UTILIZING DIGITAL ADVANCEMENTS FOR THE DIGITIZATION OF AVIATION MANUFACTURING PROCESSES

[1]Saydakhmedov R. Kh., [2]Khakimov Kh. I.
[1]DSc., Professor
[2]Master's student, Tashkent State Transport University
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Abstract. *The article discusses the use of digital technologies to optimize aviation production. The methods of CNC, computer modeling, Big Data and IoT analysis are considered. The main focus is on improving the production of aviation components through reducing time and costs, improving quality and competitiveness.*

Keywords*: digital technologies, aviation production, computer numerical control systems (CNC), computer-aided modeling (CAD), Big Data analysis, optimization of technological processes, improvement of production quality, reduction of time and costs, increase competitiveness.*

The following digital technologies are actively used for digitalization: digital design and modeling (CAD), mathematical modeling, computer and supercomputer engineering (CAE, HPC) and optimization (CAO), technological pre-production (CAM), "smart" models, "digital twins", product data management technologies (PDM), etc. product lifecycle management (PLM) technologies; new materials [1]; additive technologies (3D printers, technologies, approaches and methods of working with raw materials, development and operation of consumables); industrial sensors; robotics technologies; enterprise management information systems [2]; Big Data, etc. [3].

The development of technological processes for processing aircraft parts on CNC machines is carried out in special CAD\CAM\CAE programs. As mentioned above, this is part of the digitalization of aviation production. The main component of the system is the preparation of control programs for CNC machines.

Titanium and its alloys are widely used in the aerospace industry due to their high strength, low weight, heat resistance and corrosion resistance. The weight of titanium is approximately 56% of the weight of steel, but its strength is equal to that of steel.

The strength of titanium is maintained at temperatures above 800°F (427°C); therefore, it can be used in the cooling chambers of gas turbine engines, for fairings and partitions around engines, as well as for the skin of aircraft that can be exposed to elevated temperatures that destroy aluminum alloys.

Titanium can be processed by many methods used for processing steel and stainless (corrosion-resistant) steels. It can be cut, pulled, pressed, machined, milled, sawed and nibbled. An operator working with titanium must know the features and characteristics of titanium in order to achieve good results.

The increasing complexity of machining is a consequence of the ever-increasing use of hard-to-machine materials, such as titanium alloys and high-strength steels, as well as large-sized wing and fuselage structures (panels), including those made of high-strength materials. So, for a number of aircraft products, the volume of machine work exceeded 30% of the total airframe production. [5]

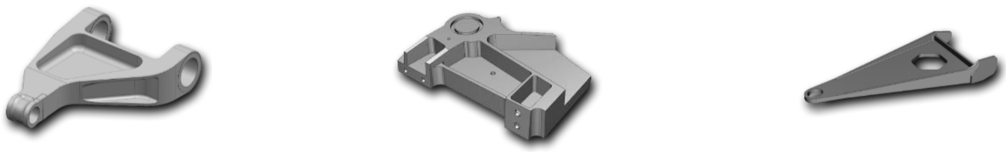


Fig. 1. Aircraft parts made using digital CNC machines. [4]

Table 1. Characteristics of the most common structural steels, aluminum, and titanium alloys. [6]

Steels and alloys		Density, g / cm^3	Tensile strength, σ_B, MPa	Specific static strength, cm × 10^5	Ultimate strength, σ_{-1}, MPa, based on 2×10^7 cycles	Specific wear resistance of smooth samples, MPa, cm^3/ g
Aluminum alloys	AK4-1 D16T V95	2.80 2.87 2.85	420 450 520	15.0 16.2 18.2	135 150 165	48 54 58
Titanium alloys	FROM 4 TOT6 TOT22	4.55 4.45 4.55	800 900 1100	17.5 20.0 24.2	420 520 620	92 116 134
Steel	30HGSA EI643 VNS-2 VNS-3	7.85 7.81 7.76 7.82	1100 1300 1250 1450	14.0 23.0 16.0 18.5	600 750 620 720	77 96 80 92

As a result of the growing global competition, the accessibility of manufacturing operations is constantly increasing. To counteract this and be more competitive, companies are adapting their processing systems. In fact, their goal is to automate countless necessary processing operations. Thus, the optimization of machining operations allows you to get high-quality products at a lower cost. In addition, the production time is reduced.[7]

Titanium alloys have revolutionized aerospace manufacturing as a result of their exceptional properties such as high strength-to-weight ratio, corrosion resistance, and biocompatibility. One of the key factors that increases the efficiency and accuracy of titanium alloy machining is the integration of numerical control (CNC) machining technology and advanced CAD/CAM software such as SolidWorks.

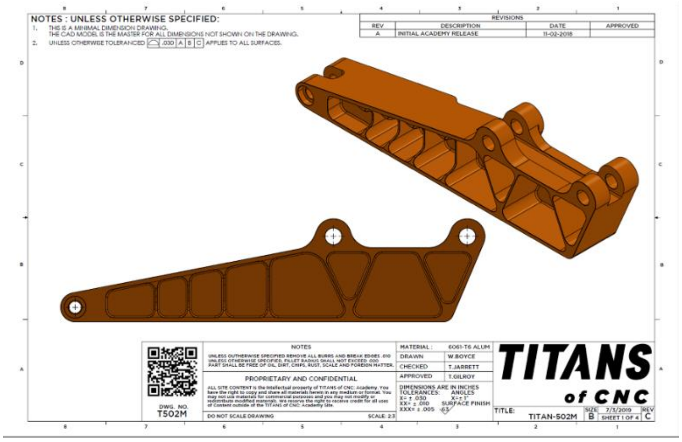


Fig. 2. Aircraft detail [8]

The part to be processed can have different geometries. A blank is required as the starting point of the machining process. Then the material removal stage begins. Material removal depends on the coordinates recorded in the G-code, which, in turn, depends on the designer's intent. However, sometimes the design approach cannot be replicated in the final product due to the fact that the process consists of several stages. As a result, the machine operator may enter inaccurate coordinates necessary for processing the workpiece. Therefore, the proposed algorithm will consist of various components. Firstly, it is important to note that each stage depends on the completion of the previous one. [9]

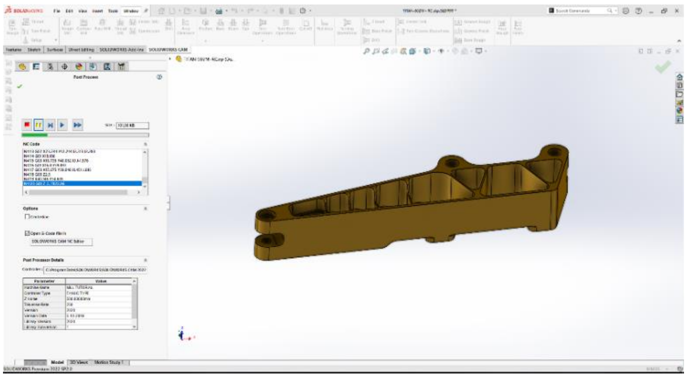


Figure 3.a

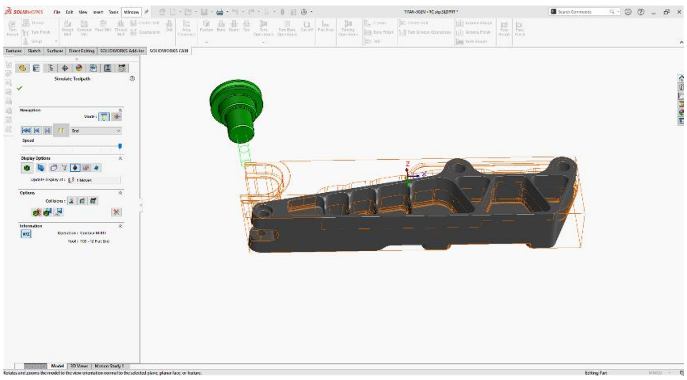


Figure 3.b

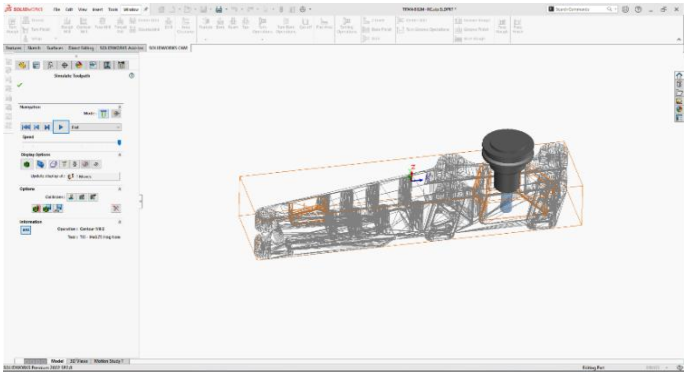
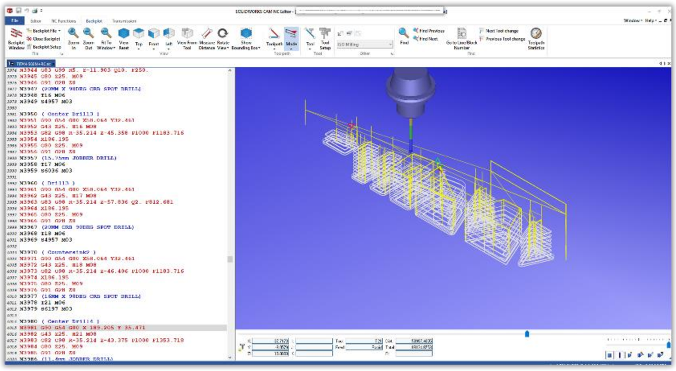


Figure 3.c



Figure

Figure 3. a,b,c,d - steps of part processing in SolidWorks.

Conclusion. The integration of titanium alloys with CNC machining technology and SolidWorks software has significantly expanded the capabilities of aerospace manufacturing. This integration enables precise, efficient and reliable production of complex titanium components critical to the performance and safety of today's aircraft, and paves the way for future innovations in the aerospace industry.

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