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CONCEPTION OF NEW AIR TARGET SZERSZEŃ-2

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Abstract

The project to introduce modifications to the air target SZERSZEŃ has been undertaken by the Air Force Institute of Technology. SZERSZEŃ has been used by the Polish Army for 10 years, during which time a number of modifications were introduced. Given this fact, it was decided to develop a new version of this UAV based on the experience gained during its maintenance and operation.

Another aspect of this project is to focus on improving the repeatability of production by optimizing the technology processes. To achieve this aim the new instrumentation for the production of composite parts in prepreg technology was designed. The paper reviews the production possibilities for this aircraft using a new technology and presents the advantages of the modified construction and the new technology.

Keywords: UAV air target, design, technology, integration of control systems.

INTRODUCTION

The air target SZERSZEŃ was created over 10 years ago at the Air Force Institute of Technology for the purposes of the Polish Army, where it is still being used today. More than 30 aircraft have been manufactured so far. This UAV is utilized as a reusable air target. It starts from a dedicated launcher and lands either using a thrown parachute or in a classic way on the bottom side.

Basic data:
Wing span – 3,2 m;
Max. start weight – 35 kg;
Radius – 20 km;
Max. speed – 180 km/h;
Ceiling – 1000 m.

MODIFICATIONS

The 3D design was created using reverse engineering based on 2D documentation and 3D scans. The design of geometry and structure was created in the NX software (Fig. 1). The design includes the improvements resulting from the experience gained during maintenance and service.

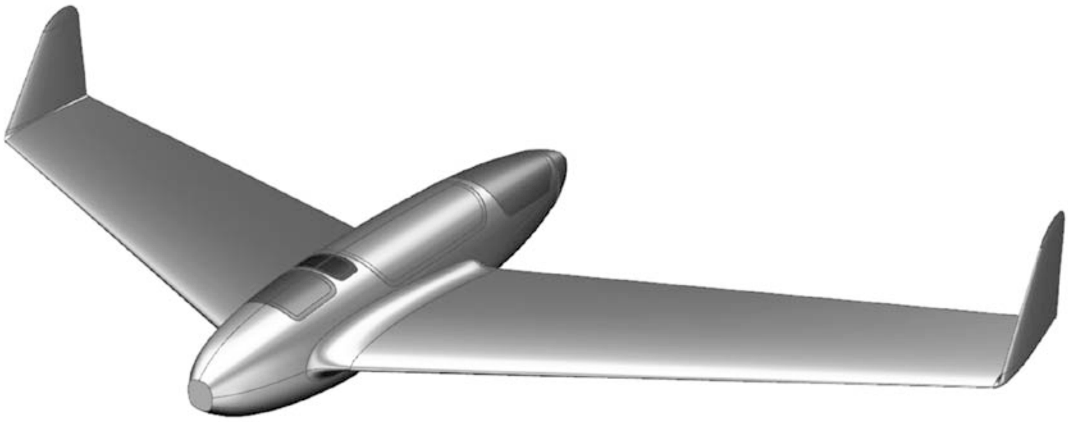

Figure 1. 3D visualization of geometry of „Szerszeń”

The main challenge to be addressed was to rectify the incorrect balance of aircraft. During maintenance, the center of gravity was moving backwards. Therefore the bottom front part of the aircraft structure had to be loaded using a 2-kg lead weight. This weight was equal to around 5 % of starting weight and to around 15 % of useful load. To solve this problem it was decided to elongate the front part of the aircraft by 50 mm as shown in Fig. 2. This value was calculated based on the balance sheet. As a result, the engine moved forward, which improved the balance without adding extra weights and permitted increasing useful load.

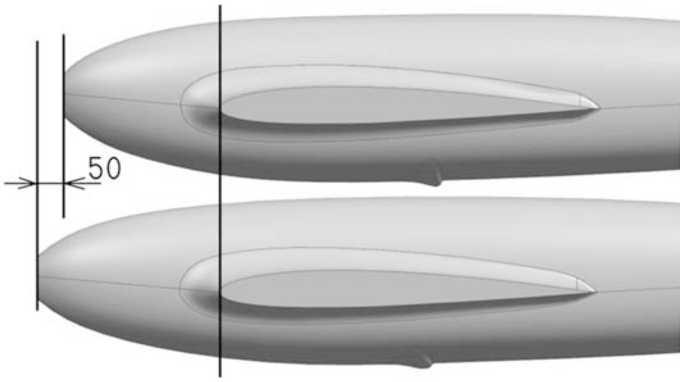

Figure 2. Elongation of the aircraft to improve balance

Another problem to deal with during maintenance concerned difficulties in replacement and regulation of the wing servomechanisms controlling the ailerons. The main problems were the difficulty with correct positioning and time-consuming regulation after the replacement. The previous technology used for making sockets is shown in Figure 3.

The problem with positioning appeared at stages b and c where a large amount of adhesive had to be used to join the bottom of the socket and the bottom of the wing. After that, an aluminum plate was connected to the servomechanism with double-sided tape (Fig. 3d). This plate was mounted in the socket with bolts (Fig. 3e), which could also generate the positioning error.

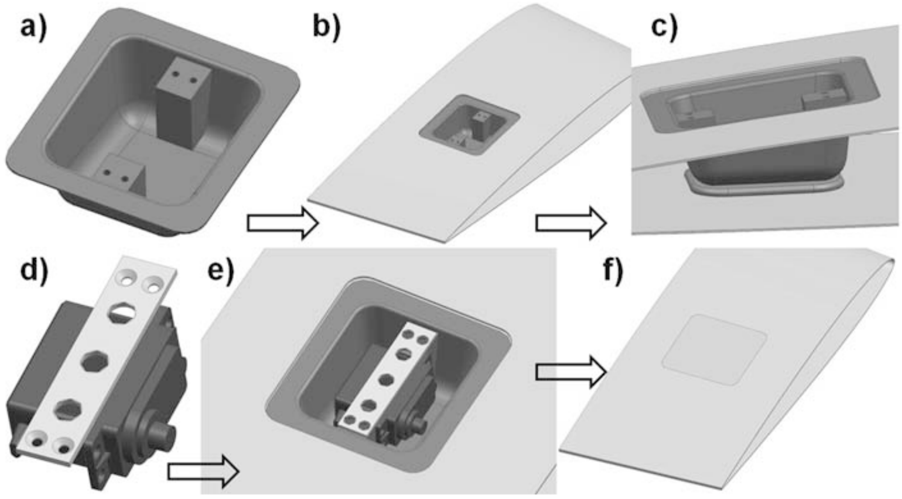

Figure 3. Previous technology of making a socket in the wing for the servomechanism: a – laminating the socket; b, c – gluing the socket inside the wing; d – bonding an aluminum sheet to the servomechanism with double sided tape; e – screwing the servomechanism to the wing; f – mounting the cover with tape.

A new solution proposed eliminates some stages of the previous process and decreases the fabrication time needed (Fig. 4). The socket for the servomechanism is now made during laminating the upper wing cover (Fig. 4a1), which permits correct positioning and repeatability. The elements with the internal thread are bonded to the internal side of the upper wing cover (Fig. 4b1). These elements are used for screwing the outer cover to the socket. The cover of the servomechanism is laminated in a separate mold (Fig. 4a2). This element is stiffer than the one used in the previous technology because it is joined with the servomechanism. The mounting element for the servo is made in 3D printing technology and bonded to the cover by a positioning tool with a small amount of adhesive (Fig. 4b2). Stages a and b shown in Figure 4 can be performed independently at the same time. Then the cover is screwed into the wing (Fig. 4c). This solution helps to achieve right positioning and allows replacing the servomechanism in shorter time without tapes.

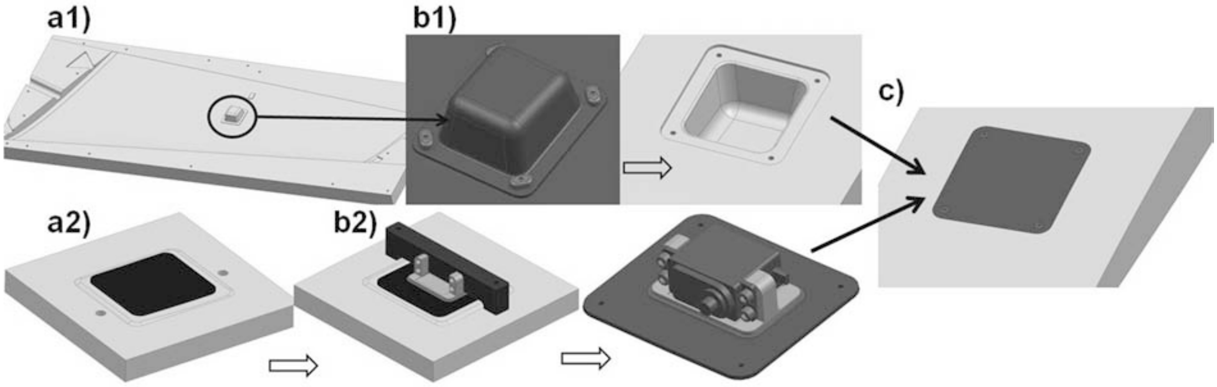

Figure 4. New technology of making the socket in the wing for the servomechanism: a1 – laminating the upper part of the wing with the socket; a2 – laminating the cover of the socket; b1 –the part with screws bonded to the wing; b2 –element for mounting the servomechanism connected to the cover; c – screwing the cover with the servomechanism to the wing

TECHNOLOGY

The technology modifications for this aircraft are planned to be made in autoclave technology with prepreg materials. The process is intended to involve five stages – Fig. 5: (i) milling negative molds from modeling boards with a CNC machine, (ii) making a test model to be used to check the compatibility of the molds in the assemble process, (iii) making positive molds from heat resistant resin and carbon fibers in autoclave, (iv) making negative molds destined for the manufacturing stage, (v) using these molds to manufacture all composite elements in autoclave technology with prepreg materials. Molds for autoclave should be made from the material with the small thermal expansion coefficient [1]. It was decided to use graphite epoxy composite.

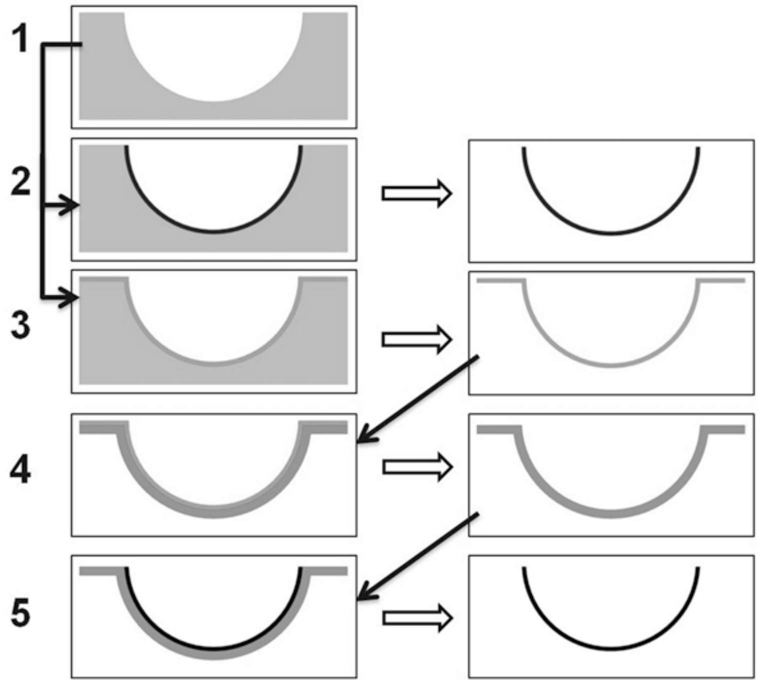

Figure 5. Five technology stages envisaged in the project; 1 – negative molds from modeling board, 2 – making a test model, 3 – positive molds, 4 – negative molds for autoclave, 5 – making composite part from prepreg using autoclave

The planned number of molds is 40. This number of molds allows manufacturing all composite parts at the same time. Is saves time because there is no need for dividing positive models or making technology offsets. This solution decreases the number of technology stages. Is also shortens the time needed for curing processes necessary for composite parts. Separate molds for covers and other bonded elements ensure the compatibility of parts, which allows each part to be made independently. This number of molds makes it possible to use autoclave in an effective and economic way as one autoclave process consumes a lot of energy.

Another way of optimizing technology time and cost is to use 3D printing. This brings cost reduction for small quantities [2] and decreases man-hours in traditional methods. Additive manufacturing technologies enable manufacturing complex parts containing cavities [3]. The 3D printing technology is used in the aerospace industry to make lightweight parts such as the wing with lattice structure [4]. This technology offers a wide range of possible applications including making aircraft wind tunnel models [5], air ducts [6], and flight control systems [7]. Modifications to prototypes can be quickly implemented e.g. bevel gears [8].

It is planned to make positioning tools, mounting and bonded parts using 3D printing. 3D printed elements can be bonded inside the structure without adding laminate reinforcement. Fig. 6. shows molds of the aircraft body and the wing with the positioning tools for the bonded parts.

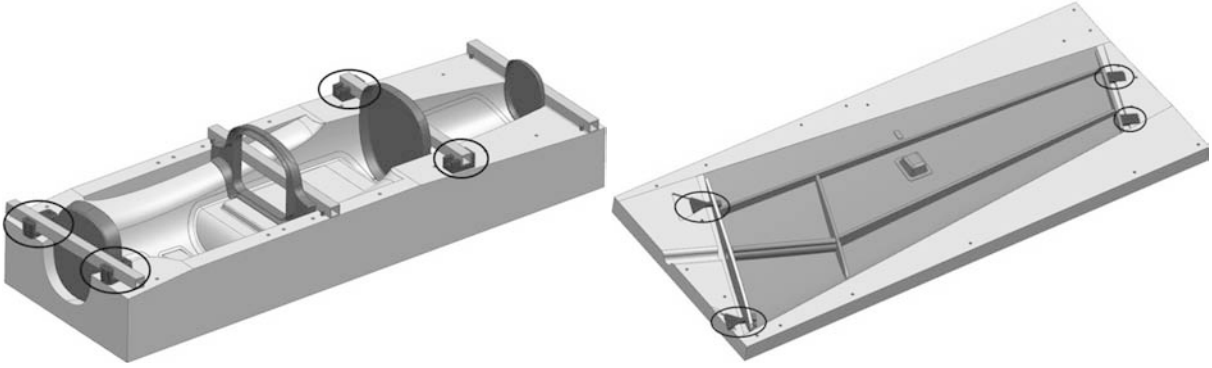

Figure 6. Example of using 3D printed tools for positioning elements of the body and the wing

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