

Automated Laser Assisted Stringer Positioning System

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ABSTRACT

Stringer misplacement in the latest design of full CFRP wing covers causes cost and lead time in the further processes due to reworks in the torsion box assembly. To improve and solve this matter, ARITEX has developed an automated Laser assisted Stringer positioning system that allows the flexible, one-by-one and accurate position of the non-cured Stringers in the wing cover.

This paper describes how ARITEX has developed and implemented this system in two different CFRP wings using the same technical concept adapted to the context and geometry of each aircraft, and how the targets were achieved reducing the misplacement problem from previous projects.

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INTRODUCTION

One design solution of CFRP wings is to paste T-Shaped stringers directly to the cover skin (cured or not) on the curing mold. First tooling experiences are related to HTP, where all stringers were positioned at the same time to the skin mold by turnover jigs, the mold was mechanically positioned and mechanically coordinated to the stringer turnover jig. First operations are to manually position the non-cured stringers to the turnover jig, after manual works, the turnover rotates 90° and directly position the stringers to the mold as shown in [figure 1](#).

This solution was approximately identical for smaller HTP's and the quality was achieved, but for larger sizes, as the 20m-long HTP for the A380, some issues appeared and should be improved for further large scale wing covers:

- Difficult mechanical coordination due to lower strength of the mold.
- Difficult access to work on stringers and curing tools loading.
- Non Flexible system to work for different versions (each side of the turnover was dedicated to a hand of the HTP).
- Hard to integrate this system to a fully automated flow-line manufacturing workshop.
- Difficult recovery for damaged stringers.



Figure 1. A380 HTP Stringer Positioning jig.

DESIGN DRIVERS

With the experience of these previous projects, for the new family of CFRP wings the following design drivers were expected to be implemented in order to improve the manufacturing processes:

- Stringer accuracy better than ± 1 mm in the complete length.

- Cover mold positioning in station $\pm 20\text{mm}$ without any mechanical location.
- No mechanical coordination between stringer positioning tool and cover mold.
- Flexible system that is able to be adapted for future versions and models.
- Fully automatic system without manual operations.
- Process and Quality controlled in Real time.
- System easy to be integrated in a flow line.

CONCEPT SOLUTION

The overall concept solution for the manufacturing process was a workflow where the different phases of the stringer manufacturing, from its initial lay-up phase to the final positioning, was working as a flow-line working as a pull-system with separated work system with different buffers between them, in order to have a high rate with a high overall performance, and ending with the fully automated positioning system.

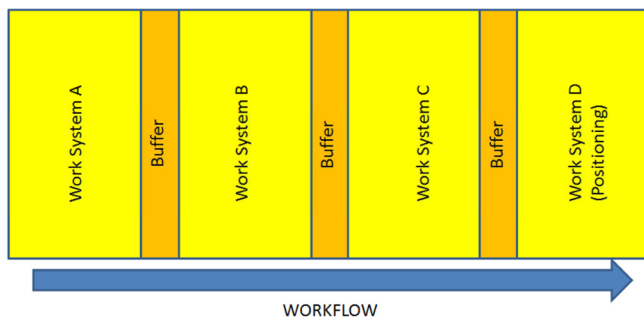


Figure 2. Workflow concept

Stringer Tool

The better way to allow this workflow concept is to preassembly the stringer in a dedicated tool which can be transported through the different work systems, stored in the buffers and, at the end, used as a holding tool for the final positioning. This stringer tool gives to the system the required flexibility to the different versions, with main interfaces to each work system, and a stringer geometry interface for each geometry of the wing. Only by having different stringer tools, the different versions of the wings (or different models of the aircraft!) can be processed through the workflow without changing the general machines.

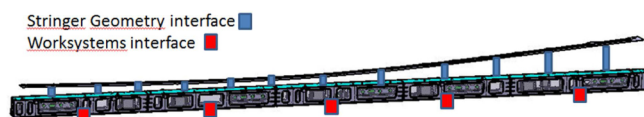


Figure 3. Stringer tool concept

Positioning Concept

In order to comply the design drivers, the positioning concept must be a system where a measuring device controls the position of the mold and the position of the stringer, so the coordination between the stringer positioning system and the skin mold will be done by this measuring system, and in the same time will give a real-time control of the position of the stringer on the wing skin. The positioning device must be a tool with all necessary degrees of freedom to position the stringers one-by-one, using the main interfaces of the stringer tool and guided by the measuring system until the position of the stringer on the skin mold.

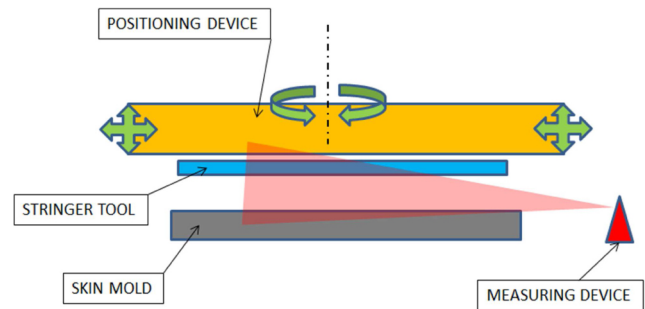


Figure 4. Positioning device concept

The measuring system is only required to control 2-axis of the stringer position, X and Y of the skin cover (length and width). The Z axis (height) is not necessary to be checked by the measuring system due to the uncertainty of the skin thickness. This skin thickness in CFRP could have a big dispersion and it is not possible to know the exact Z position. To stop the vertical movement it will be necessary to control the skin-stringer contact using load-cell installed in the positioning device.

Positioning Process

The process followed to position all stringers on the skin step by step is the one shown below:

Step 1: Mold positioning

The Skin mold is positioned with no accuracy in the workstation. Then, the measuring device reads the targets placed on the skin mold (or even King-Queen holes in the skin) and do a correction to the coordinate system in order to fix the theoretical positions of each stringer to the real skin position.

Step 2: Stringer tool pick-up

The positioning device goes to the Stringer tool buffer and pick-up the one that is chosen by the positioning sequence. This configuration could change depending on the workflow, lay-out, buffer type, interfaces with stringer tool, etc.

Step 3: Movement to skin mold

The position device moves the stringer tool to the calculated real position done in step 1, but stops the movement as near as possible to the final position.