Manufacturing based on feature recognition using NX

I Stănăşel[1], F S Blaga[1], T Buidoş[1]

Department of Industrial Engineering, Faculty of Managerial and Technological Engineering, University of Oradea, Romania

stanasel@uoradea.ro

Abstract. Competition in the market causes companies to update continuously their products both in terms of design and performance and in terms of manufacturing technologies to ensure high performance, low cost and manufacturing time. The integration of Computer Aided Design (CAD) applications with Computer Aided Manufacturing (CAM) applications has led different researchers to study the concept of recognition of features in as many activities as possible that contribute to the achievement of a product, starting from design, manufacturing, production planning, assembly, quality management. In order to make the production process more efficient, it was approached the automatic realization of the programs for numerically controlled (CNC) machine tools based on the characteristics of the features that make up the part. The paper presents a case study on how to perform machining programs on CNC machine tools using the facilities offered by Siemens NX application based on feature recognition.

1. Introduction

The evolution of the competitive environment determines the companies in the market to update the requirements related to product design, complexity, quality, durability, environmental protection, delivery deadlines. This development has made it necessary to identify some performant technologies which allow, once a faster development of products, and on the other hand, to ensure a manufacturing process faster and of superior quality. By the development of computer technology they have appeared and have developed applications to assist the whole life cycle of products from conception to end of use and its recycling.

The computer can process very large amounts of data in a short time without error, so reducing the intellectual effort of the designer, who in this way does not have to do a routine work, but to focus on the innovative aspects of the product.

In the design stage, the use of the applications of CAD (Computer Aided Design) allows the designer to alter the data quickly and to realize multiple variants of design of the same product from which to be identified the optimal variant.

Computer Aided Manufacturing (CAM) can have several interpretations. Computer Aided Manufacturing refers both to the obtaining the G code programs to control the CNC machine tools, flexible manufacturing systems, and the automatic design of production processes in which all aspects of the production process are controlled. Currently, however, computer-aided manufacturing involves the use of applications which allow the management and monitoring of manufacturing equipment such as CNC machine tools and industrial robots and flexible manufacturing systems.

Using CAM allows shortening the time of product development, increases the efficiency of the manufacturing process and also allows increasing the quality of processing by checking the CNC program performed by simulating tool paths.

Integration of CAD applications with CAM is a necessity, because it allows reducing errors which occur when using neutral formats, increases productivity, reduces product development time, and ensures greater flexibility [1]. The development of applications in the field of engineering has led various researchers to study the concept of the feature recognition in as many activities as possible, which contribute to the achievement of a product from design, manufacturing, production planning, assembly, quality management. For the purpose of making the production process more efficiently, it was approached the automatic realization of the CNC programs, starting from the characteristics of the features which make up the piece.

In the paper [2] is presented a method and a case study regarding the execution of the CNC programs for different features (slots, holes, etc.). The CNC program is based on reading and recognizing these forms and transposing of the repetitive commands of these shapes into macros.

In article [3] is approached the realization of parametric CNC programs based on recognition of the features of the 3D model and is proposed a new model for Feature-based Machining.

The researchers [4] analyze the role of modeling and the characteristics of the product features in its manufacturing process.

The authors [5] approach the development of a manufacturing model based on features recognition in terms of productivity and cost. Experiments are performed to compare the model made with a commercial system.

The article [6] proposes a way of sequencing of a machining process based on both knowledge-based rules and geometric reasoning rules. A set of rules is developed to perform the machining sequences which are validated by a case study.

Taking into account of these considerations, the integration of CAD with CAM applications at the current stage of development is a necessity, features having a very important role in the integration process, because the design and manufacturing data can be associated with features that contain the information which can be interpreted to achieve sequencing of technological process. The features with common characteristics can be grouped in order to reduce the processing time.

From the studies carried out, it was found that there are concerns regarding the development of algorithms for automating the process of automate manufacturing through the recognition the features of 3D model, with the aim of reducing the time for developing the CNC programs.

The paper shows how to make the G code programs for numerically controlled machines using feature recognition facilities provided by the Siemens NX application.

2. Considerations about Feature-Based Machining in NX CAM

At the present stage, most systems CAM may import the 3D model in a neutral format of the parts. Traditionally, achieving the code G for processing on the CNC machines tools using a CAM application complies, in principle, the steps mentioned in figure 1.

Siemens NX is one of the most powerful integrated CAD /CAM solutions, offering efficient 3D modeling tools as well as advanced tools for programming numerically controlled machines up to five axes, high speed machining, hybrid manufacturing, programming of robots for manufacturing operations [7]. NX CAM has also the possibility to automate the process of making the programs for CNC machine tools by using specific manufacturing templates for different types of features (hole, pockets, steps, threads, boss, etc.).

The feature recognition is possible for both native 3D models made on the NX platform, as well as 3D models made in other CAD systems and imported in a neutral format. Once the entities have been recognized, the information is processed and, in accordance with the rules and filters defined in Machine Knowledge, are identified the processing operations, tools, cutting parameter, and the path of each tool is generated. The block diagram for automating the CNC automation process is presented in figure 2..

Machining Knowledge Editor (MKE) and Machining Knowledge Library (MKL) are the core for automating machining process. MKE is the tool that enables the manufacturing technology based on the data provided by MKL. MKL contains rules regarding on the features that can be recognized, which manufacturing operations can be adopted, what type of tool can be used and which size of tool can be selected for the considered manufacturing operations.

Recognized Features are checked based on the rules defined in MKE. These rules can achieve automatic manufacturing process, select the operations and the necessary tools, and if the material of the workpiece and the tool are known, the cutting parameters are established, and finally it will be determined the optimal tool paths for each tool used to process a recognized feature.

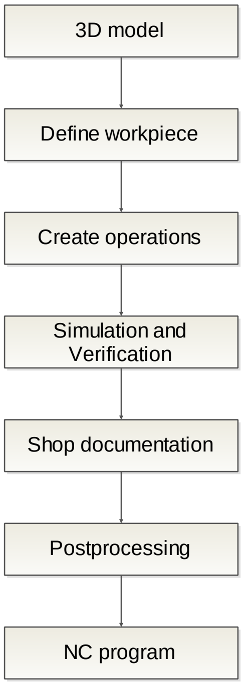

Figure 1. Main steps for getting G code using CAM application

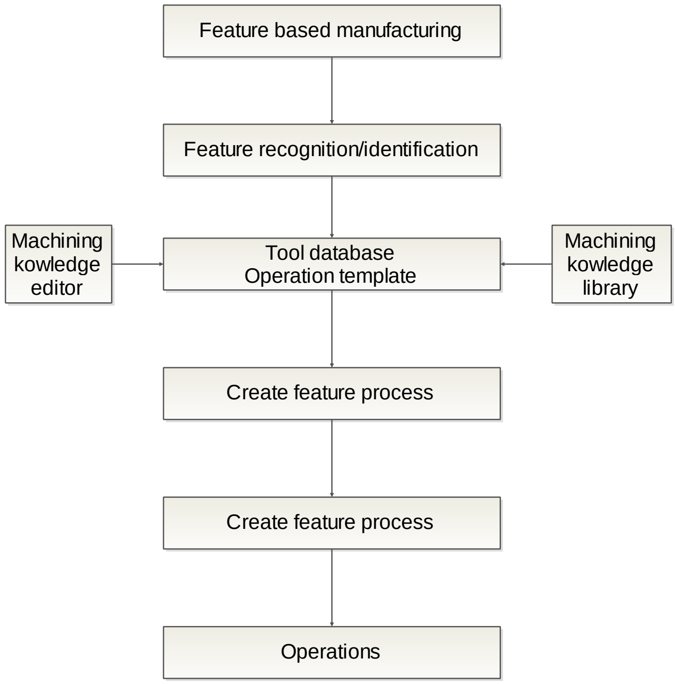

Figure 2. Block diagram for automatic generation of CNC programms

The features which can be recognized and processed automatically refer to the holes, slots and pockets, and irregular feature created by the user. Siemens NX provides more options for the recognition of features like as: feature identification, parametric recognition, legacy hole recognition, legacy making, pocket recognition, and manual recognition. In the above methods, feature identification and parametric recognition (figure 3) are more commonly used and NX recommends that users use the second way of parametric recognition [7].

The NX feature-based machining module can recognize and create processing operations for a wide range of manufacturing processes such as turning, milling, wire EDM.

Regarding the milling operations, feature-based machining module can create different operations such as: Hole Making, Floor /Wall Milling, Cavity Milling, Thread Milling, and Hole Milling, Planar Milling, Plunge Milling, Z -Level Milling, Fixed Axis Surface Contouring, Variable Axis Z -Level Milling, Variable Axis Surface Contouring. In the process of feature recognizing by NX, the user does not need to do any intervention [7]..

3. Example of use Feature-Based Machining in NX CAM

The workpiece that is processed is shown in figure 4. It is a prismatic one, with circular pockets, holes, counterbore holes and thread holes. Some of these features are chamfered. The material of the workpiece is aluminum alloy 7075.

After defining the coordinate system used in the manufacturing and at the dimensions of the blank, the features are recognized. Recognition can be done automatically, or you can specify the types of features to be recognized (figure 5). You can introduce some search restrictions, by indicating a specific area where features to be recognized are located, or by specifying the access direction of the tool during processing. In figure 6 are shown recognized features and their position on the piece.

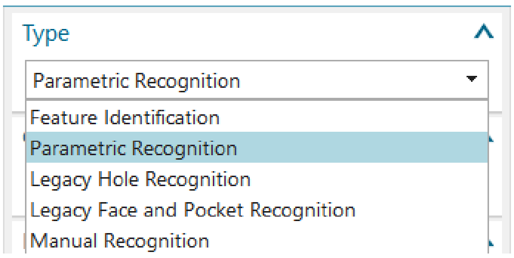

Figure 3. Types of feature recognition.

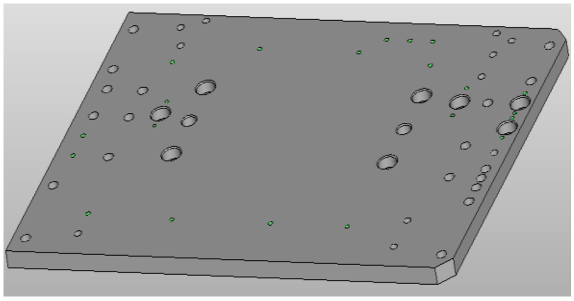

Figure 4. The workpiece to be processed.

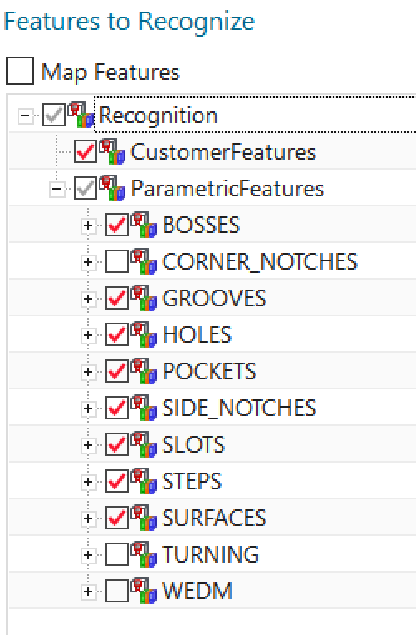

Figure 5. Features to be recognized.

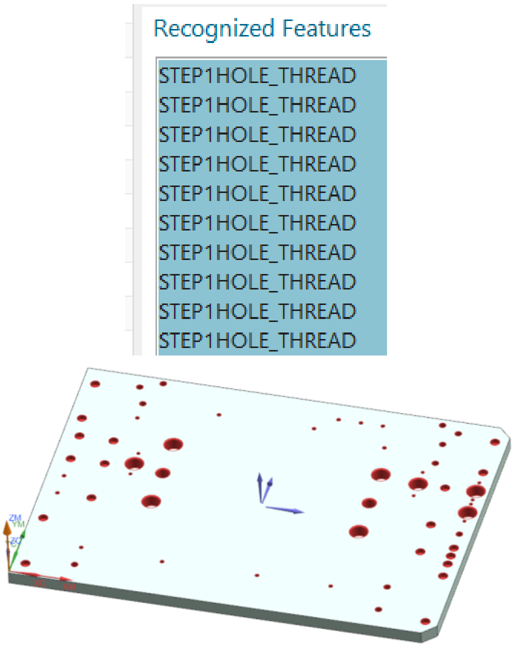

Figure 6. Recognized features and their position on the workpiece.

The next step consists to create feature process. Knowing the workpiece material and the dimensions of the recognized features (figure 7), based on the data in the knowledge libraries are identified the types of manufacturing operations (figure 8), the types of tools, and are chosen their dimensions, are determined the cutting parameters, and it is performed sequencing of operations. The tool paths for each tool is automatically generated (Figure 9) and their 3D simulation is shown in Figure 10.

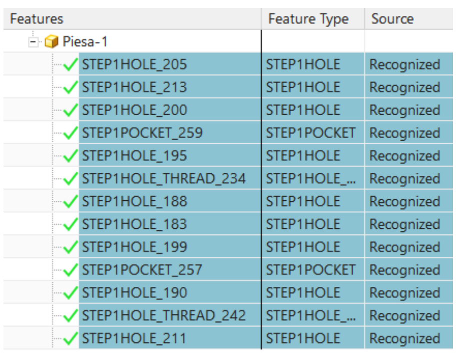

Figure 7. Feature navigator.

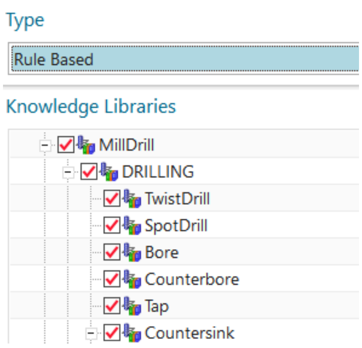

Figure 8. The types of processing operations.

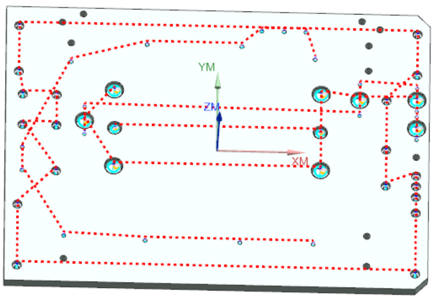

Figure 9. The cutting paths for each tool.

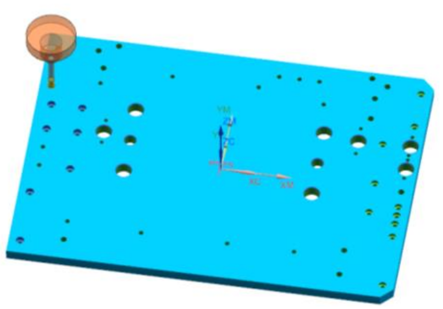

Figure 10. The 3D simulation of the cutting paths.

The CNC program was done by post-processing for a HAAS CNC machining center. Before running on machining center, the program was tested using a backplotter. The machined part is shown in Figure 11.

Figure 11. The obtained part.

4. Conclusions

Feature-Based Machining reduces the time required to achieve CNC programs. They are used standardized manufacturing processes which contribute to the decreasing of programming errors. Feature-Based Machining is realized automatically, in this way being eliminated the repetitive work of the programmer. Feature-Based Machining can be used for parts from various fields (mold, machinery, automotive, etc.) dominant features being pockets, holes, slots.

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