

Development of a Knowledge System for Data Management of the Pre-Production Stages

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Abstract – Preparation of projects introducing new production takes into account all aspects related to development and technical preparation of production, production of prototypes, familiarization with production, processing marketing sales support, as well as preparation of service support. PLM systems represent the tools for automating engineering activities in the product life cycle. These solutions are based on the idea of a close cooperation between individual areas involved in the final product, from its design to the end of its technical life. Collecting a large amount of data and information about the product under observation is typical for this kind of activity. PLM integrates the areas of computer aid, database and information systems, and computer networks. This article points to the creation of a knowledge-based application environment for data management of a small business with a description of its functions and possibilities of use.

Keywords – application environment, knowledge system, pre-production stages, product life cycle management, process documentation, PTC Creo Parametric.

1. Introduction

The development and design stage, that conceives of the shape, design and overall structure of the product, design documentation including, significantly impacts the total costs and therefore the price of the product. [1], [2], [3]

In the 1980s, a massive introduction of CA systems (computer-aided systems) proved to be an effective step in reducing costs, shortening the TPP (technical preparation of production) and increasing the efficiency of TPP stages [4]. The engineering calculations, analyses, modeling and design documentation became streamlined and accelerated [5]. Presently, there is pressure to design projects and use elements and project management methodologies which would enable planning and management of all processes and stages related to launching new products on the market and significantly reduce the duration of TPP stages [6], [7]. Customer requirements of reducing development stages, minimizing costs, and increasing product quality put pressure on shortening the product innovation cycle [8], [9]. Meeting the requirements to shorten the overall product cycle, from design to delivery to the customer at the lowest production costs, is the most important prerequisite for success of a company [10], [11].

From the CA tool application point of view, the generation of Process Documentation has recently gained traction in the field of computer aided production [12], [13]. It is a progressive form of automated generation of simplified technology documentation and is primarily designated to be used in NC machining. This option has emerged from the requirement to speed up the production of technology documentation when deploying complex CAD/CAM/CAE systems. It can be said that by nowadays, all important players in CAD/CAM systems have incorporated this functionality into their products [14]. However, it should be noted that this documentation is often simplified, has the form of reports generated automatically on the basis of predefined parameters when creating specific machining cycles [15], [16].

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The article describes the design of the application environment of the system for managing data from the process documentation generated by the software as well as other important information of the manufacturing company. The primary goal of the software application designed for small business needs is to design and create data environment that integrates the CAD/CAM/CAE outputs of the PTC Creo Parametric system into the process documentation with a database applicable to the final technological documentation.

2. Determining the Structure for Creating an Application

The main task before the creation of the application is to determine the basic requirements of the application with regard to the selection of the appropriate input data necessary for specifying the solved task (Figure 1).

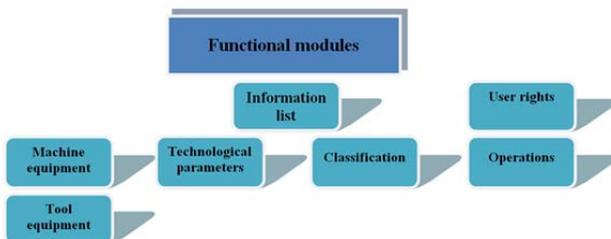


Figure 1. Block diagram design of the application

On the basis of the input data, individual information blocks were designed according to a hierarchically defined sequence:

- Information list; including basic component information, 3D graphic and image illustrations of the component supplemented with a text and drawing documentation. The information list also offers a vector graphics editor for quickly adding design drawings in the form of a sketch of comments with the printing option, and a versatile parametric 3D CAD modeling system for better presentation and visual representation of the 3D model.
- Machine equipment; containing basic information on machine equipment with a graphic interpretation accompanied by technical documentation and details, such as: name of machine/measuring instrument.
- Tool equipment; containing basic tooling information with the images of the tools accompanied by the technical documentation. The basic information on used tools include tool number, tool name, tool type, tool standard, tool size, tool material, tool timing, number of tools and note.

- Technological parameters; including the calculation of the basic required values for input to the CAM system when creating a NC program with the option of additional external applications for calculating cutting parameters, mathematical functions and the option of viewing the machine tables.
- Classification; containing the sorter of components according to the classification code, consisting of assigning a numerical code according to a classified degree of component features.
- Operations; a list of process documentation operations sorted by the sequence and the tool used with the name, graphical display of generated toolpaths for the given operation, operation number, type of operation, machining allowance, rotation frequency, offset, material shedding, feed rate and others selected for generating in PTC Creo Parametric.
- User rights; a list of users with specified rights for recording, editing, deleting data, and the general administration rights of all users working in the application environment.

3. Description of the Created Application Environment

Purpose and use of the proposed system for the process documentation management:

- fast data storage in one place to facilitate communication and collaboration between workplaces and workers,
- modification management and data archiving in the database,
- inserting, viewing, and editing the added data in the database (assignment of a particular tool from an internal tool database found in the inventory file of the company information system),
- assignment of a specific workplace where specific technological operations are carried out,
- sorting data in tables and encoding components,
- creation of automatically generated reports in the form of printouts,
- sharing messages and distributing important information.

After signing into the app, a tab list is available. The first tab offered is called *Datasheet* (Figure 2). The Basic Database Datasheet with the main data clearly provides more information about added records such as *Component Name*, *Component Shape*, *Weight*, *Material*, *Semi Finish*, *Length*, *Drawing Author*, *Date of Adding*, and *Note*. All of these data can be edited at any time via the available editing buttons.

Additional records can be specified by created files for checking, changing, creating a note or possibly modifying the geometry and setting during the stage of component and assembly sets creation of the respective programs:

- drawing documentation in *.pdf format by opening Adobe Acrobat Reader and Inkscape vector graphics editor,
- drawing documentation in *.drw format of the PTC Creo,
- a 3D model in the *.prt format of the PTC Creo software,
- a 3D model in the *.stp format with the FreeCAD 3D modeling CAD system,
- technical documentation with a more detailed technical description of the *.doc and *.pdf file (MS Office, Adobe Acrobat Reader),
- a *.asm machining program in the PTC Creo CAM environment,
- process documentation generated on the basis of templates created in the PTC Creo complex CAD/CAM/CAE environment in *.html format.

Once a record has been saved, the record will be displayed in the base table environment with all the entered data, searchable based on the criteria you entered, and a combination of them in the *Search*, *Author*, *Date of addition* editing rows. Data added to the files will be made available for opening them in the appropriate programs associated with the software and applications for their correct opening. Open documents can be edited as needed, and then replaced with a note of their editing.

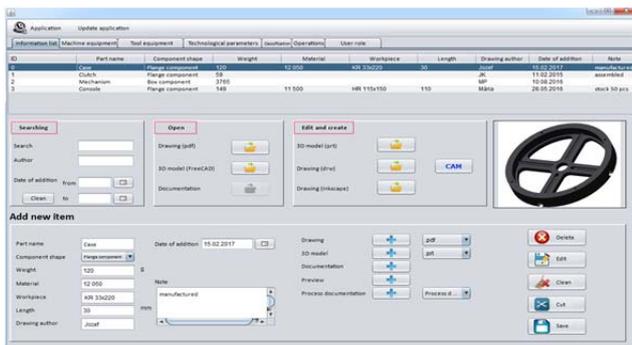


Figure 2. Information list tab

The second tab named *Machine equipment* (Figure 3) provides information about machine operation equipment. It consists of basic information such as *Machine/Gauge Name*, *Machine Type*, *Control System*, *Production Technology Type*, *Date of Manufacture*, *Machine Size*, *Number of Machines*, and *Note*. As in the first tab, it is possible to edit and delete all of these data, or save new records with the option of adding visual preview records in the form of previews and technical documentation in *.doc and *.pdf. The added records can be filtered to

quickly and easily search for the desired record from the database equipment table by correctly typing it in the *Search* row or specifying the search entry by providing the *Production date*.

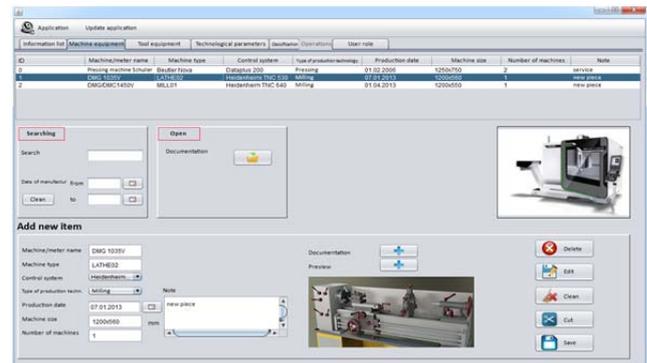


Figure 3. Machine equipment tab

The third *Tool Equipment* tab (Figure 4), similar to the previous machine features tab, contains the option to add records such as *Tool Number*, *Tool Name*, *Tool Type*, *Tool Norm*, *Tool Size*, *Tool Material*, *Tool Timing*, *Number of Tools*, and *Note*. It also offers basic search of saved records from the tool table database and addition of a picture preview of a particular tool with the attached technical documentation in the *.pdf format.

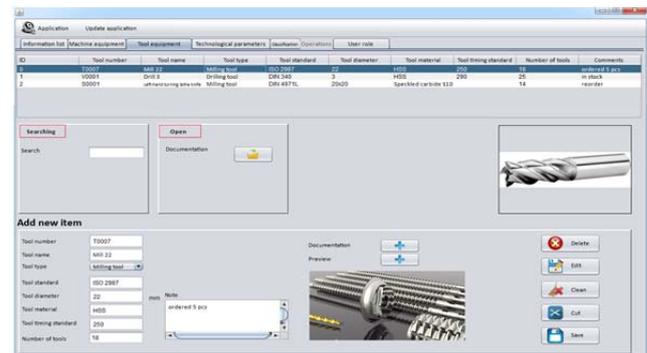


Figure 4. Tool equipment tab

The fourth tab called *Technological Parameters* (Figure 5) serves for the additional calculation of the basic cutting parameters needed for completing writing during NC program creation in the PTC Creo Parametric environment. Based on input values, the application can calculate the speed, feed rate, material shedding and performance values. If you need to calculate additional values, there is an external application that is selected by the *Calculation of Cutting Parameters* button (Walter Machining Calculator) or for calculating mathematical functions and additional mathematical calculations, the external calculator application can be executed using the *Calculator* button as well as the possibility of viewing the machine tables (the *Machine tables* button) or a quick search via an Internet browser (*Google* Button).

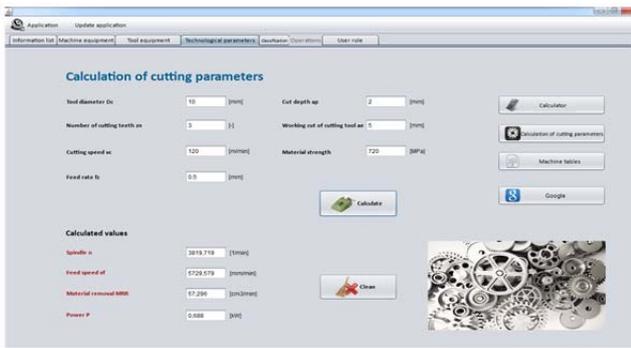


Figure 5. Technological parameters tab

The *Classification* tab provides quick searching for specific components by entering the relevant component code. The classification code (Figure 6) is obtained by determining the basic features of the component, which are correspondingly classified according to the shape of the component (rotary, flange, box), material (grade 11, 12, 13 and 14 steel), max. length (0-20 mm, 20-50 mm, 50-80 mm, 80-110 mm, 110-140 mm) and the weight of the component (0-200 g, 200-500 g, 500-800 g, 800-1200 g, 1200-1500 g).

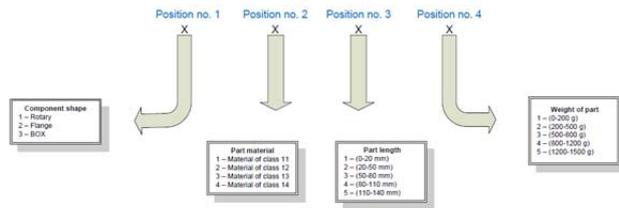


Figure 6. Schema of a proposed classification code

After the correct code entry and the start of sorting, a specific table entry is found and the options for opening a drawing in *.pdf format, a 3D model in *.prt format in the PTC Creo Parametric environment, documentation in *.pdf or *.doc format and complete process documentation in *.html format are made available, if the data were inserted in the application environment (Figure 7). It is also possible to quickly send an e-mail message for eventual consultation of deficiencies in the created ground for quick correction and change of parameters in the production.

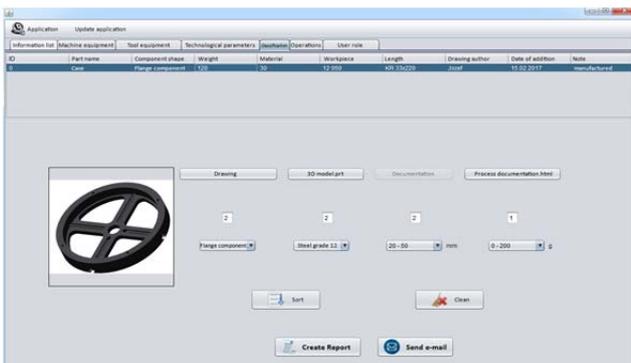


Figure 7. Classification tab

You can use the *Create Report* button to generate the printout automatically in the *Classification* tab environment. The generated printout contains basic information about the component automatically retrieved from the data table (Figure 8). The section is supplemented by a visual representation in the form of an overview, a process documentation in the form of a table listing all the basic data entered during the creation of the CAM program in the PTC Creo Parametric environment, obtained by rapid generation through predefined templates, and also complemented by a technical drawings of the component.

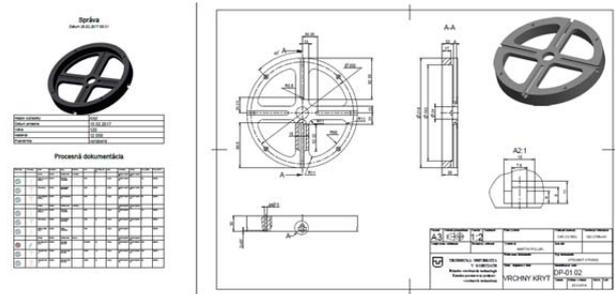


Figure 8. Preview of a generated report

The *Operations* tab (Figure 9), which is available when selecting a record from the datasheet database table or by entering the correct component code entry in the *Classification* tab, contains the saved process documentation converted from the *.html format into the created spreadsheets. The tab presents the summary process documentation generated in a complex CAD/CAM/CAE system with complete data on each production operation, including important machining parameters, graphical representation of tool paths, and a complete tooltip displayed directly in the application environment for quick view.

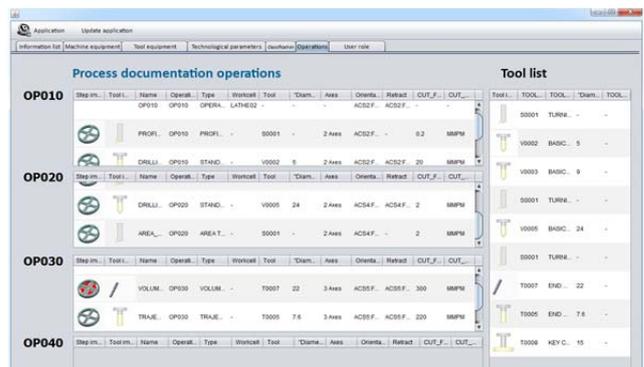


Figure 9. Operations tab

The *User Role* tab (Figure 10) contains user data, their numbers and rights assigned to them, with the ability to add new users to administrators (full rights users), delete and modify user rights for data management, and protect them from potential misuse, damage or unwanted deletion.

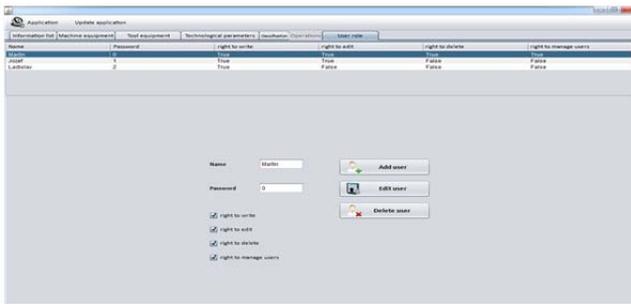


Figure 10. User role tab

4. Conclusion

The aim of the work was to create a knowledge system for the field of technological preparation of production, to manage and archive created documentation and data obtained directly from the complex CAD/CAM/CAE system PTC Creo Parametric. PTC Creo Parametric is a complex system offering professional drafting of design in the field of construction and technological works. It is also a suitable tool for creating templates and generating process documentation. After completing the outputs generated and processing them, a system was developed in the form of an application environment of the database system to create a base for data with a data base. The created system is used to archive and manage data generated by creation within the PTC Creo Parametric environment, supplemented by a number of additional information and data on collected items.

By fulfilling the specified requirements and then putting the created application environment into real production, the following major changes were observed:

- improving the quality of communication between workplaces,
- elimination of misunderstandings arising from inadequate communication between the staff of the individual workplaces,
- clarity in the description of additional information on produced products, tools and equipment,
- improving the quality of archiving and data management,
- increasing the overview of the company's machinery and equipment,
- introducing a component sorting for their quick specification,
- securing unauthorized person access to the database of important documents defined by user rights and administering the application by the authorized person (administrator),

- introducing the creation of automatically generated reports in the form of information printouts,
- time saving owing to rapid data updates directly in the application environment for timely adjustment of production parameters, possible change or rapid intervention in the production process to ensure trouble-free operation,
- improving the accuracy and efficiency of producing quality components.

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