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Development Of Technological Schemes For Machining Of Parts Of Elements Of High-Precision Forming Tooling And Compression Blades For Five-Axis Machining Robotic Cells

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Abstract

Fundamental requirements to the choice of primary workpieces, and processing datum surfaces for blanks machining using numerical control machines are analyzed in the article. Primary blanks for production of parts – representatives of high-precision forming tooling and compressor blades of gas turbine engines in the context of single-unit production are analyzed. Basic reference surfaces of representative parts are selected. Artificial secondary bases of processing datum surfaces are designed. Technologic locating charts for parts – representatives on the bench of numerical control machines are developed. Structural solutions of "technologic blocks" and "technologic gains" for parts mounting and fixation are proposed. Technologic assembly units for large size representative parts fixation and location of parts – representatives of high-precision formative tooling using the snap-change tooling components produced by the company SCHUNK are developed. The obtained results are the basis for the design of robotic technologies for fabrication of parts – representatives and compressor blades of gas turbine engines in the context of single-unit production.

Keywords: Manufacturing process flowsheet, Systems of basing, Technological cubes blocs, Parts – representatives, High-precision forming tooling, Compression blades

1. Introduction

Distinctive features of the current stage of development of engineering production are stricter requirements for the quality of products, the use of innovative methods of processing of materials, the widespread use of machine tools with numerical control. This fully applies to the technology of manufacturing elements of gas turbine engines (GTE) and high-precision tooling.

The basis for solving these problems is the adoption of reasonable and fair solutions on the early stages of designing manufacturing processes of precision tooling elements, including the choice of initial blanks and technological bases for the transacted operations. That determines the flow chart of the required orientation of the workpiece in the working space of the process equipment, and when performing operations on the multistage CNC, opportunity to complete processing of all elementary surfaces of the part with a single setup.

The actual accuracy of the implementation of the size specified by the designer, proper positional relationship of machined surfaces, the degree of complexity and design of the necessary tools, cutting and measuring tools, performance and other technical and economic parameters of parts machining depend on the sound and correct decisions on the technological scheme of the performed processing operation.

2. Development of technological basing schemes

2.1. Analysis of the stages of development of technological processes

Design processes in accordance with GOST 14,301 - 83 "Unified system for technological preparation of production. General rules for the development of technological processes" [1] include the basic steps presented in Figure 1.

The third and fourth stages, marked in Fig. 1 by double border determine the technological scheme of the required orientation of the workpiece in the working space of the process equipment for the operation.

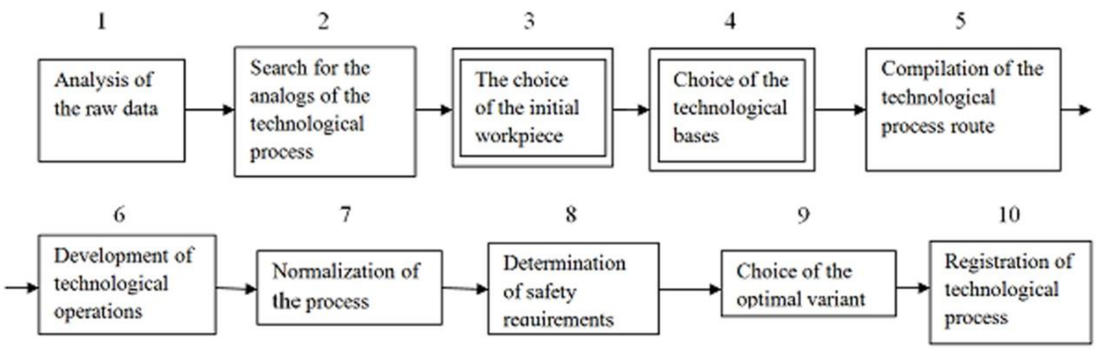

Fig. 1: Stages of the design process of parts manufacturing

2.2. Design of the workpieces

The step of selecting the primary billet, comprising establishing its shape, size and surface quality, largely determines the amount of machining required to produce the finished part. Therefore, the rational choice of the initial billet is of great importance for the improvement of the technical and economic parameters of the process of parts manufacturing [2].

The choice of the initial billets for the manufacture of standard parts – representatives of high precision forming tooling and compressor blades for gas turbine engines was made for single and small batch production, characteristic of "AVIADVIGATEL", where small series of parts are made. Therefore, workpieces of simplified geometric shapes in the form of regular cuboids for parts – representatives of precision tooling and the regular-shaped cylinders for compressor blades of gas turbine engines were selected.

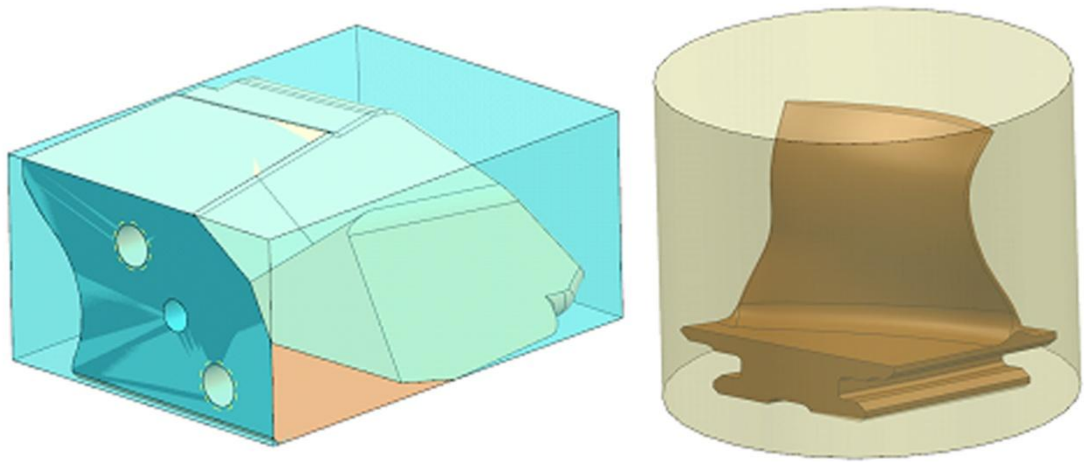

Fig. 2: Examples of blanks "Insert" and "The Level 7 blade"

2.3 The choice of the locating chart

Installing of the blanks on multioperational CNC machines is made on technological bases, pre-prepared in conventional universal machines. An important task in selecting the main technological base for processing the part on the multistage machine is to provide a complete machining of the workpiece on all sides with the fewest reinstallations [3].

The machining of the stock would begin with the preparation of the technological bases. Wherein the first in the database set the surface (or a combination of the surfaces) is treated with the help of which a larger number of degrees of freedom would be taken away from the workpiece. Such a surface may be an installation or double rail base. The plane selected as the main base for the parts – representatives of high-precision forming tooling, is the mounting base. Further, using this surface as one of the technological bases, the other surfaces of the workpiece which are the part of a set of technological bases, are processed.

In this paper we analyzed 18 types of standard parts of high-precision forming tooling and 7 standard parts – representatives of compressor blades for gas turbine engines [4]. For each part of high-precision forming tooling the main base surfaces for the implementation of a standard chart "on two holes with parallel axes and a perpendicular to them plane" were identified. For each blade the main basic surfaces for the implementation of one of the standard schemes based "on a cylindrical surface" or on "two holes parallel to the axis and perpendicular to them plane" were identified. If necessary, the design concept of artificial technological bases in the form of holes for dowel pins on the main basic surface was determined. For all parts – representatives a planar face with the largest dimensions or a cylindrical surface of the technological gain7 was selected as the main basic surface. Figure 2 shows the main basic surfaces of the parts – representatives of the "Insert" and "guide vane".

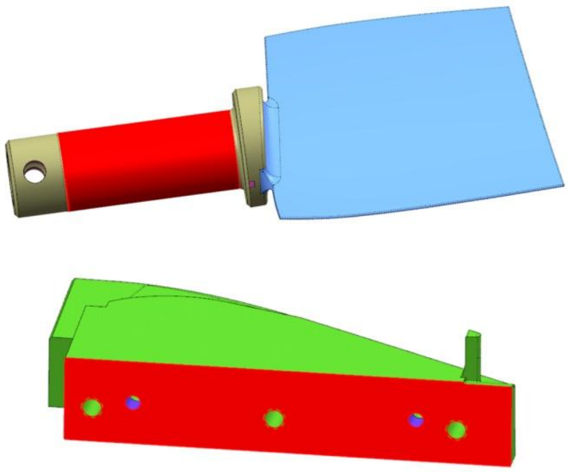

Fig. 3: Examples of major base surfaces of the parts "slider" and "guide vane"

3. Implementation of technological schemes of installation of parts of high precision forming tooling

3.1. Designing technological "cubes".

In order to meet the requirement of full machining of a workpiece on all the sides in a single setup or with the least number of reinstalls, it is offered to locate and fix the blank parts of high precision forming tooling on the desktop of CNC machine in the elements of quick-change tooling of the company SCHUNK (machine vise) [5], in which the workpiece is fixed with the help of the "technological cube". The structural layout of a typical "technological cube" with the accuracy of basic geometric parameters is shown in Figure 4.

Typical "technological cubes" have two mounting holes for mounting pins and one, two or three holes for the screws to fasten it to the primary plane. Dimensions in respect to - "technological cube" surface, adjacent to the main base plane of the part, and the location of installation an mounting holes must meet the demand of the maximum contact area between the main base surface of the installed part and the main surface of the "technological cube" in order to provide high rigidity and stability of the assembly unit: workpiece –"technological cube" in the company SCHUNK tooling.

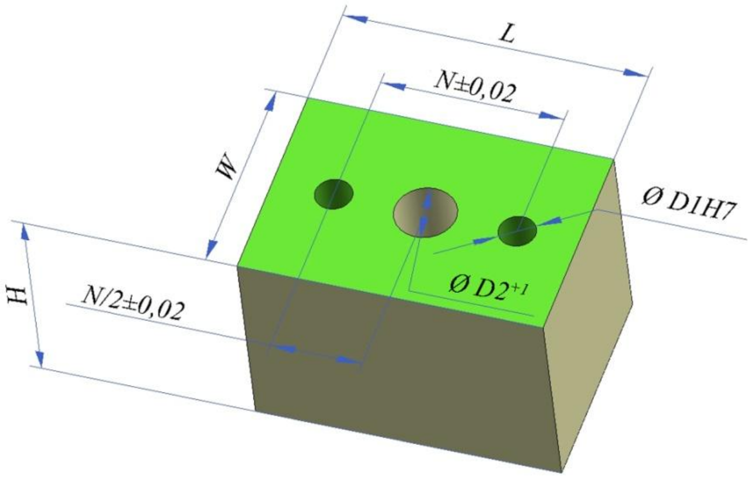

Fig. 4: The structural layout of a typical "technological cube"

3.2. Design of additional installation components of the assembly units

When selecting technological base, it may occur that the version of billet location, dictated by dimensional relationships between the workpiece surfaces is difficult to implement because of the small dimensions and the length of the surfaces, which should be used as a technological bases or due to the design details of the part, that makes it difficult or makes it physically impossible its basing on these surfaces [6].

In the first case, in order to avoid significant error in the workpiece setting any kinds of part's surfaces that meet the requirements of the technological bases, including pretreated free surfaces can be used as the base technology.

In the second case, it is necessary to create special surfaces in the form of mounts, pivot holes, fingers mounting holes, which must be processed at the first transactions and used as technological base, when manufacturing the part.

Figure 5 shows a typical scheme of assembly unit blank - "Technological cube".

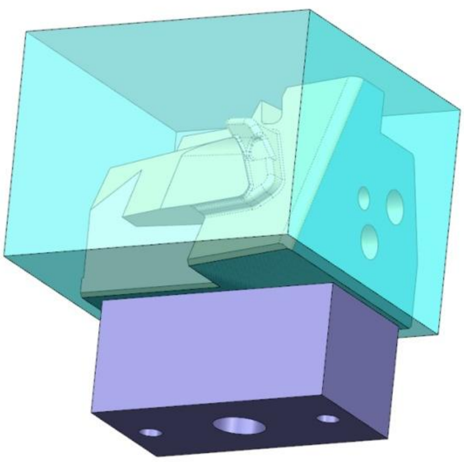

Fig. 5: Technological scheme of installation and fixing of the blank part "liner" to "technological cube"

3.2. Design of assembly units for the deployment of large parts

To install and secure large parts of "Stove" type it is suggested to use pallet and extensions included with the standard equipment of the company SCHUNK instead of "technological cube" With this installation scheme, typical scheme based "on two holes with parallel axes and perpendicular to them plane» is preserved ". On the main basic plane of the part's blank there will be two basic artificial holes Ø25H7, mating the cylindrical surfaces of mounting extensions. Figure 6 provides a typical installation scheme of a blank of the part "Stove" using standard pallets and extensions of the company SCHUNK.

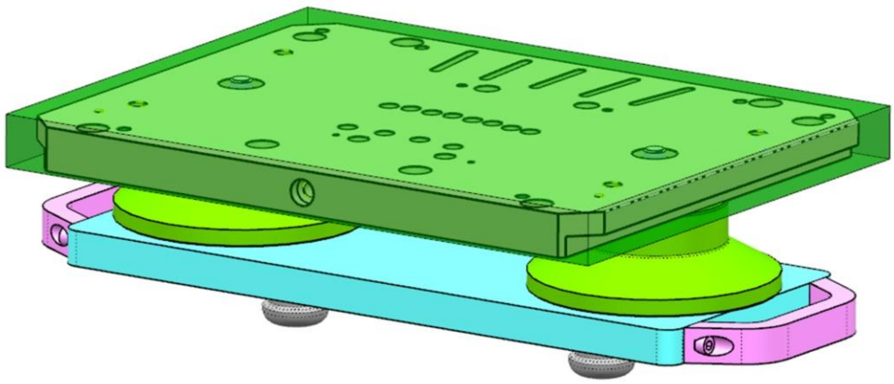

Fig. 6: Technological scheme of the installation of the blank of the part "Stove" using pallets and extensions included with the standard equipment of the company SCHUNK

4. Implementation of technological schemes of the blades' installation

4.1. Designing technological gains

To meet the requirement of the full billet (workpiece) machining on all sides in a single setup or with the least number of reinstalls it is offered to locate and fix the blank blades on the desktop in the elements of quick change tooling of the CNC machine of the company SCHUNK (machine vice and three-jaw chucks) [5] in which the is fixed directly by the shank or with the help of the technological gain. The structural diagram of a typical "technological gain", planed for making two blades with precision of basic geometric parameters is shown in Figure 7.

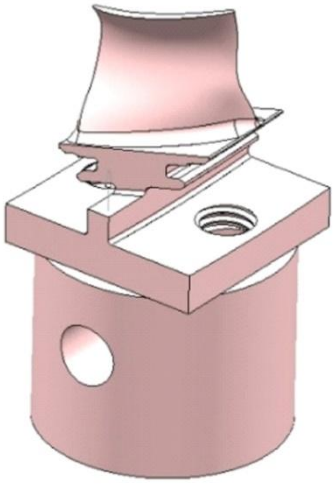

Fig. 7: Design example of changeable technological gain for the part "compressor blade"

Typical "technological gain" has one or two mounting holes for mounting fingers. Dimensions in terms of the main basic surface of "technological gain" should provide complete coverage of outer contours of the part. The length of "technological gain" consists of two lengths of the blades and the intermediate portion, enough to host the mounting hole and ensure high rigidity and stability of the workpiece assembly unit – element of high-precision forming tooling of the company SCHUNK.

4.2. Design of assembly units for the deployment of blades

Figure 8 shows the typical scheme of the workpiece assembly unit – element of technological tooling of the company SCHUNK for parts with cylindrical technological gain (a) and technological gain in the form of a cuboid (b).

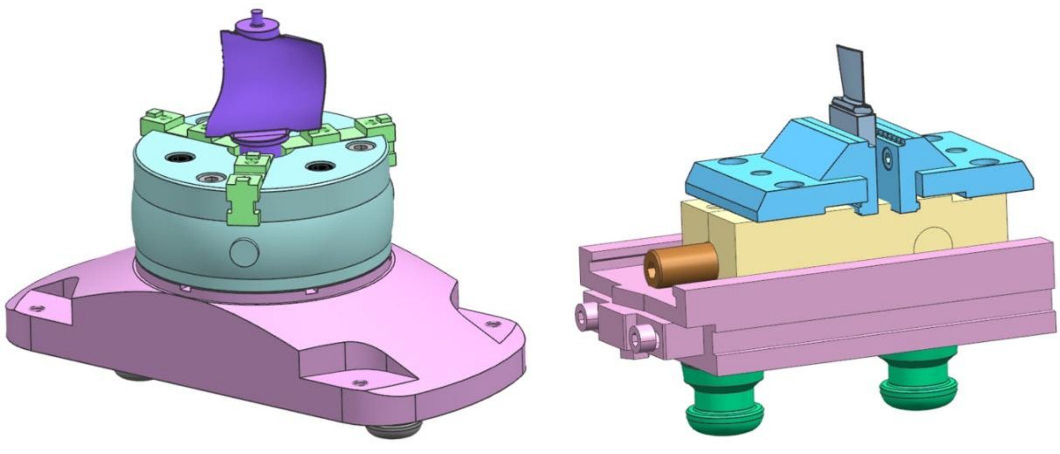

Fig. 8: Technological schemes installation blanks "The blade" with technological gains and standard equipment company SSHUNK

5. Conclusion

The work performed for the development of technological schemes of this installation is the basis for the design and fine-tuning of robotic technologies of typical parts – representatives of high-precision forming tooling and compressor blades of gas turbine engines in the framework of pilot production of company "AVIADVIGATEL."

6. Acknowledgment

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References

[1] GOST 14.301 - 83. Unified system for technological preparation of production. General rules of development of technological processes and choice of means of technological equipment. Moscow: PPC Publishing house of standards, 1983. 9 p.

[2] Suslov A. G. Manufacturing engineering. Moscow: «Mashinostroenie Publishers», 2007. 430 p.

[3] Mihajlov. A.V., Rastorguev D.A., Shirtladze A.G. Fundamentals of technological processes designing engineering industries. Staryj Oskol: TNT, 2010. 336 p.

[4] V.I Svirschev, S.A Chervonnyh, D.V Tukachev, D.A Osipovich, S.A Melnikov, R.R Nurgalin, S.E Cherepanov, E.A Savina. Typing representative parts of elements of high-precision molding tooling for developing technologies for the production of prototype five-axis machining robotic complex. Naukoemkie *tekhnologii v mashinostroenii – Science intensive technologies in mechanical engineering*, 2013, no.10 (28), pp. 34-38.

[5] Schunk. Stationary workholding (Products overview and recommended practices). Mengen, 2012. 376 p.

[6] Kolesov I.M. Bases of manufacturing engineering. Moscow: Higher school, 1999. 591 p.