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CONSIDERATIONS ON SOME SPECIFIC ASPECTS WHEN SOLVING THE TECHNOLOGICAL DIMENSIONS CHAINS

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Abstract: In this work shows the errors arising on the dimensional chains, errors made up thank to forces arising while manufacturing the part they way they are calculated. The work also shows the way of calculating both the reserves and deficits concerning the limiting values of the dimensions of the dimensional chain and the influence of the reserves and deficits on the stability of the technological chain.

1. INTRODUCTORY NOTIONS

The dimensional analysis of the technological courses is based upon the main principles of the
theory of the dimensional chains and their calculating methods. In this work the calculating methodology of the dimensional chains is expanded and its appearance changes itself depending upon the problems to be challenged while submitting to the analysis the technological courses.

Under the manufacturing practice it is impossible that the actual dimensions determine the exact values. Under settled manufacturing conditions the processed dimensions variation within some controlled ranges. The tolerances shall be specified in order to control the actual dimensions of the worked features within some controlled ranger. The tolerances shall be specified in order to control the actual dimensions of the worked features within some varying areas which are allowed for the functional requirements of the product and the manufacturing costs. The contemporary practice of tolerance designing has two sequential phases: designing the product tolerance; designing the machining tolerance.

As it is known, on the tolerance of the constitutive elements of a dimensional chain of a part a series of factors arise while designing the tolerance. So, the engineers develop the schedule for machining the manufacturing part in order to determine the manufacturing methods, working devices, cutting tools, conditions of cutting, manufacturing programs, forces arising during the manufacturing course and machining tolerances.

A dimensional chain is an assembly of dimensions taking directly part in solving the given problem and making up a closed circuit. Depending upon the destination, the dimensional chains are divided in: constructive chains, technological chains and manufacturing chains.

The constructive dimensional chains, in practice, are subdivided in: assembly chains and detail chains. For the sake of the dimensional analysis of the technological course it is necessary to solve the chains which allow to settle the deviation of the disposition of the surfaces on the whole technological course. Such chains shall be named dimensional chains of disposition deviations.

In this work we try to determine the dimensional chain made up in the course of the technological designing and which forces intervene on the dimensions of the technological designing and which forces intervene on the dimensions of the elements and their influence on the errors of the dimensions.

2. SOLVING THE TECHNOLOGICAL DIMENSIONAL CHAINS ARISING DURING A MECHANICAL OPERATION BY CUTTING A PART.

In the fig.1.1 is shown the operation of turning the edges by two blades working simultaneous. There are given: the dimensions **A** and **B** which shall be provided on the given operation. When pressing the part from rear to the center, the magnitude of the pressing force $\mathbf{P_1}$ shall oscillate. As a result of the oscillation of this force, the parts machined on the plant may take diverse positions, by moving themselves together with the shaft and the cartridge on the distance $\mathbf{t_1}$**.** When machining shall influence the cutting force $\mathbf{P_2}$**,** the magnitude of which has already on oscillation, with in some limits(for example the additional oscillation on diverse parts). To this end in view, the position of part and shaft may result in the magnitude $\mathbf{t_2}$. This could result in pressing, the blade support, too, leading it until reaching a certain magnitude $\mathbf{t_3}$.

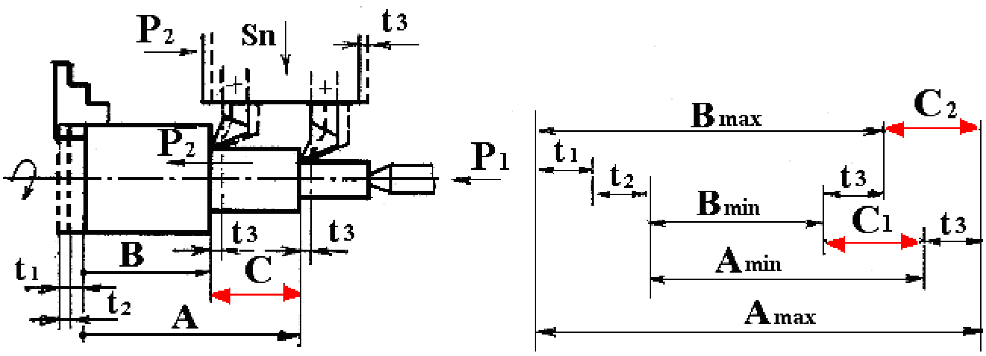

Fig.1.1. Occurrence of compensating errors while mechanically machining the parts:
a- cutting the edges on machine-tools with many blades;
b – scheme of dimensional chain

Let's study the errors of the dimensions arising thank to the above mentioned.
It is obvious that on side of the parts the errors of the dimensions **A** and **B** shall be the following:

$$\omega_A' = t_1 + t_2 + t_3; \tag{1}$$

$$\omega_B' = t_1 + t_2 + t_3 \tag{2}$$

The element C arising as a result of making the primary the elements shall be the closing element. On minimal compressions the dimensions **A** and **B** shall be minimal (fig.1.1, a).
For the studied case it is possible to build the scheme of the dimensional chain (fig. 1.1,b).
The dimensions of the closing element may be calculated according to the formula:

- for the case when the pressures (compressions) are minimal, we have:

$$C_1 = A_{min} - B_{min} \tag{3}$$

- for the case when the pressures are maximal, we have:

$$C_2 = A_{max} - B_{max} = (A_{min} + t_1 + t_2 + t_3) - (B_{min} + t_1 + t_2 + t_3) = A_{min} - B_{min} \tag{4}$$

The error of the closing element shall be :

$$\omega_C = C_2 - C_1 = 0 \tag{5}$$

The magnitudes t_1, t_2, t_3 shall penetrate into the elements **A** and **B** and mutually compensate themselves, without making any influence on element **C.**
It must be mentioned that under actual conditions, besides the above mentioned, other errors shall occur, too: for example the adjustment of the blades resulting in their uneven

wear, etc. These errors shan't compensate themselves. That is why the total error for the elements A and b may appear under the following aspect:

$$\omega_A = t_1 + t_2 + t_3 + \omega_{1A} + f \quad (6)$$

$$\omega_B = t_1 + t_2 + t_3 + \omega_{1B} + f \quad (7)$$

where : ω_{1A} , ω_{1B} – are independent errors; f – compensating errors.
The error of the closing element **C**, under these conditions, shall be given by the relation:

$$\omega C = (\omega_A - f) + (\omega_B - f) = \omega_A + \omega_B - 2f \quad (8)$$

Where the given case this equation of error of the closing element is analogical equal to the one previously got for the assembling dimensional chain.
On the actual adjustments on the machines featured by many blades, the distance amongst the surfaces made up by the blades installed in supports on a position or another may be almost always kept as the same, meaning that the accuracy of the dimension of the main (supporting surface to the machining surface shall be duly kept. For this reason, as already shown, when making these operations compensating errors occur.

3. RESERVES AND DEFICITS CONCERNING THE LIMITING VALUES OF THE DIMENSION.

The dimensions of the drawing which are not directly accomplished in the technological operations appear as closing elements of the operative dimensional chains.
For the sake of providing the accuracy of such dimensions, the conditions [1] shall be met:

$$T_R \geq \omega_R , \quad (9)$$

where: T_R - the tolerance of the dimension of the drawing which is not directly accomplished;
ω_R - variation (dispersion field) of the dimension as closing element of the operative dimensional chain.

The criterion ω featuring the reserve on the tolerance shall be determined according to the formula:

$$\omega = T_R - \omega_R \quad (10)$$

The presence of the reserve on the tolerance (ω>0) appear to be a necessary, but not enough condition for providing the accuracy of the dimension, so that even in the presence of the reserve , by moving the middle of the dispersion field against the middle of the tolerance field it shall be possible that the actual values of the dimensions we got exceed the limits of the tolerance and as a result of it shall be possible to arise the reject.
In the fig.1.2 is shown a scheme the connection between T_R and ω_R, when ω>0 and the middle of the dispersion field coincide with the middle of the tolerance field T_R. In this case, the value of the dimension A_{minRC} (got as actual minimal value of the closing element out of the calculus of the dimensional chain) shall be higher than of the dimension A_{minR} (the less tolerated value of the dimension).

The magnitude :

$$RI = A_{minRc} - A_{minR} \quad (11)$$

means the reserve(stock) of accuracy for the lower limiting value of the closing element.
Analogical shall be determined the accuracy reserve for the upper limiting value:

$$RS = A_{maxR} - A_{maxRc} \quad (12)$$

where: - A_{maxR} – means the drawing settled maximum allowed dimension;
- A_{maxRc} – means the actual maximal dimension(got as a result of calculating the chain).

If $\omega<0$, then no average actual value of the element shan't be equal with the settled average value ($A_{medR} \neq A_{medRC}$) and then one of the criteria featuring the reserve on the limiting values may be less than zero (fig.1.3). The position values **DI** and **DS** shall be determined according to the formulas:

$$DI = A_{minRc} - A_{minR} \; ; \quad (13)$$

$$DS = A_{maxR} - A_{maxRc} \; ; \quad (14)$$

these have been called deficits on the lower and upper limiting values.

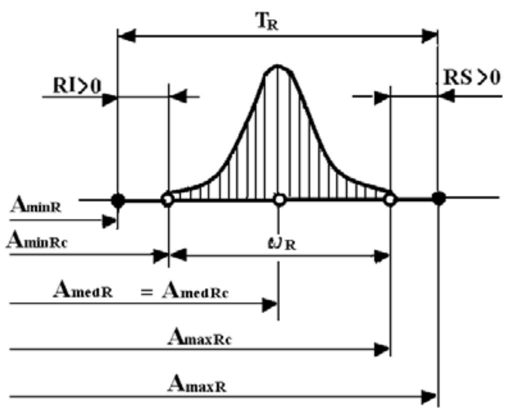

Fig.1.6. Determining the reserves on the limiting values of the dimension for $\omega>0$ and $A_{merR} = A_{medRC}$

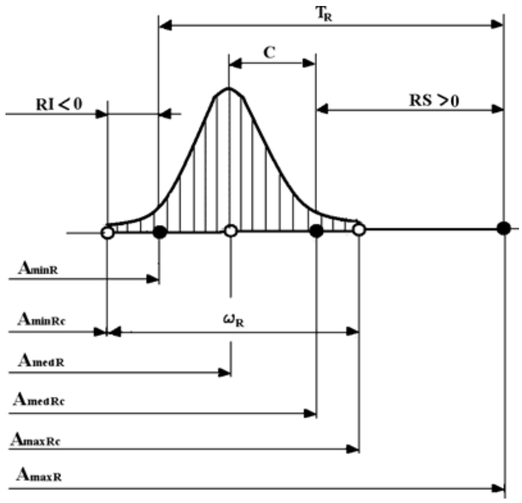

Fig.1.7. Determining the reserves on the limiting values of the dimension for $\omega<0$ and $A_{medR} \neq A_{medRC}$

The negative value of the reserve correspond to the presence of the deficit which equals the absolute magnitude of the corresponding reserve, meaning DI =| -RI | and DS =| -RS |.

The maximum allowed movement of the middle of the dispersion field against the middle of the tolerance field T_R (on $T_R > \omega_R$ **)** does not claim the occurrence of the deficit on the limiting values (fig.1.3)

The negative value of the reserve are the proof of the presence of the deficit on the corresponding limiting value, meaning that the given technological course does not warrant the production without reject and provisions must be taken for the sake of improving its quality. The meaning of the reserves RI,RS must be transfer to the magnitude of the additional layer, too, where it shall be timely.

4. CONCLUSIONS

If for the sake of solving the problem have previously settled the limiting values of the additions, then the course of getting via calculus the actual values shall have to be carried out within the settled limits. Exceeding the values got when calculating the values of the addition shall result in decreasing the quality of the technological course.

If the calculated magnitude of the addition is proved to be less than the allowed one, meaning less than the minimal needed value of the addition, then, this fact shall result in the occurrence of the traces of the previous machining operation and is decreasing the quality of the surface.

If the calculated value of the addition is higher than the highest allowed value, then, this fact result in breaking the tool and decreasing the machining accuracy.

When solving the designing problems, the distribution of the reserve(stock) ω on the limiting reserves RI and RS shall be carried out by selecting the sourcing value of the closing element.

If, as sourcing value shall be considered the less value of settling the closing element, then, in the result of the calculus of the rated value of the determined element shall be again found out the same value (to roundness) which determines RI = 0 and RS = ω.

If, as sourcing value shall be considered the settling value, then, in the result of the calculus shall appear RI = ω and RS = 0. Finally, if as sourcing value shall be considered the average value of the closing element, then, the reserves on the limiting values shall be identical, namely: RI = RS = 0.5ω.

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