish any assembly operations, we need to elevate aircraft wing by three points. In this points we designed and

manufactured 3 spherical fitting that allow elevate it with hydraulic jacks.

Automatic wing assembly

This are the environment used for automatic wing assembly. We have used a Kuka robot, demonstrator (is a little part of main jig), and dummies (lower composite cover and aluminium ribs). All tests are made with this part.

b) Environmental benefits

The main objective of the SFWA-fix wing project to create an laminar flow wing to reduce emissions is a clear enviromental benefit but it is not directly translated to the Jigs and assembly process just as part of the overall process as it is.

So we have not created a direct enviromental impact in the creation of the project but a very important contribution in this field that implicates the potential industrialization of a process like the one created.

Industrialization implicates the capability to repeat the process in an industrial enviroment and in a cost effective way so the industry could really apply these theories in the aircraft manufacturing because they are cost effective and within the working frames of the aeronautical standards.

This is a very important contribution to the environment as if the technology is not able to be absorbed by the industry them it will have the risk of not being implemented, an important contribution for the overall SFWA-Blade from PROUD is not related to the emission reduction is to demonstrate that the project is more than a demonstrators and could be a real industry standard for the European manufacturers.

c) Dissemination / exploitation of results

During project life-cycle Sertec Company has actively participated in dissemination of the project information and results many international fair. We aimed at dissemination of the knowledge developed such as the methodological advancements and the results.

A plan for dissemination knowledge obtained during the project was developed during the first project stage, to publicize our company and the project we have developed, Sertec Company Rollup.

PARTICIPATION IN FOLLOW BUSINESS EVENTS.

- 2013
  - June:
    - Le Bourget
  - November:
    - AIRTEC Frankfurt
    - Dubai Airshow
    - CleanSky General Forum
    - Aerospace Meeting Lisboa
  - October:
    - Aerotrends Bilbao
    - Aerospace & Defence Exhibition Korea
    - Defence and Security Equipment International London

- 2014
  - February
    - CleanSky Infotoday CDTI
  - March:

        - ATM World Congress Madrid
        - JEC Paris
        - Cleansky Workshop Reporting Progress
        - Cleansky Bruselas
        - FIDAE
    - April:
        - ITEC
    - May:
        - ILA
    - June:
        - Eurosatory
        - AUTOMATICA Messe Munchen
        - Aerospace & Defence Meeting Sevilla
    - July:
        - FARNBOROUGH
    - October:
        - AIRTEC
        - Euronaval Paris
        - MRO Madrid
    - November:
        - FS Events Lelystad
        - VISION Stuttgart
    - December:

      Aeromart Toulouse

- 2015
    - March:
        - Cleansky Forum day
        - World ATM Congress
        - ITER Marseilla
        - Homsec Madrid
    - April:
        - LAAD Rio
        - CERN
    - June:
        - Le Bourget
        - SYMDEX
    - July:
        - MATCOM'15
    - September:
        - PESI
        - SICUR
    - November:
        - AIRTEC
        - ASIDI

d) Communication

SERTEC MAGAZINE PUBLICATIONS

It has made two publications in different magazines:

Skyline magazine: http://www.cleansky.eu/sites/default/files/documents/skyline-12-01_0.pdf (Pag. 10)

Parliament magazine: http://www.theparliamentmagazine.eu/articles/magazines/issue-426-25-january-2016 (Pag. 17)

WEBSITES

CS SFWA link:

http://cleansky.eu/content/page/sfwa-smart-fixed-wing-aircraft

Also referred to the project on the website of the company:

http://www.sertec.net

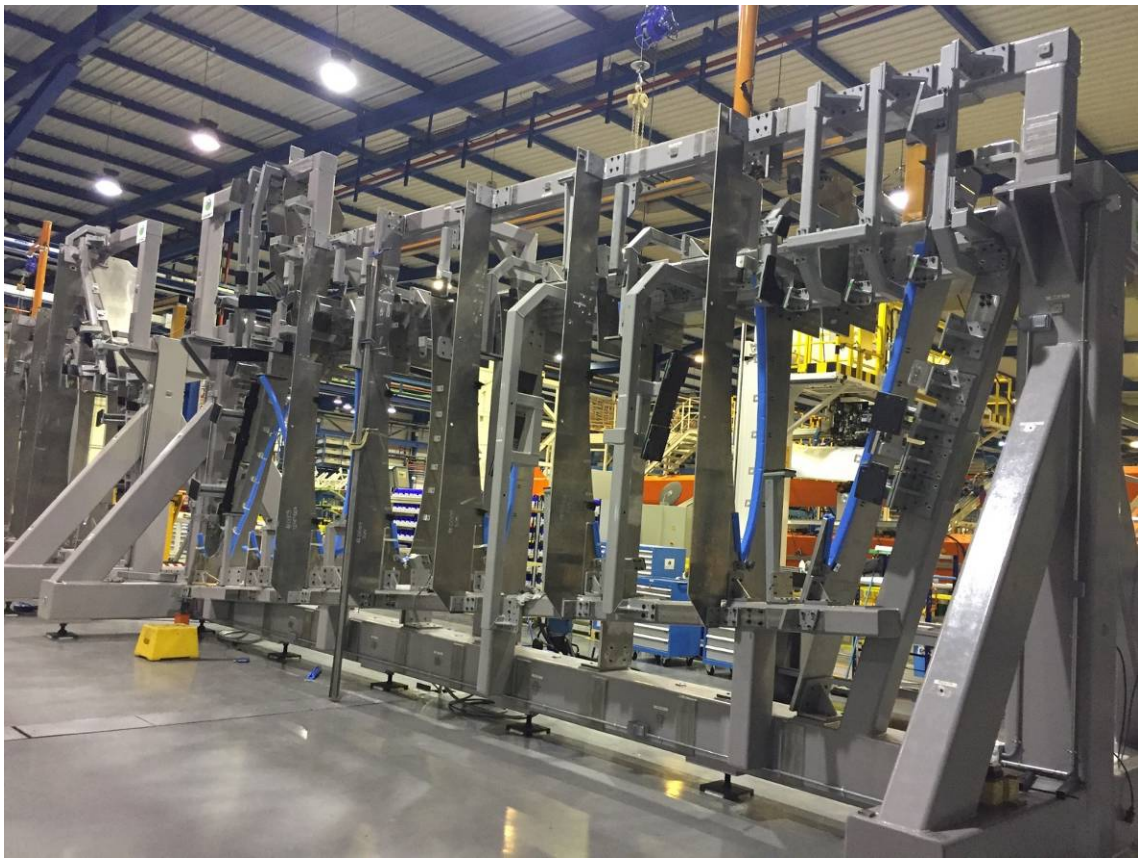

Figure 1: Main Jig

Figure 2: Complementation station

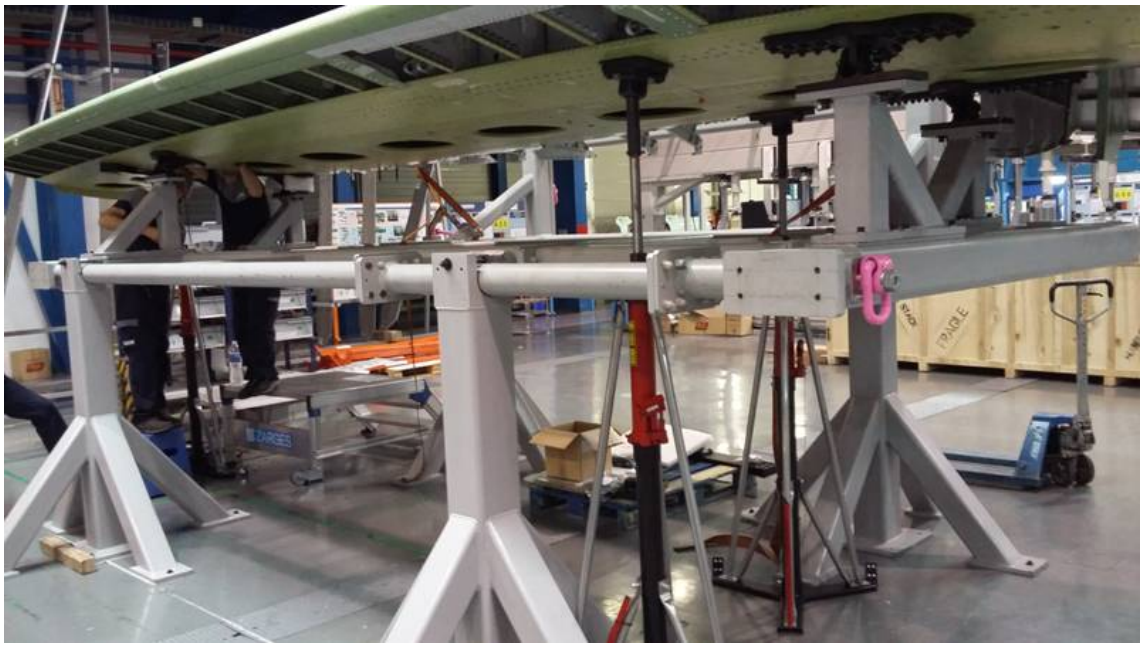

Figure 3: Jacking points

Figure 4: Transport box

Figure 5: Automatization

Project Summary

Acronym:	PROUD
Name of proposal:	Precision Outer Wing Assembly Devices
Involved ITD	Smart Fixed Wing Aircraft ITD
Grant Agreement:	296588
Instrument:	Clean Sky
Total Cost:	3.000.000,00 €
Clean Sky contribution:	2.250.000,00 €
Call:	SP1-JTI-CS-2011-01
Starting date:	09/2011
Ending date:	02/2016
Duration:	4 years and 5 months
Coordinator contact details:	Eduardo Cano Corral
	Manager

Clean Sky

eduardo.cano@sertec.net

+34 630 98 62 88

Project Officer: Sebastien DUBOIS (CSJU)

sebastien.dubois@cleansky.eu

Participating members: Aernnova

Saab

GKN

Incas

Dassault

Asco

Bias

ITA

Onera

DLR

NLR

FTI Group

Sertec