AUTOMATIZATION PROCESS OF DESIGNING THE TECHNOLOGICAL DOCUMENTATION BY TOOLS OF COMPREHENSIVE CAD-CAM-CAE SYSTEM

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The article describes an automated production of process documentation in an environment of PTC Creo 3.0. Process documentation is a simplified form of technological documentation, which is directly generated in the environment of comprehensive CAD-CAM-CAE system. Creation of process documentation is based on design of the templates that contain all the necessary information to ensure a smooth production process by production operators. Generating takes place on the inputs received from the proposal of NC machining program. The main advantage of the creation of process documentation is its fast processing, the possibility of additional editing, archiving, graphical representation of machining sequences and tools for generating at any moment during working time. The result of the creation is generated process documentation, which represents a complete supporting documentation. Generated process documentation with the created NC program provides required information for CNC machine operators to ensure the smooth process of machining parts.

KEYWORDS

automated processing, NC program, process documentation, generation

1 INTRODUCTION

Automation of machine production is the basis, which addresses the need for intensification of production and flexible responding to customer requirements. Time to realize the components, except for the actual technological process, includes all activities of non-production departments (preparatory works) and the whole issue of research, development, design, design of technology, including supply of materials, tools, gauges, jigs, production facilities, up to the moment of opening of own production. Automation and computer aided is therefore necessary to focus not only on the technological process itself, but also on the preparatory works, which is time-consuming in terms of overall structure time [Kuric 2002].

Computer aided engineering activities in pre-production stages aims to ease the burden of man from routine jobs done during the technical preparation of production. Technical preparation of production is understood as a set of activities and measures of technical and organizational character, aimed at processing design and development engineering, project documentation and material and technological organization of production processes.

Software is very important in the field of process control. Although this type of computer systems is not as popular and widespread as administrative systems and support systems design (CAD) and manufacturing (CAM), their importance is great and forms part of the implementation of comprehensive automation in engineering company. Considering that they are systems which directly control production processes and are dominant for the engineering firm, they are an important part of implementing of information technology in the company. In addition to controlling variables the computer systems are to monitor and diagnose the technological processes. They are used by the production operators but created data are also useful for top managers in the company [Kuric 2002].

The article points to the creation of process documentation in an environment of PTC Creo 3.0. The aim of creation is the elimination of lengthy processes during the step of technological preparation of production, using a simple and fast generation of process documentation directly in that system.

2 AUTOMATION IN PROCESS PLANNING

Technological preparation of production in machinery companies is one of the toughest and most time consuming stages in the preparation phase of the production process. As well as during the design of components, even during the design of production technology can consistent application bring, by means of computer technology, a qualitative turning point, consisting of automation engineering and technical activities in the removal routine, monotonous and physically strenuous activity. Analysis of the work in technical production in terms of intellectual activities of engineering and technical staff revealed that there is a large number of routine activities, for example the calculations, searching, grouping and sorting the data. They are realized on the basis of known and clearly defined algorithms. The decision-making processes of those algorithms are often repeated due to their similarities. Technologist, during designing of the technological process, is processing large amounts of information that draws on workshop drawings and specific conditions of production. Processing of this information package is based on "know-how" of manufacturing company and on known technological rules and laws derived by exact methods and many years of practice. The results of their decision process are adjusted to a certain sequence of commands, which should guarantee the most economic method of producing parts under the given conditions [Kuric 2002].

The procedures developed in manual way do not have to be optimal. It is also possible that for a given component with identical production conditions will be proposed different technological solutions on how to proceed in the production of parts. There is a problem in determining the technique which will be more effective in order to produce the component at the lowest possible cost. Due to the disadvantages of an individual and manual approach in creation of technological processes it requires a computer to support and optimize these activities. Computer support in the form of various systems allows the great acceleration of the design process, objective and flexible response to changing customer requirements, as well as changing conditions in production.

The information contained in the technological process can be divided into:

- the identification data: number of technological process, drawing number,
- the production data: number of pieces in production batch, marking of the center designated for the production of

parts, number of production orders, number of material warehouse,

- the material information: designation of material quality, consumption amount of material per component, total amount of consumed material, initial state of the material,
- the operational data: number of operations, marking of the work, marking of the workplace, type of machine, tools, jigs, gauges, brief description of the operation, number of operational instruction cards, batch time, unit time, tariff class, total time on benefit, total cost of the operation.

2.1 *Complex automation*

Complex automation is not only an automation of manufacturing processes, but all production operations which occur in the company. It means that the focus is in addition to the actual production also to pre-production stage, during which the design and technological documentation is being developed. Emphasis is also placed on the post-production stages and on all planning and management activities that are directly and indirectly related to the actual implementation of products in the company. Complex automation leads to the overall increase of efficiency in all phases of the business. Its importance lies in multiplication of the effect of the various automated subsystems that can behave autonomously, but their meaning in the common cooperation is at a higher quality level. The term complex automation means an automation of the complete manufacturing enterprise, from incoming goods through its own production process in response to automated technical production [Kuric 2002].

The importance and efficiency of CA systems in the enterprise is increasing, if the computer systems are data-integrated with each other and by sharing data it creates integrated higher units. It is preferred that among automated systems are also systems such as a storage, inter-operative handling, transport, production control, measurement and diagnosis. Mutual integration of various computerized systems together with the CA system creates a company with a high degree of flexibility.

CA systems in the current company are an indispensable tool for staff from all areas of the company. Most often it is possible to meet them in pre-production stages in the development, product design, planning and organizational activities.

Presently there are CA applications that solve a complex area of development, design and production parts. Their efficiency is greatly increased if they form integrated units with the possibility of sharing information in different databases.

The terms “integrated production” and more recently “integrated engineering” are often used in connection with the integrated system. Integrated engineering is a methodological tool that allows various stages of development and design to be realized either in parallel, respectively, with the possibility of a direct linkage. Creating an opportunities directly in the early stages of development and design to take into account later stages, such as production, assembly, etc. Integrated CA systems are a prerequisite for successful application of the methodology of integrated engineering.

One of the major trends in the CA systems it is their integration. The computer-integrated manufacturing must be automated and computer aided in all its components, i.e. through the development, design, technology and ending with the manufacture, assembly, inspection and dispatch. The concept of computer integrated manufacturing (CIM) is based on the integration of CA systems with the integration of automation systems in the enterprise. CIM creation proved after the initial bold plans as a very difficult problem, which needs to address a variety of problems.

2.2 *Integration of computer support to technological design process*

At the time of the availability of computers, many businesses, mostly by their own capacities, began to create a variety of software products, which were most often intended only to one part of the design of technological processes (such as calculation of cutting parameters). Until later, there were created the software solutions that solved the technological design process more widely - from editing of technological documentation, to the computations, searching, archiving, and various analyzes (e.g. tolerance analysis in the selection of clamping). Presently, the CAPP systems are software products that solve an area of the design of technological documentation as a complex. They are often integrated with CAD, CAM, CAQ and PPS systems.

The main advantages of computer aided technological design process include:

- higher productivity of technologists,
- rationalization of technological documentation design,
- greater readability of technological documentation,
- standardization of technological documentation,
- objectification of technological process,
- technological documentation can be optimized,
- shortening of the times required to create the technological documentation,
- start-up time of production is reduced,
- possibility of integration with other application programs and systems,
- greater flexibility for changing the production assortment,
- greater flexibility for changing the customer requirements.

3 INNOVATIONS IN PTC CREO 3.0 SYSTEM DEVELOPMENT

The Creo 3.0 is a 3D parametric design system from PTC. It provides a wide range of powerful and flexible capabilities that help to solve many challenging construction tasks. The program uses proven technology to increase productivity in the design process. The new version of Creo 3.0 allows for users to unite and work with data from any CAD system doing so by the introduction of new technology Unite. Unite greatly improves the ability to use CAD files directly from other systems in the environment of Creo 3.0. Creo 3.0 also enables the creation of innovation through stronger and better integrated tools required to design the product. These improvements in productivity offer the opportunity to focus on a higher degree of innovation and quality of its products. Unite is focused on data and challenges associated with the consolidation process CAD. This means that the designer can convert the data that need to be modified whenever it is necessary, which saves a large amount of effort and expense. In situations in which the development teams need to collaborate by using a variety of CAD formats, technology Unite allows designers to create and protect design intent between data in Creo 3.0, and other CAD systems ensuring design integrity, which allows faster and thus more effective cooperation in the design process. This has an impact on reducing the time required for delivery, quality and attractiveness of the product and allows the design team to spend more time on innovation and less time on unproductive tasks such as repetitive geometry creation and management of excessive files [Wertel 2014, Needham 2014].

The most significant improvements in the environment of Creo 3.0 [Wendenburg 2015]:

- unparalleled multi-CAD data handling capabilities,
- new and improved modelling capabilities,
- enhanced graphic performance and quality,
- drive Freestyle geometry parametrically,
- create sheet metal geometry using new functionality to automatically apply bend relief, create sheet metal rips, bend coplanar, geometry, and simplify die form and flat pattern creation,
- intuitive reference editing,
- extensive hardware libraries,
- PTC MathCAD integration,
- integrated learning tools,
- powerful analysis and diagnostic tools.

4 AUTOMATED CREATION OF PROCESS DOCUMENTATION IN THE SYSTEM PTC CREO 3.0

Before the production of technical parts there are many activities in which it is necessary to submit a faultless technical documentation based on which the product will be manufactured. In the NC machining a technological documentation is based on the principle of a simplified process flow in the form of process documentation. There are already a lot of complex CAD-CAM-CAE systems that offer the possibility to use module for the automated generation of process documentation.

The workshop documentation (Shop Floor Documentation) represents a progressive form of automated generation of simplified technical documentation and is primarily intended for NC machining area. This option resulted from the requirements of the accelerated creation of technological documentation for the deployment of comprehensive CAD-CAM-CAE systems.

It can be said that until this day, all the important players in the field of CAD/CAM systems, incorporated this capability into their products. But it must be noted that this documentation is simplified into the form of automatically generated reports based on pre-specified parameters when creating specific machining cycles. The availability of information about these modules is relatively small and it is mostly only possible to find a brief mention in the information brochures. The reason is that this documentation is still relatively new and underdeveloped component of these systems [Kocisko 2012].

Among the reported benefits of using process documentation include:

- process documentation is a cohesive organized form of necessary data which simplifies the communication between designers, production engineers and operators of NC machines,
- automation of generating the technological documentation eliminates the need for manually creating some consumer records, despite the use of CAx systems,
- outputs of these modules can be also used for archiving and maintaining the internal records which facilitates the creation of management productivity analysis,
- it allows fast positioning of process documentation on the internet because the output is directly in HTML format, which will improve the workers communication with other departments,
- process documentation can be used in the training of new operators to provide data on the current project.

The Creo 3.0 has this option available under the tab Application/Process Documentation. Automated generation is suitable for fast creation of workshop documentation, and its great advantage is the ability to archive in digital form HTML. Thus generated documentation is possible at any moment to be customized, defined and used as a simplified form of representation of technological process. The Creo 3.0 provides two options for the creation of process documentation using predefined templates. The offered templates are Process Documentation Defaults and Process Manager Defaults (Fig. 1).

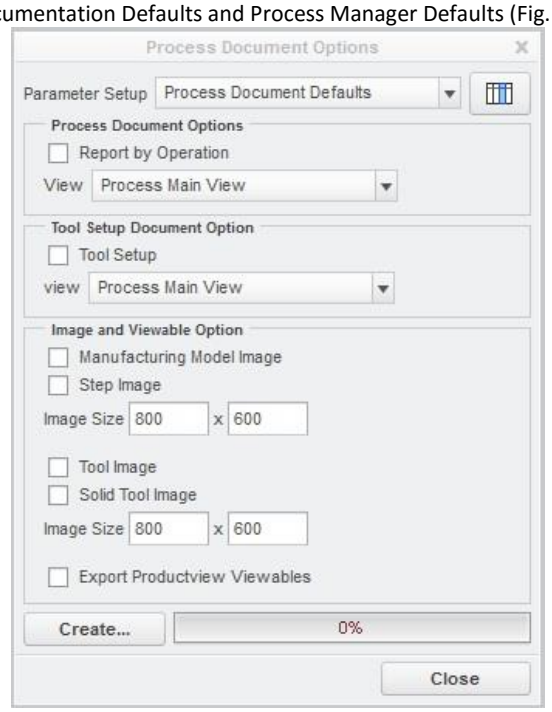

Figure 1. The environment of creation the process documentation

By selecting a template generation via Process Document Defaults are looking at a Report by operation choice of two types of display as follows: Process Main View and Tool View. The first type Process Main View contains a list of names of operations and type of operations.

In the second type Tool View (Fig. 2) is located a system preset list of tools and items such as:

- Name (tool name),
- Tool_ID (tool identification number),
- Tool_Type,
- Cutter_Diam,
- Tool_Comment.

Process (All Operations)

Name	TOOL_ID	TOOL_TYPE	CUTTER_DIAM	TOOL_COMMENT
FSETP0	-	-	-	
OP010	-	-	-	
ROUGHING_1	T0001	END MILL	10	-
FINISHING_1	T0002	END MILL	6	-
TRAJECTORY_1	T0002	END MILL	6	-
ROUGHING_2	T0003	BALL MILL	8	-
VOLUME_1	T0004	END MILL	8	-
VOLUME_2	T0003	BALL MILL	8	-
FSETP1	-	-	-	
OP020	-	-	-	
ROUGHING	MILLING_CUTTER10	END MILL	10	-
FINISHING	T0002	END MILL	6	-
DRILLING_1	DRILLING_TOOL6	DRILLING	6	-
FSETP2	-	-	-	
OP030	-	-	-	
DRILLING_2	DRILLING_TOOL6	DRILLING	6	-

Figure 2. Process documentation from the perspective of Tool View

Documentation generation content can be changed in accordance with the necessary data for production. The

auxiliary window Process View Builder (Fig. 3) is divided into two parts that are Not displayed and Displayed (not shown and displayed items) which determines the content of process documentation data. By gradually adding of items using the tool inserted, the user sets the appearance of process documentation. The selected data can then be sorted in the selected order of Displayed. In order to avoid of repeated and lengthy selection, the list of items can be saved separately.

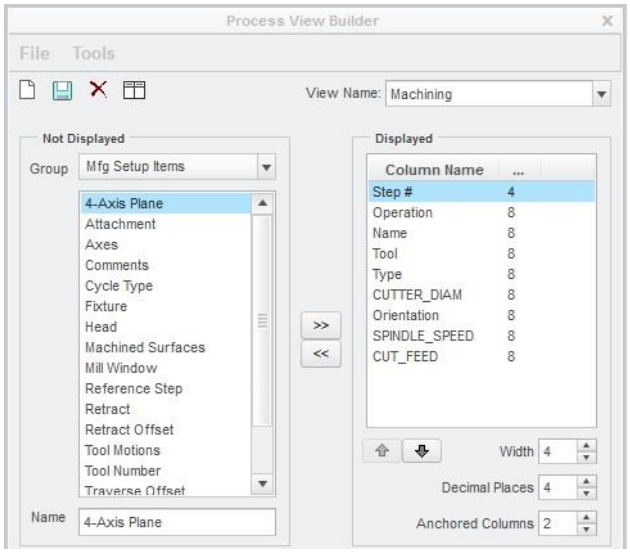

Figure 3. Process View Builder

In addition, there is also a possibility to adjust the width of column entitled Width, when calculating the number of decimal places in numerical values is option to set Decimal Places and distribution order of the required data (items) in Anchored Columns.

After editing the appearance of the template settings are saved. Before the start of generation it is necessary to be able to select the desired look of generated process documentation. Process documentation may have a look as simple text or can be supplemented by graphic illustrations of operations and tools.

After checking a field Manufacturing Model Image, Step Image, eventually Tool and Solid Tool Image the choice in the generated documentation process reflected in the representations of the graphic representation of the machined areas, and also a graphic illustration of the use of tools. By the icon Create is launches the generation process (Fig. 4), whose duration depends on the intensity and complexity of machined parts. The process can be viewed in a graphical form of tool path simulation, as determined by the sequence of set operations and machining sequence with a percentage to evaluate the success of the current generation process.

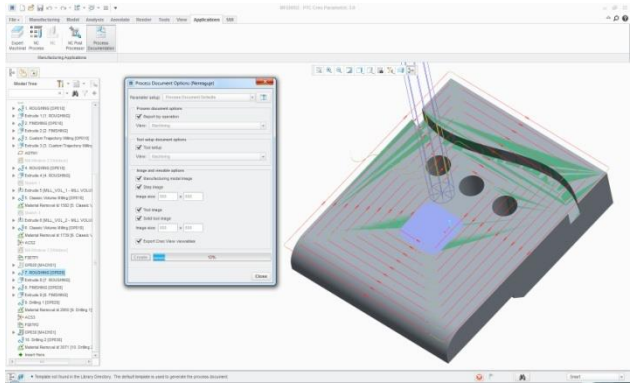

Figure 4. The process of generating the process documentation

After finishing the video demonstration, the system generates process documentation in HTML format. In Fig. 5 is shown the second operation and its sections.

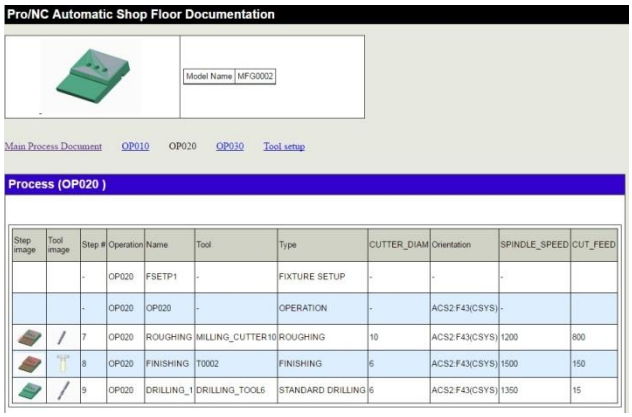

Figure 5. Process documentation generated in the system Creo 3.0

By choosing of determined sequence of machining through graphical interpretation, the system displays more detailed magnified picture presenting view of the machining areas with exact specifications of set machining operation (Fig. 6) as well as information about the tool with which a given area is machined (Fig. 7).

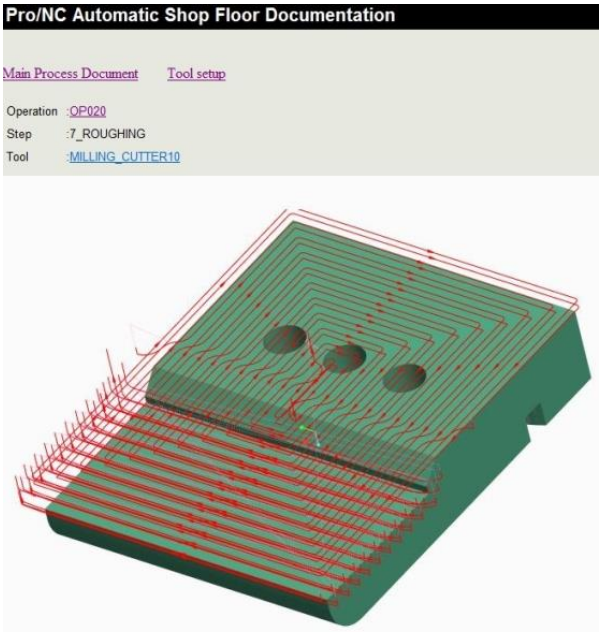

Figure 6. Detailed view of the model according to the specified frequency of machining

In the system Creo 3.0 it is not possible in the generation of process documentation to change the look or format of documentation, which is the only disadvantage in the generating process. But generated values in the table can be changed.

Process documentation is an excellent solution for trouble free communication between technologists and operators of NC machines, which currently replaces traditional hand-technological methods. The reason is mainly the speed and practicality of generating the process documentation.

Figure 7. Detailed view of the cutting tool according to the specified frequency of machining

5 CONCLUSION

At the present day, every top management is looking for reserves in all aspects of the enterprise, which would allow achieving of favourable indicators of production. An important place among information technology is computer aided systems - CA systems. They are mainly applied in the development and design of new products, calculations and analyzes in the design manufacturing, production planning and quality management. They occur at all levels of management - from workshops to senior management. CA systems are either in the form of simple support tools or they create complex software products solving a certain specific area of the engineering company. The use of different computer systems has resulted in digital information processing with clearly articulated structure information.

Manufacturers are trying to find the answer in the following areas:

- new design and tool materials,
- new progressive technologies,
- automation of machine production,
- rationalization and computer aided engineering,
- implementing information technology,
- modern forms of planning, management and organization of production.

For the production process is NC program sufficient, but it cannot be seen as a full technological process. One reason is that the CNC machine operator documentation does not provide sufficient information necessary to ensure the smooth machining parts. NC program does not provide information about the used material, used tools, selected speed, feed rate and the like. This required information needed for machine operators was necessary to incorporate into additional technological advances together with the generated NC programs through CAPP systems or manual way, without actually archiving and re straining of already established technological documentation.

In recent years, it comes on the market to automate the process of creating process documentation directly in the environment of CAD/CAM systems through the possibility of generated documentation from the draft of NC program. The advantage of the creation of process documentation in the system Creo 3.0 is the ability to modify the display parameters, attending a graphical representation of machining operations and tools. On the other hand, the major disadvantage is changing the look and shape of the generated documentation.

The generated documentation is simplified technological process that consists of defining custom template with the parameters according to the user's choice. Process documentation is completed with graphical representation of operations, tools with the possibility of archiving in HTML format.

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