Solutions in Limit Deviations for Optimum Dimensional Structures of Technological Processes of Machining

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Abstract. In the paper the analysis of the dimensional structure of different manufacturing process is made. There is shown that different schemes of designer sizes result in a different level of an optimality of a dimensional structure. At definition of number of the technological sizes as criterion of optimality it is necessary to allow both formation of the intermediate sizes and the effect of error's compensation. The detail subjected to machining, is characterized by constructive dimensional links which reflect, eventually, its functionality. The character of the constructive dimensional links is defined by the designer who takes into account the technological features of machine tools, but not to detriment of functionality. Therefore, carrying out of the dimensional analysis on a joint of these two phases is very important with the purpose of improvement of dimensional adaptability to manufacture of made details. One of criterions of this optimality has the structural nature. The effect of error's compensation is the reason for the change of the size's nominals and its limit deviations. For different variants of the linear dimensions is shown the way in which are changing the limit deviations of technological sizes.

Introduction

Designing of technological process of detail's manufacturing represents a very responsible stage of works. In many cases the efficiency of the manufacture, size of initial costs, but also costs connected to elimination of mistakes depends on quality of technological processes' designing as well as on their depth of study. The dimensional analysis takes a special place during designing technology, concerning the stage of designing, and also the stage of technological designing.

The dimensional analysis of the manufacturing process represents a methodology which offers the possibility: to establish these links at the elaboration stage of the manufacturing process, to establish the accuracy of machining, to choose correctly the machine tool's accuracy after the accuracy of machining, to establish the accuracy norms for the technological device, permits to trace out the narrow places, makes the manufacturing processes well-balanced [1, 2]. At the same time, the tackling of the dimensional analysis problems is done on the special positions, especially regarding the mechanism of the accuracy assurance. It treats, first of all, the effect of compensation of machining errors, which allows with a greater reliability to evaluate the machining accuracy considering the phenomenon of errors' compensation.

Optimality of the technological processes

The detail subjected to machining, is characterized by constructive dimensional links which reflect, eventually, its functionality. The nature of the constructive dimensional links is defined by the designer who takes into account the technological features of machine tools, but not to detriment of their functionality. Therefore, carrying out the dimensional analysis between these two phases it is very important with the purpose to improve the dimensional adaptability to manufacturing of details made.

It is known that the manufacturing process is considered optimum, if in the structure of all technological dimensional chains the number of the technological sizes is minimal [3]. This condition is respected if for each constructive size corresponds, within the technological dimensional chain, the unique technological size (Fig. 1), and in dimensional chains for machining allowances, each machining allowance is determined by two technological sizes or one technological size and one size on blank (Fig. 2). The last has two technological sizes formed at the other phase of a manufacturing process. The minimum possible number of the technological sizes

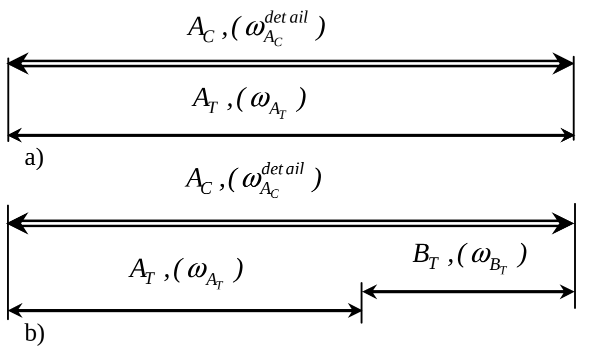

Fig. 1. The constructive size is submitted:
a) only by the technological size, $\omega_{A_C}^{detail} = \omega_{A_T}$;
b) by the technological size and one (it is possible more) in already existing (historical) size, $\omega_{A_C}^{detail} = \omega_{A_T} + \omega_{B_T}$

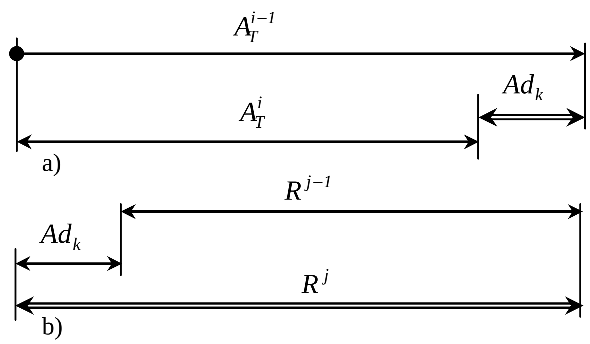

Fig. 2. Two opportunities of transformation of the technological sizes:
a) it is direct and under the control over technological base, $\omega_{Ad_k} = \omega_{A_T^{i-1}} + \omega_{A_T^i}$; b) it is not direct, as consequence of direct formation of other size, $\omega_{R^j} = \omega_{R^{j-1}} + \omega_{Ad_k}$.

$N_{T_{MIN}}$ is determined from the relation $N_{T_{MIN}} = N_C + 2 \cdot N_{Ad}$, where $\boldsymbol{N_C}$ - number of the constructive sizes, N_{Ad} - number of machining allowances. The optimum manufacturing process becomes ideal, if each surface is processed only once, thus providing the final constructive size.

It is necessary to note, that the dimensional optimality is not entirely characterized by the number N_T, but it is necessary to take into account the growth (sometimes complicated) of the technological sizes' accuracy (a case of formation of the sizes as closing link of dimensional chains).

One of directions to create the optimum technological processes is the observance of a similarity principle of the technological and constructive dimensional links graphs.

Let's consider this approach an example of a graph of linear constructive dimensional links (Fig. 3). This graph is characteristic for the turning and has two poles - two important constructive bases which should be used as technological bases. At the first installation, after machining a surface *1* with the use of a surface 6 as technological contact base (*TCB*), the surface *1* becomes adjusting technological base from which the sizes B_T and C_T are formed. During the second installation two technological adjusting bases (*TAB*) - surfaces *6* (*TAB1*) and *5* (*TAB2*) are used consistently.

It is visible, that the structure of the graph of the technological linear dimensional links completely coincides with structure of

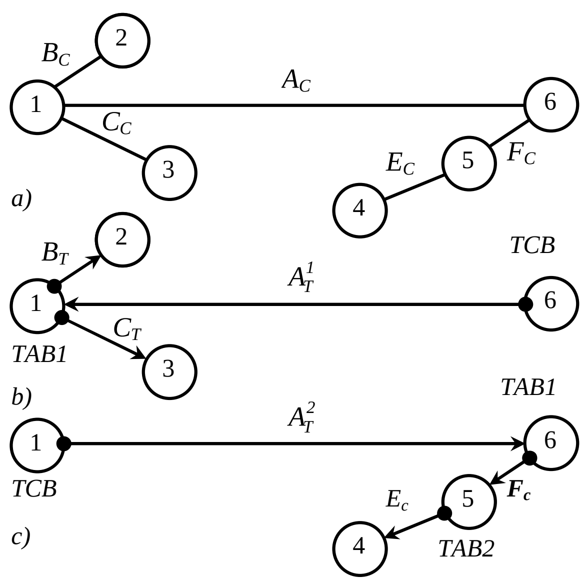

Fig. 3. The graphs of linear dimensional links:
a) the graph of linear constructive dimensional links; b) and c) the graphs of linear technological dimensional links for two installations.