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Technological similarity in process of series of type technology creating

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Analysis and modelling

ABSTRACT

Purpose: Problems of research related to creating ordered series of type of technology is realized with the intention of replacement traditional methods of selection of technological features for processes of machining. This process is realized through replacement of repeatable stages with routined stages susceptible to computer aiding.
Design/methodology/approach: This paper shows algorithmic understanding of getting input data in the process of creating ordered families of technology based on data of constructional. Basic tool of realization of data selection for the process of manufacture is the theory of technological similarity aided by computer programmes which is being elaborated.
Findings: The basic result of the analyzed problem is the realization of relations between construction and technology for specified series of types of elements of machine engines. Apart from that, there has been also describe the theory of technological similarity with its essential constituents which determine input date of algorythmisation of processes of selection of technological features on bases of constructional features.
Research limitations/implications: Described methods are closely related to the research on the process of construction and the theory of constructional similarity. Further analyses will be carried on in order to specify the theory of technological similarity in new forms of computer aiding (relational databases, theory of automatic classification).
Practical implications: The represented methods are apply for series of type of units of servo-motors hydraulic practical in mining.
Originality/value: Represented in article relations between construction and technology realized with use of theory of technological similarity they make up basic of the group technology. Method this is characterizes with possibility of shortening of times of preparation of manufacture and the enlargement of seriality of manufacture.
Keywords: Technological design; Theory of technological similarity; Series of type

1. Introduction

The similarity between specified classes of technical means is applied in different fields of science [6,11,12]. This work represents the model of passage of ordered families of construction into ordered families of technologies with use of theory of technological similarity [11,12].

The method of similarity is applied in the process of defining technological features to generate the parameters of processing.

Those parameters concern the processes of machining: turning, hole making, milling. For series of types of technology for one selected technology the parameters of process are calculated. They are being calculated by: algorithms, analytical programmes, norms. The parameters defined as standard parameters (technological features) are selected on the basis of constructional features [8,11].

Defined constructional features and processing parameters are applied to defining the parameters of processing for remaining

technologies of the series of types of elements according to rules elaborated for this method.

The transition of series of types of construction into series of types of technology requires transformation constructional features matrixes into technological process matrixes data. This process is prone to algorithmisation and consequently to computer aiding. An advanced graphic program was applied to the preparation of manufacturing processes. Constructed element is defined by constructional features: geometrical features (C_g) and materials features (C_t) [1,2,9,10]. Each technological process is defined by the process structure (Γ), that consists of: processing parameters, tool dimensions and tooling-up.

2. Stages of method and assumption

The theory of technological similarity is applied for elements characterized by constant constructional form and variational values of dimensions. Technological working plan is created by advanced graphic programs according to traditional methods. Standard structure is used to generate further technological structures by modification of chosen parameters. The selection and transformation of parameters is realized after having defined the system of relations and the system of connections and transformations between individual features.

It is important that this method is to be applied to create of technological documentation for series of types of elements.

It is characteristic for all series of types of elements to have constant constructional form of all elements. Constructional features (dimensions) are variable.

This assumption allows algorithmization of selection of quantitative technological features (parameter of processing).

Entire technological structure (kind of processing, operations, cuts, passage) remains constant for all elements of series of types.

Figure 1 represents the diagram of computational algorithm of method of technological similarity in process of creating the series of type of technology.

2.1. Definition of standard structure

The definition of standard technological structure is connected to definition of basic qualitative and quantitative technological features. Practically verified construction were accepted for the standard ones.

The assumption of a set of construction and technology is represented by equations 1.

$$Te_n^u\left\{te_k^{ej};(k=1,kz)(j=1,jz)\right\}<= \\ <= Ks_n^u\left\{(ks_k;(k=1,kz)\right\} \quad (1)$$

Manufacturing form, (containing invariable data of record of specified qualitative technological features), depends on:

1) constructional figure of element,
2) specified process of manufacture,
3) suitable forms of tools, attachments, machine tools and shanks.

2.2. Standard values of technological parameters and parameters of processing

A program of selection of parameters was created for basic processes of machine cutting to determinate parameters of processing. Program "Parameters" was worked out adaptation to necessary data to defining the parameters in advanced graphic programs I - DEAS for processes machining: turning, milling, drilling. Standard technological states are being defined upon the basis of standard parameters. Maintaining constant technological states is considered basis for fathers definition of elements of series of types.

Following technological states are analized:

- force of machine cutting $\mathbf{Pa_{Fc}}$
- power of machine cutting $\mathbf{Pa_{Pc}}$
- volumetric efficiency of machine cutting $\mathbf{Pa_{Qc}}$

Standard values of parameters of processing:

- feeds f_{e0}^i
- speed of machine cutting V_{e0}^i
- depth of machine cutting a_{e0}^i
- rotational speed n_{e0}^i

Where: i - number of operation
e0 – number of element of series of type

The values of parameters of processing define standard values of technological states. Then for constant technological states with the use of measures of technological similarity (section 2.3) the parameters of processing are generated for next elements the series of types.

2.3. Measure of technological similarity

The number of similarities defines the level of digitization of value of calculated technological parameters.

They refer to transformation features assigned to standard technological process. Their value is chosen according to the type of machining and similarity of constructional features. Their final is in according with the series of normal numbers (e.s. R20)

This paper analyzes the similarity of constructional parameter (entrance data presenting constructional quantitative feature, marked as pi) and the similarity of parameter of processing (exit data presenting the quantitative parameter of process, marked as wi).

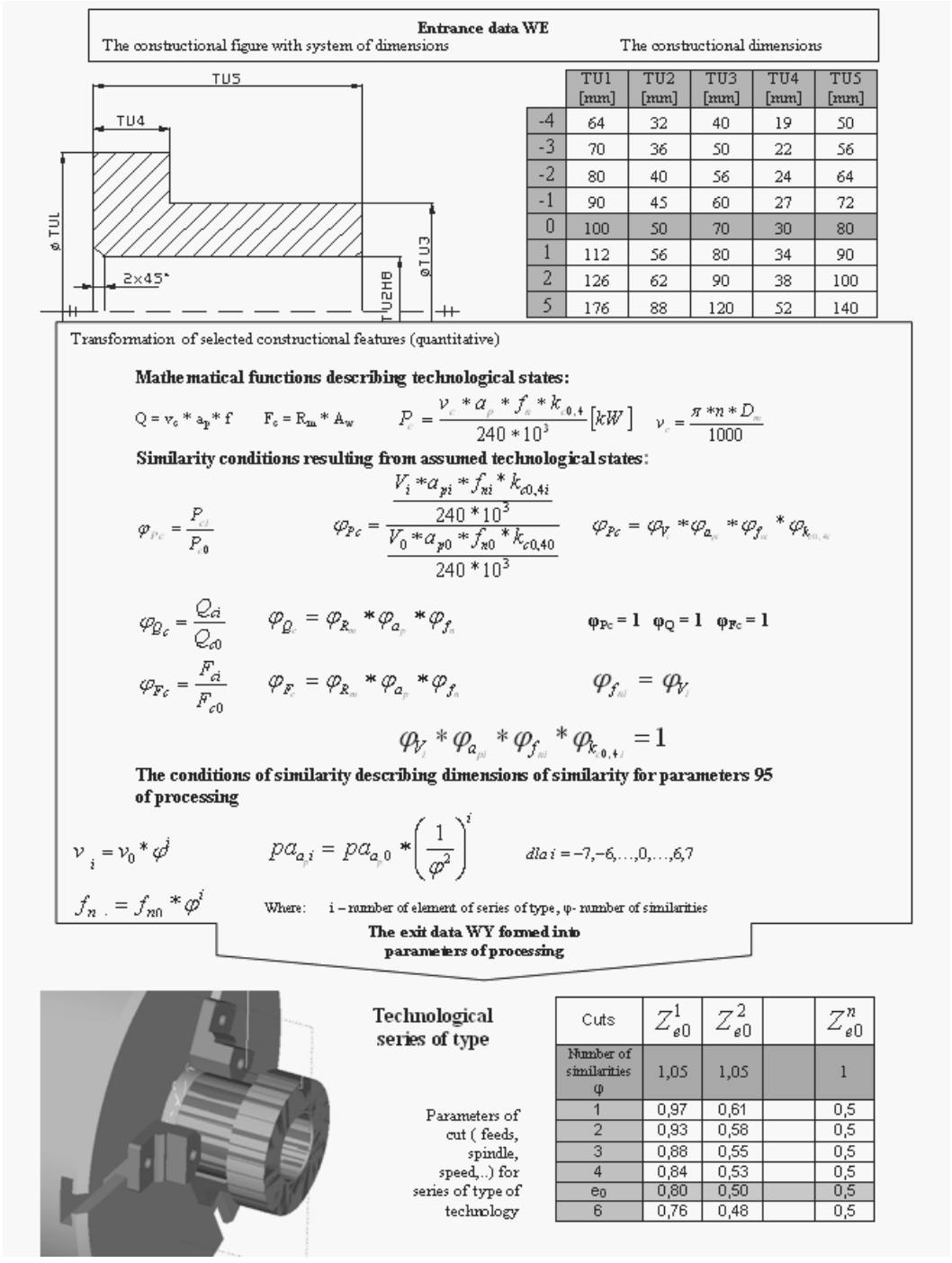
- similarity of constructional parameter

$$\varphi_{ik} = \frac{p_{ik}}{p_{0k}},$$

- similarity of parameters of processing

$$\varphi_{it} = \frac{w_{ik}}{w_{0k}}$$

Basing on defined measures of similarity value of parameters of processing are specified according to constant technological states.



	TU1 [mm]	TU2 [mm]	TU3 [mm]	TU4 [mm]	TU5 [mm]
-4	64	32	40	19	50
-3	70	36	50	22	56
-2	80	40	56	24	64
-1	90	45	60	27	72
0	100	50	70	30	80
1	112	56	80	34	90
2	126	62	90	38	100
5	176	88	120	52	140

$Q = v_c * a_p * f \qquad F_c = R_m * A_w \qquad P_c = \frac{v_c * a_p * f_n * k_{c0,4}}{240 * 10^3}[kW] \qquad v_c = \frac{\pi * n * D_w}{1000}$

$\varphi_{Pc} = \frac{P_{ci}}{P_{c0}} \qquad \varphi_{Pc} = \frac{\frac{V_i * a_{pi} * f_{ni} * k_{c0,4i}}{240 * 10^3}}{\frac{V_0 * a_{p0} * f_{n0} * k_{c0,40}}{240 * 10^3}} \qquad \varphi_{Pc} = \varphi_V * \varphi_{a_p} * \varphi_{f_n} * \varphi_{k_{c0,4i}}$

$\varphi_{Qc} = \frac{Q_{ci}}{Q_{c0}} \qquad \varphi_{Q_c} = \varphi_{R_m} * \varphi_{a_p} * \varphi_{f_n} \qquad \varphi_{Pc} = 1 \quad \varphi_Q = 1 \quad \varphi_{Fc} = 1$

$\varphi_{Fc} = \frac{F_{ci}}{F_{c0}} \qquad \varphi_{F_c} = \varphi_{R_m} * \varphi_{a_p} * \varphi_{f_n} \qquad \varphi_{f_{ni}} = \varphi_{V_i}$

$\varphi_{V_i} * \varphi_{a_{pi}} * \varphi_{f_{ni}} * \varphi_{k_{c0,4i}} = 1$

$v_i = v_0 * \varphi^i \qquad pa_{a,i} = pa_{a,0} * \left(\frac{1}{\varphi^2}\right)^i \qquad dla\ i = -7,-6,\ldots,0,\ldots,6,7$

$f_{n\ i} = f_{n0} * \varphi^i$

Cuts	Z^1_{e0}	Z^2_{e0}		Z^n_{e0}
Number of similarities φ	1,05	1,05		1
1	0,97	0,61		0,5
2	0,93	0,58		0,5
3	0,88	0,55		0,5
4	0,84	0,53		0,5
e0	0,80	0,50		0,5
6	0,76	0,48		0,5

Fig. 1. Mathematical illustration of transformations of parameters of constructional features processing according the method of technological similarity

The values of parameters are generated one after another basing following elements: constant power machining, solid efficiency of processing or strength of cutting.

The obtained values of parameters should be optimized into the range of applicable values.

In accordance with the chosen machine tool and productive possibilities the value of given parameter should be adapted to definite series of value. It results with an exception as far as maintaining constancy of constancy of technological state given, for example: of solid power of cutting (Fig. 2).

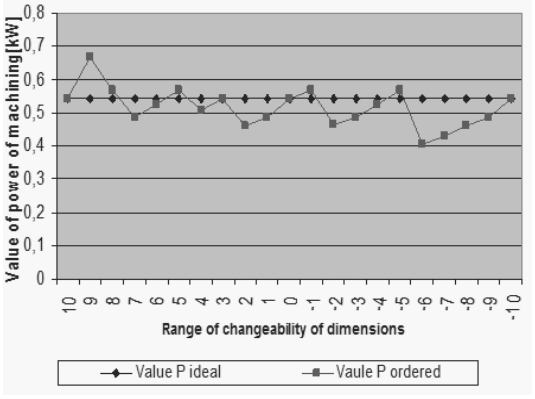


Fig. 2. The range of changeability of value of power machining standard and for ordered values of parameters for finishing turning

Figure 2 represents exchange of power of machining for finishing turning. Number of similarity φ=1.05. Standard parameters are settled on level:

	v_{n0} [mpm]	f_{n0} [mmpr]	a_{pn0} [mm]	D_0 [mm]	P_0 [kW]
i = 0	180	.,2	1	50	0.55

The machined material of a value Rm=400MPa. Standard parameters were selected, and then optimized basing on the catalogue of tools Sandvic.

3. Conclusions

The result of this paper is verification of established model of relation between constructional features (C_k) and technological features (C_t), what was verified on the example of hydraulic servo-motors manufacturing technology. The thesis listed in this paper were confirmed. The basic tool of the ordered technologies creating (Te_n) on the basis of ordered constructions is the CAD/CAM integration [3-5] and the theory technological similarity.

This paper is focused on application of theory of technological similarity to define the parameters of cut for hydraulic serwo-motors elements. This is consider a new attitude in the process of defining technological parameters for the series of types.

This method can be improved by applying the rules of metchod such as: method of creating of ordered technologies Te_n, basing on universally application of constructional form of units (shafts, targets, muffs) [5], method of group processing for technologically similar elements [6,13,15], methods focused on elementary objects, being parts of elements (hole, threads, grooves) [6,7].

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