Computer aided preparation of technological equipment manufacturing using CAD/CAM systems

Komputerowo wspomagane przygotowanie wykonania oprzyrządowania technologicznego z wykorzystaniem systemów CAD/CAM

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Article presents the possibility of using modern CAD/CAM systems for computer-integrated development processes of design, construction and manufacture of technological equipment used in quality control process. In the presented case CNC machines were used. Described the example of manufacturing preparation of fixturing system for CMM, using NX system.
KEYWORDS: computer aided production preparation, CAD/CAM systems

Contemporary manufacturing processes are increasingly being implemented using advanced computer techniques [2, 3]. As a result, CAD and CAD/CAM systems have become increasingly popular in the engineering industry, which have revolutionized both the product design phase and the computer-aided manufacturing [4, 5]. An integral part of this complex process is the stage of technological preparation of the production of products (selection of machine tools, development of individual machining operations, selection of tools and machining parameters, design and execution of machining equipment, etc.) and computer-aided quality control, increasingly implemented using coordinate measuring techniques (preparation of measuring programs, design and manufacture of control equipment, etc.).

Also CAD/CAM systems are used for the design and production (as part of technological production preparation) of various types of handles and machining and control devices.

Process of designing the necessary technological tooling involves both the design stage and the technological preparation of machining on numerically controlled machines. The general principles of a computer-based designer are not fundamentally different from those of computer-aided engineering. In both cases, the engineer follows the same design algorithm. By using the technology documentation and the catalog of standardized components in the form of computer databases, it implements the project, develops the documentation and performs the necessary calculations. Undoubtedly, however, the quality of work is changing, as a computer-based designer has a number of tools that increase design capabilities and allow for a significant reduction in project development time.

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Creating a 3D assembly of tooling using libraries of design and normalized components allows you to study the kinematic capabilities of the tooling based on the simulation of the designed handles in their workflow. In these systems, it is also possible to quickly prepare flat documentation (2D) of the proposed tooling or its selected components (executive drawings). The last stage of the work done in the CAD/CAM system is usually to develop a process of making parts of the handle and to simulate the machining process, allowing for correction of errors and generate and output the control code to the selected numerical control machine tool.

An example of such an approach to the preparation of the design and construction of the technological tooling is the process of preparing the production of the inspection handle used for measuring the body on the coordinate measuring machine [1]. The NX system was used to support virtually all stages of computer-integrated production preparation [6].

Development of the handle construction

According to the assumption, the handle design was to provide a comfortable, fast and stable fixing of the part during the measurements on the coordinate measuring machine, thus ensuring repeatability and accuracy of the measurements and reducing their time. Computer-assisted development of the handle structure was accomplished using NX system design modules.

The starting point for the design work load of the project was designed for the measurement of detail and spatial orientation it coordinates the available desktop environment (fig. 1).

The initial stage of design work is a preliminary sketch of the most important elements of the projected handle. The program automatically gives it dimensions. An example of the possibility of creating this type of construction is to design an object retainer in a measuring holder to provide a suitable shape for the surface of the measured part. During the shaping surface of the positioning use of the possibility subtracting the volume of the measured volume of the pre-designed shape of the base (fig. 2).

After performing the subtraction operations and removing unnecessary volumes, the shape of the retaining surface must be formed so that the measured element is correctly fixed in the holder, without the risk of so-called. stopping, that is, repeatedly picking up the element of the same degree of freedom. Removal of unnecessary protruding elements of the retaining surface

is removed. The length is also shortened to ensure proper contact with the surface of the part to be measured.
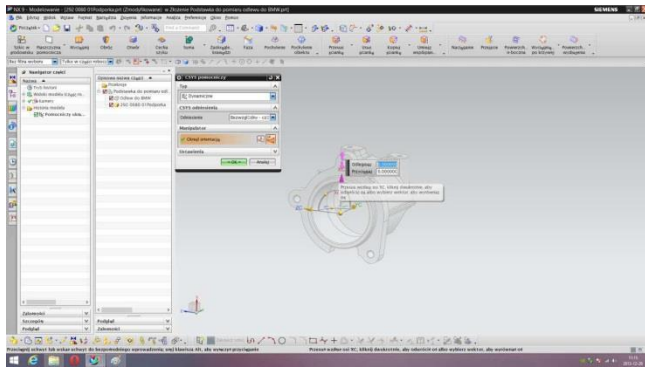

Fig. 1. Loading the design of the measured part and orienting it in the coordinate system of the graphical environment
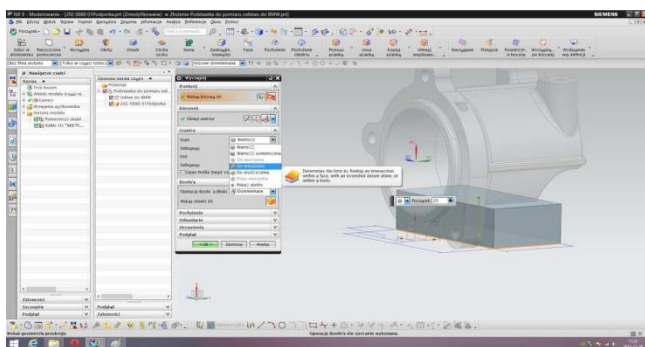

Fig. 2. Subtracting the volume of the measured element from the shape of the design retainer

The design of the technology grips requires the correct design not only of the surfaces and fixing elements and of possible abutment and support surfaces but also of the fastening elements during the technological operation. In the realization of the handle, a clamping element is provided in the form of a clamping ring which allows the clamping screw to be fastened in the grip.

The construction phase ends when the environment is created deposit will be made all designed components, and non-normalized non-unified and standard elements are loaded from the database of available standard parts of the drawings. Linking them in a functional whole can obtain a three-dimensional assembly drawing of the project holder (fig. 3).
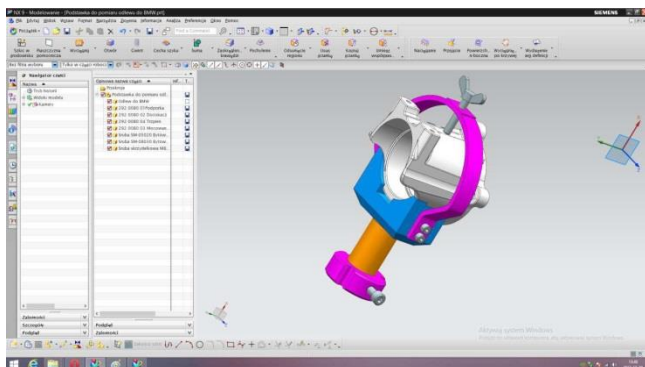

Fig. 3. Complete handle design

Updating the previously used 2D documentation generally took a long time. Every change in the project has to be implemented on several projections, and often also on several auxiliary sections and views. It is very easy to make a mistake and overlook a change on some part of the documentation – as a result, made darts and crossings do not fit together. Typically, the design of parts and assemblies in the classical 2D method excludes even the simplest kinematic or strength analysis. Preparing the assembly drawing in a 3D environment allows to check the correct operation of the handle even at the design stage – in a virtual environment, including attempts to correct the introduction of the object to the handle. If necessary, the strength calculations of the selected handle elements are also performed at this stage. In the presented project, these calculations were abandoned due to the negligible amount of forces occurring during the measurement on the coordinate measuring machine.

Preparation of construction documentation

Increasingly common parts modeling systems in 3D space clearly simplifies and accelerates the preparation of design documentation of the proposed tooling. Three-dimensional modeling eliminates the need for subsequent projections and views of the element, since all two-dimensional documentation is produced almost automatically on the basis of a solid model. The designer only retains the appropriate views and cross sections to generate. Also, in the case of solid models, changing the geometry of the model does not entail the need to modify two-dimensional drawing views as the program updates them every time the underlying geometry is changed. After converting a 3D image into 2D documentation, 2D printouts are possible.

Based on the three-dimensional model of the handle, a classic two-dimensional structural design was generated, including flat projections, views and cross sections. It was used to prepare the assembly documentation of the projected handle and workpiece drawings of its individual parts, including the complete dimensional data needed for the grip and subsequent quality control (fig. 4).
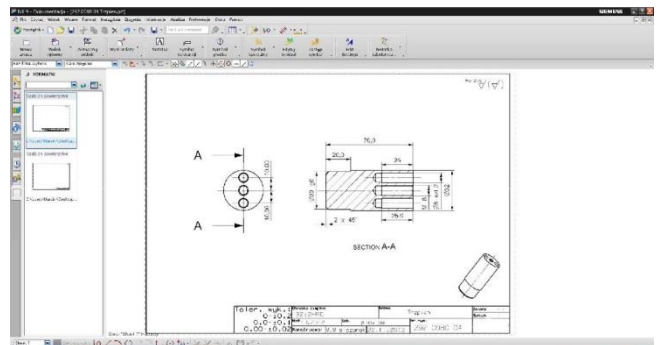

Fig. 4. Loading an exemplary three-dimensional handle and generated working drawing

Technological preparation of the handle elements

The item to be loaded into the CAD module must be correctly positioned to carry out the planned turning operation. On the selected surface (usually the front of the material) a working coordinate system is defined. At this stage, the previously designed blank shall be designed or loaded. Once done, you can move to the computer assisted processing stage of the handle element of the CAM module of the program. The software allows to choose (from the implemented program database) cutting tools for each machining

operations and cutting parameters. An exemplary selection of the tool to carry out the coarse surface roughing of the handle and the selection of the operating parameters and the generated tool paths are shown in fig. 5.
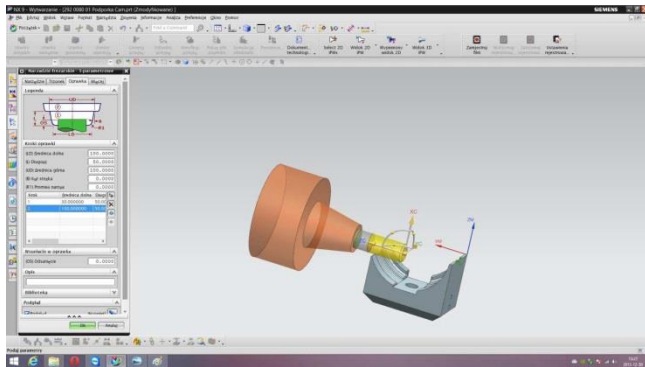

Fig. 5. Implementation of coarse milling

The last step of working with the CAD/CAM system is usually to simulate the machining process. The program's graphics allow you to visualize the machining process using a three-dimensional model of the machine tool. 3D simulation allows you to check the machining for the correct workmanship and to detect possible collisions on the machine. This eliminates the risk of damage to expensive machine components, damage to workpieces, tool breakage, tool holder and handle damage – just after any errors or potential collisions have been detected before the NC code is loaded into the machine. Verification of the implementation of the prepared processing and elimination of errors to move to generate a control code numerically controlled machine tool (fig. 6).
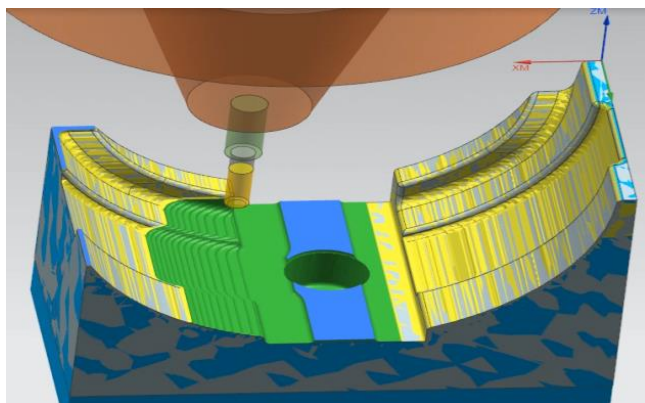

Fig. 6. Simulation of the milling process

The finished code is generated to a text file. If the computer is directly connected to a machine tool, a properly configured export module enables its transmission to the selected machine tool. Along with the code you can also generate a technological documentation that will ensure that the machine is properly prepared for use.

Conclusions

The paper presents an example of a comprehensive design process of the handle structure and the development of its technology. Thanks to computer systems, it becomes possible to quickly: design new tooling constructions, modify the design for new tasks,

and prepare the process of manufacturing handles on CNC machine tools.

Utilizing modern CAD/CAM systems in the design and manufacture of process grips not only significantly speeds up the design and implementation of new tooling, but also significantly lowers the cost of this implementation and improves its quality. The use of modern computer systems will not, however, replace the knowledge, intuition, and experience of the designer. It will only allow him to focus on developing a general concept and creative solving the details of the construction grips.

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