OPTIMIZING THE CMM CONTROL PROCESS OF AIRCRAFT FRAMES

Marius **COSMA**[1], Dinu **DARABĂ**[1], Norbert **GAȘPAR**[2]
[1] *Technical University of Cluj-Napoca North University Center of Baia Mare, Romania*
[2] *Universal Alloy Corporation Europe, Dumbrăvița, Romania*
marius.cosma@imtech.utcluj.ro, dinu.daraba@imtech.utcluj.ro,
norbert.gaspar@universalalloy.com

Keywords: aircraft structure, aircraft frames, aircraft manufacture, CMM control, modular device, sliding assembly, optimize, low cost.

Abstract*: The paper presents the optimization of the control process of a family of complex aircraft parts by designing a modular device for the CMM (coordinate measuring machine), how to assemble the elements, how to align the device on the machine table and the presentation of real advantages and disadvantages regarding the designed device.*

1. INTRODUCTION

The objective of the paper is to optimize the control on the CMM (*Coordinate Measuring Machines)* of a very large number of frames used in the structure of the aircraft fuselaje (fig.1) that are similar but at different sizes and radii. Fuselaje frames perform many diverse functions such as [1]:

-support shell (fuselaje skin-stringer panels) compression/shear;

-distribute concentrated loads;

-fail-safe (crack stoppers).

They hold the fuselage cross-section to contour shape and limit the column length of longerons or stringers. Frames also act as circumferential tear strips to ensure fail-safe design against skin crack propagation.

Fig. 1. Structure of the aircraft fuselaje

The primary loads due to fuselage as bending, shear, torsion and cabin pressure are carred by stiffeners with frames spaced at regular intervals (conventional value 20 inches for transport airplanes) to prevent buckling and maintain cross-section.

2. MODULAR DEVICE DESIGN

2.1. The current control process

The current control solution uses a dedicated device required for each frame type. For each part, a mainboard is needed for the overall dimensions of the frame plus other modules depending on the size and shape (radius) of the part. For each device an overall processing is required because on each module there must be a surface conjugated with the negative surface of the respective part.

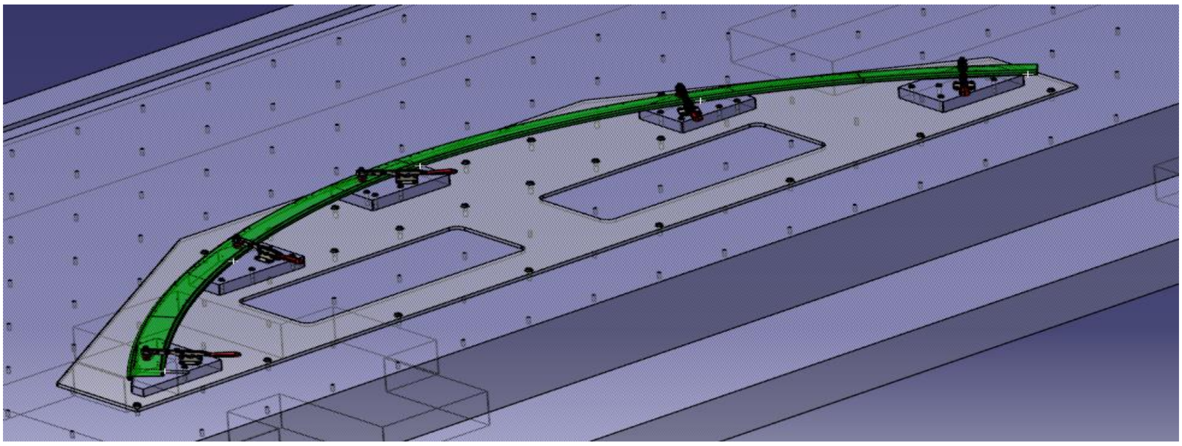
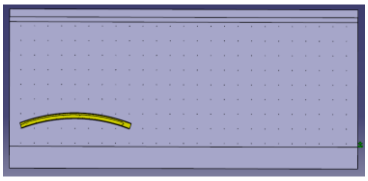
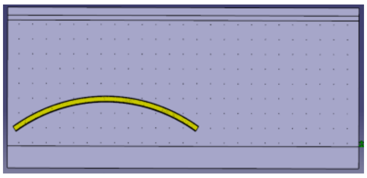


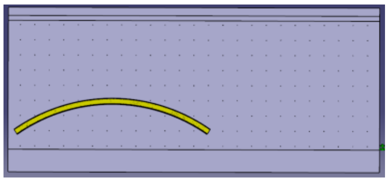
Fig. 2. One of the current control devices

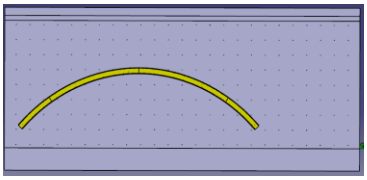
2.2. The new concept of the modular device

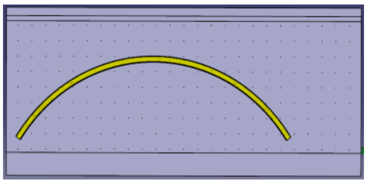
The new own concept is the use of a modular device usable for a large number of frames that can be grouped according to various criteria. The grouping is done according to the radius and length in five sets (100, 200, ... 500, *fig. 2*.).


The main piece from set 100


The main piece from set 200


The main piece from set 300


The main piece from set 400


The main piece from set 500

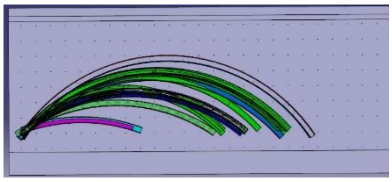

Top view with all the frames in this family

Fig. 3. Gruping the frames

The new device will contain six large modules (required for the largest frame) of which only five modules will be able to slide on the X and Y axes respectively (*fig.4*). On this assembly above, the base plate of the device is mounted and guided on the X and Y axes and has a travel limit of 510 mm on each axis. At the same time, for each axis we have mounted two locking systems in order to be able to fix the plate at the required dimensions.

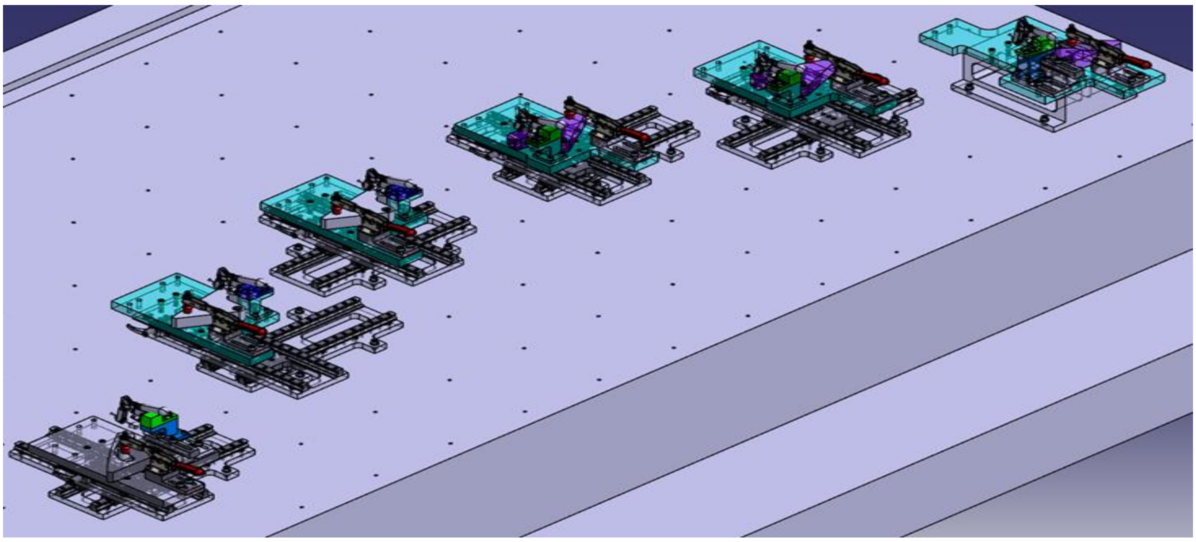


Fig. 4. The new modular control device

2.3. Design of orientation and fixing subassemblies

The new concept of the device is based on the use of modules designed to be usable, through very precise adjustments on the two axes (X and Y), using in their construction roller guides and locking systems type of Bosch Rexroth (*fig.5*).

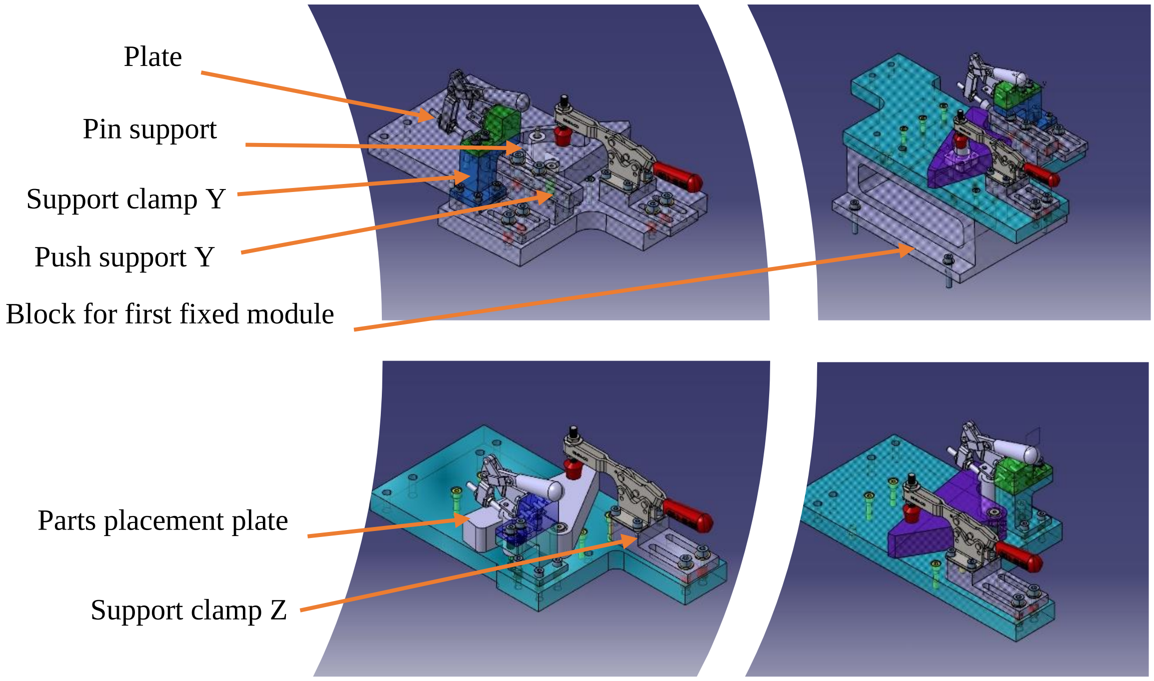


Fig. 5. The orientation and fixing subassemblies

The fixing clamp supports used to secure the frame to the device were designed to make it possible to rotate around the Z axis up to 12° (*fig. 6*).

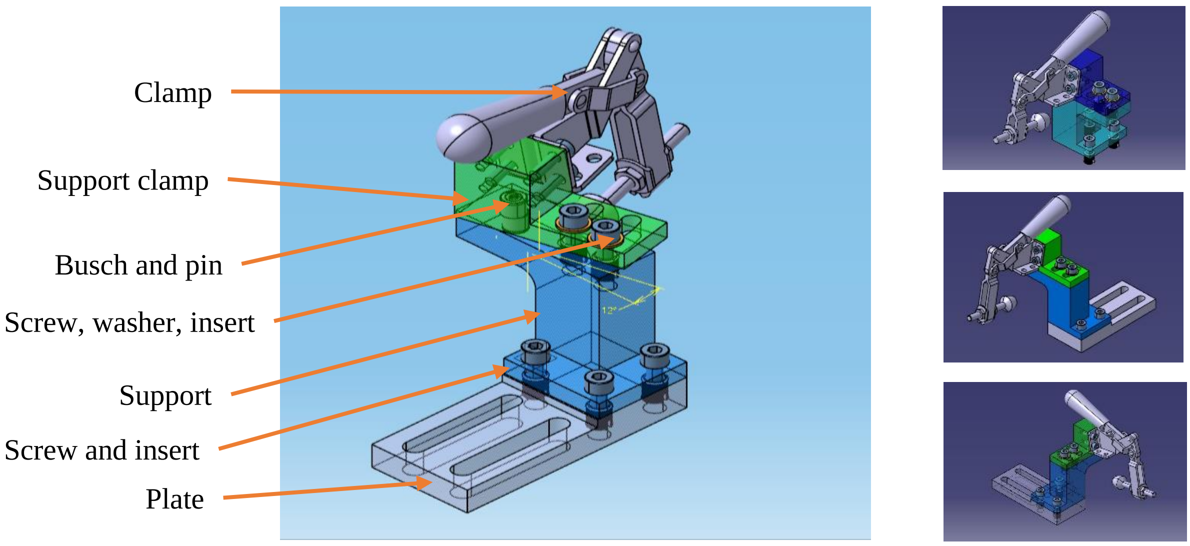


Fig. 6. The fixing clamp supports

3. THE CONTROL PROCESS WITH THE NEW DEVICE

3.1. Mounting the modular device on the CMM

To measure the parts with this device, the positioning dimensions of the modules are required for the CMM operators to position each mainboard together with its subassemblies in the required dimensions according to the shape of each part. These dimensions are set according to the shape of the part so that it is positioned centrally in the translation modules, so that they can be oriented and fixed within the limit of 510 mm of translation on the axes (exemple for one frame from 300 set, *figure 7*).

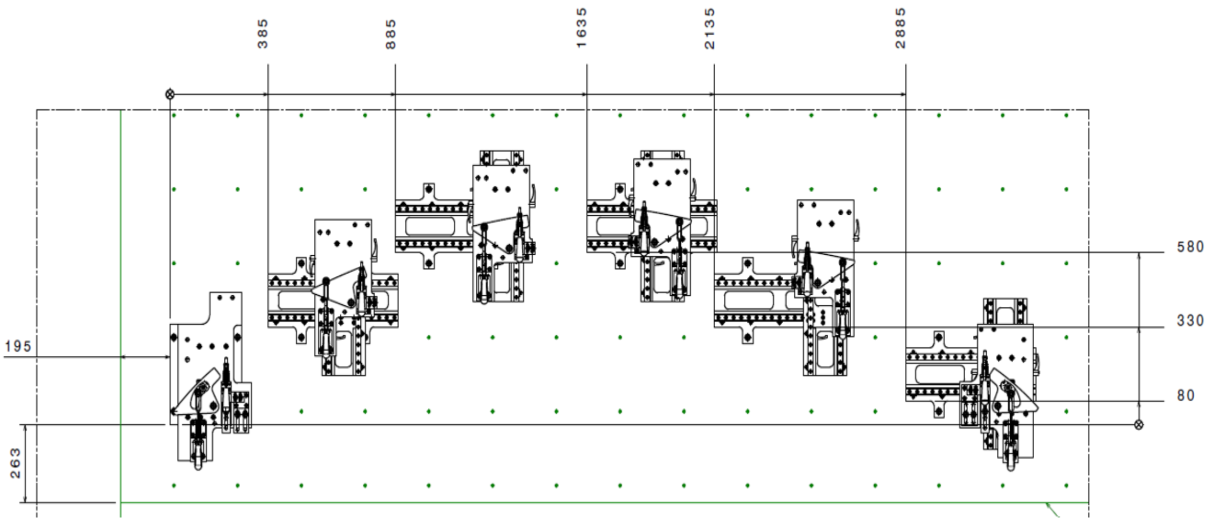


Fig. 7. Module fixing dimensions for a part

Positioning dimensions are very important because with their help the modules are structured for the shape of each part so that it can be measured and verified without the existence of certain problems. For each part, the upper modules will have to be repositioned on the X and Y axes, or if they exceed their stroke, the sliding assemblies will have to be repositioned. The holes of the coordinate measuring table are M10 threaded holes and are at a distance of 250 mm on both the X and Y axes.

The alignment of the moving bases is done with the help of the hole *Φ12H7x13* mm specially created for the positioning of the upper assemblies with precision on the machine table, all the positioning dimensions of the upper assemblies that are mounted on the sliding assemblies will be given on the X and Y axes starting from the first mainboard. fixed support.

The alignment dimensions of the part will be given from the capsule assembly with the centering pin of the first fixed support to the capsule with the pin that is found on the last sliding assembly with its afferents, so they will be exactly in the areas where the part will be positioned on the device.

3.2. Orientation and fixing of parts in the device

In the figure below you can see how the part was positioned with the pins and at the same time you can see how each subassembly works, respectively fixing the part with the fixing clips on the Y and Z axes. For each part, a control sheet is generated with the specific adjustment dimensions after which the part is oriented and fixed ready for control (*fig.8*).

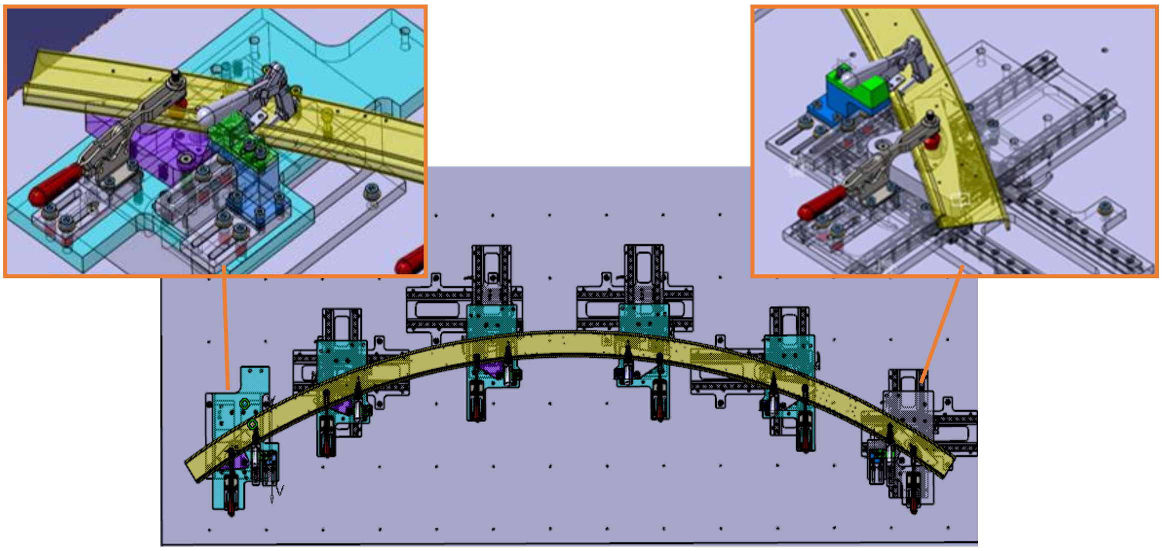


Fig. 8. Part orientated and fixed in the device

4. RESULTS AND CONCLUSIONS

The implementation of the new device in the control process on CMM brings many advantages, among which the most important would be: low cost of processing and purchasing the necessary compared to 42 devices dedicated with the negative contact surface with the part; designing only one device; storage of only one device for the whole family; reduced material consumption compared to the variant of dedicated devices; with a simple assembly of the device, several parts can be measured, being included in its stroke.

REFERENCES

[1] M. C-Y. Niu, *Airframe Structural Design,* Lockheed Aeronautical Systems Company Burbank, California, Conmilit Press LTD, 1989.

[2] N. Gaşpar, *Dissertation paper*, Technical University of Cluj-Napoca, Faculty of Engineering, coordinating professor Marius Cosma, 2021