Formation of initial data of the workpiece batch in simulation modelling precision forming

I P Balabanov, O N Balabanova, A V Groshev
Kazan Federal University, Naberezhnye Chelny Institute
423810, Naberezhnye Chelny, Mira av., 68/19, Russia.
E-mail: balabanovip@mail.ru

Abstract. Modern simulation model is limited to the creation of items. However, in actual production, we often have significantly more manufacturing products. In the article the question of the formation of the initial batch data is raised. This will more accurately simulate the processing of the party details.

1. Introduction
Using ISO 9000 series sets, new tasks appeared for introducing them in the manufacturing enterprise [1; 2]. Today it is not enough to ensure compliance with the specified values of all indicators of the volume of output, but also to stabilize the processes required to improve them [3; 4]. The basis for such controlling is able to be the simulation.

In engineering, the following measures of accuracy are given [5]: the relative position, the total deviation of the shape and the relative position, the shape deviations, waviness, roughness. After the analysis of definitions and measurement schemes it was discovered that their application is directed strictly to determine the deviation limits; there is no requirement to commit coordinate measurement; figures do not constitute a single coherent system; the part is not considered as a set of interrelated elements. Nevertheless, each of the indicators somehow affect the quality of the assignment functions. Therefore, the complete description of a set of indicators is necessary for the better management model [6].

2. Basic part
In the frame of single task indicators accuracy of the tool elements is usually considered to be systematic. Each part, at the same time, is random, and because of their quantity they can't often be identified, so it is considered that measures of accuracy workpieces are unknown [7]. But in fact, even if these values are of unknown technology, in reality full set of indicators is inherent in every workpiece. When measuring they just become known. Therefore, for the effective simulation at least random values of each individual indicator must be set which may affect the overall accuracy of the workpiece. These include all measures of accuracy, as well as the hardness and strength of the material of the workpiece. In the task the condition is that each of them can meet the requirements of the operating map, but in a real situation they may not. Depending on the processing technology on previous operations each of them is characterized by a well-defined distribution law for the largest party in the scalar value. A well-defined distribution law of deviations in workpiece shows that coordinates are typical. In this paper, we face the task of obtaining the most complete information over the status of each workpiece simulation accuracy for forming the party details on the basis of standard accuracy metrics. Let's look at an example of party identification workpieces made in accordance with...
the requirements of the drawing (see Figure 1). Material: calibrated, incised, cold-rolled round steel (GOST 7417-85).

![Figure 1. Model limitations of standard accuracy metrics](image)

The initial data for the party preparations, according to the drawing, will serve: material grade; the hardness of the workpiece (the law of distribution over the surface of a workpiece); diametrical rod size (d44-0.250); deviation from circularity (0.1); conicity workpiece (0.1/2000 mm); workpiece (160-0.250).

For the full simulation process of morphogenesis full identification of the status of all elements of the system is required. This element is also a workpiece. In accordance with the content of the process of shaping parts of each element of the workpiece, accuracy is characterized by the integral (total) index, which consists of hierarchically nested components.

It is also necessary further to define the conditions of installation and handling. In this example, it includes the definition of the end of the workpiece fastened in a holder and operator skills. In the first case, the position of the workpiece is identified in the global coordinate system of the machine, in the second - qualification will allow the operator to simulate the precise adjustment of the cutting tool size.

Each set in the drawing accuracy rate workpieces party is characterized by its distribution law in the party. For example, the distribution of the diametric dimension (d44-0.250), deviations from circularity (0.1), conicity of the workpieces(0.1/2000 mm) length of the workpiece (160-0.250), hardness and skill of the operator on (the limb) are subject to the normal distribution (Gause) and fixing in the chuck - equal probability. The material trademark can be considered constant.

At the first stage of identification party must assign each billet unique number constant throughout the workpiece life cycle. Next, we form a system of initial batch data for each of the workpieces of proposed indicators

Allocation algorithm in more detail is shown by the example of figure diametrical size of the workpiece. As mentioned above, the distribution of the diametrical size of the workpiece in the party subject to the normal distribution law. The initial data for the construction of such a law would be: number of pieces in the game (N); nominal value of distributed parameter (dnom); upper deviation of the accuracy (ES); lower deviation of the accuracy of (ei); width of the interval (sigma); centre grouping (X); [8; 9]

In the second stage, it is necessary to translate the histogram distribution curve. To do this, ask the sampling interval, i.e. determine the width of the column histogram [8; 10]. It is advisable to take the sampling step equal dividing the price of the measuring tool (for measuring 0.025 micrometer).
where \( \delta \) - the coefficient of the sample standard deviation; \( x \) - the value of shifting the center of the grouping.

Then determine the values of the distribution function at the midpoints of sampling intervals by formula (1) and calculate the sum of the values of the distribution function (2) at the midpoints of sampling intervals:

\[
f(m) = \frac{1}{\sqrt{2\pi \times \delta}} \times \exp \left( -\frac{(x-m)^2}{2\delta^2} \right) \tag{1}
\]

\[
B = \sum_{m=ei}^{es} f(m),
\tag{2}
\]

where ES - upper deviation of the accuracy; ei - the lower deviation of the accuracy.

To complete the calculation of the amount of detail in the discretization interval it is necessary to calculate the distribution coefficient index, i.e. number of units of a normal distribution attributable one part in the batch (3):

\[
k = \frac{B}{N} \tag{3}
\]

where \( N \) - number of pieces in the batch;

and then determine the number of pieces relating to each interval, by dividing the distribution function in the middle of each sampling interval on the distribution coefficient of batch (4).

\[
n_i = \frac{f(m)}{k} \tag{4}
\]

In connection with estimated quantities workpieces on the intervals to the whole, there can be a situation where the total value of workpieces is different from the number of workpieces in the party. To resolve this discrepancy it is proposed to compare the amount of workpieces obtained in histogram to the original value, and add / remove missing / excessive harvesting of the center column grouping, thereby bringing the number of workpieces in accordance with the initial data.

At the final stage randomly assign each room a specific workpiece value of the index exactly, in accordance with this distribution.

3. Conclusion

In accordance with an algorithm, accuracy is defined by specific values of all other parameters. After the completion of the identification of the values of all parameters, we obtain the accuracy of available state database of each workpiece. The values obtained are fully consistent with regulations for batch of workpieces. This information will create a model of each particular workpiece based on law describing each part in the machine system, a move equation of the workpiece relative to the machining part of a cutter and as a result, to obtain the equation removes allowance.

Thus, thanks to this technique, random errors and processing bases, due to inaccuracy of manufacturing can be determined regularly.

References

[1] M. Standartinform 2012 . GOST ISO 9000-2011. Interstate standard . Quality management system. Fundamentals and vocabulary (ISO 9000:2005, IDT) Quality management systems. Fundamentals and vocabulary ( enacted on January 1, 2013 Order Rosstandart from 22.12.2011 N 1575 - st)
[2] Chow-Chua, Clare; Goh, Mark; Wan, Tan Boon (2003). "Does ISO 9000 certification improve business performance?". International Journal of Quality & Reliability Management 20 (8): 936. doi: 10.1108/02656710310493643.

[3] M. Standartinform 2012. GOST ISO 9001-2011. Interstate standard. Quality management system. Requirements (ISO 9001:2008, IDT) Quality management systems. Requirements (came into effect from January 1, 2013 Order Rosstandart from 22.12.2011 N 1575 - st)

[4] Corbett, Charles J.; Montes-Sancho, Maria J.; Kirsch, David A.; Song, CX; Wu, H; Dai, Q; Irier, H; Upadhyay, AK et al. (2005). "The Financial Impact of ISO 9000 Certification in the United States: An Empirical Analysis". Management Science 51 (7): 1607-16. doi: 10.1287/mnsc.1040.0358. JSTOR 20110397. PMC 3292193. PMID 22037496.

[5] GOST 24642-81 Basic norms of interchangeability. Tolerances of form and position. Basic terms and definitions. Official publication

[6] SV Kasyanov, LA Simonov. IP Balabanov Managing the process of forming the party details using a simulation model // Problems of mechanical engineering and materials technology at the turn of the century: Collection of articles VIII International Scientific and Technical Conference. Part I. - Penza, 2003, p. 198-201

[7] Balabanov IP, Simon LA Modeling precision molding processes based on the identification of indicators of the quality of a blank // Proceedings of the III International scientific-practical conference "CAR AND Technosphere", Kazan, 17-20 June, the Kazan: Kazan State Publisher University of Technology, 2003, 1160 p

[8] Magnus YR, Katishev PK, Peresetskii AA, Econometrics. Initial course. Textbook. 2nd ed. . Rev. - Moscow: Delo, 1998. - 248.

[9] Nancy R. Tague (2004). "Seven Basic Quality Tools". The Quality Toolbox. Milwaukee, Wisconsin: American Society for Quality. p. 15. Retrieved 2010-02-05.

[10] Wheeler, Donald J. "What About Charts for Count Data?". Quality Digest. Retrieved 2010-03-23.