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Databases and computer programs selection of technological features

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Analysis and modelling

ABSTRACT

Purpose: The main reason for starting the research concerning the new methods of selection technological features. This process is realized across the replacement of the repeatable stages with the routined stages susceptible to computer aid.
Design/methodology/approach: The main tool of algorithmization is the developed theory of technological similarity, supported by data bases application method [8,15].
Findings: The main achievements presented in this paper are developed method orientated on computer aiding and computer program method, both used in designing process of the new technical features.
Research limitations/implications: Analyzed methods develop algorithmisation of selection features and support integration with the process of the preparation of the production. Further analyses will be carried on in order to specify the theory of the technological similarity in the new forms of computer aiding (relational databases).
Practical implications: The represented programs were being developed on the practical examples of creating the module systems of hydraulic cylinders used in mining, slag cars used in metallurgy and gears series of types.
Originality/value: Programs and data bases presented in the paper are basis of selection of the technological features in the process series of types of the technology creating. All of these applications support the intensive development of the types of technical features and affect on their competitive on the ready market.
Keywords: Technological design; Materials and engineering databases; CAD/CAM

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1. Introduction

The selection of technological features values is one of the basic problems of series o types of the technology creating. It is the most susceptible stage to algorithmisation and computer aiding.

In the process of creation the ordered families of technology, two basic areas of the transformations, in set of construction and technology are as follows [3]:

- ε_j - subordinating between constructional forms and components of production process structure,
- ε_i - subordinating between constructional features and values of technological parameters,

The purpose of the integration of this environment is to find the connection between the individual areas of sets.

The methods of selection of quantitative and qualitative technological features are as follows:

- technological similarity [11,12,14],
- algorithmic method [13],
- CAM method [11].

The theory of technological similarity is applied for elements characterizing the constant constructional form and the

variables the values of dimensions. The technological working plan is created in traditional way with the use of advanced graphic programme. The standard structure will be used for generating the next technological structures through the modification of the chosen parameters. The only form of technological structure is invariable stays. Selection and transformation parameters are realized after definition system of the relation of connections and transformations between individual features.

Algorithmic method realizes subordination between the elements of series of technology and elements of constructions types on the basis of plan of production with operators use (Equation 1). Technological operators transform the quantitative and qualitative constructional features $x_{m1}^{e_j};\left(l=1,lv_j\right)$ in the sets of quantitative and qualitative technologial features xt_{ia}^{u} in family of technology described by technological structures $\Gamma_{rw}^{te_j};\left(j=1,\ldots,jz\right)$.

$$CK^{te_j} \xrightarrow{operator} CTe^{tej},\ \left(j=1,\ldots,jz\right) \tag{1}$$

CAM method presented CAD/CAM integration [1,4]. For this purpose the advanced graphic programme I-DEAS was applied.

The integration of the advanced graphic programme is the most advanced and effective method of the CAD/CAM integration. The advanced graphic programme is based on the uniform patternel of data. The comparability of data between the constructional patternel and technological one occurs there. The processing parameters programme were created to present this standard technology with the base of tools, tooling-up.

The associativeness creating of the technology consists of the exchange of 3D model element and semi finished product and renewed execution of the processing simulation with all settings of the standard technology

The transition from series of type of construction into series of type of to technology required transformations the constructional features matrixes in matrixes data to the technological process. It is the process susceptible for algorithmisations and is similar to the computer aiding.

A constructed element is defined by constructional features: geometrical features (C_g) and materials features (C_t) [2,9,10]. Each technological process is defined by the process structure (Γ), that consists of the processing parameters, tool dimensions and tooling-up. The computer aid of this process may be improved by the application of the transformations of the quantitative features into the preparation of series of type of technology (creating the databases and computational programmes).

2. System and construction

System is a set of relations of conjugations and relations of transformation of technical mean [2,3,9]. Relations of transformation depend on changes of properties of material objects. Among relations of transformations there are:

- relations of convert,
- relations of displace.

Relations of conjugations describe conjugations between material objects.

Among methods of system notation there are:

- verbal notation,
- block notation,
- graph notation,
- notation with virtual reality.

Construction is a set of structures and product conditions, described by design features CK [2,7,10]. Structures and conditions states are properties of product formulated by design engineer.

Traditional forms of construction notation:

- assembly drawing,
- working drawing,
- catalog drawing,
- and others.

Computer forms of construction notations:

- 2D notation with use of computer programs of PC class,
- 3D notation with use of computer programs of PC class,
- 3D notation with use of advanced computer programs.

Among design features CK, here we have:

- geometrical design features C_g,
- material design features C_t,
- assembly design features C_m

$$CK = C_g \cup C_t \cup C_m \tag{2}$$

Geometrical design features C_g describe external structure and macrostructure of the technical mean [3,9]. Among geometrical design features here we have:

- qualitative geometrical design features $\prod_g$
- quantitative geometrical design features $|\mathbf{W_g}|$

$$\mathbf{C_g} = \prod_g \cup |\mathbf{W_g}| \tag{3}$$

Qualitative geometrical design features $\prod_g$ describe geometrical form of technical mean, external and internal surfaces.

Quantitative geometrical design features $|W_g|$ are considered as a set of dimensions describing geometry of technical mean and dimensions describing macrostructure (surface roughness, tolerance form, position tolerance etc.).

$$|\mathbf{W_g}| = \mathbf{N} \cup |\mathbf{T}| \tag{4}$$

where:
N - nominal value of dimension,
|T| - dimensional tolerance with tolerance range.

2.1. Series of types of construction

Series of types of technical means (Fig. 1) represented by ordered family of construction is a set of constructions $Ts_n\left\{ks_k^t;\left(k=1,\ldots,kz\right)\right\}$ with constance constructional form $\left(\Pi^t=const\right)$ and variational values of dimensions $\left(w_{kl}^t=\mathrm{var}\right)$. Properties of series of types, especially series of types of elements

$t_m^{te_j};(m=1,\ldots,mz)$ are important for process of ordered construction families creating [3,6].

The variation of series of types are module systems of constructions. Module of construction $mk_m^{rwe_j}$ is a construction of element with optimalizated variety of design features. Optimization results and set of rules of selection RG_n [3] enable creation of more advanced module constructions Ks_n^m. Moreover the selection of constructional modules according to rules of selection enables creation of modules of construction characterized by high variationality and restricted only by number of modules of construction.

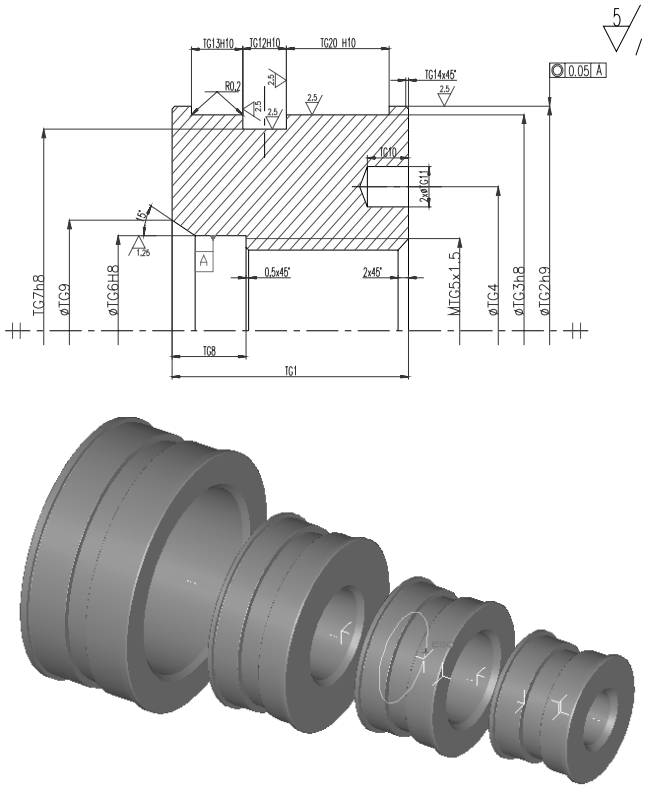

Fig. 1. Series of types of element of servo-motor

3. Technology

Technology is a state of product manufacturing, described by technological features.

Among technological features C_{Te} here we have:

- qualitative technological features $\mathbf{\Gamma_g}$,
- quantitative technological features $|\mathbf{T_g}|$.

Qualitative technological features describe:

- technological structure of manufactured element,
- form of semi-finished product ,
- form of cutting tools,
- form of tooling.

All these features are named a technological form. Technological structure depends on form of series of construction.

$$\mathbf{C_{Te}} = \Gamma^{tej} \cup |T|^{tej} \tag{5}$$

where:
Γ^{tej} =const - technological form,
T^{tej} =var - technological parameters.

Equation 6 presents all technological features:

$$C_{Te} = (\Gamma_s \cup \Gamma_p \cup \Gamma_n \cup \Gamma_o) \cup (T_{pf} \cup T_{ps} \cup T_n \cup T_o) \tag{6}$$

where:

Γ_s - technological structure	T_{pf} - dimensions of semi-finished product
Γ_{pf} - form of semi-finished product	T_n - dimensions of cutting tools
Γ_n - form of cutting tools	T_o - dimensions of tooling
Γ_o - form of tooling	T_{ps} - parameters of processing

Quantitative technological features describe: dimensions of a semi-finished product, dimensions of cutting tools (inserts shape, dimension of holder), dimensions of tooling and parameters of processing (feeds, depth of cut, cutting speed).

All these features are called technological parameters.

3.1. Series of types of technology

In aspect of under the examination constructions of hydraulic servo-motors the consecutive methods of creating the ordered families of technology were distinguished:

1. method of creating of ordered technologies Te_n, basing on universally applied the constructional form of units (shafts, targets, muffs) [4,8],
2. method of group processing for technologically similar elements [10,14],
3. the methods oriented on elementary objects (the postal entire) being with parts of elements { the hole, threads, grooves) [4,6,16],
4. the method of creating of ordered technologies te_k on the basis of ordered constructions ks_m^{te}, elements.

The work was oriented on creating of ordered technologies on the basis of ordered constructions ks_m^{te}, elements. In method this on level constructions the element of required construction the ordered technology be assigned (Eq. 7).

$$ks_m^{te_j} \rightarrow te_n^{te_j} \tag{7}$$

The process of ordering of technology is realized for series of type (Equations 6) or module series (Equations 7) with applying there where this was possible identical operations, cuts, parameters of processing, seizing, tools, gears.

$$ts_m^{te_j};(m=1,mz_j) \tag{8}$$

$$mk_m^{rwe_j};(m=1,mz_j) \quad (9)$$

The basic methodological assumption to creation of ordered technology of manufacture of element (the hydraulic servo-motors) it is constant or the imperceptibly differential structure of technology Γ^{tej} and the variation of technological parameters T_a^{tej}. In order to the obtainment the most effective integration of process of creating series of types of technology with process of creating of ordered construction performance undermentioned standards must be required:

1) sorting constructional data (constructional features) making up the basis to creating of technological components of ordered technology,
2) transfer from construction the how the grandest number of data to process of manufacture,
3) the maximum connection of constructional features with manufacturing technology,
4) minimisation of redundancy of information,
5) the development of the relational database,
6) minimization of variety of construction and technological processes particularly with constructors and technologists' subjective feelings,
7) typical constructional solutions and technological processes that modules computational programmes should be presented.
8) developing computer programmes and their application in order to integrate the working environment process engineers and design engineers [8].

4. Technological data bases

The basic way of the technological features selection (Te_n) on the basis of ordered constructions is the process of date bases creating [12,15]. For this purpose the advanced graphic programme I-DEAS was applied.

Worked out applications represent the integral (general)conception of preparation series of technology (Fig. 2). The approach causes that for the specified series of types of construction k_{si} (i= -n, …., 0,…., n) the series of types of technology creates t_{ei} (i= -n, …., 0,…., n) with maintenance constant (or imperceptibly differential) technological structure Γ=const and variables (resulting from transformations constructional features with the use of worked out methods) the technological dimensions T=var. This process represents Fig. 2, where the definite construction MTU_... . definite technology belongs to Te_MTU_… defined with the use of worked out methods.

The implementation of this process is connected with integration process in graphic programs.

Integration in the advanced graphic programme is the most advanced and effective method of the CAD/CAM integration. The advanced graphic programme base on the uniform patternel of data.The processing parameters were created to represent this standard technology with the base of tools, tooling-up and the programme correction.

All processes of creating of the construction and technology families are based on construction and technology parameterization [3].

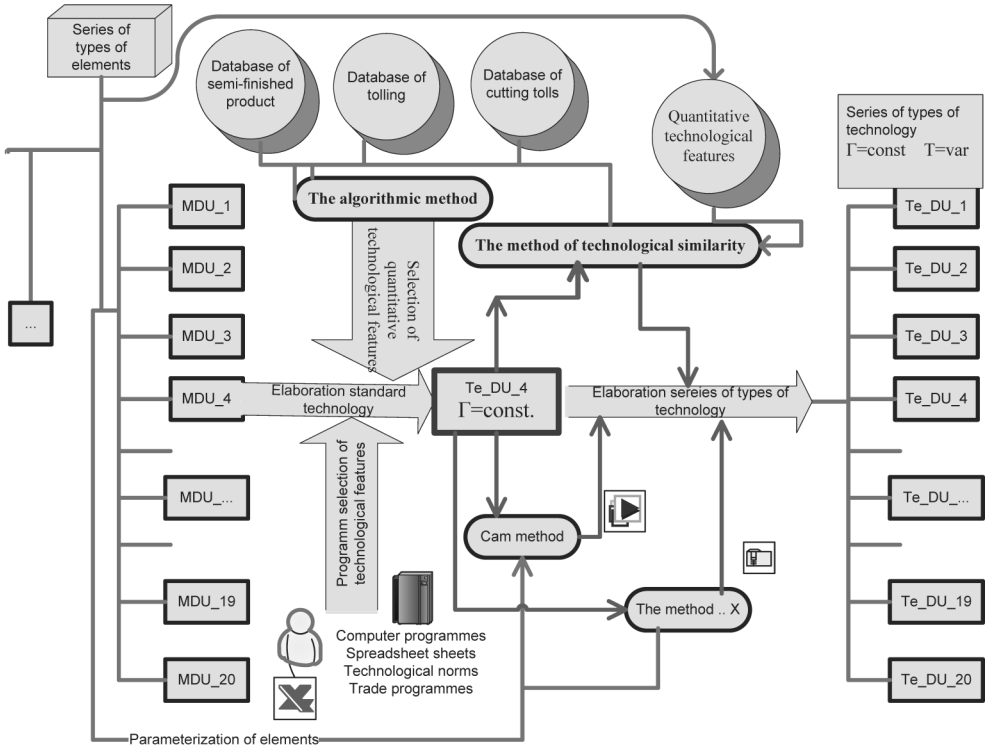

Fig. 2. Integral conception of process of creating series of types of technology

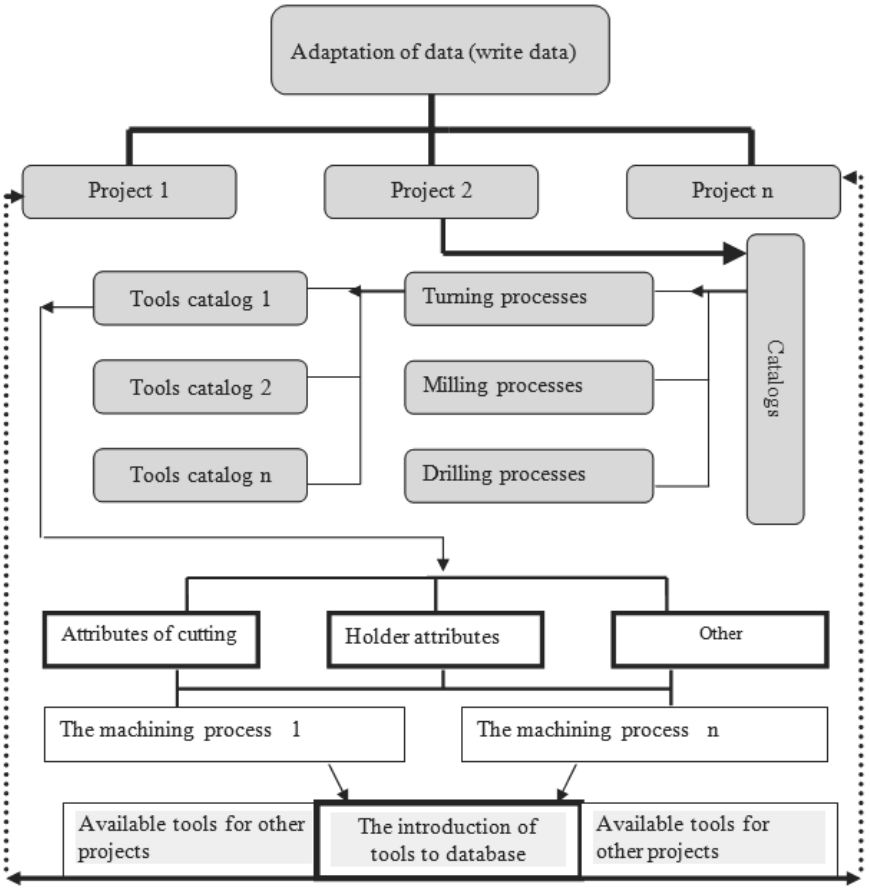

Fig. 3. Structure databases of tools

4.1. Database of tools

For the purpose of creating of technology on the example of the graphics program I-DEAS was performed the tool database. In this work the selection and determination of the tool is based on the guidelines offered by the manufacturers of tools: Sandvik and Baildonit. Specifications tools determinations by these producers will be ignored only by their determination in the database and use the tool for machining processes will be taken into account. Block diagram of database is shown in Figure 3. As an example will be presented the process defining of tools parameters for turning in programme I-deas. Each tool is assigned to a particular treatment process.

Each process is assigned specified directory and project. This process shows Figure 4.

After an earlier recording of each tool in the directory is possible to use the tool through each time referring to a specific directory tools.

Introduction of tools for the projects will be presented for turning tools: S25T-PSKNR/L 12. Data of turning tools shown Fig. 5.

Figure 6 shows a dialog box with tool parameters. Example of tools entered into the database shown in Figure 7.

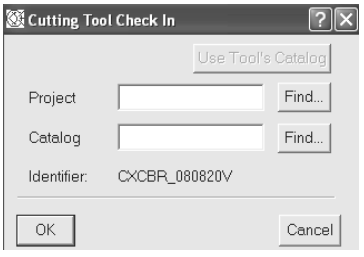

Fig. 4. Dialog box introducing tools for project

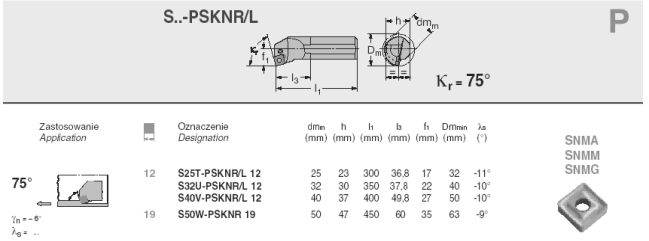

Fig. 5. Data of tool input to the database

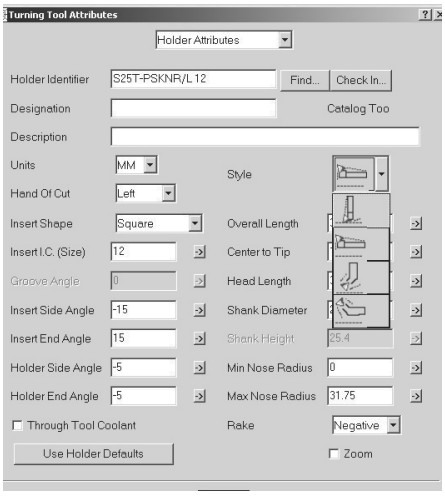

Fig. 6. Databases of tools parameters

Tools are saved in directory. Determining the parameters of the tool is made of:

- Tool Station Attributes,
- Insert Attributes,
- Holder Attributes.

Parameters for Holder Attributes: Insert I.C. Size, Insert Side Angle, Insert End Angle ,Holder And Angel, Style, Overall Length, Head Width, Head Leagth, Shank Width, Shank Haigth, Min Nose Radius, Max Nose Radius, Rake (Negative, Positive, Neutral)

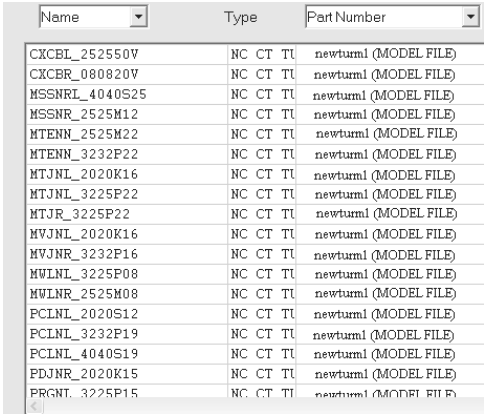

Fig. 7. Example of database tools for turning

Parameters for Tool Station Attributes: Turret Station, Tool Control Point X Offset, Nose Radius Center -Touch Off, Tool Control Point Y Offset, Nose Radius Center, Touch Off, Gage Length, Offset Register, Cutter Compensation Register, Orientation Angle, Spindle Direction (Counter - Clockwise).

Parameters for Insert Attributes: Insert Identifier, Designation, Description, Units (MM - IN), Insert Shape (100,80,55,35 Diamond, Triangle Square, Round, Trigon, Groove, Cutoff, Thread), Insert I.C. (Size), Nose Radius Thickness, Rake Angle, Material.

The process of database of tool creation shown Figure 8.

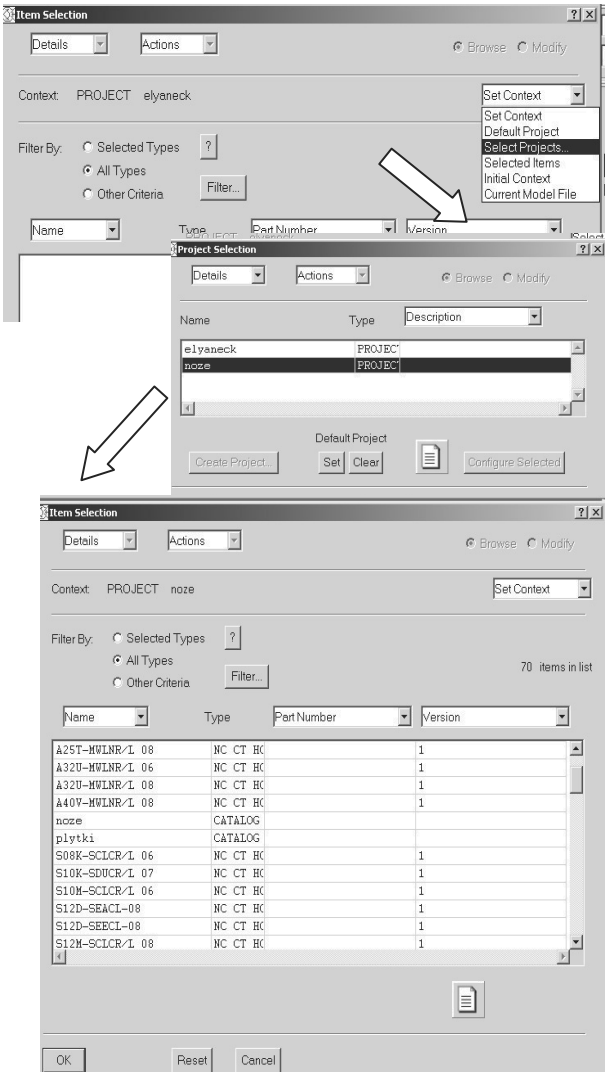

Fig. 8. Dialog box of tools for project implementation

In order to describe principles of the selection and the record of the particular tools for the purposes of creating typoseries an outside introduce determined features of the tool for the operation of rolling, milling and drilling. Starting the application takes place from the level of the specified operation of the Γ technological structure. Tools are classified depending on the variety of given operation.

Every tool can be identified in the base at applying support forms containing determined features identifying each tool. All introduced tools can be projected in the form of reports. Bookmark reports were created to identify the tools in the base for the sake of certain, characteristic of their features. For example on Figure 8 was described the generation of the report from the bookmark rolling/boring. After choosing an open option the report rolling or milling appears dialog box with the choice of the

determined value of the parameter?. After the entry of determined number (suggested by the program e.g.: all
knives for the internal processing, 2 - all knives for external processing) they are generated tables of tools brought into the program.

In the case of the bookmark for the report of deepening calling the tools is realized with determining the type of the grip on the countersink (1 - cylindrical grip, 2 conical grip).
Forms serve for determining certain above established features of tools, which are defined during the introducing of the new tool into the base.

Forms contain classified features of the tool connected with:

- form of the tile (forms of tiles of chosen producers),
- fastening (determining position of the tool e.g.: horizontal, vertical),
- fastening of the tool (way of fastening of the tool in the machine tool e.g.: cylinder handle, rectangular handle, driller handle, Morses' cone and, tang handle, itp.),
- the tool (given about the structure of the tool e.g.; folded, uniform),
- processing (given about applying the tool for a given kind of processing e.g.: external, internal),
- producer of tools (determination of the name of producer and address data),
- system of the fastening (given about the way of fastening the tile on the handle).

Determining the tool for rolling is connected with the introduction of basic of their characteristic sizes associated with operations of:

- external rolling,
- boring,
- rolling of gooves and cutting off.

4.2. Tooling database

Tooling in the processes of machining simulation is one of the required elements of the creation of a particular machining process.

Taken parameterized basic elements and machining process:

- three-jaw chuck, Figure 9,
- clamping jaw, Figure 10.

Made models, including tables of parameters. The individual elements are as follows:

A 80	A 160	A 630
A 85	A 200	A 800
A100	A250	
A 110	A 315	
A 125	A400	
A 140	A 500	

where:
A -identification number, 80 - size scale

All elements of assembly was determined in the same index. This allows for easy completing tooling.

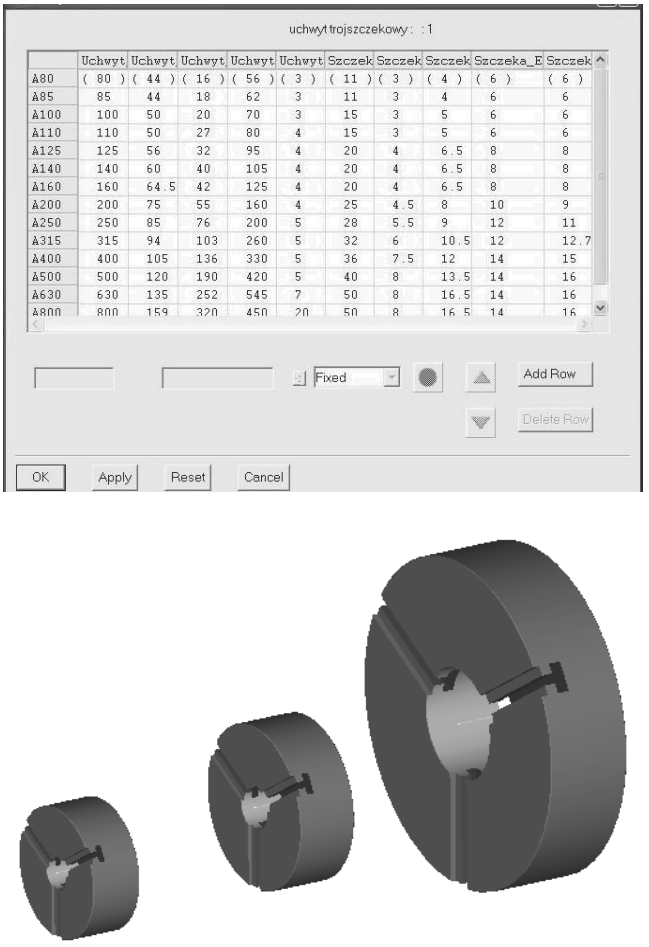

Fig. 9. The picture of parameterized three-jaw chuck with appropriate table of parameters

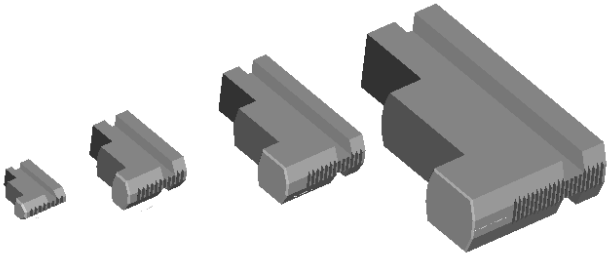

Fig. 10. The picture of parameterized of clamping jaw

Elements can be made to the database as a simple model without technological properties of objects (basis points, the working plane, etc.).Downloading the elements of the database is realized by reference to the name of the project. Then select the directory or library and selecting the part show Figure 11.

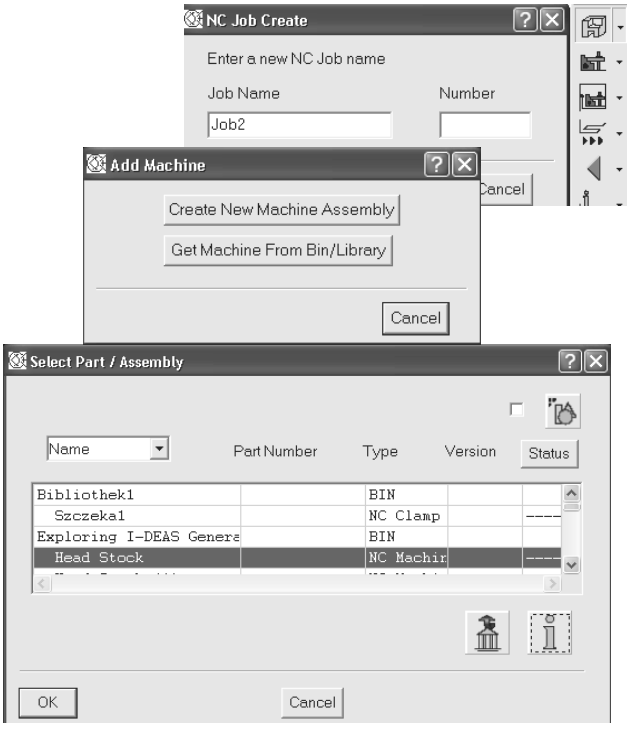

Fig. 11. Downloading elements from the database

5. Applications

In order to using databases and methods of determining individual technological features, was worked out an application letting for semi-automatic generating quantitative elements of technological documentation with applying methods and database of technological components.

The application allows to using created methods in cooperation with the program AutoCAD, the program Microsoft Exel and with the database in the program Access and I-deas.
The process is described graphically on Figure 13. After starting the application a starting window is coming in. In next step they are making the choice of the method of the selection of technological features.

After starting the next bookmark, should be made a choice of typosize from produced elements of the plumbing servomotor. A next dialog box allows for the read-out of the information about the chosen module in area Structural Data

The second area of a dialog box lets for selecting technological features. This process can be realized with the application of: algorithmic method

Possible is generating technological documentation with applying the application AutoCAD. Program for chosen typosize can generate the technological card and instruction cards based on operators. For chosen type of processing (rolling, milling, drilling) after determining the number of similarity for changing structural features quantitative technological features are generated with applying inserted numbers of similarity.

Block diagram of the technological features selection is shown in Fig. 12.

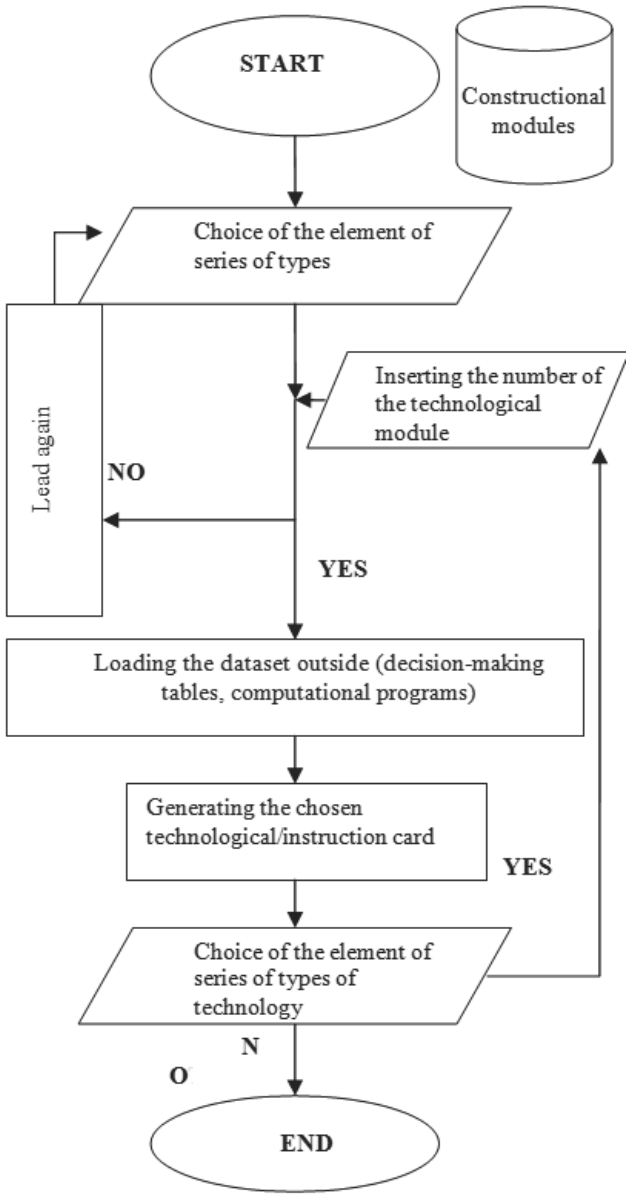

Fig. 12. Block diagram of the application

The user has the possibility to obtain:

- picture 2 D of chosen typosize,
- picture 3 D,
- structural documentation of elements of the servomotor for whole typoseries in the form of working drawings in the program AutoCAD,
- structural dimensions in the form of the data table (Microsoft Excel).

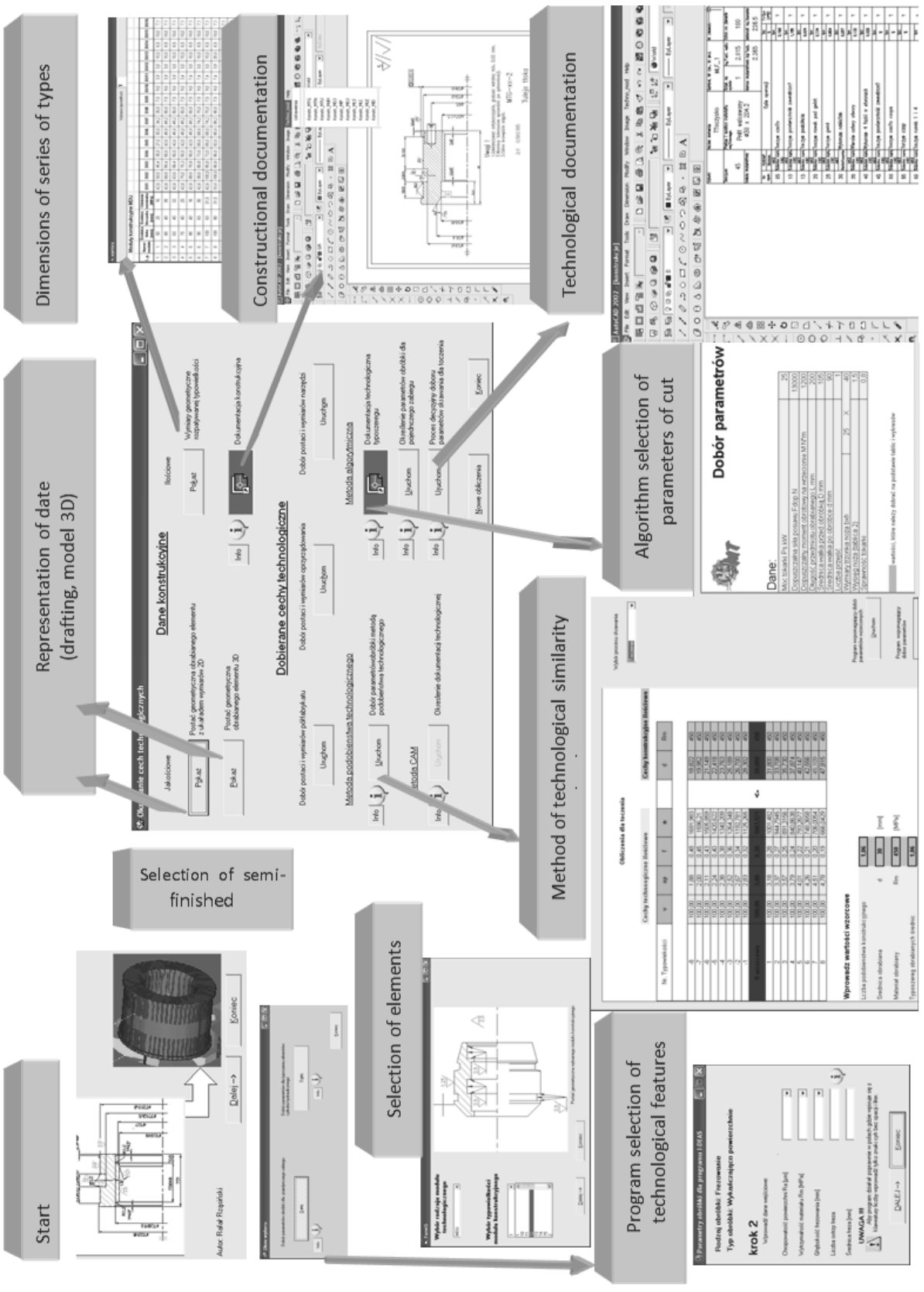

Fig. 13. Graphic diagram of application selection technological features whit use applications and databases

6. Conclusions

Development of database elements are dedicated to the machining processes:

- turning,
- milling,
- drilling.

Databases of technological elements allow for faster development of manufacturing preparation process.

Undertaken tasks are susceptible on algorithmization and computer aid. Moreover, it concerns both the methods of selection of quantitative and qualitative technological features. Working on defined reports between construction and technology the row of applications and computational programmes were elaborated. Visual BASIC programming language as well as AutoLISP used in AutoCAD programme were applied in preparing computational programmes. Access and I-DEAS programmes were applied to create the databases of tolls and instrumentations.

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