ABOUT THE MUTUAL INFLUENCE OF DESIGN AND TECHNOLOGICAL DIMENSIONAL STRUCTURES AT CREATION OF THE OPTIMUM TECHNOLOGICAL PROCESSES TO MACHINING ¶

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ABOUT THE MUTUAL INFLUENCE OF DESIGN AND TECHNOLOGICAL DIMENSIONAL STRUCTURES AT CREATION OF THE OPTIMUM TECHNOLOGICAL PROCESSES TO MACHINING

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Abstract: In the given work it is shown, that at machining the technological dimensional structures are optimum if they are similar to the design dimensional structure of a detail. The conditions of the locating and fastening, and also some technical requirements interfere achievements of similarity. In these cases the directed change of the design dimensional structure of a detail is recommended due to recalculation of the sizes. From this point of view creation of technological process represents a compromise of mutual approche of the dimensional structures of a detail and of a technological system.

Key words: machining, technological dimensional structures, design dimensional structure

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1. INTRODUCTION

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Designing of technological process of a detail's manufacturing is very responsible stage of works. From quality of designing of technological processes, from their depth of study in many cases respects efficiency of the manufacture, size of initial costs, and also costs connected with elimination of mistakes depends. The dimensional analysis takes a special place during designing technology, concerning the stage of designing, and also the stage of technological designing /1 – 5/.

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 in detriment of their functionality. Therefore, carrying out of the dimensional analysis on a joint of these two phases it is very important with the purpose of improvement of dimensional adaptability to manufacturinf of made details.

Historically they developed so, that in the beginning technologies were developed in conditions of application of the universal equipment with technological opportunities connected with one method of processing. It gave an opportunity to use a principle of overlapping of bases to achieve the accuracy of the sizes during a set of operations. The multifunctional modern equipment also allows to form a complex of surfaces variously located from each using other various methods of processing. The problem of maintenance the accuracy of the sizes is solved using of a principle of unity of bases due to effect of errors compensation.

One of most complicated problems during the elaboration of the manufacturing process is the synthesis of dimensional structure. It is necessary to execute not only dimensional analysis of a developed manufacturing process but also to achieve on this basis the optimum dimensional structure.

2. OPTIMALITY OF THE TECHNOLOGICAL PROCESSES

One of criteria of this optimality has a structural nature. The manufacturing process is considered optimum, if in the structure of all technological dimensional chains, the number of the technological sizes is minimum /1/. This condition is respected if for each constructive size there corresponds within the technological dimensional chain the unique technological size (figure 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 (figure 2). The last has two technological sizes formed at the other phase of a manufacturing process. The minimum possible number of the technological sizes $N_{T_{MIN}}$ is determined from the relation $N_{T_{MIN}} = N_C + 2 \cdot N_{Ad}$, where 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 /1/. It is necessary to note, that the dimensional optimality is

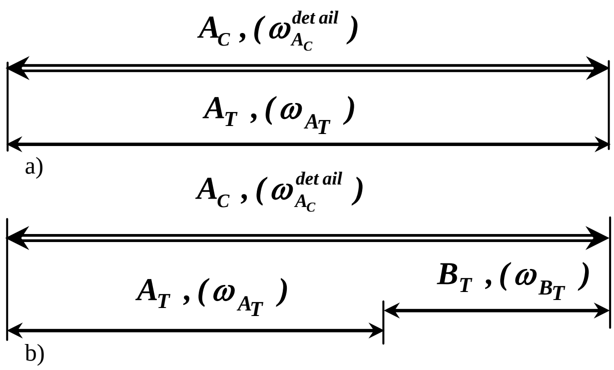

Figure 1. The constructive size is submitted:
a) only by the technological size, $\omega_{A_C}^{det\,ail} = \omega_{A_T}$;
b) by the technological size and one (it is possible more) in already existing (historical) size,
$$\omega_{A_C}^{det\,ail} = \omega_{A_T} + \omega_{B_T}$$

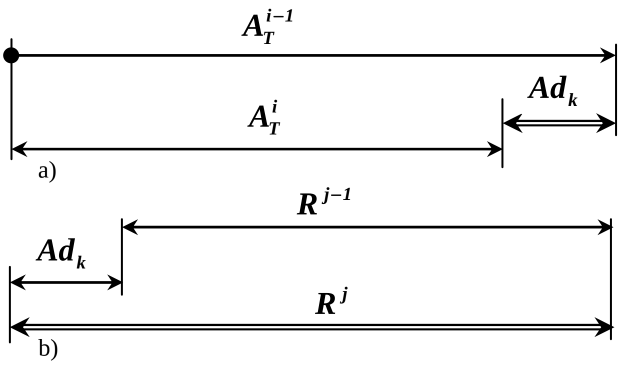

Figure 2. Two opportunities of transformation of the technological sizes:
a) it is direct and under the control over technological base, $\omega_{Ad_k} = \omega_{A_T^{i-1}} + \omega_{A_T^i}$; b) it is not direct, as consequence of direct formation of other size,
$$\omega_{R^j} = \omega_{R^{j-1}} + \omega_{Ad_k}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

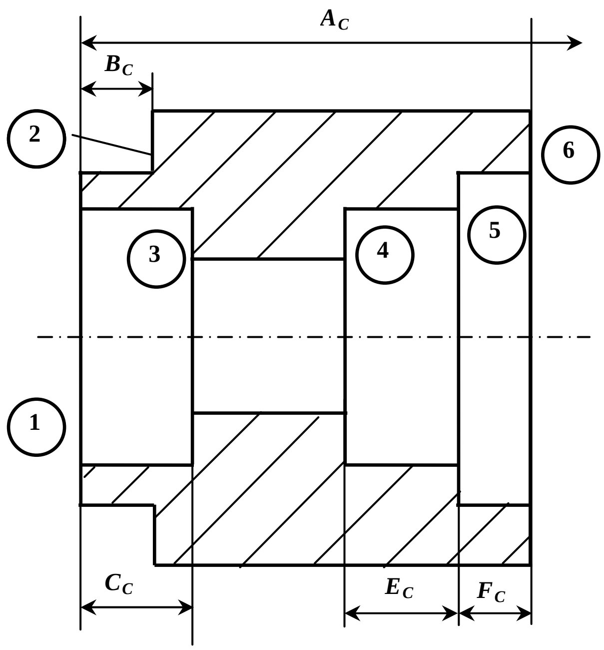

Figure 3. Detail - body of rotation

not entierely 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 creation directions of 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 construction and of a technologuy of a detail machining (figure 3).

The graph of linear constructive dimensional links (figure 4) 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.

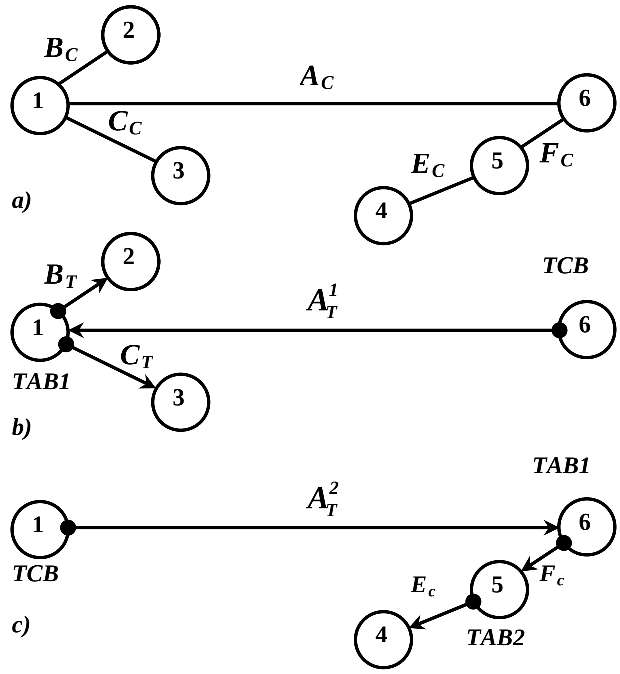

Figure 4. The graphs of linear dimensional links: a) the graph of linear constructive dimensional links; b) and c) the graphs of linear technological dimensional links for two installations

It is visible, that the structure of the graph of the technological linear dimensional links completely coincide with structure of the graph of constructive linear dimensional links. As a result of it, the accuracy of the constructive sizes is formed directly in conformity with the figure 1a.

The dimensional structures exist much and the situation similar figure 4 meets seldom. For example, in the case of constructive dimensional links shown on figure 5, by the first installation, the machining of surfaces is similar to the previous example. During the second installation, there is a problem of sequence of operation elements connected to the presence of

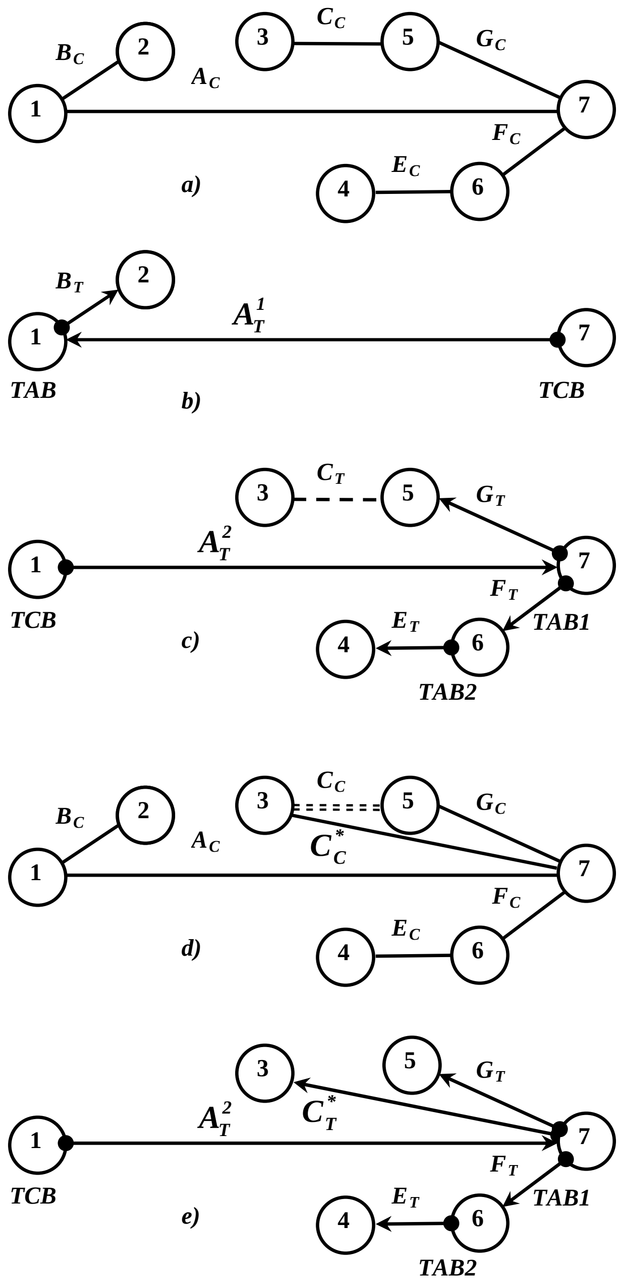

Figure 5. The graphs of linear dimensional links with bifurcation in unit: a) the graph of linear constructive dimensional links; b) and c) the graphs of linear technological dimensional links for the first installation and the second installation with bifurcation in the nod *7*; d) the graph of linear constructive dimensional links after recalculation of the sizes; e) the graphs of linear technological dimensional links for the second installation without a bifurcation in the nod

bifurcation in unit *7* from which outcome two equivalents which exclude mutually each others continuations (fig. 5a).

The solution in this situation is the change of the constructive sizes on a line with a lower accuracy, replaceing the size C_C by the size C_C^* according to the dimensional link $C_C = C_C^* - G_C$, in which the replaced size C_C is the closing (figure 5d). In this case, by the second installation the surface *7* is machined, and it becomes a technological adjusting base *TAB1* for machining the surfaces *3*, *5* and *6*, and the surface **6** becomes a technological adjusting base **BTR2** for machining the surface *4*.

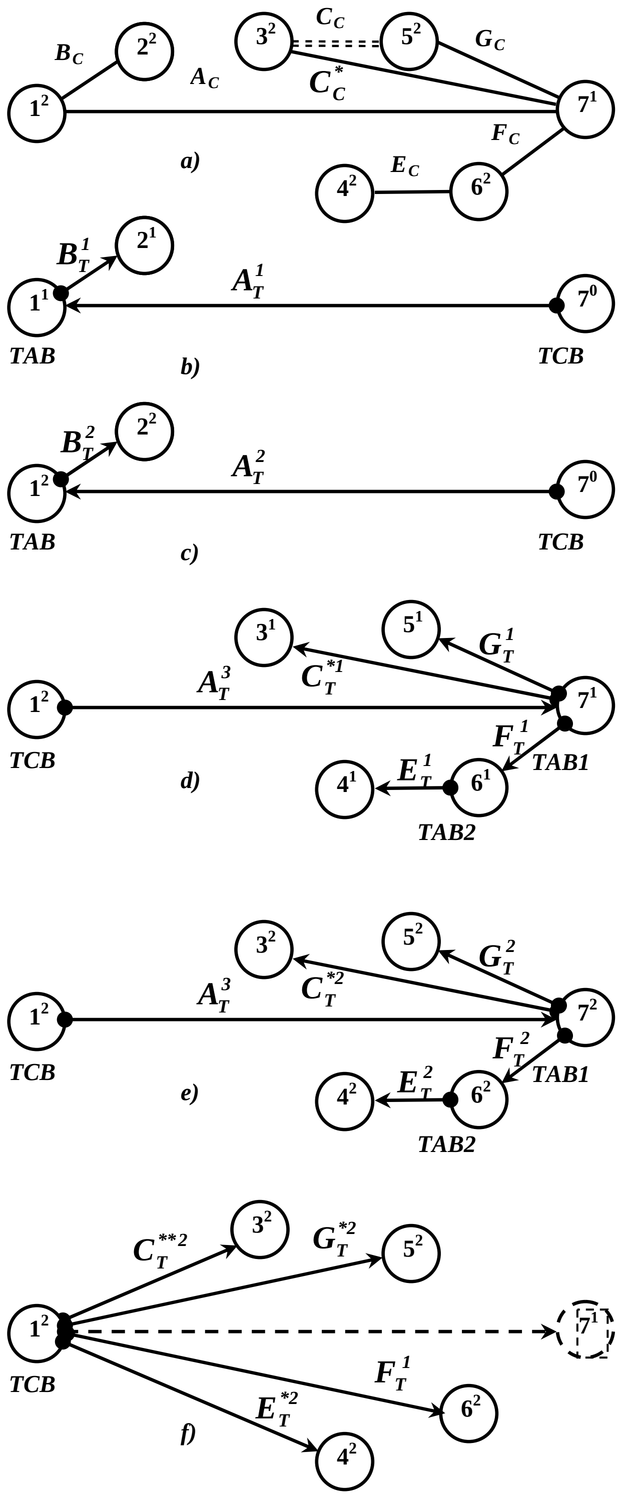

Figure 6. The graphs of linear dimensional links with break.

The problem of formation the technological dimensional structures similar to those constructive, becomes complicated if the number of operation elements stipulated for different surfaces is various. So, in the case of constructive dimensional structure shown on figure 6, the absence of necessity of repeated machining of a surface ***7*** the graph of technological dimensional links has a break. There are two ways of taking a decision. Either the break is eliminated by repeated machining of a surface ***7*** (figure 6e), or it is necessary to carry out recalculation of the sizes (figure 6f).

It is necessary to note, that recalculation of the sizes can be carried out and from a surface ***1*** (figure 6).

The structure of linear dimensional links is not dominating at an establishment of schemes of locating and definition of sequence of surfaces processing. Drawings of details rather frequently provide requirements to accuracy of a relative positioning of surfaces. As consequence of it, there are situations when the graph of the linear constructive dimensional links put forward the requirement of one surfaces use as technological bases, and the graph of technical requirements of a relative surfaces positioning – to the others. If for preliminary phases of machining it is preferable to be guided by the graph of linear dimensional links, on final phases of machining it is necessary to prefer the graph of technical requirements of a relative positioning. For especially exact and responsible details it is preferable to take into account by all phases of machining of the graph of technical requirements of a relative surfaces positioning.

Quite often, an obstacle in achieving the similarity of graphs of the linear constructive and technological dimensional links is the impossibility to create and use the complete set of technological bases from the necessary surfaces. It is connected with the fact, that on the blank surfaces have deviations from the correct geometrical form. In fact the graphs of dimensional links are created on the basis of the details drawing, and are used at basing the surface of blank.

The technological installation provides the use of the device so that a number of surfaces either are used for basing and fastening, or become inaccessible to machining. Therefore, a part of requirements starting with the structure of the graph of constructive dimensional links cannot be executed and the graph of technological dimensional links are based on the recalculation of the sizes and cannot be similar to the graph of constructive dimensional links.

3. CONCLUSIONS

1. Constructive dimensional structures are the initial precondition for creation the optimum technological process.
2. From the point of view of strategy of accuracy achievement, the optimality of technological process is provided with formation of each constructive size in the corresponding with the technological size.
3. The general direction of creation of optimum technological processes is the similarity of the graphs of the constructive and technological dimensional links.
4. The variety of dimensional structures of details, the variety of technical requirements, the distinction of technical requirements for the surfaces complicate the process of achievement of similarity of the graphs.
5. At a choice of schemes of basing at preliminary stages of processing it is necessary to be guided by constructive linear dimensional links, and at the final stages - by the graphs of the accuracy requirements of a surfaces relative positioning.
6. For achievement of similarity of the graphs it is possible to resort, depending on the situation, either to recalculate the sizes for overcoming the bifurcation in units of the graphs, or to additional machining of the surfaces in order toeliminate the breaks in graphs of the technological dimensional links.
7. The recalculation of the sizes is necessary to be accomplished on a line with the least accuracy.

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