STATISTICAL METHODS MANUFACTURING PROCESS CONTROL

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Abstract

This paper offers a short introspection on the use of the statistical control fiches for manufacturing processes, representing the parameters that are established under this purpose.

Key words: *control, limits, capability, tolerance*

Control methods of manufacturing processes aimed on the one hand process capability analysis, and on the other hand set limits - criteria for current control and routing processes. Defining capability as a measure of how accurately the process achieves quality characteristics pursued statistical method will have to assess the performance of machinery to achieve a framing appropriate field scattering (where the feature which takes values) in the field of tolerance (where feature which must fall under quality standards).

Analysis capabilities make approaches require pre aimed:

• Establishing feature or set of features to be controlled (as having importance in defining the overall quality of the product);

• Check the stability of the production process;

• Determining parameters based on which it will carry over.

While the first objective is solved, usually based on treatment techniques and descriptive data - graphics, of which the most common is Pareto chart, the other two objectives are achieved through the application of complex methods, analytical, differentiated by type of production treaties[1] :

• For the average productivity of production processes - High-volume survey method;

• For high productivity processes - survey method low volume.

If the survey method of working on a large sample size may range between 100-300 copies, appearing necessary to check the homogeneity of data in order to estimate the correct parameters specific statistical production process.

Polls low-volume method (current evidence) revealing involves several samples (samples, approx. 25) small (4-10 elements measurable characteristics and features attributive elements 20-60), being necessary to verify the uniformity surveys point environmentally and dispersions.

Experimental verification of normality distribution will be done in both cases the tests, in the second case for each sample individually.

Likely determine the fraction defective p - the probability x characteristic values to exceed the limits of the tolerance - will characterize precision machine specialists considering that a process can be assessed as if $p \leq 0,02$ statistical control.

$p=P(X<T_i ;X>T_s)=1-P(T_i \leq X \leq T_s)=1-[F(T_s)-F(T_i)]$, where

T_i, T_s = tolerance limits their upper and lower

1. Baron T. şamd – Quality and Reliability, Ed Tehnică 1988

$F(x)=P(X \leq x)$ specify is the distribution function of the characteristic X

For a normal distribution feature:

$P=1-[\phi (z_s)-\phi(z_i)]=1-2\phi(z_s)$, unde $z_s=(Ts-Ti)/2\sigma$

σ= feature standard deviation studied

In practice, it can lead to either fraction defective probable p, starting from the specified tolerance either will be able to plan a field of tolerance T = 2zp * σ, where zp is variable Laplace table by the fraction defective p chosen.

Based on the distribution can be approximated normality and scattering characteristic range of manufactured products:

$L \approx 6\sigma$

$Li=3\sigma$; $Ls=3\sigma$

because it demonstrates that 99.7% of the values recorded in an observation found in this interval (the theorem of Chebyshev 3*σ*).

Indeed, if X is a normal characteristic parameters μ division and σ^2 using its properties (symmetry x = μ) we have:

$X \in N(x,\mu,\sigma^2)$ and $a,b \in R$:

$P\{a \leq X \leq b\} = \int f_x(x;\mu,\sigma^2) \cdot dx = F_0 (b-\mu/\sigma) - F_0 (a-\mu/\sigma)$

$P\{| X-\mu|<\varepsilon\} = 2F_0(\varepsilon/\sigma)-1$

If $\varepsilon=3\sigma \Rightarrow$

$$P\{|X-\mu|<3\sigma\} = 2F_0 (3\sigma/\sigma)-1 = 2F_0(3)-1=0,9974$$

Control methods current - routing the flow - will consider process stability - highlighting the fact that it is only under the influence of causes production random or under the impact causes the production systematic, inducing deviations from specifications should be traced and eliminated.

Stability is assessed in two ways:

• As a center position of the two fields of interest for the characteristic studied: field of tolerance and field scattering, which characterizes the adjustment work, and can be put out with statistical indicators of position - mean, median, mode;

• As the size of the two fields - field scattering employment in the field of tolerance - which characterizes the precision machine and can be evidenced by indicators static scattering (variation): linear or quadratic deviation, amplitude, coefficient of variation.

The production process will be considered stable when statistical parameters that measure the center of a (control) or scattering (precision) remain constant over time.

Checking correct two goals involves the use of combined methods of control:

• method of arithmetic mean and standard deviation;

• arithmetic mean and amplitude scattering method;

• median and amplitude scattering method.

Walking production process can thus be assessed using samples consisting of a small number of pieces taken in order manufacture, incidentally extracted.

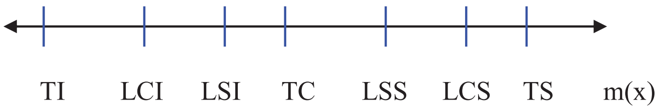
Indicator test will not only coincide by chance pointer whole lot, but when process stability, you have to belong control areas (the trust or the authorized error).

This implies that one initial stage we can set such limits for parameter adjustment and the accuracy of (spreading).

In general, choose the probabilities working for 99.8% and 95% control limits for supervisory limits, which corresponds to defective fractions of 0.2% and 5%.

Representing a value axis positioning control limits and orderly supervision, notice that we have no limitation for scattering parameter lower accuracy can be as small.

Positioning control limits and surveillance



CLI - lower control limit
LCS - the upper limit control
LSI - lower limit surveillance
LSS - the upper limit surveillance
TI - the lower limit of the tolerance
TS - the upper limit of the tolerance
TC - Center field tolerance

Effective practical approach consists in taking periodic samples from the process of Volume n, registering actual values achieved for each product and feature of the n X1, ..., Xn.

Calculated for each sample statistical indicators needed (mean or median, standard deviation or amplitude scattering), and comparing the limits of control / supervision established a priori, the stage preliminary study capability, identify to what extent the process complies not as in control and precision, taking additional measures of supervision if parameters are within the limits of surveillance and control, stopping and identifying the cause disruptive if the parameters are outside the control limits.

Combinations of states as precision manufacturing process and adjustment

Table 1

parameters adjustment X, M_e / parameters precision σ, R	LSI≤m≤LSS LSI≤M_e≤LSS	LCI≤m<LSI LCI≤M_e≤LCS or LSS<m≤LCS LSS<M_e≤LCS	m<LCI M_e<LCI or m>LCS M_e>LCS
σ≤LSS R≤LSS	* as stable process control and precision * continue I	* stable process as precision, stability limit for adjustment * continue II	* process control unstable as stable as precision * process stops V
LSS<σ≤LCS LSS<R≤LCS	III	IV	VI
σ>LCS R>LCS	VII	VIII	IX

□ stable process □ process stability limit □ unstable process

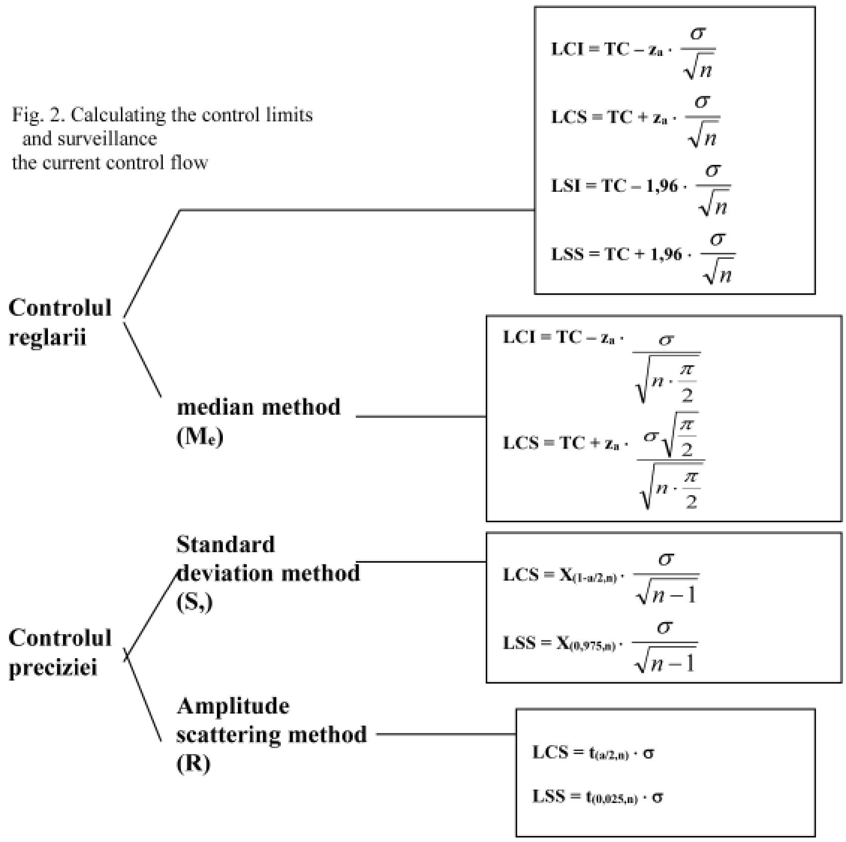


Fig. 2. Calculating the control limits and surveillance the current control flow

Note : n – sample volume; σ - the standard deviation is evaluated by previous studies; α - threshold of significance chosen; usually $\alpha \in \{0{,}002\ ;0{,}05\}$; z_a – table value-function Laplace

$X(1\text{-}a/2,n) = \sqrt{x^2(1-a/2,n)}$ = table value- function X^2

$t_{a/2,n}$ = table value- function Student

Statistical control sheets are practical tools that apply these methods in enterprises, control charts consisting watch graphical representation of statistical indicators compared with the limits of control / supervision admitted.

We must add that, based on the theory of checklists created by W.A. Shewhart, many authors consider their usefulness especially in the analysis phase of the process and installation of the state of statistical control.

The purpose of building sheets(X, R), during this period consists in emphasizing so-called “unnatural behavior » its, and finding corrective actions. Note that this achievement records, although it can be quantified statistically, has its causes in the process itself and as a result, corrective action - seen as a centering level intervention and / or specify the process-is a purely technological problem.

Due to the more complex quality modern products - determined by a set of features - checklists will be used only within a specific consideration of quality features that subject to a separate investigation or where the process It has no means automatic adjustment and the possibility of collecting and processing data in a timely manner can be done without difficulty.

Also in the successful establishment of such research should not be forgotten insurance component metrology, one of the causes of unnatural behavior checklist is measurement error.

A specific form of control sheet which avoid disadvantage primarily related to computing and that can be a tool of self-control is control sheet for individual values. This involves the direct use of individual values measured (without calculating statistics selection), through their representation on the control chart.

The process is considered normal if there is one statement:

- In each group of n values recorded, all values are between the limits of surveillance;
- In each group of n values, no value falls outside the control limits, the more value falls in each of the warning areas, the rest in the range surveillance.

The process is considered satisfactory if one of the situations occurs:

- A value out of control limits;
- Two values of the group fall in the warning areas

Without requiring further computation, but measurement and graphical representation on chips standardized, followed by the announcement line technology in the event of deviations from the rules under which the process is considered satisfactory, this process constitute an effective instrument of self-control.

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