Proceedings in MANUFACTURING SYSTEMS

Proceedings in Manufacturing Systems, Vol. 5 (2010), No. 3 ISSN 2067-9238

THE POSSIBILITIES OF GROUP REPRESENTATIVE UTILIZATION AT NC MACHINING WITHIN NEW CAPP SOFTWARE

Katarina MONKOVA[1], Peter MONKA[2]

Abstract: *The article deals with the utilization of group technology inside new software. This software aids the multivariant manufacturing process plans creation and consequently it supported the processing of information in several versions. It can be used for optimization according to the selected criteria, for the generation of technological documentation and NC programs on the basis of hybrid approach. NC program, as one of process plans form, can be for individual parts generated automatically on the basis of group representative that is created as 3D model in CAD/CAM system. The output of CAM module – CL data – is imported into new software application as the basis of NC program.*

Key words: *CAD/CAM system, Individual Application Software – IAS, CAPP, NC program, Group representative.*

1. INTRODUCTION

The present situation in the industry is characterized as a period of intense progress of technologies at the significant computer aid in all branches of industry. In connection with the technical progress it is increasing the pressure on the manufacturers to develop and make the products as soon as possible at the minimal cost in required quality. The product must be competitive, it must be up to qualitative and functional standard, it must have reasonable price, efficacious design, and it must have regard for safety, ergonomic and another aspects, which decided about its marketability.

All information represents the know-how of the plant, so it is important to store this information. It is suitable to archive all data in digital form today and use it in various stages of the manufacturing process. It is very important for the operator to know the data flow and on the basis of this knowledge made it as simple as possible.

It enables [1]:

- to increase of production effectivity and quality.
- to dynamically adapt data structure for actual situation and for user specific conditions with minimum negative effects,
- to select the way of process plan creation, whether it will be utilized approach of group technology or whether it will be done for every part separately. If the part will be manufactured using of NC machine, the producer will be able to decide how the NC program originate, whether it will be written manually or whether it will be created by
- means of CAM system.
- to select the parts with the similar material and dimensional characteristics, with the similar process plans; therefore it will be considerably able to save the batch time.
- to import of process parameters easier and faster,
- to short preparing time for the technological documentation
- to use information not only for the generating of technological documentation, but also to the processing of details for store, economic and wage records.

Many of Slovak plants were obliged to transform their production schedule, quantity, types and kinds of products, after 1989 (the year of marked political-sociable changes in previous Czechoslovak republic), but they work with unchanged philosophy up to this day. This is one of the reasons why they are still out of competition to west firms despite of cheaper manpower.

Other problems areas in Slovak plants are [2]:

- The low level of information technology (live data, information availability and uniformity of information structures).
- The computer aid has not systemic character; only subprograms are used, mostly at difficult, often incompatible, computing systems.
- The absence of the tools, which makes it possible to analyse of dynamic system properties important for the planning of high automation system at short time.
- The missing of the tools and time space for other alternative solutions, including possibilities of their testing and optimization.

These facts press on manufacturers to debug the limitations listed above. One of the solutions is to build information systems, which integrate needed data and provide live data to each workman, that are necessary for labour-saving work and for the receiving sufficient decisions.

The requirement to use of such information system, which is adapted Slovak market conditions, brings some

[1] PhD, Assoc. Prof., Faculty of Manufacturing Technologies, Technical University in Kosice, Department of Technological Devices Design, Sturova 31, 080 01 Presov, Slovakia, ++421/517723791, *E-mail: monkova.katarina@apeiron.eu*

[2] PhD, Assoc. Prof., Vice-head, Faculty of Manufacturing Technologies, Technical University in Kosice, Department of Manufacturing Technologies, Sturova 31, 080 01 Presov, Slovakia, ++421/517723791, *E-mail: peter.monka@tuke.sk*

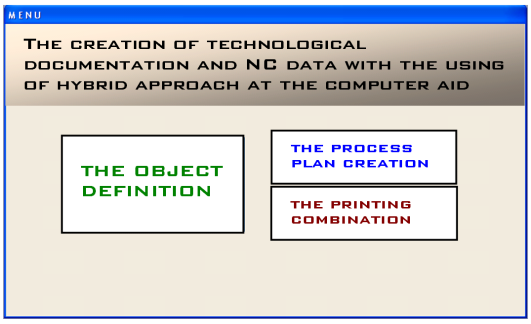

Fig. 1. The basic application menu.

of manufacturers to idea to create new system in collaboration with academics. That's why the Department of Manufacturing technologies on the Faculty of Manufacturing Technologies of Technical University in Kosice was connected to the project focused to the development of new information system practically applied.

Some conditions were specified for system:

- it must be able to do from over viewing points,
- it mustn't restrict new products at their put on the manufacturing process.

Therefore the system was build on the basis of these technological approaches:

- Individual,
- Type technology,
- Group technology.

The basic menu of new system is shown in Fig.1.

2. THE POSSIBILITIES OF NC PROGRAM CREATION IN IAS CONDITIONS

2.1. The types of NC program creation inside the IAS conditions

The introducing of PC into process plans creation predicts that two parts are in every process plan [2]:

- working part, which determinates the operation type (e.g. tooling, milling, grinding, etc.);
- information flow, which represents processing of all information needed for the manufacturing operation controlling.

The working part of process plan and information flow finds their application at the controlling of NC machines in flexible conditions of automation through NC programs and corrections.

The suggested software application considers the approach from several views, such are for example:

- Used data storage system;
- The objects of group technology coding;
- The manner of NC program generation;
- The manner of manufacturing documentation creation.

To be this application maximal flexible from the view of operator request, its environment was created so that operator was able to work by the following manners:

- Hand programming by direct writing of NC program
  - is suitable for very simple operations;
  - typical example is turning (the tool moving only in two axes).
- Partially automated programming by direct selecting of the commands from the IAS environment
  - using within group technology for the simple parts mainly at the turning with possibility of application for other types of machining, e.g. milling.
- Automatic generation of NC program in CAD/CAM system conditions
  - NC program is saved in native format of control system of selected manufacturing machine through IAS software application,
  - NC program is in the relation to the part (all commands for NC processing are in one file) or it is in the relation to the group of operations that results to specific shaped feature (for example no cylindrical hole).

    This manner of NC program generation is suitable for complex shaped parts, where NC program can consists of several thousand rows. The generation is done on the basis of geometric data about part (assembly, subassembly), tool, jigs, etc. It depends on the choices technology and execution strategy.

The example of the partially automation possibility of NC programs creation with the utilization of group technology inside IAS can be shown on group representative for shaft parts. It contains most frequent types of outside respectively inside surfaces and features of shafts as are: cylindered surfaces, conical surfaces, threaded surfaces, concave surfaces, convex surfaces, chamfers, rounds.

2.2. Automatic CL data generation

The most profitable manner of NC program creation from the view of labour content is automatic generation of NC program in CAD/CAM system conditions. For the majority of NC users, NC is about productivity and flexibility − making a lot of parts, and many different parts, on one machine tool. This was true even before computer numerical control (CNC) superseded an earlier generation of machine tools that did not have the benefit of microprocessor-based control technology. With the level of automation being used in CNC machining the level of consistency and quality increased. CNC automation eliminated errors and provided CNC operators with time to perform more tasks. The CNC automation also allowed for more flexibility in set-up and job changes and today's CNC machines are productive, capable and flexible, too.

How to create those new and different programs has taken various approaches. Many CNC machines can be programmed on the shop floor, with the operator entering data at the control panel. This method has been very popular, especially for simpler workpieces. Programs can also be prepared "off-line," away from the machine tool, using computer-aided manufacturing (CAM) software. This method is most often used for more complex workpieces. The latest CAM software for the PC (personal computer) provides many automated features that make NC programming largely a push-button affair, regardless of how simple or complex the workpiece might be [3].

The most important file produced by any CAM system is the NC program that will run the machine tool. General-purpose CAM systems produce programs to run variety of different types of NC machines. There can be virtually an unlimited number of machine and control

combinations. To accommodate this large variety of output requirements, most CAM systems produce a neutral tool path file. That is, the file is not intended for any specific machine but simply contains generic commands to do such things as change a tool or turn on the coolant. This neutral file traditionally has been referred to as the CL (cutter location) file. A separate program, generally referred to as the postprocessor, is used to format the neutral CL file into an NC program that is suitable for specific machine/control combination.

2.3. The parts assigned to one group representative

Complex group representative can be represented by 3D model (Fig.2) with plenty of shaped and geometrical features (hole, round, chamfer, pin lock groove, slot, etc.). It was prepared as representative for shaft parts to show the possibility of automatic NC program generation inside IAS.

On the basis of this component, Pro/Engineer as one of big CAD/CAM systems, allows to create other similar parts within group technology. It is realized in Family Table module by the feature skip variation through commands Yes/No or by dimensions change. The environment for new part defining on the basis of already existed is on Fig.3.

Some parts generated by means of Family table following one group representative are shown in the Fig. 4. The parts from n.1 till 9 in this figure originate by varying of some features (surfaces with the certain shape, lock grooves, slots, chamfers, rounds, etc.) which these parts have or have not.

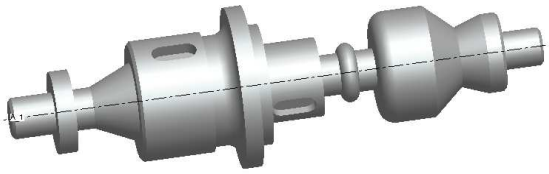

Fig. 2. Complex − group representative.

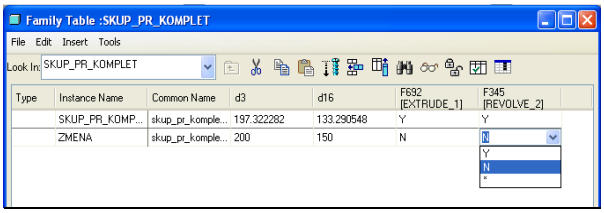

Fig. 3. Preparation of new component within group technology.

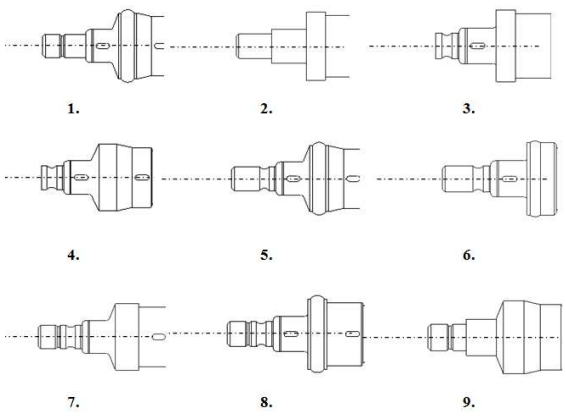

Fig. 4. The parts generated on the basis of group representative.

Further advantages of Family table utilization:

- They are simple and compact way of the crating and storing a lot of objects.
- They save time and labour so that they allow standardizing generated objects.
- They enable to generate the model variants from basis one without the necessity to create every model extra again.
- They enable to create gently differ variants from original without necessity to use the relations for model change.
- They enable to create object tables that can be stored as the file and used in object register.

3. VERIFICATION OF DATA PROCESSING AT NC PROGRAM CREATION IN "IAS" ENVIRONMENT

The verification of IAS in the relationship to the object manufacturing was based on two approaches to the technological documentation preparation:

- The group representative and contextual parts;
- The parts unfilled to the set inside the group technology.

Process plans and NC programs in the module *Process plan creation* for every type were done.

Consequently these outputs were generated through the *Print sets*:

- Process plan;
- NC program for derived part;
- Production time summary.

The data verification was realized on the part displayed in the Fig.5. It was prepared on the basis of group representative (shown in Fig. 2) by means of Family Table in CAD/CAM system Pro/Engineer.

The model listed above was inside database assigned to group representative and its characteristics were load to IAS in interface that is shown in Fig. 6.

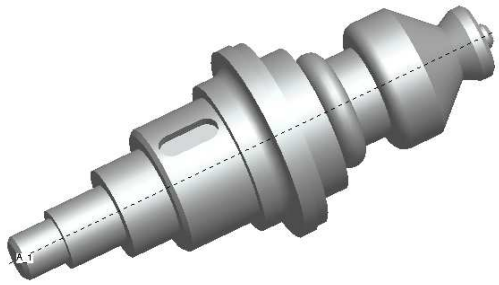

Fig. 5. 3D model of parts for NC program verification.

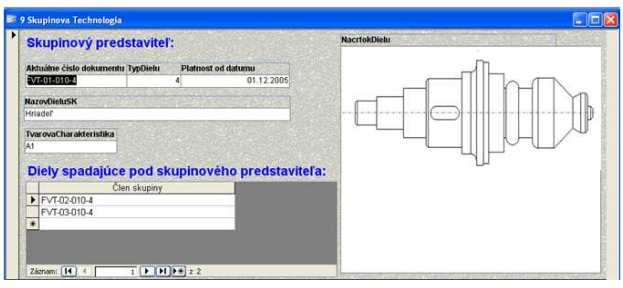

Fig. 6. The object assignment to the group representative.

CL data generated in CAM system were by means of postprocessor transformed to NC program for the selected control system.

4. CONCLUSIONS

The substantial influence on the technical, social and economical level of manufacturing process improvement has the computer technique implementation into technological preparation of manufacturing. The plant that uses computer aid in this production phase is able respond very quickly on the change produced assortment. It is allowed also by high computing power, but by CAPP system, too, that is able to modify already existed technological documentation or to create completely new documentation. It is necessary to realise that utilization of group representative for the NC program creation depends on many factors and NC program already once generated may not be suitable for another type of control system, respectively another type of the machine. What makes CNC so flexible and productive is the ability to run different workpiece programs. With the right program, machining is a pushbutton affair.

Also the manner of the material cut may not be identical (for example the control system doesn't allow to made the same continual out surface contour by the cycle, in this case it is necessary to cut every individual surface separately). From the view of flexible accommodation to concrete situation it would be suitable to prepare NC programs of various representatives for various control systems and these programs very quickly modify in case of requirement or use another type of process plan from IAS menu. Also it is necessary to say that functionality every made NC programs is important to verify in a practice and consequently the program to debug. It is the same in the case of NC programs prepared in the IAS conditions. Production preparation based on the database principles allows a greater flexibility of manufacturing units when searching for the means of effective production processes with required economic results. The results presented in the article are used in author's workplace conditions and in some Slovak plants.

On the basis of the aforementioned theory characteristics the information system was created and applied into real production conditions in the computer aided process planning consisting of approximately 6 000 components. The given product was a result of the co-operation between a German company, providing investments and co-operation of the activities, and Slovak companies providing a technical process planning and the production of a final product.

The main contributions of assigning IS, elaborated on the basis of the multi-variable process planning in the real manufacturing conditions, can be summarized as follows:

- reduction of the variability of warehouse stock (at the first application by nearly 30 per cent);
- immediate information about the product elaboration
- fast acquisition of the details via interfaces for the wage records and accounting;
- elastic analytical tools enabling the adoption of better decisions;
- acquisition of the statistical values of parameters applicable to plan production in the future.

The software tool was created in the way to be easily implemented to an already existing information company structure via flexibly adjustable interfaces. It is also user-friendly, developed with the characteristics of GUI, typical for OS MS Windows, so that the basic grasp of its functioning does not require expensive trainings. Of course, if the maintenance of this system is to be productive, it must be familiarized with the given philosophy and possibilities of tactic and strategy planning, through which the production can be optimized. The ground tasks for near future in focus of authors are:

- research for general format of process plan data;
- investigation of production environs in other European countries;
- study of graphical features use for process planning.

ACKNOWLEDGEMENTS: The results presented in the article are used in authors workplace conditions and they originate with the direct supporting of Ministry of Education VEGA 1/0558/08.

REFERENCES

[1] O. Bilek, I. Lukovics, *Finite Element Model of Dynamics within Highspeed Grinding Process*, Academic Journal of Manufacturing Engineering, 2009, 2 (7), pp. 6−11, ISSN 1583-7904.

[2] I. Kuric, et. al., *Computer Process Planning in Machinery industry*, TU Lodz, Bielsko-Biala, Poland, ISBN 83-87087-00-9, 1999.

[3] J. Mihalcova, J. Dobransky, *Analyse of lubricant liquids in aircraft* engines *by tribotechnical diagnostics*, Scientific Bulletin, 2008, Vol. 22, serie C, pp. 281−286, ISSN 1224-3264.

[4] K. Monkova, M. Hatala, R. Cep, *Some problems that originate at the creating of 3D model with difficult shapes without the parameters and dimensions of real part*, Proceedings of scientific works of VSB TU, Mechanical Engineering Part, Vol. 54, No. 1, pp. 159-163, Ostrava, 2008, ISBN 978-80-248-1891-7, ISSN 1210-0471, VSB TU Ostrava.

[5] A. Panda, *Regulation of manufacturing processes*, CHISA '99: 46, Conference of chemical and process engineering, CVUT Prague, October 1999, ISBN 80-86059-28-6.