Computer Aided Manufacturing Process Planning by Group Technology Application

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Abstract—**The program for machine is important for creation a new parts in industry. In this time, the NC (numerical control) is very used. NC is technology, in which the program for controlling of the machine is used; for example for drilling, lathes, milling, conventional and unconventional cutting machines (laser, water-jet, plasma). CNC programming may use the application of Group Technology theory. Group Technology (GT) is a philosophy for manufacturing and strategy, which helps a company in understanding what it manufactures and how those products are then manufactured. When some properties are once identified, it is possible to capitalize on these similarities by processing together groups of families (similar parts). Then the opportunity for unnecessary duplication of effort for creation a new program and solving of some problems are minimized.**

I. INTRODUCTION

The program for machine is important for creation a new parts in industry. In this time, the NC (numerical control) is very used. The first NC machines were in 1940s and 1950s. NC is technology, in which the program for controlling of the machine is used; for example for drilling, lathes, milling, conventional and unconventional cutting machines (laser, water-jet, plasma). It is better like the using of manual programming by levers or handwheels. Numerical Control has two main types of NC, which are different by the method of program saving. CNC (Computer Numerical Control) – the control system of machine is directly connected to local control computer. Second main method is DNC (Distributed Numerical Control). It is more modern and it is characterized by flexible distributed controlling of several machines from common centre. CNC programming may use the application of Group Technology theory.

Group Technology (GT) is a philosophy for manufacturing and strategy, which helps a company in understanding what it manufactures and how those products are then manufactured. Some parts, which have similar properties, are grouped together. When some properties are once identified, it is possible to capitalize on these similarities by processing together groups of families (similar parts). Then the opportunity for unnecessary duplication of effort for creation a new program and solving of some problems are minimized [6].

II. NC PROGRAMMING AND ITS BASIC METHODS

The tool engineer must understand NC in order to design fixtures and cutting tools for use with NC machines. The design engineers must know knowledge of NC to perfect dimensioning and tolerance creation techniques for workpieces to be machined on NC machines and for example managers, foremen, and team leaders should understand NC well enough to communicate intelligently with fellow workers. But NC programmers, operators, setup people and others working directly with the NC machines must have an extremely good understanding of this technology [1].

NC machine tools offer some benefits, for example, it is more comfortable work for operators - improved automation. The intervention of operator is minimized and eliminated. The most of these machines can run during their machining process without the operator´s control and operator can do with other tasks. With these advantages of NC machines, operator is not very fatigued and fewer mistakes are created by operator in the machining process. For operator, the less knowledge are needed opposite the machining of parts by conventional machine tools.

The other main benefit of NC technology is identical and accurate workpieces. Today's NC machines boast almost unbelievable accuracy and repeatability specifications. This means that once a program is verified, two, ten, or five thousand same workpieces can be easily produced with precision and consistency.

In this time, when the requirement of just-in-time is very important and needed, the time of set up of these machines are fundamental. But these NC machines have a very simply set up and the loading of programs is easy, therefore these today´s machines meet to these production requirement.

In this article some methods of programming are described. It is manual programming, conversational (shop-floor) programming and CAM system programming [7].

A. Manual Programming

Manual programming can be a little tedious. In this method of programming the words and commands are used. But every good programmer should have a good knowledge and understanding of this manual programming. It is like in a school. Firstly, the students must understand and know how to perform arithmetic calculations manually and then they can try to used calculate and to do this work easier.

For the some application, manual programming may be the solution for creation of program. In this time too, a lot of companies employ manual programming techniques rather like only CNC programming techniques. And jobs for only CAM programmers are limited. But when the CAM system is used, there is time too, when NC program

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(at G-code level) must be changed for correcting mistakes during the verification of the program. The programmer has opportunity to optimize the program after the running of some first parts. But if the programmer should perform this elementary changes by CAM system and creates new program, so, very long work time can be wasted.

B. Conversational (Shopfloor) Programming

Conversational programming is very used method of programming. It has become popular in recent years. The program for parts is created at the CNC machines. In generally, the shop-floor creates program using graphic and menu-driven functions. The programmer can visual check whether inputs are correct and how the program is created. When the program is finished, the most conversational controls show a tool path during the machining cycle.

These conversational controls are different from one manufacturer to the next. CAM system, in the most case, can be perceived as a single-purpose CAM system and provides suitable means how to generate programs for a single machine. Conversational controls can be forewarned, too. Some these controls, generally older models, can be programmed only conversationally at the machine, so, for example the off-line programming can´t be used. But the most newer models can run in a conversational mode or accept externally generated G-code programs.

Some companies use these conversational controls and others consider them wasteful. But companies which employ a lot of people utilize their NC equipment. NC operator may set up tooling, prepare the program, verify or optimize the program and actually run production. In company, anything that can help the operator will streamline production. These controls can reduce time [8].

In this time, when time is very important, many companies want to keep their NC machines running for as much time as possible. Down time is perceived as wasted time. During the running of one job, one people may set up tools for the next job, other may write and verify program or something others tasks. Operator can only be expected to load and unload workpieces. These companies doesn´t want to develop their programs on-line, while the machine is not producing. But when the companies need to programming only a limited number of different workpieces at the CNC machines, the conversational programming may not be the best programming alternative.

C. CAM System Programming

CAM (Computer Aided Manufacturing) system is CA system, which is used for preparing of data and the programs for NC machines. This system is used in automated production of the mechanical parts, assemblies, etc. Particularly the geometrical and other data, which were obtained during the computer design of the part, are used in CAM system.

Postprocessor is tool, which transfers the geometrical data to code acceptable for control system, is part of CAM system. The CNC machines have different control systems and every systems need for transfer data different postprocessor. The libraries of these postprocessors and also modules for simulation and animation of production process are often integrated as a part of the CAM systems. User by these simulations can verify operations which are performed on the workpieces and so can prevent the collisions of the tool with fixtures or workpiece [2].

The one of properties, based on which is possible to class the CAM systems, is their completeness and compatibility with other CA systems, primarily with CAD systems. So, CAM systems are possible to class to two groups [10]:

1. *CAM systems integrated in frame of the complex CAD/CAM/CAE systems.*
   There are mainly products known as „big“ CAD/CAM/CAE systems, for example CATIA, NX - former Unigraphics, Pro/Engineer and also „medium“ CAD/CAM systems, for example Cimatron or VisiCAM. The advantages of these systems are their completeness and integration of individual CAD, CAM and CAE modules. Therefore in these systems, the problems with transfer of geometrical data among individual parts and modules, are not existing.
2. *Specialized CAM, respectively CAD/CAM systems.*

This group is possible to divide into several groups:

a) Complex CAM systems - for computer supporting of more technologies - for example SURFCAM, SmartCAM, Mastercam, AlphaCAM, etc.
b) Specialized CAM systems - for computer supporting of concrete technology - for example for milling PowerMILL and WorkNC, for production of the circuit boards ECAM 350, etc.
c) CAM superstructures of the specialized CAD systems. Most known is HyperMILL, which is superstructure of CAD systems AutoCAD and Mechanical Desktop.

For the CAM systems is typically, that are focused on the computer aided manufacturing and their modules for creating the solid models are at low level (enable to create only wire-frame and 2D models, but not solid models). Solid models are needed to transfer from specialized CAD systems.

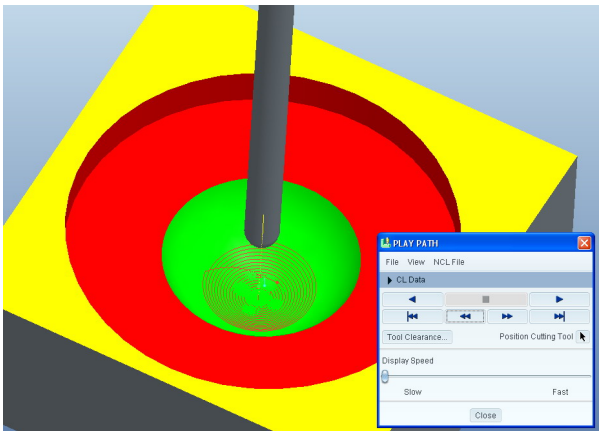

Figure 1. Simulation of CNC milling in Pro/Engineer

Some these CAM systems, which are very used and have the best quality, have modular structure. Therefore these CAM systems can create NC programs for lathes, milling, laser cutting, etc. They have the libraries of processors for transfer of data from CAM system to code for control system of machine. These systems can

simulate the production process and so the some errors in NC program can be found, for example collision of the model and tool.

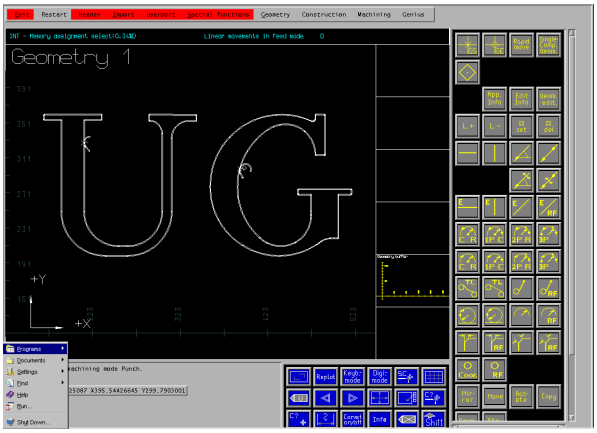

Figure 2. NC Programming of water-jet cutting

The requirements to save or improve the competitive level of products urge the producers to use CAM technologies as frequently as possible in relation to their facilities and this trend is expected also in the future. Using only one component of CAD/CAM/CAE systems, for example CAD may decrease the application effect of these modern tools in enterprise [4].

III. APPLICATION OF GT THEORY FOR NC PROGRAMS PREPARATION

A process plan is very important step in the product realization. This step takes a big effect for quality of product and for the cost of producing. Scheduling, production planning, part programming, etc., these inputs take a process plan. In the past the most of manufacturing systems were operated by humans. Therefore these systems were slowly for new information and inflexible. But today, the production method is gradually moving toward automation. Flexible automation has been especially stressed in recent years. Automated process planning or CAPP (Computer Aided Process Planning) is a way, how the computers can be used for generating a process plan. When this system is right set up can be a "reason" for dynamic response, fast plan generation and for example smooth interface between design and manufacturing functions.

NC program is similar as technological process plan, therefore, when GT can be used for automated creation of technological process plans, it can be used for automated creation of NC programs, too.

Thousands of items are produced in manufacturing. Every part has a different size, function, shape. But after closer consideration, some similarities among components can be found (Fig. 3). Parts classified and grouped into families produce a much more tractable database for management [4].

Group technology is the realization that many problems are similar, and that by grouping similar problems, a single solution can be found to a set of problems thus saving time and effort [6].

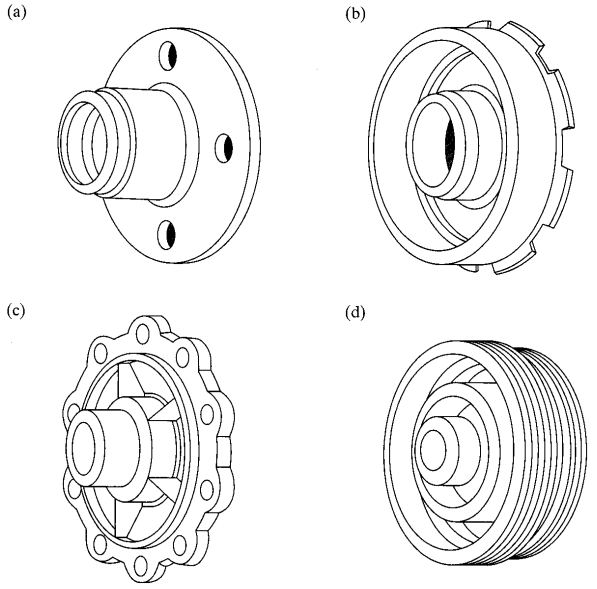

Figure 3. Grouping parts according to their similarities

Group technology can be used in many different areas in production systems. In term of design components, a lot of components have a similar shape (Fig. 3), while these similar components can be grouped into the families. Then the new part can be created by only the simply modifying of existing component design from the same family.

The familiar procedure of the generating of NC program using Group Technology contains of proposal of type representative of manufactured parts. Example of type representative for manufacturing of rotary parts is on Fig. 4.

The attitude based on principles of GT can be applied to the procedure of NC program creation. The algorithm must be followed for proper recognition of characteristic features and categorization of parts. The initial section of the algorithm includes the recognition and description of particular geometrical features, either they are of functional or only of geometrical nature. First, the basic geometrical shape of the part should be considered (rotary, planar or box type). Then all the elements, like holes, slots, pockets and grooves should be taken into consideration and used for categorization to relevant group.

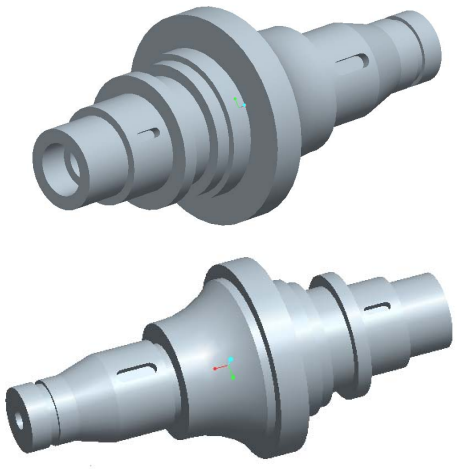

Figure 4. Complex part for NC cutting

This representative part has all types of shapes of surfaces, which are on components of production selection. Then for production of type representative, the creation of NC program is created by manual or using CAM system. When the program is finished, subprograms are allocated to pertaining parts of the type representative. Thus, the special program can be created, or program environment for creation of new program based on the shape modification of produced components can be used with aid of combining each part of NC program. The part of algorithm of developing procedure for generation of NC programs using group technology is shown on Fig. 5[9].elsevier industrial engineering

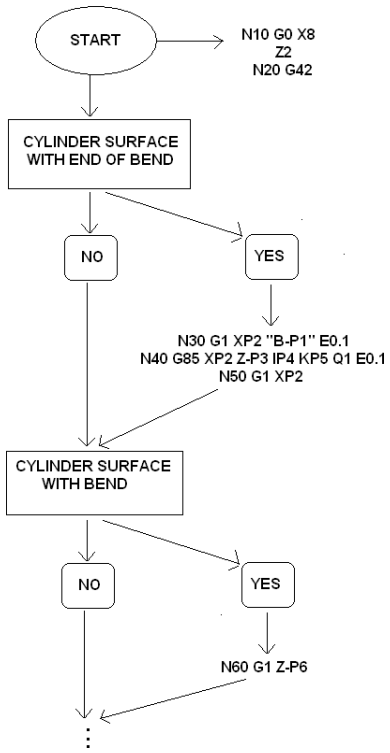

Figure 5. Algorithm for NC program creation

Figure 6. Window of GroupNC program

On Faculty of Manufacturing Technologies of Technical Univesity of Kosice with a seat in Presov, on Department of Production Technologies, the program for creation of NC programs with use of Group Technology is prepared. This program is named GroupNC and its first window is showed in Fig. 6.

IV. CONCLUSIONS

It is needed to know, that design-technological standardization will carry full effect till in case of the complex application. This technology must be used in all processes of company together, production and quality management, design, technology, material supply, etc. On the start of implementation of this process, the resources like financial, staff, some equipment and realization time are high.

The results of this implementation can be observed after the plumbless time of onset, usually 3 to 5 years. Therefore the support and understanding of management and workers, which implement this standardization, is needed. The using of program applications of computer aided technical preparation of production, which is a part of whole managing and informative system of company in frame of computer integrated production is good way for applying process of this technological standardization.

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