Method of refusals for technological preparation of group processing of basic holes

E Y Tatarkin, A M Firsov, A G Ovcharenko, V A Kalistru

Biysk Technological Institute, Trofimova str. 27, Biysk, 659305, Russia

e-mail: mrsi@bti.secna.ru

Abstract. Analysis of the group stages of the preparation process for the body parts has shown that the existing methods of design does not account a number of factors that give rise to unacceptable deviations (potential failure) the output process parameters. Algorithm design of group process with the use of methods of "Analysis of the types and consequences of failure" and design search is proposed. This allows the design phase to identify potential failures, to develop measures to prevent such failures and to provide the required output parameters.

Introduction

The efficiency of modern technological equipment is determined by the degree of its utilization. Increased equipment utilization is possible through the use of batch processing components, the principles of which were developed by S.P. Mitrofanov, A.P. Sokolovsky [1, 2, 3] and found in the works of B.M. Bazrov [4, 5].

Today, the group handling is not widely used in the manufacture of case details due to the large variety of structural forms, materials and methods of production of billets. It is not possible to create complex parts for which is possible to use standard technology solutions. One solution to this problem is the association of case details in groups of design and technological features basic holes, the complexity of processing that can be more than 60% of the total labor input.

A distinctive design feature of the base hole is not always possible to apply technological solutions for the processing of basic holes of all details within the group. This is due to the fact that structural and other features not included in the normative and technical documentation. Therefore processing of such details, even over a single technological process can lead to unacceptable deviations (potential failure) [6, 7]. In this case, the model adopted technological solutions specific to individual processes do not provide the required output parameters of group process step in the manufacture of all details of the group. When processing some details of the group there are potential failures, such as failure to comply with a geometric precision machined surfaces, performance, costs, etc.

Troubleshooting failure by the trial moves and measurements during debugging, or when the process significantly increases the complexity. Therefore, it is necessary to predict the appearance of potential failures at the design stage of technological processes (TP) for all the details combined into a group and to take measures to prevent them.
Materials and methods

Prediction of output parameters TP and their potential failures may be performed using analytical, statistical and expert methods of estimation. However, in multiproduct production conditions when designing batch processing application of these methods is not always possible, because a group can be combined by various design details.

An analytical method may be time-consuming and not always adequate for all the constructions of details, the results of statistical studies are often lacking, and the peer review only allows a qualitative assessment of the output parameters. Therefore, you need a method to identify potential failures arising in the performance of the process. This will identify the main causes of failure and their possible consequences, to develop action to eliminate these causes or mitigate the consequences.

The authors proposed a perspective method of "Analysis of failure modes and effects", which has been used successfully to assess the reliability of various facilities and technology [8-10]. However, the use of this method in the design of group processes (GTP) is unknown and requiring additional research.

According to [11] the design of group process involves a number of steps that can be grouped into three basic 1-analysis of the original data and the creation of a grouping of details of complex details; 2 - design of TP for complex details and assessment of its results; 3 - provision of conditions to TP and documentation. However, the design of GTP handling of details with distinctive design features necessary to introduce additional steps.

These stages are connected with the analysis of the influence of special structural components parts within the group, assessing their impact on the output parameters of the TP.

Changing the conditions of the TP, designing technological and technical solutions taking into account the structural features of group details provide required output parameters for all the details.

The implementation of these proposed steps are made using the methods of "Analysis of the types and consequences of failure" and design search.

Results and discussions

Algorithm of design of GTP using the above methods is presented in the form of a scheme consisting of 7 stages (Figure 1). In the first stage the original data for the design were analyzed: drawings of parts with specifications for dimensional accuracy, the deviation of the surface roughness, etc.; software task and deadline for the task; financing offer and the cost of technology.

Grouping of parts on different grounds are produced after the analysis of the original data and the award of the contract for the manufacture of parts. When you combine a group of different design details it is necessary to identify similar in design and technological features surface and create an integrated surface that combines all the features of surfaces of parts.
In stage 2, the group operation and plan when processing a particular surface of the range of parts group are developed. If the group together different parts of the structure, the group operation is developed for integrated surfaces. For them, technology is determined by the sequence of actions to provide the desired process requirements. Thus, a design and technology unit, which consists of integrated surface and process for the group details are created.

Transition plan surface treatment parts, tools and processing modes are selected from a database of known standard solutions, regulated legal and technical documentation. Since the group merged with the details of design features, which are not considered legal and technical documentation, it is necessary to analyze the impact of these features on the process. If there are structural elements or other factors which may lead to potential failures, it is necessary to analyze their effect on the output parameters TP.

The third stage of the design is carried out according to the requirements of the method "Analysis of the types and consequences of failure" and includes a number of actions:
- to establish an expert group to identify potential for failure of the process and their implications;
- the level of importance of the consequences of refusal is determined by 10-point scale ($C$);
- the level of importance of the reasons for the emergence is determined by 10-point scale ($R$);
- the level of significance of detection of failure in the manufacturing process is determined by 10-point scale ($D$);
- for each failure risk priority number equal \( RPN = C \cdot R \cdot D \) is calculated. \( RPN \) has a value from 1 to 1000, a critical risk priority number \( CRPN \) ranges from 100 to 125;
- number of each priority risk is analyzed. If \( RPN < CRPN \), the failure is considered to be insignificant, the design process ends and the paperwork is done (Figure 1, stage 7). If \( RPN \geq CRPN \), the failures are considered to be significant and for operations such new technological solutions are developed.

On the fourth stage it is necessary to analyze the availability of technological solutions in the database of information to support the design of group processes. This database contains information on structural elements of detail that can be the cause of failure, failure modes, and technological solutions that prevent the occurrence of failure wholly or reduce its exposure to acceptable requirements.

This information support is formed from data obtained in the design of TP with similar structural and technological features. If there is a technological solution that was previously developed, it is necessary to carry out its assessment of the criteria, which include a set of requirements in terms of functionality, technology, economy and safety.

If an existing solution is satisfied the requirements, it is used to improve the process (Figure 1, stage 5), which is to change the type of processing, structure, tools equipment, processing conditions, etc.

If the technological solution does not satisfy the requirements, go to stage 6 "Design of technological solutions to address potential failures." In this case, new technological solutions includes the formulation of the problem in the design, development, technical specifications and the design itself. At this stage, methods of search engine design, such as "brainstorming", "heuristic methods", "morphological analysis and synthesis" and others are used. Founded technological solution is evaluated using criteria.

In meeting the required specification technological solution is used to improve the TP (Figure 1, stage 5) and is entered into a database for further information to support the application.

After the improvement of the TP priority the number of risk \( RPN \) is determined. In the case of providing the desired output parameters for TP it is taken to implement, otherwise the cycle repeats as long as the condition is met \( RPN < CRPN \).

**Conclusions**

An analysis of the stages of the preparation technological process for the group of case details found that the current methodology does not take into account a number of design factors, or other structural nature, which give rise to unacceptable deviations of the output parameters of the process.

An algorithm for the design of group process with the use of methods of "Analysis of the types and consequences of failure" and design search is offered. This allows the design phase to identify potential failures, to develop measures to help prevent the emergence of failures and provide the required output parameters in the implementation of the group process.

The proposed method allows to detect and eliminate potential failures that may occur as a result of the lack of data in the normative and technical documentation on the design of technological operations, the design features of the workpiece and other factors at the stage of technological preparation of production.

**References**

[1] Mitrofanov S.P. Nauchnaya organizaciya mashinostroitelnyh proizvodstv [The scientific organization of engineering industries]. Leningrad, Mechanical Engineering, 1976. 710 p.

[2] Mitrofanov S.P. Grupovaya tekhnologiya mashinostroitelnoy proizvodstva. Tom 1. Organizaciya grupovogo proizvodstva [Group technology engineering production. V.1. The organization of group production]. Leningrad, Mechanical Engineering, 1983. 407 p.
[3] Sokolowski A.P. Kurs tekhnologii mashinostroeniya. Chast 1. Obshie voprosy tekhnologii mehanicheskoi obrabotki [Course of mechanical engineering. Part 1. General questions machining technology]. Moscow- Leningrad, Mashgiz, 1947. 435 p.

[4] Bazrov B.M. Modylnaya tekhnologiya v mashinostroenii [Modular technology in mechanical engineering]. Moscow, Mechanical Engineering, 2001. 368 p.

[5] Bazrov B.M. Tipovaya tekhnologiya v sovremenyh usloviyah [Types of technology in modern conditions]. Naukoemkie tekhnologii v mashinostroenii - High technologies in mechanical engineering, 2014, no. 4, pp. 44-46.

[6] GOST 27.202 - 83 Reliable technology. Technological systems. Methods for assessing the accuracy of the parameters of quality of manufactured products. Moscow, Publishing Standards, 1983. 350 p.

[7] GOST 27.310 - 95 Reliable technology. Analysis of the types, effects and criticality of failures. The main provisions. Moscow, Publisher standards, 1996. 20 p.

[8] GOST R 51814.2-2001 Quality systems in the automotive industry. The method of analysis of species and the effects of potential defects. Moscow, Publishing standards, 2001.- 19 p.

[9] Firsov A.M., Vdovin A.V., Timokhovitch I.V. Proektirovanie tekhnologicheskogo proycesa obrabotki rezaniem na osnove ucheta otkazov tekhnologicheskoi sistemy [Design process machining on the basis of accounting failures of technological systems]. Mekhaniki XXI veku - Mechanics of XXI century, 2013, №12, pp. 155-159.

[10] Tatarkin E.Y., Firsov A.M., Kalistru V.A. Obespechenie tochnosti bazovyh otverstiy korpusnyh detalей pri grupovoi obrabotke putem prognozirovaniya parametricheskikh otkazov [Ensuring the accuracy of basic holes of body parts in the group treated by predicting parametric failures]. Naukoemkie tekhnologii v mashinostroenii - High technologies in mechanical engineering, 2015, №5, pp.15-29.

[11] R 50-54-93-88 Recommendations. Development and application Processes. Moscow, Publishing standards, 1988. 15 p.