USING THE SHEWHART CONTROL CHARTS BY PROCESS CONTROL

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Resume
This article deals with the statistics pursing the process capability of turning in screws production in RIBE Slovakia, k.s. In technical practice, an important group of statistic methods is formed by analyzing qualification of measures, production equipment and qualification of process. By the term "process qualification" we mean the ability of the process to observe required technical parameters by required value and tolerance limits. Findings of the process capability can be isolated in the estimate process capability (before starting the production) and permanent process capability. Also, we have finished the quest for the process capability where the indexes C_p and C_{pk} are bigger than the determined value of 1.33 points.

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1. Introduction

In technical practice, an important group of statistic methods is formed by analyzing qualification of measures, production equipment and qualification of process. Out of the statistic methods mentioned above the most frequently used is examination of process qualification. By the term "process qualification" we mean the ability of the process to observe required technical parameters by required value and tolerance limits. Findings of the process capability can be isolated in the estimate process capability (before starting the production) and permanent process capability. The main distinction is in time span, in quantity of obtained values and in the form of obtaining them. This information presents facts for the customer about the expected fulfilment of his requirements.

We can say that the process is capable if C_p and C_{pk} are bigger than 1.33.

The input data comprises:

- definitive conditions of series production,
- convenient and able measuring equipment of high accuracy,
- able production facilities,
- statistically encompassed process through the quality control charts,
- test on assumed division,
- technical and other specification correctly expressing the customer's request.

2. Material and methodology of experiments

2.1. Description of the process:

Operating step:

Turning according to the production order WZ 12 860 B RIBE ISR – axial screw

Mark*:* *slot width*

Rating value: $1.62^{+0.08}$ *mm*

Lower Specification limit (LSL): *1.62 mm*
Upper Specification limit (USL): *1.70 mm*
Check centre:
Mitutoyo profile projector with precision of 0.001 mm.
Production device:
turning machine TRAUB TB 30
Volume of subgroup: *N = 250 screws*
Measure of subgroup: *n = 5 screws*
Interval of taking: *every 30 minutes*
Number of subgroups: *k = 50*

The criteria for competence valuation are indexes C_p and $C_{pk.}$ By looking at the product specification we consider the screw´s slot width of $1.62^{+0.08}$ mm as a critical sign. We measure the slot width with a profile projector with precision of 0.001 mm and with capability of a measuring device. We suppose a normal division of the process and appreciate the suitability of application partitions through the medium of likelihood networks. By regulation of the turning process we shall use a regulating schema control chart for the average and span ($\overline{X}$, R). In the turning process we use turning machine TRAUB TB 30 as a production machine.

2.2. Calculation of specification limits

Average range in subgroups

$$\bar{X}_i = \frac{1}{n}\sum_{j=1}^{n} X_{ij} \qquad (1)$$

i = 1, 2 ....k and j = 1, 2 ...n,
X_{ij}*– measured value in i- subgroups*
j – serial number of measured value in i-th subgroups
k – number of subgroups
n – file size

Span in subgroups

$$R_j = MAX(X_{ij}) - MIN(X_{ij}) \qquad (2)$$

i = 1, 2 ... k and j = 1, 2 ...n
MAX (X_{ij}) *and MIN*(X_{ij}) *is maximum and minimum value in i-th subgroup.*

Process average :

$$\bar{\bar{X}} = \frac{1}{k}\sum_{i=1}^{k} \bar{X}_i \qquad (3)$$

$\bar{X}_i$ *- average of j-th subgroup*

Span average :

$$\bar{R} = \frac{1}{k}\sum_{i=1}^{k} R_i \qquad (4)$$

R_i, X_i are spans and averages in *i*-th subgroups (*i*=1, 2, ..., *k*). $\bar{R}$ and $\bar{\bar{X}}$ in quality control charts are central lines (*CL*).

Calculation of specification limits:

$$UCL_R = D_4 \cdot \bar{R} \qquad (5)$$

$$LCL_R = D_3 \cdot \bar{R} \qquad (6)$$

$$UCL_{\bar{X}} = \bar{\bar{X}} + A_2 \cdot \bar{R} \qquad (7)$$

$$LCL_{\bar{X}} = \bar{\bar{X}} - A_2 \cdot \bar{R} \qquad (8)$$

D_4, D_3 and A_2 are constants depending on the volume of subgroups *n*, in our case n = 5: D_3 = 0.000, D_4 = 2.114, A_2 = 0.577.

Qualification of turning process

$$C_p = \frac{USL - LSL}{6 \cdot \hat{\sigma}} = \frac{T}{6 \cdot \hat{\sigma}} \qquad (9)$$

$$C_{PK} = \frac{USL - \bar{\bar{X}}}{3 \cdot \hat{\sigma}} \qquad (10)$$

$$C_{PK} = \frac{\bar{\bar{X}} - LSL}{3 \cdot \hat{\sigma}} \qquad (11)$$

USL – Upper Specification limit

LSL – Lower Specification limit

3. Results

In the turning process of the RIBE screw we obtained values for 50 subgroups. The characteristics $\overline{X}$ and R were applied in quality control charts. Then we added regulation bounds and central lines to quality control charts .

For quality control chart $(\overline{X}, R)$ these are the actual regulation bounds:

UCL_X = 1.6758 mm

UCL_R = 0.04525 mm

LCL_X = 1.6448 mm

The process was mastered correctly, no regulating limit was overloaded and no trend or violation of the middle period was shown. The process is a mastered situation and no systematic influences impact on it. The general average is $\overline{x}$ = 1.66016 mm, the average span R = 0.054 mm. After qualification attestation the process can be treated as qualitatively qualified, indicators of qualification C_p and C_{pk} are higher than 1.33.

C_p = 1.45 C_{pk} = 1.44

Consequently, we have figured our values to quality control chart (Fig. 1), where on the top is a control chart for $\overline{X}$ and below - for *R*.

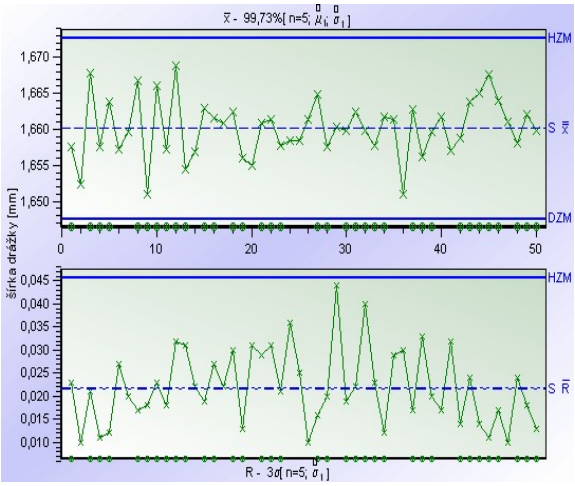

Fig. 1. Quality control chart

4. Summary

The capability of the turning process in RIBE Slovakia showed that the process provides the products which satisfy demanded quality criteria. The values of a potential process capability and a real process are respectively C_p = 1.45 C_{pk} = 1.41. These values are higher than the rate 1.33 and the process is able to provide products in compliance with tolerance zones.

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