Statistical Control of the Technological Process Stability to Manufacturing Cylindrical Parts into High Series

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ABSTRACT. This paper presents a calculation algorithm for verifying on-line of the manufacturing process stability in large and mass series of some cylindrical parts from axes type. Through experimental investigations, we conducted a statistical control on a sample parts batch to determine the machining accuracy of some checking turret lathes.

In the first phase, we performed a statistical analysis of the technological process preceding the manufacture of cylindrical parts in large and mass series. For checking the normality assumption of the deviations for parts machined, we established the main statistical parameters as being arithmetic mean and standard deviation. With these parameters, I could calculate the fraction of probable defective parts.

In the second phase, we determined the control limits for the arithmetic mean and standard deviation. With these parameters I could pursue in chronological order the actual achievement of the workpiece size. In this way, I could check the technological process stability on-line for well-defined period's time, between two successive adjustments of the machine-tools.

Introduction. Following the actual technological manufacturing process of the cylindrical parts from the axes type, these will have deviations from the dimensional accuracy and geometric shape [2 and 7]. The main factors contributing to the processing deviations emergence are [1, 6, 8 and 9]: the geometrical inaccuracy of machine-tools; the imprecision of the measuring instruments used; the fastener imprecision of workpiece and of the cutting tools; the wear of cutting tools; the variation and modification during the cutting process the thermal parameters for machine tools, fastener devices, workpiece and cutting tools; the elastic deformation of the technological system; the unevenness of cutting depth; the variation of internal stresses into the processing material.

The manufacture type and the causes producing these deviations, determine the check method for the machining process stability. Into the large and mass series production case, it uses exclusively a statistical analysis [1, 3, 5, 6, 11 and 12]. Being a section of this analysis, the statistical control is carried out on a sample of representative parts, considered as a standard. Thus, both during the manufacturing process and after its completion [2, 4, 6, 7, 8 and 13], batches of 100 pieces are taken to be checked individually. The statistical analysis of the measurement results provides information about the technological process stability. But the timeframes needed to process the experimental data can adversely influence the productive capacity, with negative effects on manufacturing costs.

In paper we propose an active statistical control of the machining accuracy, conducted on-line during the technological process. The experimental investigations demonstrated the supercomputing capacity of relevant information in connection with possible trends of disturbance/impairment or decreasing the manufacturing accuracy [9, 10, 12 and 14]. In this way it was possible to correct operative the technological process without interrupting the manufacturing cycle, for it to be stable over time and to avoid the emergence of non-conforming parts.

Investigations were conducted over some cylindrical parts of the axes type which have been manufactured in high series on a checking turret lathe. The schematic diagram is shown in Figure 1.

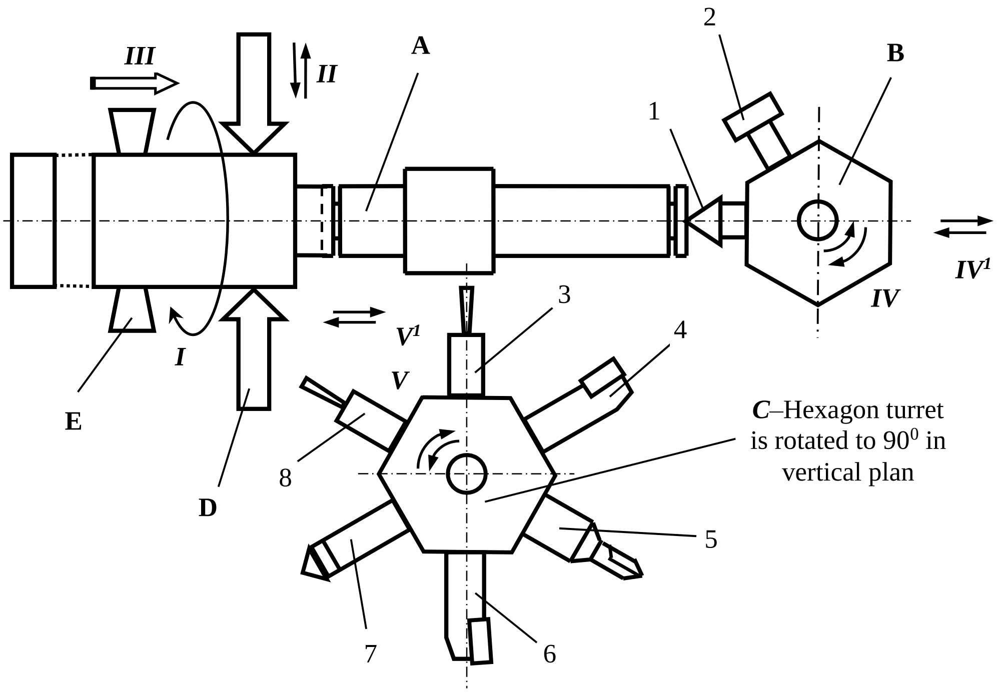

Fig. 1. The principle scheme of the testing plant.

The blank denoted by ***A*** has the shape of a long cylindrical bar. This one it is operated in a primary rotational movement ***I*** with the help of a gripping device ***D***. The metal cutting of the blank takes place in a sequential cycle of movements ***II* - *III* - *IV/IV¹* - *V/V¹***, using tools which are adjusted to dimension. A positioning device ***B*** includes a running center ***1***, and a buffer brake ***2*** as a plug. Another device ***C*** as a hexagon turret contains a specified number of tools for each technological operation. Thus: a necking tool ***3*** for grooving; a facing tool ***4*** for frontal lathing one end; a center drill **5**; a hook tool ***6*** for exterior lathing; an angle cutting tool***7*** for beveling at 45^0 and a parting tool ***8***. Another device ***E*** ensures the working advance of the blank ***A*** for processing new parts.

The technological itinerary it is: (1) the blank is fixed into ***D*** by movements ***II***; (2) the blank into the rotation movement ***I*** is actuated; first, are processed the clean-frontal one end and the centering hole, with the help of the tools ***4*** and ***5***; (3) the device ***D*** releases the blank ***A*** which it is driven by device ***E*** up to contact with the buffer (plug) ***2***; (4) the device ***B***, through the movements ***IV* - *IV¹***, ensures a supplementary support for the blank ***A*** by the means of running center ***1***, after which it takes place processing the exterior cylindrical surfaces with the help of the hook tool ***6***, through the movements ***V* - *V¹***; (5) is continue processing of the two channels by means of the necking tool ***3***, after which the edges are beveled at 45^0 with the angle cutting tool ***7***; (6) the workpiece fall off by means of the parting tool ***3*** and the technological cycle stands ready to start again.

The main statistical parameters. The main statistical parameters that characterize a certain size X from a controlled parts series [1, 4, 6 and 15], can be grouped as follows:

1 Parameters of general trend, giving information on adjustments made:

1.1 The unweighted arithmetic mean of the sampling fraction string $\bar{x}$; for a discrete distribution, it is calculated using the relationship:

$$\bar{x} = \sum_{i=1}^{n} \frac{x_i}{n} \tag{1}$$

where x_i – the actual size of the controlled parts in their manufacturing order *I* from the sampling fraction string *n*;

n – number of parts constituting the controlled sample size

1.2 The median of the sampling fraction string M_e, i.e. the value for which the frequencies having smaller or higher values than herself are equal, and calculate with the relationship:

- For an uneven number *n* of ordered parts ascending, $n = 2k + 1$:

$$M_e = x_{k+1} \tag{2}$$

- For an even number *n* of ordered parts ascending, $n = 2k$

$$M_e = \frac{x_k + x_{k+1}}{2} \tag{3}$$

where $k = 1, 2, 3, \ldots$

1.3 The modal value of the sampling fraction string M_0, which is the characteristic value with the highest frequency, and calculate with the relationship

$$M_0 = \bar{x} + 3\,(M_e - \bar{x}) \tag{4}$$

1.4 The central value of the sampling fraction string x_c, *which calculate with*

$$x_c = \frac{x_{\max} + x_{\min}}{2} \tag{5}$$

2 The parameters of scattering, giving indications about the processing accuracy:

2.1 Dispersion of the sampling fraction string σ^2, which is calculated for the discrete distributions using formula:

$$\sigma^2 = \sum_{j=1}^{k} \frac{f_j.(x_j - \bar{x})^2}{n} \tag{6}$$

where f_j – the frequency values the same rank j

2.2 The standard deviation of the sampling fraction string σ, which is given by the square root of dispersion:

$$\sigma = \sqrt{\sum_{j=1}^{k} \frac{f_j.(x_j - \bar{x})^2}{n}} \tag{7}$$

2.3 The amplitude of the sample fraction string D, is calculated as the difference between highest and the lowest value measured:

$$D = x_{\max} - x_{\min} \tag{8}$$

Statistical control of processing accuracy. We supposed that on the dimensional dispersion of the measured semi-products, acts only random variables as accidental factors [1, 5, 7, 9 and 15]. Moreover, we supposed that a predominant influence no factor hasn't; in this case, the random variable it is subject to a normal distribution law (Laplace and Gauss) and its function has the form:

$$F(x) = \frac{1}{\sigma\sqrt{2\pi}} \int_{-\infty}^{+\infty} e^{-\frac{(x-\bar{x})^2}{2\sigma^2}} dx \,, \tag{9}$$

where $\bar{x}$ and σ are distribution parameters (arithmetic mean and standard deviation).

Statistical control was performed during the technological process and includes the following sequence: (1) statistical analysis of the technological process before application the control; (2) development of data sheet for control; (3) performing the proper statistical control;

1 Statistical analysis – it applies before using statistical control [1, 9, 12, 14 and 15]. Statistical analysis aims evaluation of the technological process stability as well as the statistical parameters determination. With the help of these parameters it will perform control in the event that manufacturing process is stable and is conducted normally. The analysis steps are the following: (1) conducting the survey on a representative group of parts (usually 100 pcs, processed successively); (2) the preparation of the time graphic; (3) the variability study of the technological process; (4) independence checking of results achieved; (5) checking of the normality assumption; (6) calculating the fraction of probable defective parts and drawing conclusions about technological process.

2 The control data sheet – practically, here are identified the nonconformities and it is detected the time of onset of perturbations in the technological process by recording and interpreting the variations statistical parameters as well the values characteristic compared to some control limits [2, 5 and 13]. Mainly, are used two statistical parameters: one for tendency (when adjustments are made), and the other for scattering (when accuracy repairs are made). According to these parameters, the following more common methods are used: (1) method of arithmetic mean and the standard deviation; (2) method of arithmetic mean and the amplitude; (3) method of the median and of the amplitude.

3 Performing the proper statistical control - according to the chronological criterion, to well-defined timeframes, samples of parts are taken. After that, the two select statistical parameters should be determined [2, 3 and 13]. If they it falls between the established control limits, the technological process takes place normally and can it continue. When one of the parameters is outside the control limits, means the technological process is unstable (adjustments and/or repairs are needed) and requires stopping the machine-tools for detecting and removing the causes. The parts which were processed during the timeframe from the preceding sample verification they will be rigorously controlled, piece by piece, because appeared rejects. The technological process can continue after remedying the nonconformities.

Statistical control of the technological process stability. Application to manufacturing cylindrical parts. The work drawing of the cylindrical parts is shown in Figure 2. These parts are used for the closure devices of the tarpaulins on TIR-s. Heat treated at 28-32 HRC, the parts are made from quality steel 3C45 (SR EN 10083-1.2). The market demands require machining some axes in batches of 40 000 pcs/month. From functionally, is important to ensure the assembly quota of $\Phi 12_{0}^{+0.045}$ mm. The sharp edges are beveled to 0.5 x 45^0.

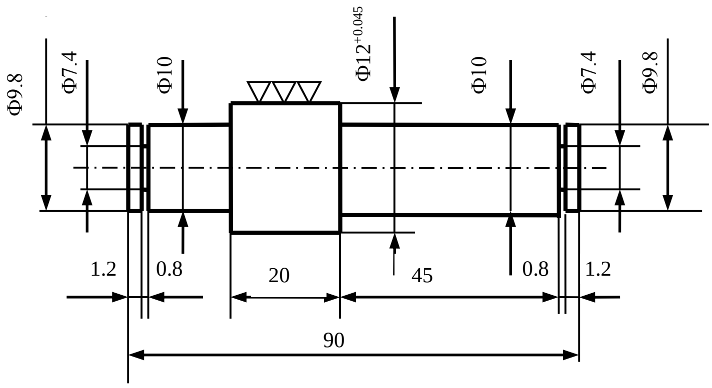

Fig. 2. The work drawing of the axes.

The experimental tests were based exclusively on the active control of the assembly quota during processing ($\Phi 12_{0}^{+0.045}$ mm). The statistical parameters used were the arithmetic mean $\bar{x}$ and standard deviation σ. With the help of these parameters, we calculated the specific control limits, valid for machining of the cylindrical parts indicated in Figure 2. The sampling on-line to well defined timeframes, the measuring of the functional quota and the automatic processing of the values effective measured provides important information about the stability of the technological process.

1 Statistical analysis of the technological process before application the statistical control

1.1 Conducting the survey - we determined actual values x_i of the controlled size $N = \Phi 12_{0}^{+0.045}$ for a number $n = 100$ pcs, in the order of their processing. The measurement results were recorded in the data sheet which is shown in *Table 1*. For measurements, we used a micrometer with dial comparator heaving a measuring field *0 – 25 mm* and *0.002 mm* division value.

Table 1. The effective values measured for a batch n = 100 pcs in the successive processing order.

No. crt.	x_i /mm/	No. crt.	x_i /mm/	No. crt.	x_i /mm/	No. crt.	x_i /mm/
1.	12.010	26.	12.016	51.	12.022	76.	12.014
2.	12.006	27.	12.018	52.	12.024	77.	12.022
3.	12.008	28.	12.022	53.	12.020	78.	12.024
4.	12.004	29.	12.012	54.	12.020	79.	12.016
5.	12.012	30.	12.026	55.	12.018	80.	12.020
6.	12.016	31.	12.014	56.	12.022	81.	12.020
7.	12.002	32.	12.008	57.	12.016	82.	12.028
8.	12.008	33.	12.014	58.	12.018	83.	12.018
9.	12.016	34.	12.016	59.	12.022	84.	12.022
10.	12.014	35.	12.010	60.	12.020	85.	12.026
11.	12.010	36.	12.018	61.	12.030	86.	12.024
12.	12.006	37.	12.022	62.	12.024	87.	12.020
13.	12.012	38.	12.012	63.	12.014	88.	12.018
14.	12.004	39.	12.020	64.	12.020	89.	12.030
15.	12.010	40.	12.012	65.	12.022	90.	12.022
16.	12.008	41.	12.014	66.	12.018	91.	12.028
17.	12.016	42.	12.028	67.	12.028	92.	12.020
18.	12.014	43.	12.020	68.	12.020	93.	12.024
19.	12.012	44.	12.026	69.	12.024	94.	12.034
20.	12.020	45.	12.022	70.	12.016	95.	12.018
21.	12.026	46.	12.018	71.	12.022	96.	12.026
22.	12.018	47.	12.016	72.	12.024	97.	12.020
23.	12.002	48.	12.020	73.	12.018	98.	12.022
24.	12.014	49.	12.020	74.	12.020	99.	12.032
25.	12.010	50.	12.012	75.	12.020	100.	12.024

1.2 The time graphic - allows the formulation some comments on the dynamic stability of the technological process. The measurement results are shown in Figure 3 in a rectangular axis system.

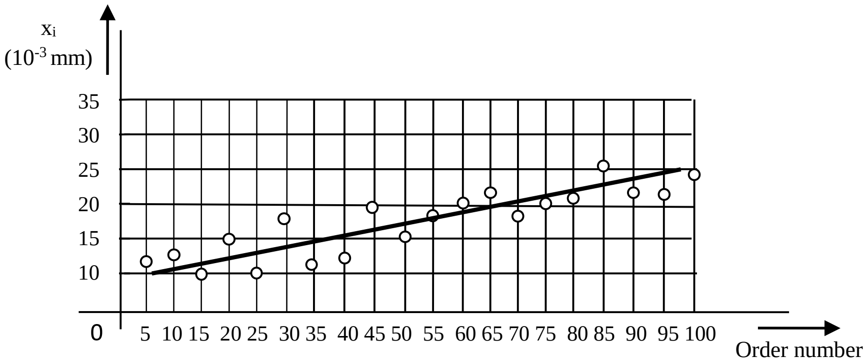

Fig. 4. The time graphic of the measurement results.

On the ordinate is plotted the effective value of the controlled size *N* denoted x_i, and on abscissa is the order number of the measured piece, of 5 in 5 in the strict order of processing.

Analyzing the time graphic, it can be noted a slight upward trend in the effective size of the measured quota. This we explain by the pronounced wear of the tool edge, when is freshly sharpened, and due to thermal instability of the technological system in the beginning period of the machining.

1.3 Variability study of technological process - consists into determining the distribution law of actual values $N = \Phi 12_{0}^{+0.045}$ of the measured parts. From statistically, is identifies the effective values measured x_{max} and x_{min} and then it calculate the amplitude *D*, using equation (8). In this case:

$$D = 12.034 - 12.002 = 0.032 \text{ mm}$$

The amplitude *D* it is divided into $k = 5$ equal intervals, and the effective values of the measured parts contained in each interval, form a class; we highlight that each class includes and the values which are equal to the lower limit of interval. For each class, it determine the mean value $\bar{x}_j$ and the absolute frequency m_j, where $j = 1, 2, \ldots, 5$ represents the order number of class.

The distribution parameters $(\bar{x}$ and $\sigma)$ is calculated, where the measured values are grouped in classes of equal amplitudes, with the following relationships:

$$\bar{x} = c + d\,\frac{\sum_{j=1}^{5} m_j \left(\frac{\bar{x}_j - c}{d}\right)}{n} \tag{10}$$

Respectively

$$\sigma = d\sqrt{\frac{\sum_{j=1}^{5} m_j \left(\frac{\bar{x}_j - c}{d}\right)^2}{n-1} - \frac{n}{n-1}\left(\frac{c - \bar{x}}{d}\right)^2} \tag{11}$$

where d – the amplitude of class (d = 0.007);

c – the mean value with the greatest frequency ($c = x_{10}$= 12.020)

To simplify the calculation for determining the distribution parameters, *Table 2* was prepared.

Table 2. The items for calculating the statistical distribution parameters (arithmetic mean and standard deviation).

No. class	Class limits	$\bar{x}_j$	m_j	$\frac{\bar{x}_j - c}{d}$	$m_j \cdot \left(\frac{\bar{x}_j - c}{d}\right)$	$m_j \cdot \left(\frac{\bar{x}_j - c}{d}\right)^2$
I	12.000-12.007	12.0035	6	- 2.357	- 14.142	33.332
II	12.007-12.014	12.0105	16	- 1.357	- 21.712	29.463
III	12.014-12.021	12.0175	45	- 0.357	- 16.065	5.735
IV	12.021-12.028	12.0245	25	0.643	16.075	10.336
V	12.028-12.035	12.0315	8	1.643	13.144	21.595
					$\sum$ = - 22.70	**$\sum$ = 100.461**

Substituting the values obtained into above relations (10 and 11), we obtain the following distribution parameters:

$$\bar{x} = 12.020 + 0.007\,x\,\frac{-22,70}{100} = 12.020 - 0.007x\,0.227 \approx 12.018\ mm$$

Respectively

$$\sigma = 0.007\sqrt{\frac{100.461}{99} - \frac{100}{99}x\left(\frac{12.020 - 12.018}{0.007}\right)^2} = 0.007\sqrt{1.01475 - 0.08245} \approx 0.00676$$

The histogram of distribution in a system of rectangular axis, where on ordinate is the absolute frequency of class m_j, j = 1, 2, …, 5 and on abscissa the order number of the class, is shown in Figure 4.

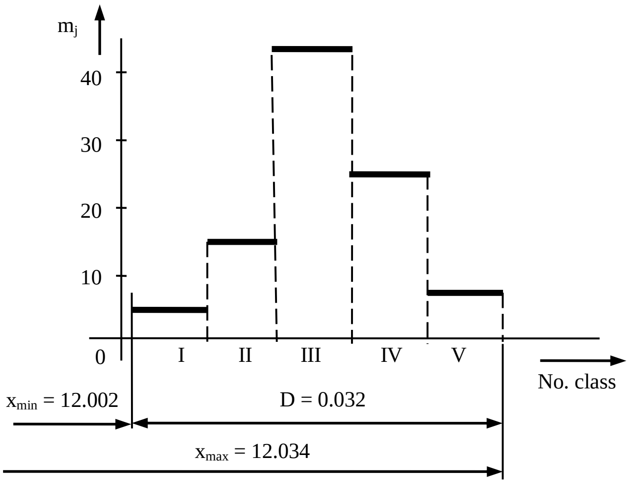

Fig. 4. Histogram of the absolute frequencies.

1.4 Checking of the normality assumption

To check the concordance between the experimental distribution and a certain theoretical distribution, we calculated [9, 10, 11 and 15]:

$$\chi^2 = \sum_{j=1}^{k} \frac{(m_j - n\,p_j)^2}{n\,p_j} \tag{12}$$

and we compared this value with the critical value established into statistical tables, where p_j is the probability calculated on basis of the theoretical distribution so that the characteristic size to have a value within the interval *j*.

For this purpose, for simplify the analytical calculations, we drawn up *Table 3*. In this table, the minimum number of classes was originally 10. But, by merging with the adjoining classes [1 and 10] we reached 8 classes because absolute frequency of the values from extreme classes was lower than 5 (we had 4 in first class, respectively 2 in the tenth class).

Values of function $\Phi(z_j)$ can be found into mathematical tables and the probabilities p_j are set as follows [2, 7, 12, 13 and 14]:

$$\begin{aligned} p_1 &= \Phi(z_1) + 0.5 \\ p_j &= \Phi(z_j) - \Phi(z_{j-1}) \\ p_k &= 0.5 - \Phi(z_{k-1}), \end{aligned} \tag{13}$$

where *k* – the class number (*k* = 1, 2, … , 8);

$\Phi(z_j)$ - Laplace’s function.

Table 3. Items for calculation of the parameter χ^2.

No. crt.	Class limits	x_i	m_j	$z_j = \frac{x_i - \bar{x}}{d}$	$\Phi(z_j)$	p_j	$(m_j - n p_j)^2$	$\frac{(m_j - n p_j)^2}{n p_j}$
1.	-∞ - 12.0084	12.0084	10	- 1.37	- 0.4147	0.0853	2.1609	0.2533
2.	12.0084–12.0116	12.0116	5	- 0.91	- 0.3186	0.0961	2.2521	2.2114
3.	12.0116-12.0148	12.0148	15	- 0.46	- 0.1772	0.1414	0.7396	0.0523
4.	12.0148-12.0180	12.0180	9	0	0	0.1772	76.0384	4.2911
5.	12.0180-12.0212	12.0212	28	0.46	0.1772	0.1772	105.6784	5.9637
6.	12.0212-12.0244	12.0244	20	0.91	0.3186	0.1414	34.3396	2.4285
7.	12.0244-12.0276	12.0276	5	1.37	0.4147	0.0961	21.2521	2.2114
8.	12.0276- +∞	+∞	8	+∞	1	0.0853	0.2809	0.0329
			∑ = 100			∑ = 1	∑ = 17.4446	

If the actual and theoretical statistical distribution are into accordance, the calculated size χ^2_{calc} will not exceed a critical value χ^2_{crit}. The critical value is appropriate to risk of order *I(α)* and to the degrees number of freedom *ν*. The risk of order *I*(*α*) is determined in such a way that $P\left(\chi^2_{calc} > \chi^2_{crit}\right) \le \alpha$.

Really, for the degrees number of freedom *ν = 10 - 3 = 7* (it's was determined in accordance with the extreme classes that have m_j<5, as well the statistical parameters - arithmetic mean $\bar{x}$ and standard deviation σ^2 - which were calculated based on observed data) and for the risk of the order $0.001 \le p = 0.0024 \le 0.02$ with *α = 0.01*, we obtained $\chi^2_{crit} = 18.5$. This value is obviously greater than the size calculated $\chi^2_{calc} = 17.446$.

Therefore, for experimental data resulting from measuring the functional quota of the axes *N*, we admit the normality assumption and we accept that the statistical distribution unfolds normally.

1.5 Calculating the fraction of probable defective parts

The fraction defective or the percentages of probable rejected parts, represent probability that the characteristic value x_i to exceed the limits of tolerance field and it is calculated with [3, 4, 9, 11, 12 and 14]:

$$p = 1 - [\Phi(z_s) + \Phi(z_i)] \tag{14}$$

where:

$$z_s = \frac{T_s - T_c}{\sigma} \text{ and } z_i = \frac{T_i - T_c}{\sigma} \tag{15}$$

where T_s and T_i – upper respectively lower limit of the specified tolerance field;

T_c – center of the specified tolerance field;

$\Phi(z_s)$ and $\Phi(z_i)$ – Laplace's function values.

Substituting the known values, both those provided in the work drawing, and those obtained by effective measurements, we obtain:

$$z_s = \frac{0.045 - 0.0225}{0.00676} \approx 3.33 \text{, respectively } z_i = \frac{0 - 0.0225}{0.00676} \approx -3.33$$

Substituting the values for the arguments, z_s and z_i, and knowing that $\Phi(-z) = \Phi(z)$, we obtain the following values for Laplace's function:

$$\Phi(z_s) = \Phi(z_i) = 0.4988$$

Consequently, the fraction of probable defective parts it is:

$$p = 1 - (0.4988 + 0.4988) = 1 - 0.9976 = 0.0024$$

Since $0.001 \leq p = 0.0024 \leq 0.02$, the scattering field of the random variables x_i is approximately equal to the specified tolerance field in the work drawing. Under these conditions, the technological process is carries out normally and it is controllable in statistical terms.

2 Statistical control based on arithmetic mean and standard deviation

For the checking efficiency of manufacturing process stability of the parts type axes, it is accepted that the further controlled sample, is $n = 5$ pcs. The timeframe between two successive samples, depending on the production volume, is [2, 10. 11 and 14]:

$$I_t = \frac{60}{p_m}\sqrt{nM} \quad /\text{min}/ \tag{16}$$

where p_m –production rhythm /pcs/hour/;

M – the mean number of parts processed between two successive adjustments /pcs/

From technical documentation resulted that the time norm to the axes processing on turret lathes is 1.25 min/pcs and the average number of machined parts between two successive adjustments is 500 pcs. With this information, the timeframe between two successive adjustments of the machine-tool is:

$$I_t = \frac{60}{45}\sqrt{5 x 500} = 62.5 \text{ min}$$

Thus, at intervals of 62.5 minutes, are taking samples how many 5 pcs. For each sample, we calculate the arithmetic mean and standard deviation, with relations:

$$\bar{x}_i = \frac{1}{5}\sum_{j=1}^{5} x_{ij} \text{, respectively } \sigma_i = \sqrt{\frac{1}{5}\sum_{j=1}^{5}\left(x_{ij} - \bar{x}_i\right)^2} \tag{17}$$

where i – represent the sample's rank;

j – the part number in the order of processing (j = 1, 2, … , 5)

Under these conditions, the control limits for arithmetic mean was calculated depending on the standard deviation σ for the fraction of probable defective parts $0.001 \le p = 0.0024 \le 0.02$ using the relationships [1, 7, 10, 11 and 14]:

$$L_{ci\bar{x}} = T_c - A\,\sigma, \text{ respectively } L_{cs\bar{x}} = T_c + A\,\sigma \tag{18}$$

where T_c – center of the specified tolerance field;

A – coefficient calculated from statistical tables for risk of the order $I(\alpha)$ and the argument z

Therefore, the effective values of the control limits for arithmetic mean are:

$$L_{ci\bar{x}} = 0.0225 - 1.431\ x\ 0.00676\ \approx 0.013, \text{ respectively}$$

$$L_{cs\bar{x}} = 0.0225 + 1.431\,x\ 0.00676 \approx 0.032$$

In order that the machined parts to be accepted, the first time it is need that each tool be adjusted to dimension, so that the scattering field center of errors to overlap with the middle of the tolerance field. Namely, by software, the tool edges are adjusted to quota 12.0225 mm. If for each sample of 5 pcs consecutive machined, the arithmetic mean is located within the limits of 0.013 mm and 0.032 mm, then the machine tool is properly adjusted and the technological process is stable.

Control limit for the standard deviation is established in function by the size of the fraction of probable defective parts so that the risk of order $I(\alpha)$ to be as small as:

$$L_{c\sigma} = G\,\sigma \tag{19}$$

where G – coefficient calculated from statistical tables for risk of the order $I(\alpha)$

Consequently, the effective value of the control limit for standard deviation is:

$$L_{c\sigma} = 2.12\ x\ 0.00676 \approx 0.014$$

If for each sample of 5 pcs consecutive machined, the standard deviation is less than the control limit $\sigma \le L_{c\sigma} \approx 0.014$, then tool ensures the processing accuracy, and the technological process is stable.

3 Performing the proper statistical control

During the manufacturing process of each batch of 40 000 pcs, at time intervals of 62.5 minutes, it is extract on-line a sample of 5 pcs successively processed under practically identical conditions. With these samples values, we can calculate the arithmetic mean and standard deviation for the functional quota N, using relationships (17). The calculated values are then compared with control limits established by relations (18) and (19).

If the calculated statistical parameters fall between the control limits, then technological process is stable and the machined parts are appropriate.

Discussions and conclusions. The experimental researches have constituted the background of a verification algorithm on-line of the technological process stability for manufacturing cylindrical parts on turret lathes. Has been designed a predictive model for operating data and/or technological parameters, which was based on the evolution analyze of statistical parameters. It is not important how was made the sampling of operative data. The parts can be actively controlled, during processing or manually, at certain timeframe.

Thus, based on the anticipated results determined by calculating the arithmetic mean and standard deviation on samples of 5 pcs collected to preset timeframes, we can formulate the following conclusions:

- if $\bar{x}_i$ and σ_i are in the established control limits, it is considered that the technological process is carried out normally and the processed parts are appropriate with the technical documentation;

- if $\bar{x}_i$ exceeds one of limit but σ_i is below the limit established, means that the adjustment of machine-tool has been affected; in this case, it stops the turret lathe for restoring the adjustment, and the processed parts in the timeframe from the previous control they will check piece by piece;

- if σ_i exceeds the limit established, regardless the arithmetic mean' position toward its control limits, means that was affected the precision of machine-tool; the checking turret lathe it stops and by the appropriate maintenance program (current repairs and/or major repairs) it is brought to normal parameters of geometric precision; the processed parts in the timeframe from the previous control they will check piece by piece, also;

The importance of verification algorithm lies in that enables, among others, determination on-line of the instability trend of the technological process. In this way, we can take action to prevent any disturbances of machine-tool leading to the appearance of defective parts and stop the production (small adjustments, compensation the tool's wear or changing some worn parts of machine-tool etc.).

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