

UTILIZATION OF CAD/CAM SYSTEM PRO/ENGINEER IN MECHANICAL ENGINEERING INDUSTRY

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Abstract: CAD/CAM systems have a dominant position in the air, automobile and space industry primarily. This article presents utilization of CAD/CAM system Pro/Engineer in technological preparation of production of several important Slovak industry companies. There are described proposals and creation of manufacturing processes and solution of practical task.

Key words: CAD/CAM system, NC machine, CL data, postprocessor .

1. INTRODUCTION

Computer aided programming is gradually being replaced by computer – aided manufacturing programs that can generate the NC program directly from a CAD file. Modern “open architecture” CNC systems, based on industrial personal computer (PC) structures prefer programming and operation in the CAD/CAM mode. At the present time are used for automation programming integrated CAD/CAM systems. The application of CAD/CAM systems gives not only decrease of possible number errors, but gives substantial acceleration and improve the quality of technical preparation production, the application of modern procedures, (FEM simulation, verification, ect.) and considerable savings in consequential processes (production, NC programming, etc.). Technological possibilities are continuously expanded and include the basic technical trends in this area. Several CAD/CAM systems from various firms are at the market nowadays. They differ from degree of integration, technical equipment and last but not least the price of the system. At the Slovak republic are known from them – Pro/ENGINEER, Catia, I-DEAS, Euclid 3 UNIGRAPHICS, and etc. The utilization of CAD/CAM systems is highly effectiveness, because it enables to reduce the process development time and the introduction of a new product in the market heavily [4].

Because at present the CAD/CAM systems have a dominant position in the air, automobile and space industry primarily this article describes utilization CAD/CAM system Pro/ENGINEER in industry practice. The introduced tasks were solved on the basis of the requirements from the cooperation with Slovak industry plants.

2. CAD/CAM SYSTEM PRO/ENGINEER

Pro/ENGINEER is full parameter 3D graphic CAD/CAM system, determined mainly for general manufacture engineering and for automation of design engineering. System covered the whole processes from preliminary design, through drawing documentation to programs for manufacturing of designed parts on numerical control machine tools. With graphical system Pro/ENGINEER is possible to create fully, unambiguous and accurately space model of solid body – simply and quickly.



Fig. 1. Module Pro/NC – extending the functionality of Pro/ENGINEER to manufacturing – Mill, Turn, Wire EDM, Sheetmetal [7].

Pro/ENGINEER contains about 35 modules that directed for individual applications (Pro/Manufacturing – Fig. 1, Pro/NC-Check, Pro/ Moldesign etc.). The substance of system, basic model Pro/ENGINEER can be used independent or in combination with other models according to requirement users.

In the CAD part of the system is the work finished by the creating of geometry structures. Than follows the work in the CAM part according to the following steps:

- setting of initial conditions includes unit definition, zero point, its displacement etc.;
- assignment of the concrete operation consists in the input of correspondent NC sequence with a concrete tool to separate roughing and finishing cycles;
- working simulation enables the picturing of either tool trajectories;
- creation of a CL data file and the start-up of the post-processor is the final phase of NC generation program for a concrete machine tool.

3. UTILIZATION OF CAD/CAM SYSTEM PRO/ENGINEER IN PRACTICE

CAD/CAM system Pro/ENGINEER is used at Faculty of Mechanical Engineering University of Žilina, the Department of Machining and Automation mainly for edu-

cation of the objects aim at technical preparation of manufacturing. Our Department had cooperation with some mechanical engineering plants that use system Pro/ENGINEER in their technological preparation of production. In frame of this cooperation the Department participates on solving of some problems from the area of the CAD/CAM system utilization.

3.1. Solving tasks from industry practice

The one of the task was solved for plant **CHIRANA DENTAL, s.r.o. Piešťany**. The main orientation of this plant is research, production, sale and service of dental technique. The production programme of plant is the production area of dental set, dental chairs and dental stools series DIPLOMAT. Nowadays the original technologies of these products production become out of date and unsuitable. The plant decided to applicate the CAD/CAM system Pro/ENGINEER to the technological preparation of production. The idea is that the production on conventional machines moves into the production only on CNC machines. To the dental set series DIPLOMAT are delivered dental chairs – DM10 (Fig. 2). The requirement of plants was to propose the manufacturing process for component of back head on dental chair DM 10 (Fig. 3).

Till now this plant has only postprocessor for CNC milling machine HURON CX 10 (Fig. 4). That is why the solving of this task required the proposal of post-processor verification for a milling machine HURON CX 10 too. Because component of back head has small values the proposal and manufacturing process was created for five pieces of components at the table of milling HURON CX 10. In Fig. 4a is displayed the screen with design of fixtures with five back head components in CAD/CAM system Pro/ENGINEER and in Fig. 4b is displayed detail of the real machine fixture with manu-



Fig. 2. Dental chairs DM10 – series DIPLOMAT.

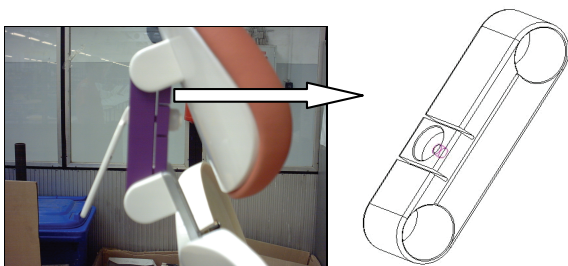
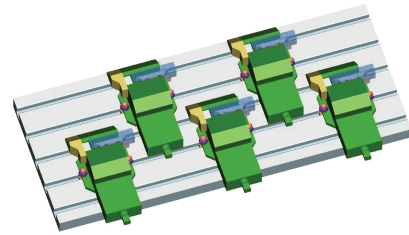
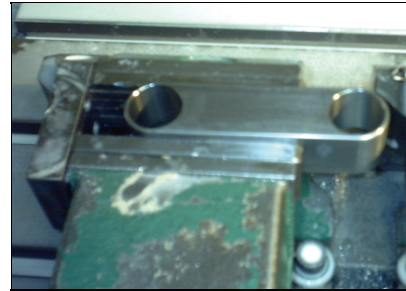


Fig. 3. Component of back head on dental chair DM 10.



a



b

Fig. 4. The screen with design of fixtures with 5 back head components in Pro/ENGINEER: a) detail of the real machine fixture; b) detail of the real machine fixture with manufacturing component.

facturing component. All manufacturing process in CAD/CAM system was divided to five NC sequences contents the competent technological operations.

In CAD/CAM system Pro/ENGINEER the simulation of created manufacturing process allow to display all critical places of the manufacturing process, the collision of the tool with the work-piece or fixtures. The simulation of back head component manufacturing process in NC/CHECK module of CAD/CAM system Pro/ENGINEER is displayed in Fig. 5.

Developed NC program was transformed to the machine control system and the final verification of the postprocessor was verifying step by step by the manufacturing of back head component on milling machine.

Utilization of propos resolution brings to plant shorten machining time for production of one component – 38,5 min. The result was the reduction of machining time for production of one back head component more than 70%. The production of back head component becomes shorter, economically favourable, more precision and complies to the to the quality product requirements. Using of CAD/CAM system Pro/ENGINEER and application of propose machining technology on CNC milling machine brings:

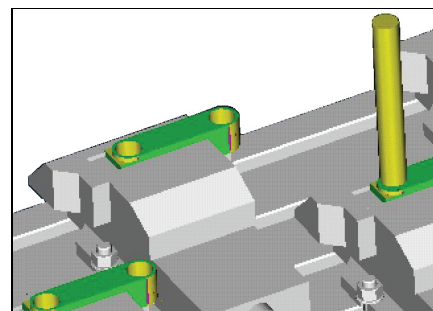


Fig. 5. NC Check – simulation in CAD/CAM system Pro/Engineer.

- reduction of preparation time resp. modification of technological process;
- simplification of production and additional correction of model construction;
- transparent generation of component database for further using.

The next requirement from the practice was solved for plant **ZTS Námestovo, a.s.** The main problem of solving task was the creation of proposal of manufacturing process in CAD/CAM system Pro/ENGINEER, reducing of manufacturing costs and manufacturing time for brace producing of engine (Fig. 6b) Caterpillar C7 Turbo (Fig. 6a). Proposal and manufacturing process was created for the milling machine Bridgeport vmc 1000 xp2.

The goals by the solving of this problem was:

- reduce prime cost for the brace of engine Caterpillar C7 2271 Turbo production;
- reduce working machine employment of horizontal milling machine and drilling machine- substitute more machines by one CNC machine;
- reduce the number of fixtures;
- reduce the high course of manufacture production;
- shortening of production time and of accuracy of manufacture expansion.

The solving procedure of this task required by the using CAD/CAM system Pro/ENGINEER especially:

- propose the new technology for manufacturing process of engine brace 7C 2271;
- create the 3D model of engine brace;
- propose the new suitable fixtures;
- choose milling tools and technological parameters;
- generate the CL Data;
- simulate the manufacturing process in the setting of CAD/CAM system Pro/ENGINEER.

In Fig. 7 is described preliminary design of fixture and technological process for brace of engine C7 Caterpillar C7 2271 Turbo in CAD/CAM system Pro/ENGINEER.



a



b

Fig. 6. Engine: a) Caterpillar C7 2271 Turbo, b) brace of Caterpillar C7 2271 Turbo engine.

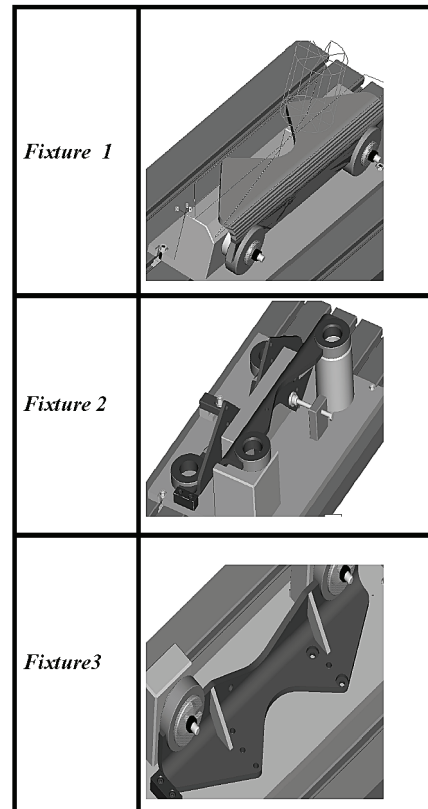


Fig. 7. Preliminary design of fixture and technological process for brace of engine.

The result of new technological propos utilization brings to plant reduction of prime cost for the brace of engine Caterpillar C7 2271 Turbo production about 30%, reduction of working CNC machines employment, reductions the high course of manufacture production and shortening of production time about 56%. Difference between new and old technological proposal are shown in the Fig. 8.

The next task was solved for plant **KDR s.r.o. Žilina**. The requirement was – to create the proposal of manufacturing process of segment for buffer drum MP0-000521 (Fig. 9) by the help of CAD/CAM system Pro/ENGINEER.

One of steps which allowed expressive decrease of segment production time was:

- shortening of production preparation and utilization of suitable technological machining process;

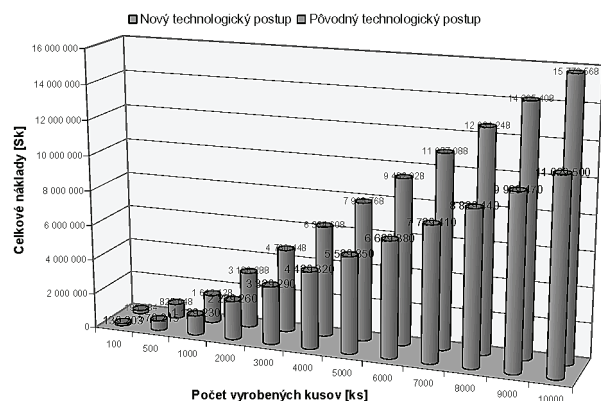


Fig. 8. Difference between new and old technological proposal.

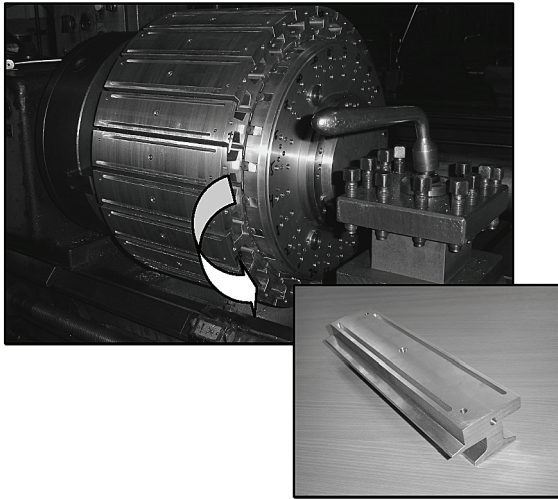


Fig. 9. Segment for buffer drum MP0-000521.

- suitable control NC program with the minimal number of no load tool movement;
 - suitable machining tools and technological parameters for machining;
 - using of suitable machine tool.
- The result of this cooperation was proposal of the new technology.
- construction proposal – 3D graphic model of segment in CAD/CAM system Pro/ENGINEER (Fig. 10);
 - proposal of segment manufacturing process creation in Pro/ENGINEER;

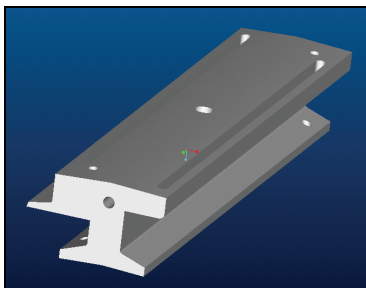


Fig. 10. 3D graphic model of segment in CAD/CAM system Pro/ENGINEER.

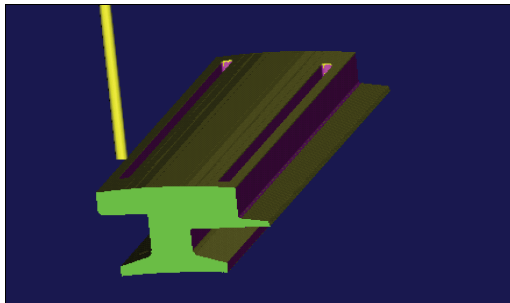


Fig. 11. Graphical simulation in system Pro/ENGINEER.

- checkout of manufacturing process proposal by the graphical simulation in system Pro/ENGINEER (Fig. 11);
- generation of CL data file and NC program for machine centrum MCV 1000 with control system HEIDENHAIN 426;
- verification of segment production on the machine centre MCV 1000.

The production of segments becomes shorter, economically favourable, more precision and complies to the to the quality product requirements.

4. CONCLUSIONS

The effective utilization of CAD/CAM systems expressively contributes to the product life cycle shortening. This article describes some of the technological possibilities of concrete CAD/CAM system, but general view of CAM utilization in industry practice is given too. The cooperation between department and industry plants included the proposals of new products, new technology or design fixtures and parts from practice. The results of cooperation brings the new knowledge and experiences applicable not only into education but to the research activities too.

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