# Transformative Use of Additive Technology in Design and Manufacture of the Aircraft Flight Control Actuator

Krzysztof Warzocha [1)], Jerzy Szura [2)], Piotr Bąk [3)], Tomasz Rogalski [4)], Paweł Rzucidło [5)], Grzegorz Kopecki [6)],Grzegorz Budzik [7)]

[1)] *Domin, ul. Wojska Polskiego 20, 39-300 Mielec / Rzeszow University of Technology, Faculty of Mechanical Engineering and Aeronautics, Powstańców Warszawy 12 Av., 35-959 Rzeszów, Poland, email: krzysztof.warzocha@domin.co*

[2)] *Domin, ul. Wojska Polskiego 20, 39-300 Mielec / Rzeszow University of Technology, Faculty of Mechanical Engineering and Aeronautics, Powstańców Warszawy 12 Av., 35-959 Rzeszów, Poland, email: jerzy.szura@domin.co*

[3)] *Domin, ul. Wojska Polskiego 20, 39-300 Mielec / Rzeszow University of Technology, Faculty of Mechanical Engineering and Aeronautics, Powstańców Warszawy 12 Av., 35-959 Rzeszów, Poland, email: piotr.bak@domin.co*

[4)] *Rzeszow University of Technology, Faculty of Mechanical Engineering and Aeronautics, Powstańców Warszawy 12 Av., 35-959 Rzeszów, Poland, email: orakl@prz.edu.pl*

[5)] *Rzeszow University of Technology, Faculty of Mechanical Engineering and Aeronautics, Powstańców Warszawy 12 Av., 35-959 Rzeszów, Poland, email: pawelrz@prz.edu.pl*

[6)] *Rzeszow University of Technology, Faculty of Mechanical Engineering and Aeronautics, Powstańców Warszawy 12 Av., 35-959 Rzeszów, Poland, email: gkopecki@prz.edu.pl*

[7)] *Rzeszow University of Technology, Faculty of Mechanical Engineering and Aeronautics, Powstańców Warszawy 12 Av., 35-959 Rzeszów, Poland, email: gbudzik@prz.edu.pl*

Aircraft flight control actuator has been designed to achieve the highest level of safety integrity along with the greatest simplicity and lowest weight. Additive Manufacturing (AM) techniques especially SLM (Selective Laser Melting) are applied in order to meet these objectives. Fatigue strength of the AM manufactured parts is critical in order to design complex aerospace components. In the paper the newest researches on pressure loaded parts produced by SLM are presented as well as the modern approach to design the Fly-By-Wire (FBW) actuator with the architecture which aims to simplify the methods of failure detection which need to be embodied within the flight control computer [1].

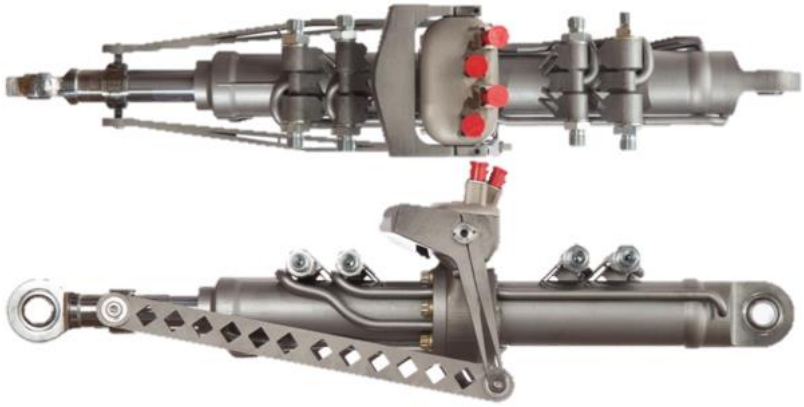

Fig.1. Yasa FBW Actuator

A flight control actuator is the key element in the FBW actuation system [2]. The electronic system is a fully quadruplex architecture and is fail operational even in the event of three failures. It includes a redundant three phase channel motor with independent drives for each control lane. Each of

the stator sectors is mechanically separated and capable of driving the load of the rotor in the event of failure.

The servoactuator system is a dual tandem configuration with a hydro mechanical anti-jam mechanism. It has two direct drive servovalves with mechanical feedback linkage from the main ram to the secondary outer sleeve of the servovalve. Dual hydraulic arrangement with independent valves allows the occurrence of one mechanical or hydraulic failure without performance loss.

The actuator receives four electrical command signals and two hydraulic supplies. The actuator can produce ram displacement in response to electrical command signals, and continue operation after failure of any input or internal part.

FCAs (Flight Control Actuators) are complex items. The use of AM technology significantly influenced the design and manufacture of many complex components contained within the assembly of the actuator to meet rigorous safety-critical requirements [3]. FCA produced by Yasa Motors Poland is both lighter and has fewer parts. With respect to weight, it is around half the weight of the equivalent mechanical servo and less than half the weight of any FBW alternative [1].

**References**


[1] Brochure of Yasa Motors Poland, access only for Yasa Motors Poland employees

[2] Kleemann E., Dey D., Recksiek M., *The development of a civilian fly by wire flight control system*, DaimlerChrysler Aerospace, ICAS 2000

[3] Tyczyński P., Siemiątkowski Z., Bąk P., Warzocha K., Rucki M., Szumiata T., *Performance of the maraging steel sleeves produced by SLM with subsequent age hardening.* Materials 2020, 13, 3208

[4] Warzocha K., Bąk P. *Method for manufacturing the aircraft valve block*, Patent PL227484, Poland, 2017