УДК 658.512.22

# METHODOLOGY FOR APPLYING REVERSE ENGINEERING TO CASTING PARTS
# МЕТОДИКА ПРИМЕНЕНИЯ РЕВЕРС-ИНЖИНИРИНГА ПРИ ИЗГОТОВЛЕНИИ ДЕТАЛЕЙ ОТЛИВОК

Pokrovsky A.V.
Scientific advisor: N.S. Aristova, Associate Professor
Kazan National Research Technical University named after A.N. Tupolev
Kazan

В данной статье рассматриваются возможные этапы и шаги при использовании методики обратной разработки в процессе создания деталей отливок на авиационных предприятиях, анализируется потенциал данного метода производства и приводится список шагов для получения продукта с помощью реверс-инжиниринга.

In order to meet the challenges of expanding aircraft production and to speed up the process of aircraft part design, various approaches have been introduced, such as the application of modern additive technologies, composite materials, as well as the use of topological force analysis. Despite the rising popularity of additive technologies (which are currently being introduced into the production process at large enterprises), their novelty is the detrimental factor which sometimes restricts their practical implementation, due to the inexperience of manufacturing personnel who lack expertise in the development of technical documentation and fail to design adequate technical processes of operation and production using these newfangled methodologies. However, there is another very promising approach to the design and manufacturing of aircraft parts, which combines the best of both "old school" design methods and cutting edge software solutions. This article considers this recently introduced direction of aircraft design – reverse engineering – as a more suitable alternative for aircraft parts manufacturing.

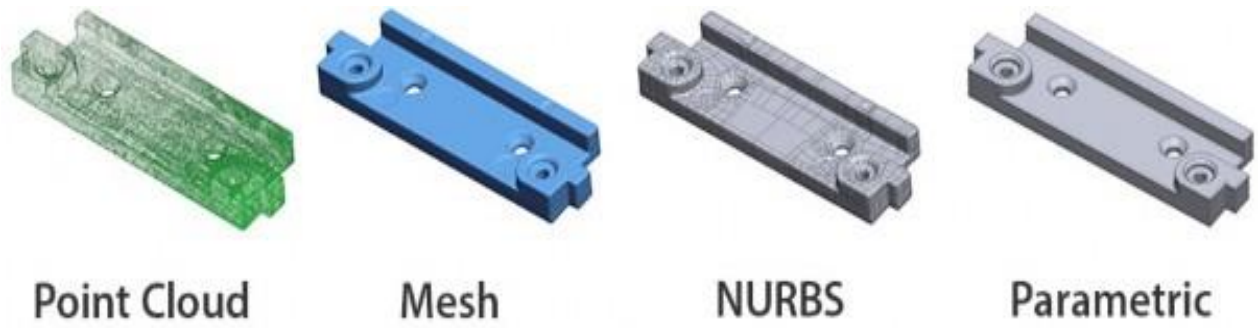


*Fig 1. Main stages of reverse engineering process in pictures. [5]*

Reverse engineering has become a very prospective path in aircraft manufacturing, as it replaces and facilitates many processes, especially that of product inspection. Reverse engineering consists in creating an exact copy of an object based

on an existing model, having the same physical characteristics [3]. Reverse engineering is useful in cases where a manufacturer wants to replace an imported component with an in-house manufactured analogue or restore design documentation (and/or production guidelines) for a unit which has been in circulation for quite some time without a digital specification.

This method is not widespread in Russia, but has enormous potential and prospects for further experimentation. As of today, there is hardly any digitalised precise technical documentation in circulation in aircraft enterprises; moreover, most technical process descriptions are produced and handled by separate outsourcing companies that provide reverse engineering services.

*Fig 2. Reconstructing sample via point cloud.*

The digital "twin" part, obtained as a result of a full cycle of reverse engineering, enables designers to start improving the technical characteristics of the unit through a series of engineering calculations aimed at figuring out the possible operating modes and changes in internal design solutions, without changing the overall geometric dimensions of the part.

To properly scan and transfer a part or structure into virtual space, one needs to follow a list of rules. Although there is no generally accepted methodology for measuring the units using reverse engineering principles, scanning objects complies with officially adopted guidelines at the state level, like State Standard (GOST). Within those frameworks, each enterprise or company may determine its own methodology. Still, it is generally possible to identify the key stages that will be similar for all processes, regardless of their location. In particular, the following steps should be highlighted:

1. Preparing the product for scanning: disassembling the product into parts and determining the approximate dimensions, materials used and planes for scanning.
2. Three-dimensional scanning and obtaining a 3D model using scanners and other auxiliary equipment.
3. Development of a working three-dimensional model: modeling and editing the resulting model, converting the point cloud into a polygonal 3D

model. Any CAD software (NX, Geomagic Design X, etc.) can be used for this step.

4. Carrying out engineering calculations to confirm the required characteristics of an individual part or product.
5. Development of design documentation.
6. Manufacturing a prototype according to design documentation.
7. Testing the resulting part to confirm the calculated strength characteristics, etc.
8. Summarizing and deciding whether reverse engineering was successful.

Despite the accuracy of the technology declared by manufacturers of 3D scanning equipment, some errors may still occur, and therefore it is necessary to carry out additional verification of the point cloud to confirm the stated measurements and dimensions of parts. This, in turn, entails additional costs, and on-site workers must have a certain level of qualification and technical expertise to carry out this operation properly.

Therefore, it should be noted that this technology will take its rightful place at aviation enterprises only in case the proper training of workers is carried out. Still, compared to other types of training, this skill should not present any difficulties. All things considered, it may be safe to assert that reverse engineering offers a viable replacement for the imperfect 3D printing technologies, and may be considered a sustainable, resource-efficient and prospective method of aircraft part design and manufacturing.

**References:**

1. Гончаров, П.С. NX для конструктора-машиностроителя. [Текст] / П.С. Гончаров, М.Ю. Ельцов, С.Б., М. Коршиков – ДМК-Пресс, 2016. 504 с.
2. Attaran, M. The rise of 3-D printing: The advantages of additive manufacturing over traditional manufacturing [Text] // Business Horizons. 2017. Vol. 60. No 5. P.: 677-688.
3. Raja, V., Fernandes, K.J. Reverse Engineering: An Industrial Perspective. [Text] / Vinesh Raja; Kiran J. Fernandes. – Springer Science & Business Media, 2007. – P. 3. ISBN 978-1-84628-856-2.
4. Галиуллин, Р. Обратное проектирование в машиностроении: 4 условия успешного внедрения [Текст]/ Р. Галиулин. IQB technologies [Website] – URL: https://blog.iqb.ru/reverse-engineering-machine-building (date of application – 13.11.2023)
5. Thayer, K. How Does Reverse Engineering Work? [Text] / Ken Thayer www. globalspec – [Website]. URL https://insights.globalspec.com/article/7367/how-does-reverse-engineering-work (date of application – 13.11.2023)