DBSMP – THE NEW APPROACH TO INTEGRATED DATA MANAGEMENT IN SPECIAL MATERIALS PROCESSING

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Summary

Development of high-precision products with difficult materials often requires use of unconventional techniques and manufacturing technologies. The studies are labor-and cost-consuming. Development of a database in which they are collected and made available the information necessary for designers of machinery and process design engineers, process is a matter of considerable importance. This paper presents the principles of design and structure of the database DBSMP (DataBase Special Materials Processing) and implementation of the system.

Keywords: special materials processing, database structure.

DBSMP – nowe podejście do zintegrowanych systemów danych obróbki materiałów o specjalnych właściwościach

Streszczenie

Kształtowanie precyzyjnych wyrobów z materiałów trudnoobrabialnych wymaga częstokroć zastosowania niekonwencjonalnych technik i technologii wytwarzania. Prowadzone badania są praco- i kosztochłonne. Opracowanie bazy danych, w której są gromadzone i udostępniane informacje niezbędne dla konstruktorów urządzeń technologicznych oraz dla technologów projektujących procesy, obróbki jest zagadnieniem o istotnym znaczeniu. W artykule przedstawiono zasady konstruowania i strukturę bazy danych **DBSMP** (**D**ata**B**ase **S**pecial **M**aterials **P**rocessing) oraz implementację systemu.

Słowa kluczowe: materiały o specjalnych właściwościach, struktura bazy danych

1. Introduction

The treatment of special materials requires wide knowledge in various technical areas. The availability of modern systems of production management does not fulfill all the needs connected with e.g. ensuring quality, optimization of materials treatment process, or gathering information and transferring specialist knowledge [1]. Special attention needs to be paid to the systems like CIM (Computer Integrated Manufacturing). At present, also such commonly known tools as CAD/CAM and CAP/CAQ, and even ERP and MRP [2], are added to this class of information technology solutions. However, the need of integration with new types of tools from within the area of Knowledge Based Engineering as well as Knowledge Based (Expert) Systems is still evident.

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The amount of information connected with the process of production which can be isolated, stored and processed is huge and it would be difficult to address this issue in the form of one and integrated tool. On the other hand, the division of information causes problems, like the difficulties of sharing knowledge internally within one organization or the group of organizations, or sharing knowledge externally in the form of commercial databases, or popular offset packages. This is the reason why most attention has been paid to the building of a tool supporting some of the knowledge areas in the treatment of materials characterized by special features – fig. 1.

The shaping of materials difficult to process (for example cutting multi-layer materials[3], titanium, special ceramics or zinc alloys) often requires special methods, equipment and technological devices and tools. Thermo-vision and high-speed scanning for monitoring the cutting zone materials [4] or Hybrid machining combines two or more processes for shaping and/or finishing machine parts, tools, electronics devices and micro parts (these hybryd processes are developer to enhance advantages and to minimize potential disadvantages associated with an individual technique)[5]; characterized by high complexity. Many methods also requires a number of costly attempts, what only justifies the sense of creating a substantial database regarding this subject.

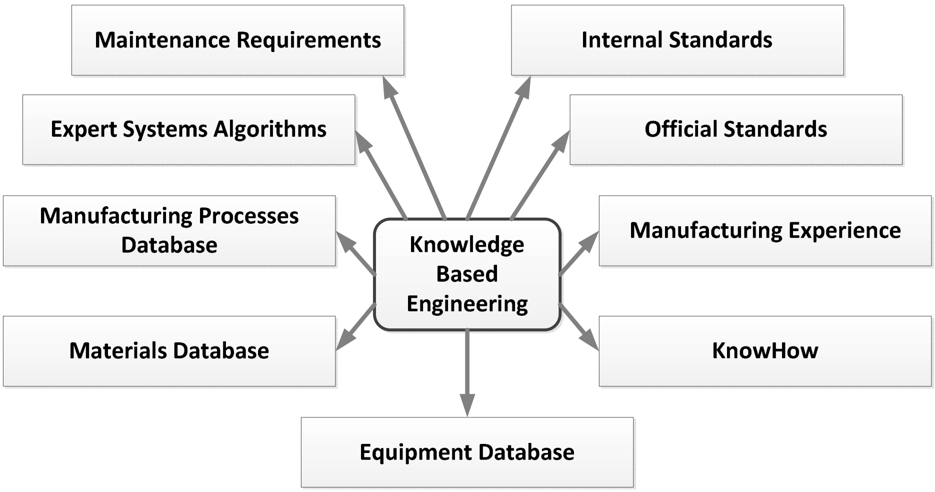

Fig. 1. Domains of present Knowledge Based Engineering (KBE)

2. System concept

On the basis of analysis of existing systems and the range of knowledge subject to the possibility of gathering and utilizing in the real production circumstances, the concept of DBSMP system (DataBase Special Materials Processing or BoMS in national context) has been created.

Discussing the problems of using various, separate systems from within KBE area (fig.1), a number of assumptions directly connected with the modules of future DBSMP information system planned to be implemented has been adopted.

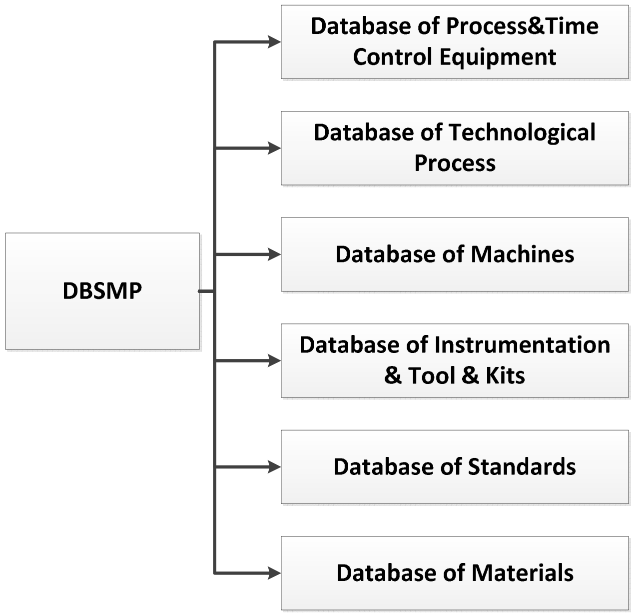

Fig. 2. Main modules of DBSMP (BoMS) system

Requirements of Database of Standards:

- the possibility of cataloguing norms and other standards, together with presenting both the vendor and the area of applying the norm;
- the building of the hierarchy of norms;
- the storing of the optional number of documents connected with norms/ standards

It appears then that the implementation should enable the cataloguing of optional number of norms in the way which makes it possible to define various versions for the same standard, which is the building of the hierarchy of documents, with the unlimited number of documents connected with the norm [6].

Requirements of Database of Materials:

- the possibility of creating the optional number of categories of materials connected with the norms and descriptive materials in the form of the optional number of files;
- the possibility of cataloguing materials according to its kind, type, etc.;
- the connecting of kinds of materials with norms, e.g. ASTM, stored in the module of norms and standards;
- the defining of the optional number of parameters typical for the particular kind of materials, e.g., providing the ranges of working temperatures, in which the materials can be used, and also the defining of these parameters;
- the defining of the optional number of materials assigned to the particular kind of materials together with their basic descriptive data, e.g. patterns;
- the storing of the optional number of documents connected with the material as well as the building of the hierarchy of documents regarding the specific material.

Requirements of Instrumentation (also tools and kits):

- the possibility of describing the optional amount of equipment according to its type, which can be:

1) an independent element of the material treatment process,
2) an element of the machine/machine tool set,
3) an element of an independent set unused in the machine/ machine tool;

- the defining of the optional number of parameters typical for the particular equipment, together with presenting the norm for the particular parameter;
- the storing of the optional number of documents connected with equipment, e.g. drawings, instructions and the building of the hierarchy of documents for equipment

For tools identical assumptions have been adopted as for equipment. The building f the set of tools is also indispensable, which is required by the methods like SMED [7] as well as RMS (Reconfigurable Manufacturing Systems) [8].

Requirements of Machines (Also Time Control Equipment):

- the possibility of cataloguing the optional number of technological machines, which are used e.g. in the processes of materials treatment, together with the division into a group and kind;
- the defining of the number of parameters typical for the particular group and kind of machines and the defining of norms for these parameters;
- the possibility of defining periodic service of machines together with registering the planned timings and the actual timings [9];
- the defining of the optional number of parameters for service, the defining of working parameters and the registering of the values before and after the service;
- the storing of the optional number of documents connected with the services as well as the building of the hierarchy of documents;
- the registering of events, which can be assigned to the exploitation of machines, e.g. breakdowns and failures;
- the storing of the optional number of documents connected with events and the building of the hierarchy of documents.

Such an attitude includes the requirements of TPM and TQMain. However, there is a need to point out, that this attitude requires over-standard functionality, which should be implemented during the second stage of the system development.

Requirements of Database of Technological Process:

- the possibility of cataloguing the optional number of material treatment processes connected with technological processes and processed material;
- the storing of the optional number of documents connected with material treatment processes, e.g. the storing of the sets of characteristics and the building of the hierarchy of documents;
- the defining of the particular material treatment operations within the whole material treatment process;
- the storing of the optional number of documents, which a user can include into the operations of the material treatment process (e.g. the drawing of the processed material together with the stages of its application according to the particular actions of operations) as well as the building of the hierarchy of documents;
- the defining of the optional number of actions within the treatment operation;
- the defining of the optional number of documents, which a user can include into the action (e.g. the drawings of the element under process), as well as the building of the hierarchy of documents;

- the defining of the full set within the material treatment operation consisting of the optional number of machines, tools, equipment and tool sets, also the sets of the SMED type [10].

Additionally, the possibility of registering in the real time or in the optional time frames of changeable parameters of material under process and equipment used in the treatment process should be taken into consideration, for the need of experiment, checking the correctness of the material treatment process, as well as for the need of TQMain and other quality – providing systems.

3. System solutions and implementation

The requirement of high level of modularity caused, that the finding of such information tools, which would enable the fast and easy adding of new functionalities, has become a necessity. However, it is not easy to achieve, especially due to the fact that the majority of frameworks, because of being internally complex, does not meet this requirement. Of course, the integration of new modules is possible, but not easy.

The usage of the so-called heavy-weight Model-View-Controller (MVC) frameworks, e.g. Zend, Symphony or Yii, has been given up in favour of the usage of very fast micro – frameworks.

The micro-framework used, similarly to hard frameworks, uses the MVC model, but it is the model of data that has become the basis of building a new application. The carrying out of the project and implementing of the system is based on the basic structures of data in the form of a relation from a relational model of data [11]. Despite the passing of time and the development of the most modern models of data, a better method of designing and applying the structures for storing data has not been developed [12].

The original project of the layer of data has been created for the system of Oracle 10 g in Oracle JDeveloper, which enabled to model the appearance of main modules of application. The implementation of tables and their auxiliary structures (indexes, foreign keys, user defined procedures, triggers and assertions [13]) has been applied for the server of MySQL-5 databases. The system is then adapted to be used both with servers of MySQL databases and Oracle (at a larger scale, for huge production systems in future).

In accordance with the assumptions, the project has been divided into modules, adding to the modules the possibility of data audit, support for the authorizing options and checking the authenticity of users (A&A). Auxiliary tables for client applications as well as dictionary tables have been devised. At present, DBSMP consists of 112 tables; it is impossible to present the full ERD diagram for the model of the data [14]. The example of relation of tables for the module of norms and materials management is presented by fig.3.

The first module of databases is the set of tables, which provides the possibility of operating and working on internal, as well as external standards (e.g. norms), in accordance with the knowledge and assumptions within the area of storing information according to their hierarchy or the optional documentation (files).

The cataloguing of information on materials from the possibility of a detailed description of kinds of materials through the adding of particular materials together with files and connecting them with norms (fig.3.) is a far complex element. What is important, the defining of the optional number of parameters both for various kinds of materials and specific materials (taking their full hierarchy into consideration), e.g. heat-resistant steel, is possible [14].

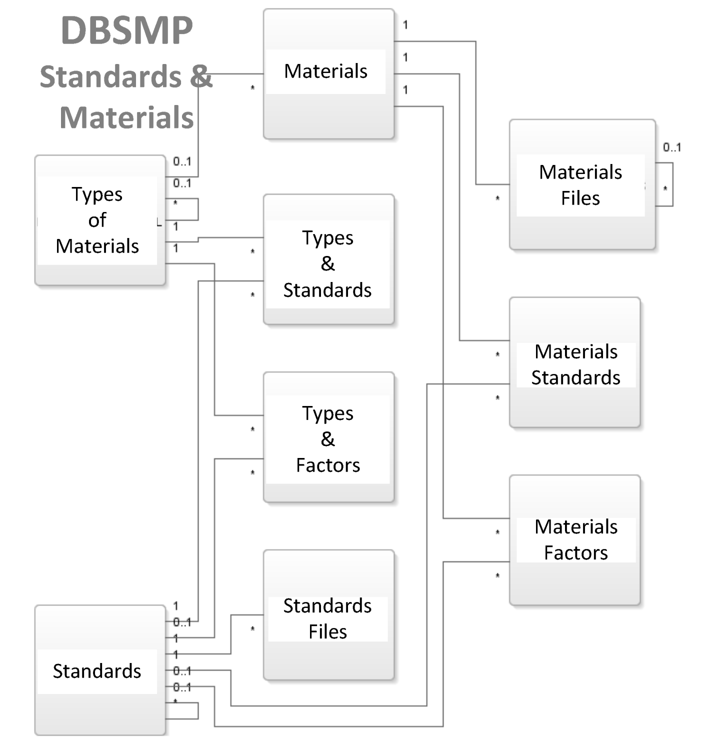

Fig. 3. Data Model for Standards and Materials Modules designed in Oracle JDeveloper

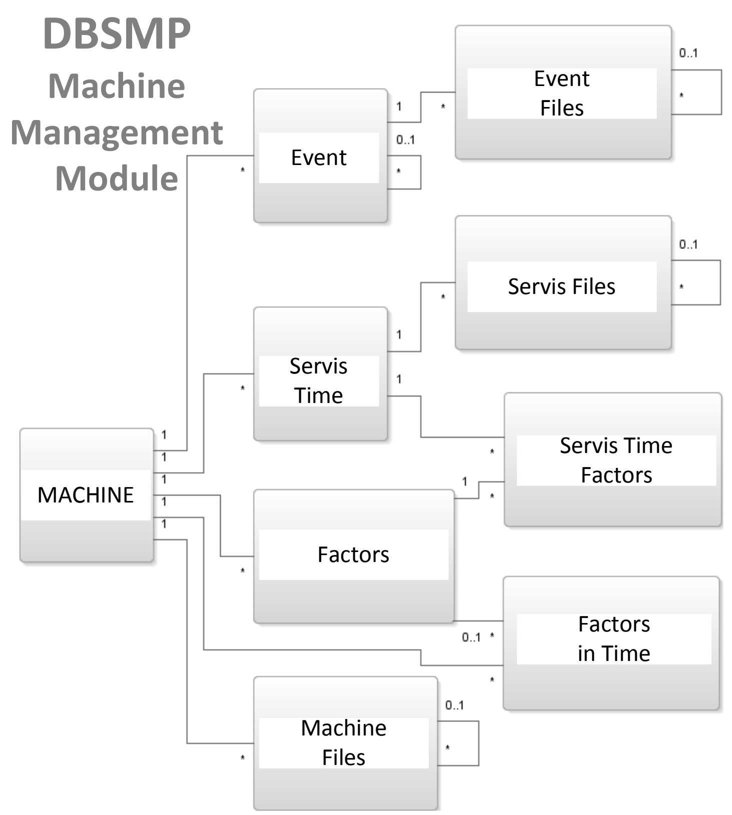

Fig.4. Data model for Machine Management Module designed in Oracle JDeveloper

Another element of data model is the set of tables and auxiliary structures used for cataloguing of information on equipment and tools, which can be used as:

- an individual element of materials treatment process;
- an element of the set for machine/ machine tool
- an element of an individual set, unused in machine/ machine tool

Following the above, it has become necessary to build the composition for creating this kind of sets. Together with tools, equipment and their sets, it is possible to catalogue the optional number of files and parameters (also connected with norms).

The service of information on machines is by far more complex (fig.4.) due to the bigger amount of information indispensable for e.g. TPM or TQMain. Apart from files and parameters, special relational containers have been created for storing service information on technological and various events together wit the possibility of monitoring optional parameters connected with this and registering parameters of the machine in time, e.g. during the treatment process.

Thanks to the advanced model of data, a user of the system, e.g. the main technologist asking a proper question should obtain data regarding the treatment of the specific material accompanied by conditions required by norms and the set of technical devices. Within the discussed system also the functionality necessary for cataloguing data on values of optional parameters changeable in the specific time (also Real-Time) has been implemented, but depending on the possibility of technical devices and digitalizing data.

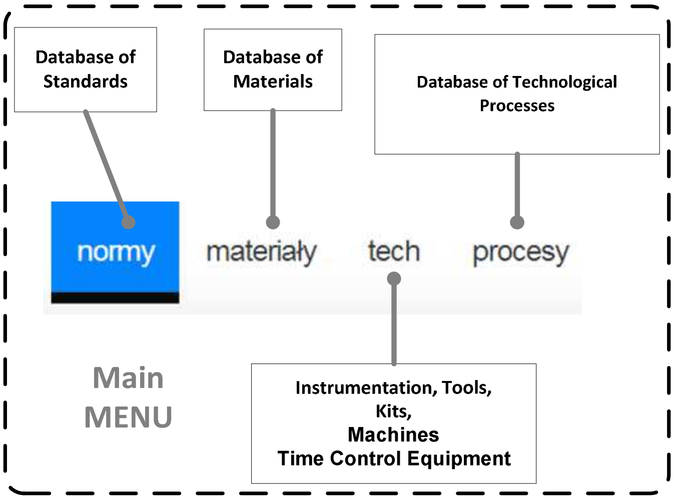

Fig. 5. DBSMP and its context modules

In accordance with the designed layer of data, the logic layer and user interface have been built. The example of realizing the main menu taking into consideration the division into the dependant modules is shown by fig.5. All the modules are mutually dependant on the Database of Standards, which is a result of the specificity of system.

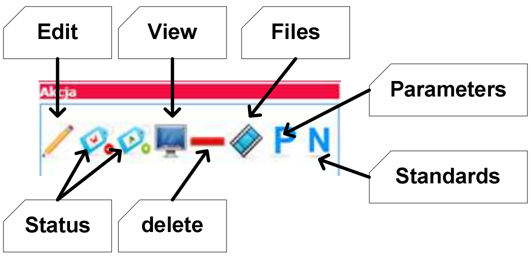

Fig. 6. Extended CRUD operations in DBSMP

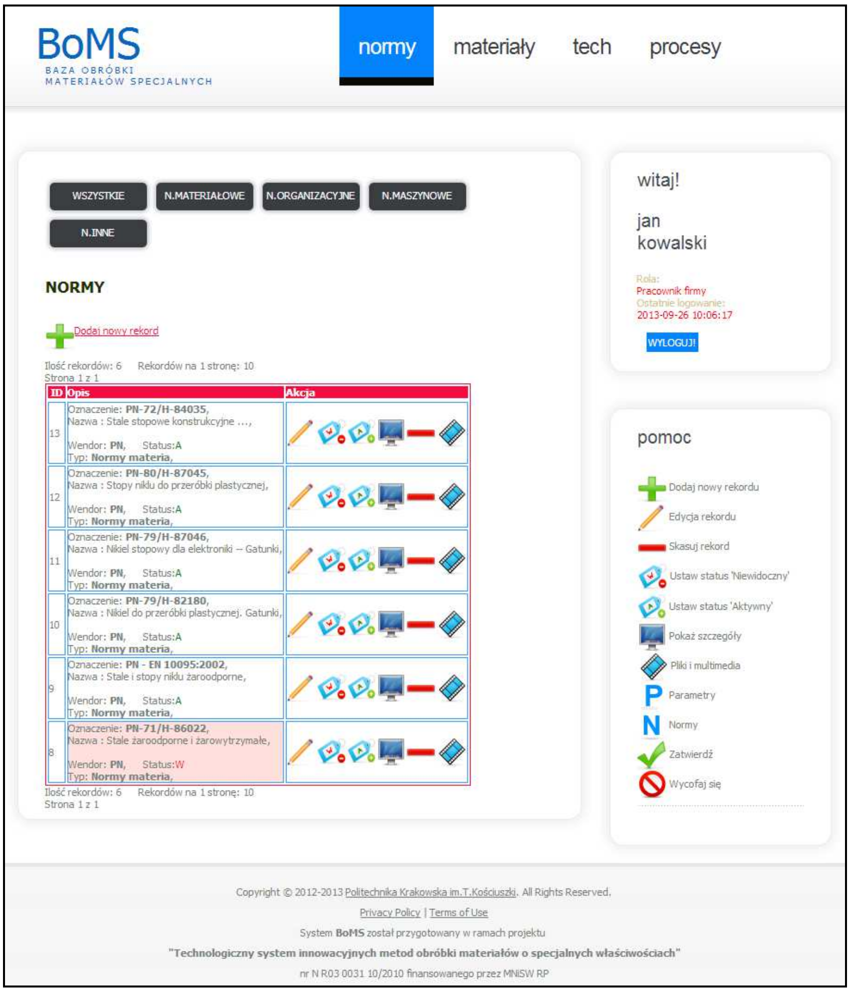

Fig. 7. DBSMP – database of standards

For the purpose of comfortable usage of application (easy to use), the appearance of all the sets of indexes of the type of CRUD (Create, Read, Update and Delete) in the User Interface (UI) has been unified. The extended version of CRUD consists of (fig.6.):

- an additional option of the review of the record details (View),
- the (web) page used to manage the files (Files),
- the management of parameters for the specific record (Factors),

as well as the management of norms for the specific record (Standards).

Thanks to the User Interface it is more transparent and, for every element, it guarantees the access to a similar set of options, in particular to the management of norms and parameters apart from the module of norms (fig.7.).

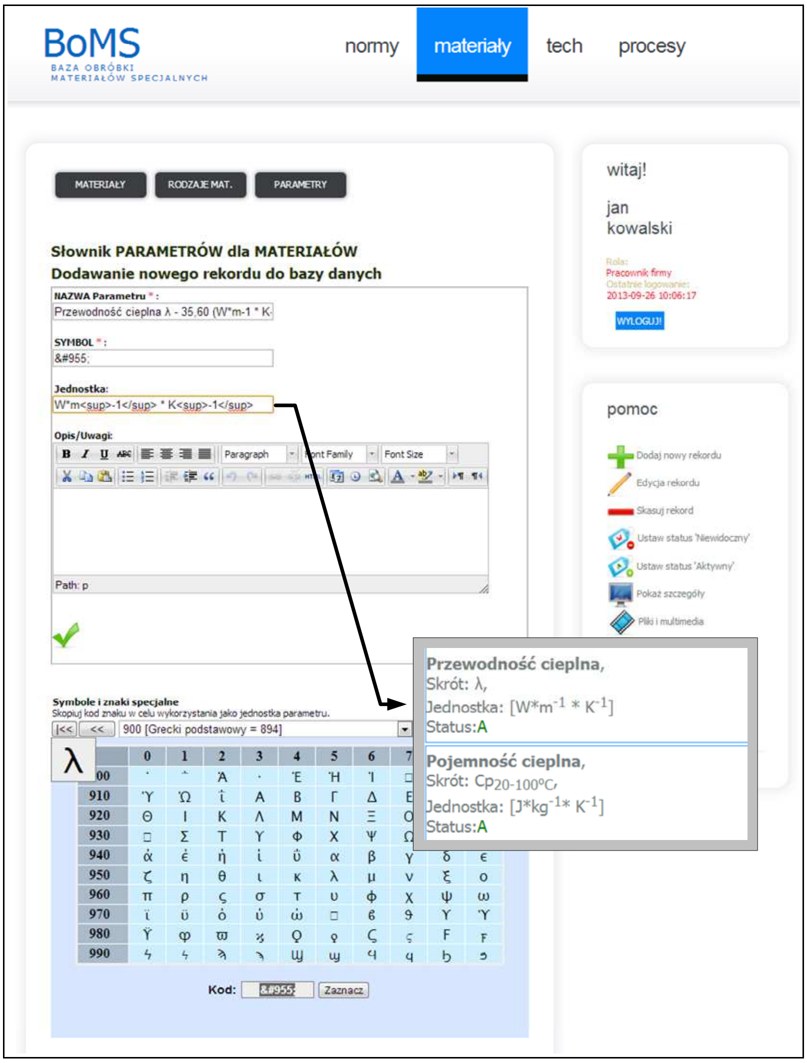

Fig. 8. DBSMP – advanced editor of factors description with Polish user interface

In the application many standard as well as extended programmer elements have been used, such as the possibility of registering symbols and mathematical equations based on UTF-8 sign codes. It has been shown on the example of edition of the registration of markings and the measure unit for an exemplary parameter – fig. 8. Because of the limited version of this review it is impossible to describe all the functionalities of the DBSMP system, which is still being extended for additional functionalities.

4. Conclusions

The supporting of engineering processes with the help of solutions from other areas of knowledge [15] finds its own reflection in the development of various systems, in which the motivation is some idea, e.g. the improvement of the maintenance of the technological park, an the motivation are highly specialized programs. As it has been shown, within the area of cataloguing information on the special materials treatment, due to the specificity of this area, there is some kind of gap of information. There are no complete processes supporting engineers with the choice of a specific process of in the strictly defined treatment process. However, it has been shown, that the building of such an integrated system is possible. DBSMP enables the operating on the various areas of knowledge, in a far broader context than single systems of supporting production used in factories.

It has to be underline that DBSMP has been designed in such a way as to enable the cataloguing of much greater amount of information than it is considered by its current implementation. Taking into consideration the possibility of storing the values of parameters in the time context, I is possible to use it for educational as well as experiment purposes, e.g. in the R&D departments.

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