# UNELE ASPECTE ALE MODELARII STATISTICE IN ANALIZA CAPABILITATII SI A FIABILITATII PROCESELOR TEHNOLOGICE

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# SOME ASPECTS OF THE STATISTIC MODELLING IN THE CAPABILITY AND FIABILITY OF THE TEHNOLOGICAL PROCESSES ANALYSIS

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**REZUMAT**

In lucrare sunt analizati factorii care pot influenta capabilitatea proceselor tehnologice cu implicatii in scaderea preciziei de prelucrare a pieselor si a calitatii produselor.

Autorii propun o analiza comparative a variantelor de procese tehnologice, private sub aspectul capabilitatii acestora, din care se poate evidentia varianta optima de proces.

**ABSTRACT**

In the paper there are analyzed the factors that might influence the capability of technological processes with implications in the decrease of manufacturing precision and quality products.

The authors propose a comparative analysis of the technological processes variants, under their capability aspect, from which it can be underlined the optimal process variant.

## INTRODUCERE

In cadrul activitatilor privind asigurarea calitatii produselor, cea a omologarii capabilitatii proceselor de fabricatie ocupa un loc important.

Studiul capabilitatii presupune determinarea performantelor proceselor si verificarea daca variatia naturala a acestora se incadreaza intre limitele prestabilite.

De aceea, pentru omologarea capabilitatii unui proces tehnologic este necesara abordarea urmatoarelor aspecte:

- Controlul statistic al procesului
- Determinarea indicatorilor de capabilitate ai procesului

In conformitate cu SR EN ISO 9001/4.9. un proces trebuie sa se desfasoare in conditii controlate. Calculul indicatorilor de capabilitate ai procesului se considera pentru o repartitie normal (Gauss-Laplace) cu parametrii: media μ si abaterea standard δ.

Pentru un interval de variatie normal a procesului 6δ cu toleranta T, indicatorul de

## INTRODUCTION

In the activities regarding the insuring quality products, the one of the approval of the processes manufacturing capability stands a remarkable place.

The study of the capability assumptions the determining of the processes performances and checking if their natural variation borders between the established limits.

That's why, for the approval of the capability of one tehnological process it is required the following aspects [1]:

- The statistic control of the process
- Capability indicators of the process determination
-

In accordance with SR EN ISO 9001/4.9, a process has to develop in controlled conditions. The reckoning of the capability indicators is considered for a normal repartition (Gauss-Laplace) with the parameters: medium μ and standard defiance δ.

For a normal variation interval of the process 6δ with tolerance T, the capability capabilitate al procesului se determina cu relatia:

$$Cp = \frac{LCS - LCI}{6\delta} \qquad (1)$$

Unde LCS si LCI reprezinta limitele de control superioara si inferioara, cand valorile μ si δ raman constant pentru o perioada lunga de timp. Daca se folosesc valorile estimate μ si δ, calculate cu relatiile:

$$\mu = \frac{1}{k_i}\sum_{i=1}^{k} x_i \qquad (2)$$

şi

$$\sigma = \frac{\sqrt{1}}{ki}\sum_{i=1}^{k} S_i^2 \qquad (3)$$

Unde k reprezinta numarul esantioanelor prelevate, iar $S_i$ – abaterea standard a esantionului I, atunci valoarea estimate a indicatorului de capabilitate este:

$$Cp = \frac{LCS - LCI}{6\delta} \qquad (4)$$

Care nu este suficienta pentru evaluarea capabilitatii procesului tehnologic.

De aceea, este necesar ca procesul tehnologic sa fie centrat in interiorul campului de tolerant, caz in care devin mai important indicatorii de capabilitate la care limitele se refera la media procesului (fig. 1).

Acesti indicatori de capabilitate se calculeaza cu relatiile:

$C_{p\delta}$ = LCS- μ/3δ ; $C_{p\mu}$ = μ-LCI/3δ (5)

Indicatorul decisive care exprima capabilitatea procesului este $C_{pk}$ = min {$C_{po}$, $C_{pu}$}sau valoarea estimata $C_{pk}$ = min {$C_{po}$,$C_{pu}$}, unde $C_p \geq 1,66$ si $C_{pk} \geq 1,33$, cand pentru piesa preliminara trebuie sa se execute cel putin 125 de valori masurate. [3]

indicator determines with the relation:

$$Cp = \frac{LCS - LCI}{6\delta} \qquad (1)$$

where LCS and LCI represent the control limits – superior and inferior, when the values μ and δ remain constant for a long period of time. If there are used the estimated values μ and δ, determined with the relations:

$$\mu = \frac{1}{k_i}\sum_{i=1}^{k} x_i \qquad (2)$$

and

$$\sigma = \frac{\sqrt{1}}{ki}\sum_{i=1}^{k} S_i^2 \qquad (3)$$

where k represents the number of taken samples and $S_i$ – standard defiance of the first sample i, then the estimated value of the capability indicator is:

$$Cp = \frac{LCS - LCI}{6\delta} \qquad (4)$$

which is not enough for evaluating the technological process capability.

That is why it is necessary that the technological process to be centered inside the tolerance field, case in which they become more important the capability indicators at which the limits refer to the process medium (fig. 1).

These capability indicators are calculated with the relations:

$C_{p\delta}$ = LCS- μ/3δ ; $C_{p\mu}$ = μ-LCI/3δ (5)

The decisive indicator that expresses the process capability is $C_{pk}$ = min {$C_{po}$, $C_{pu}$} or the estimated value $C_{pk}$ = min {$C_{po}$,$C_{pu}$}, where $C_p \geq 1,66$ and $C_{pk} \geq 1,33$, when for the preliminary piece has to be executed at least 125 measured values.

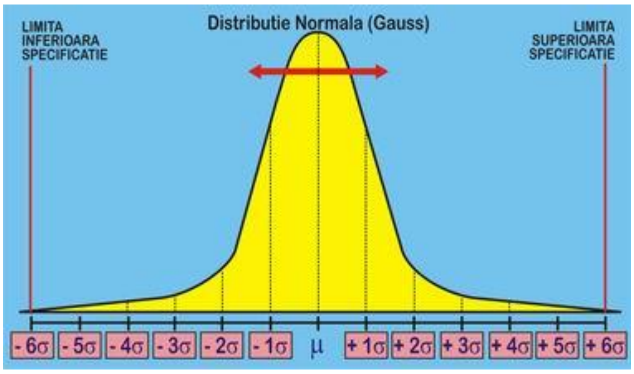

Fig. 1

Daca consideram pierderile pentru societate L, conform metodei Taguchi [3,4] in cazulompararii a doua procese tehnologice cu capabilitatile

$$C_{p1} = \frac{LCS - LCI}{6\delta} \qquad (6)$$

şi

$$C_{p2} = \frac{LCS - LCI}{6\delta} \qquad (7)$$

Vom avea:

$$L_1 = k_1 \times \Delta_1^2 \; ; \; L_2 = k_2 \times \Delta_2^2 \qquad (8)$$

unde:

- $K_1$, $k_2$ reprezinta raportul dintre pierderea beneficiarului si tolerant de fabricatie
- , reprezinta abaterile caracteristicii (x) fata de media μ, fig. 2.

Deoarece

$$C_{p1} = \frac{T_1}{6\delta_1} \; ; \; C_{p2} = \frac{T_2}{6\delta_2} \qquad (9)$$

$$L_1 = k_1 T_1^2 \; ; \; L_2 = k_2 T_2^2 \qquad (10)$$

Se poate deduce:

$$\frac{L_1}{L_2} = \frac{k_1}{k_2}\left(\frac{T_1}{T_2}\right) = \frac{k_1}{k_2}\left(\frac{C_{p1}}{C_{p2}}\right)\left(\frac{\delta_1}{\delta_2}\right) \Rightarrow \frac{C_{p1}}{C_{p2}} = \frac{\delta_2}{\delta_1}\sqrt{\frac{L_1}{L_2}} \cdot \frac{k_2}{k_1} \qquad (11)$$

Relatia (11) poate fi utilizata, in general, la compararea capabilitatilor a doua procese tehnologice, in conditiile estimarii factorilor δ, L si k.

If we consider the losses for society L, as in Taguchi method [3,4], in the case of comparing two tehnological processes with the capabilities

$$C_{p1} = \frac{LCS - LCI}{6\delta} \qquad (6)$$

and

$$C_{p2} = \frac{LCS - LCI}{6\delta} \qquad (7)$$

we will have:

$$L_1 = k_1 \times \Delta_1^2 ; L_2 = k_2 \times \Delta_2^2 \qquad (8)$$

where:

- K1, k2 represents the ratio between the beneficiary loss and manufacturing tolerance;
- $\Delta_1$, $\Delta_2$ represents the defiance of the characteristics (x) between the average μ, fig. 2.

because

$$C_{p1} = \frac{T_1}{6\delta_1} \; ; \; C_{p2} = \frac{T_2}{6\delta_2} \qquad (9)$$

$$L_1 = k_1 T_1^2 ; L_2 = k_2 T_2^2 \qquad (10)$$

it can be deducted:

$$\frac{L_1}{L_2} = \frac{k_1}{k_2}\left(\frac{T_1}{T_2}\right) = \frac{k_1}{k_2}\left(\frac{C_{p1}}{C_{p2}}\right)\left(\frac{\delta_1}{\delta_2}\right) \Rightarrow \frac{C_{p1}}{C_{p2}} = \frac{\delta_2}{\delta_1}\sqrt{\frac{L_1}{L_2}} \cdot \frac{k_2}{k_1} \qquad (11)$$

The eleventh relation can be used, in general, at comparing the capabilities of two technological processes, in the conditions of estimating the factors δ, L and k.

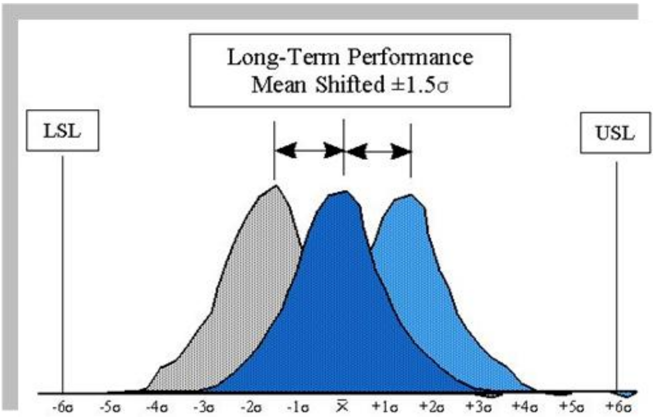


Fig. 2

Variatia capabilitatii proceselor tehnologice poate fi considerate ca rezultatul influentei nefavorabile a factorilor perturbatori sistematici si intamplatori, ceea ce conduce la micsorarea fiabilitatii procesului tehnologic $F_{teh}$ , determinata pe baza relatiei [2]

$$F_{teh} = \frac{1}{2}\left\{\emptyset\left[\frac{1}{\delta\sqrt{2}}(LCS-\mu)\right] - \emptyset\left[\frac{1}{\delta\sqrt{2}}(LCI-\mu)\right]\right\}$$

unde Ǿ reprezinta functia Gauss-Laplace.

The variation of the technological processes capability can be considered as a result of the bad influence of the systemic and random factors, which conducts to the decreasing the technological process fiability $F_{teh}$, determined with the relation [2]:

$$F_{teh} = \frac{1}{2}\left\{\emptyset\left[\frac{1}{\delta\sqrt{2}}(LCS-\mu)\right] - \emptyset\left[\frac{1}{\delta\sqrt{2}}(LCI-\mu)\right]\right\}$$

Where Ǿ represents the Gauss-Laplace function.

## CONCLUZII

Cunoasterea capabilitatii proceselor tehnologice urmareste de fapt determinarea performantelor reale ale procesului. Aceasta analiza a capabilitatii se face inaintea utilizarii fiselor de control (de tip Shewhart).

## CONCLUSIONS

The technological processes capability knowledge actually follows the determination of the real performances of the process. This analysis of the capability is made before using the Shewhart files.

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