УДК 658.512.22
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ПРИМЕНЕНИЕ МЕТОДИКИ РЕВЕРС-ИНЖИНИРИНГА ДЛЯ ПРОИЗВОДСТВА ДЕТАЛЕЙ И ПРОВЕРКИ ВПИСЫВАЕМОСТИ ОБРАЗЦОВ В МАШИНОСТРОЕНИИ

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APPLICATION OF REVERSE ENGINEERING TECHNIQUES FOR THE PRODUCTION OF PARTS AND FITABILITY CHECK OF SAMPLES IN MECHANICAL ENGINEERING

Reverse engineering is the process where a part or a collection of parts is measured and analyzed to create a dataset that enables the reproduction of such objects, or to use this data for the development and creation of new, modified, and improved components and devices compared to the original. The reverse engineering process involves processing raw data about an object within Computer-Aided Design (CAD) systems. This specialized software is used for the computer design of objects. Currently, the issue of import substitution has become particularly relevant. Due to technical and organizational constraints, the production of certain equipment domestically often faces challenges [1]. Additionally, servicing imported machinery, which includes replacing components during operation, as well as manufacturing parts with complex geometries, can incur significant costs, prompting enterprises to seek effective solutions to these problems. The advancement of additive technologies, particularly reverse engineering methods, presents opportunities for addressing these challenges. This article will examine two cases of applying this technology: creating an electronic model of a part using only a physical sample without drawings or documentation, and employing reverse engineering techniques to verify the fit of the manufactured part against the electronic model, thereby checking for dimensional deviations.

The measurement arm used is the ROMER ABSOLUTE ARM 7530SI, with a scanning accuracy of ±0.084 mm and point repeatability of ±0.03 mm. The working range of the arm is 3 meters, with a measurement temperature of 25°C [2]. Factors affecting the accuracy of the scanning results include surface cleanliness, reflectivity, surface color, and adherence to the recommended measurement temperature. In the first case, the equipment used is a fixture for a tensile testing machine.

Using 3D scanning, a point cloud of the part was created and imported into Geomagic Design X for further processing. Geomagic Design X enables automatic

surface segmentation based on the point cloud, allowing us to generate a set of simple surfaces that will be utilized to recreate the part in question [3]. For this particular component, we need to obtain a cross-section sketch since it is a rotational part, as well as the axis around which the rotation will occur. Additionally, sketches of the part's cutouts are required. The sample part is shown at image (Fig. 1a). The necessary sketches, along with the axis, are exported to Siemens NX. By performing a rotation operation, we create a solid body where the required technological holes of specified diameters are made, and the necessary fillets are added. The results of the point cloud processing in Geomagic Design X are shown in the image (Fig. 1b). Subsequently, working drawings are prepared in NX, which will be used for the processing of the workpieces.

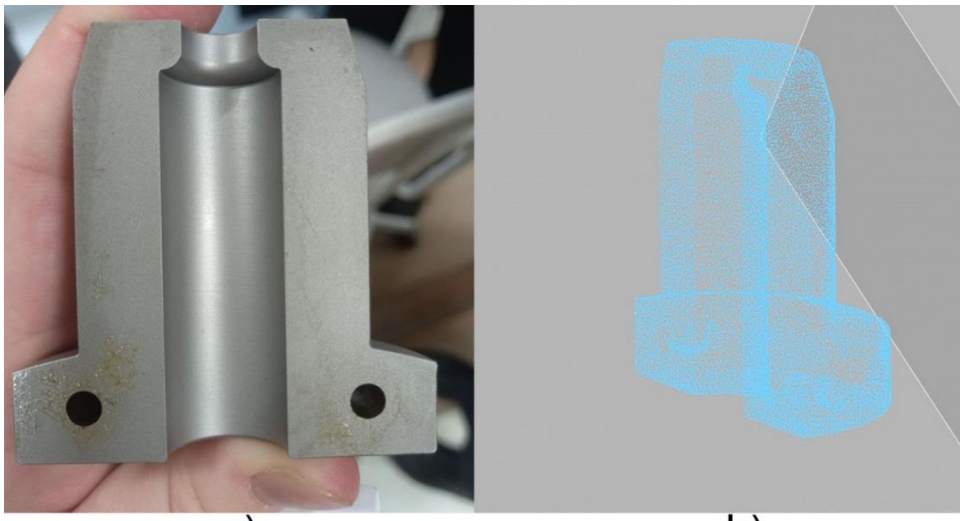

Fig. 1. The part under consideration:
a – sample part; b – resulting point cloud in Geomagic Design X

Let's examine the second case of applying reverse engineering technology for checking the fit of a part within a model. In this context, the process is analyzed with respect to a specific measurement and the size control of a threaded bushing, whose 3D model and overall view are depicted in Fig. 2.

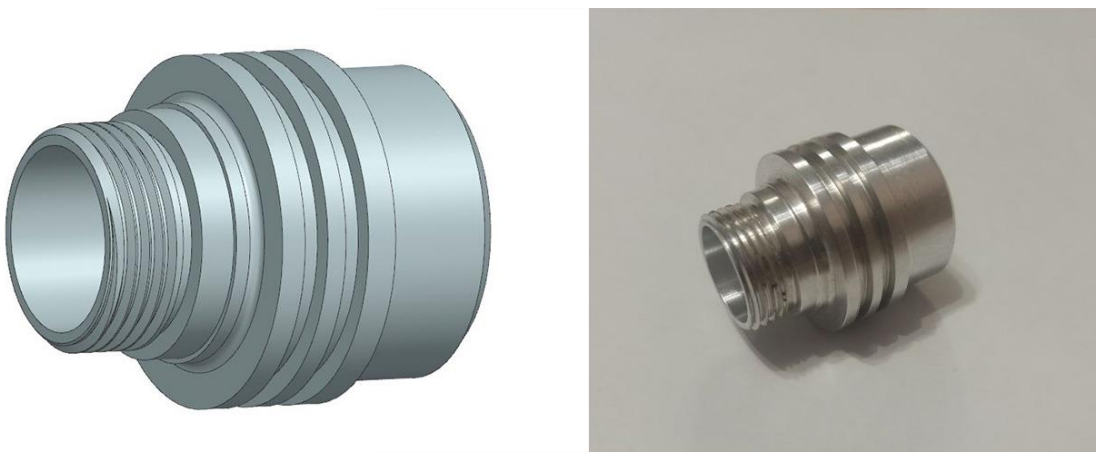

Fig. 2. General view of the 3-D model and photo of the threaded bushing

This component is manufactured using a CNC lathe. The procedure begins with securing the part on a measuring table to ensure that the bushing remains in a fixed position throughout the measurement process. The scanning of the component is carried out as the required surfaces for inspection are filled. The resulting point cloud is used for size comparison when the original CAD model is loaded into the software. Next, points are selected on the corresponding surfaces of both the part and the point cloud (three points per surface) to align the original model with the point cloud. The PolyWorks program automatically fits surfaces, minimizing discrepancies between the inspected surfaces. The analysis results are presented in a color chart, displaying deviations from the required dimensions with an accuracy of up to eight hundredths of a millimeter. The report is shown in Fig. 3.

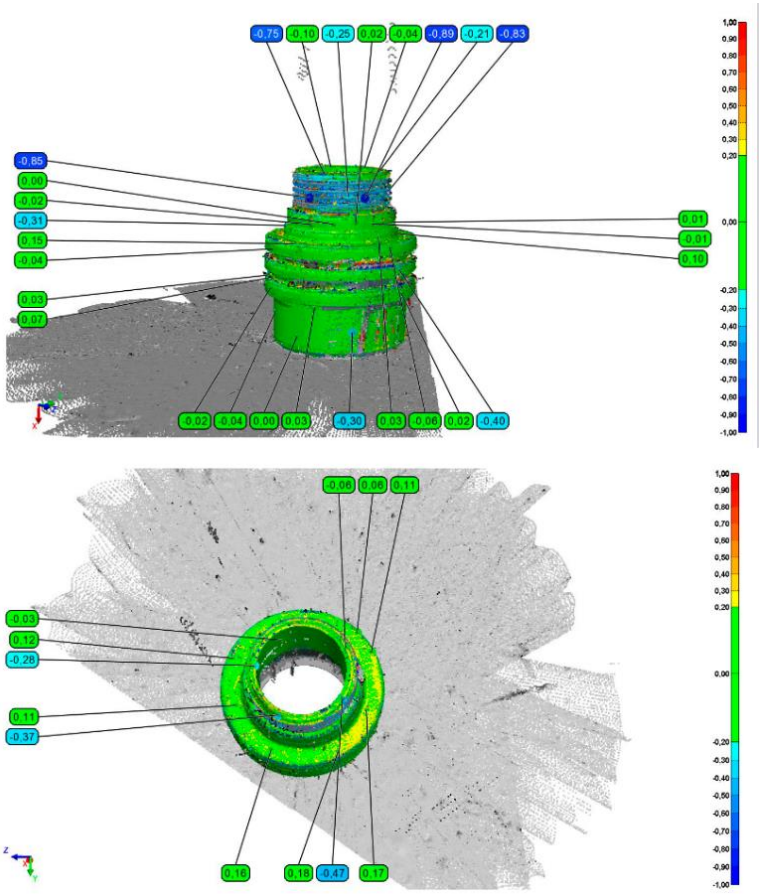

Fig. 3. Model deviation results report.

The findings indicate that unacceptable dimensional deviations are observed solely on the thread, as anticipated, while other geometric dimensions fall within acceptable limits. Utilizing a micrometer with an error margin of 0.005 and a gauge designed for assessing the metric thread's required diameter and pitch, we achieved results comparable to those obtained through reverse engineering.

The study demonstrates that reverse engineering is an effective method for creating electronic models of components and verifying the dimensions of samples and blanks. This approach yields precise information regarding component dimensions and facilitates the analysis of variations, aiding compliance with established

standards. However, the primary challenge lies in the novelty of this technology and the absence of standardized methods, which raises concerns among large corporations. Consequently, this situation results in a shortage of professionals in this domain, hindering the advancement and adoption of reverse engineering [4].

Despite these challenges, the potential for developing and implementing reverse engineering methods in domestic enterprises remains substantial. With the ongoing evolution of digital technologies, we can anticipate significant advancements in this field, ultimately enhancing the efficiency and competitiveness of businesses in today's market landscape.

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