NEW ASPECTS OF MANUFACTURING ON MACHINE TOOLS

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Rezumat. *În acest articol se prezintă modalităţi de prelucrare prin frezare pentru minimizarea timpului de prelucrare şi creşterea preciziei de prelucrarea la operaţia de frezare plană şi analizarea diferitelor strategii de prelucrare la operaţiile de frezare a buzunarelor. Aceste analize se vor face prin modificarea unui singure variabile din cadrul operaţiilor de prelucrare: în cazul operaţiei de frezare variabilă plană, prin montarea unei plăcute speciale WIPER cu formă diferită de celelalte plăcuţe montate, iar în cazul operaţiei de frezare variabilă a buzunarelor, prin schimbarea la fiecare buzunar prelucrat a strategiei de prelucrare.*

Abstract. *In the paper are presented the modality to minimize the production time and increase the machining accuracy in the milling operations and to analyze different milling strategies. In this analyze the only on modification for face milling operation was to change the tool geometry by mounted a special shape insert WIPER, that have a different geometry, and for pocketing operations the changes was by using different milling strategies for manufacturing pockets. The application for this analyze is a simulation between the process technologies in virtual fabrication made using Esprit CAM (Computer Aided Manufacturing) software.*

Keywords: Virtual manufacturing, computer aided manufacturing

1. Introduction

The goal of present manufacturing technology is to produce even at the first part correctly in a shortest time and most cost effective way increasing the economic efficiency of the company as much possible. Since the product complexities increase and the competitive product life cycle times are reduced, the realization and testing of physical prototypes become major disadvantaged for the successful and economically advantageous for production on the modern CNC machine tools. Presently the aerospace industry, automotive industry can no longer allow expensive manufacturing and testing of prototypes or process strategies to detect physical weaknesses and to improve design our NC programming. Instead, to achieve the various components manufacturing processes is using virtual manufacturing to reduce costs and time for product testing. Virtual manufacturing is a tool that made the simulation of the production process (manufacturing) that can be analyzed and tested like in the real process. Iterative changing of a step in virtual manufacturing process design (programming) and variants changes made by the programmer in the NC programming to reach the requirements, will significantly reduce programming time and cost of the part production [1,3,4].

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Milling is a process extensively used process for manufacturing of mechanical components for automotive industry, aerospace industry, die and mould industries. The process is a versatile process and has many application areas such as a simple face milling a flat surface or reaching complex freeform sculptured surfaces [2].

The paper presents the analysis and the optimization in a virtual manufacturing process for testing part. The paper is structured as follows: minimize processing time and increase processing accuracy in face milling operation presented in section 2. Analysis pockets milling strategies presented in section 3. Section 4 presents the complete process simulation including the simulation of machine tools, clamping devices and the cutting processing of the integral parts which involving a virtual manufacturing simulation of the process.

2. Minimizing machining time and increase processing accuracy in face milling operation

Research manufacturing process should lead to improved surface and time processing based on physical constraints considered in the construction design. The first step would be to model the manufacturing process, depending on work material, tool geometry, speed, processing depth and results that we want is to achieve the accuracy of surface processing.

In this case the only one variable that will be change in face milling operation is the cutting tool geometry, and the other values remain unchanged. The cutting tools used to perform this operation has the following characteristics:

- tool diameter: Dc =25 mm;
- Number of teeth: 4;
- inserts dimensions 12 mm;
- spindle speed 3500 rot/min;
- cutting speed 275 m/min;
- depth of cut: ap=2 mm;
- Entry mode: ramp;
- Exit mode: ramp;
- The angle of penetration: 10°;
- step over % of diameter: 50%.

2.1 Face milling operation using a classical tool

In this case was use traditional tool without making changes in his construction. The surface area that is processed is shown in figure 1. In this case a tolerance was necessary for a future finishing processing of at least 0.5 mm because it will result in a cutting tool with a 3.6 μm surface roughness and a processing time of 15:12 minutes. To reach an acceptable roughness is needed a further processing finishes, which will increase processing time with 02:48 minutes, so that the final result of the pocketing processing time will go up to 18:00 minute.

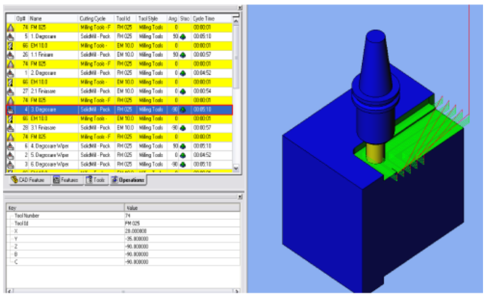


Fig. 1. Face milling operation using a classical tool.

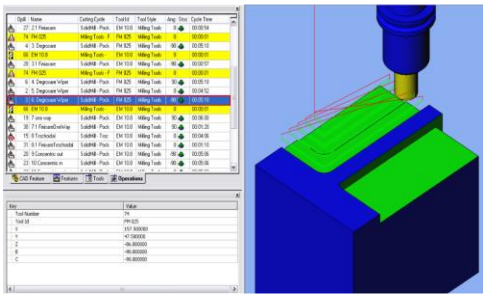


Fig. 2. Face milling operation using a tool with Wiper.

2.2 Face milling operation using a tool with "Wiper"

In this case we will change the geometry of the cutting tool by fitting one Wiper insert. This is shown in Figure 2. A wiper insert will improve surface finish at high feed rate an the long parallel land of the insert allows increased feed per revolution by up to four times the normal feed, still maintaining surface quality. It is normally enough to use only one wiper insert in the cutter.

Following operation with this tool processing time remains the same as cutting regimes will not change, time will remain the same, in this case is not necessary to achieve the finishing milling operation, total processing time is 15:12 minutes.

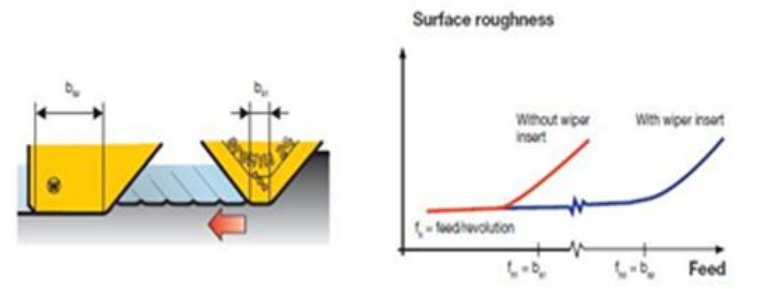


Fig. 3. Wiper inserts.

3. Pockets milling

To improve surface processing in pocket milling operation case should be taken into account the constraints of accuracy and precision surface processing. In this case was manufacturing the pockets by modification the milling strategies and the other values remain unchanged. Cutting tools used to perform this operation has the following characteristics:

- Tool diameter: Dc =10 mm;
- Number of teeth: 4;
- Spindle speed 6366 rot/min;
- Cutting speed 300 m/min;
- Depth of cut: ap=1 mm;
- Entry mode: ramp;
- Exit mode: ramp;
- The angle of penetration: 10°;
- Step over % of diameter: 50%.

The pocket size is 110×55×20 mm and having a volume of material removed 121 000 mm³.

3.1 Pocket milling using "one-way" strategy

The cutting tool will do the cutting movement in one direction for making pocket in several horizontal lines crossing and having a final retreat from the point of cutting up the new starting point represented by line red in the figure. Using this process strategy for manufacturing the time processing was 06:00 minutes, and the roughness surface after this process is not good and will require a future finish process and the manufacturing time was 01:20 minutes. The full time to manufacturing the pocket is 07:20 minutes.

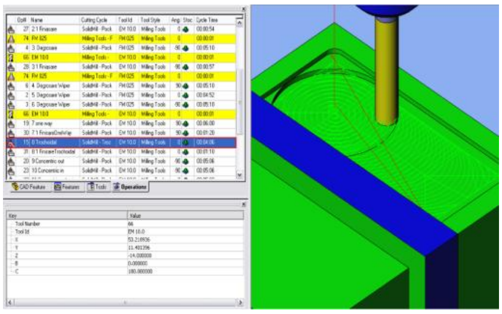


Fig. 4. Pocket milling using "one-way" strategy.

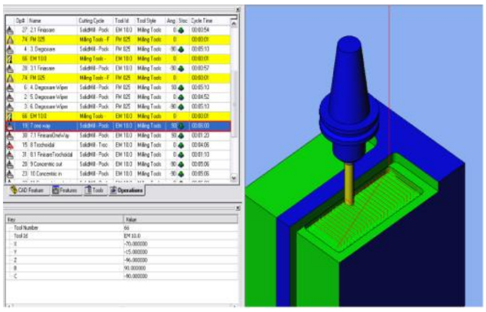


Fig. 5. Pocket milling using "trochoidal" strategy.

3.2 Pocket milling using "trochoidal" strategy

The cutting tool movements will be made along one arc and the processing time was 04:06 minutes and obtaining a processed surface of a high quality and tool wear on tooth surfaces is very low tool. Appling the milling operation using trochoidal strategy is not necessary to use further operation for pocket finishing [2].

3.3 Pocket milling using “concentric out” strategy

The movement of the cutting tool was made from the center to the exterior of the pocket following the pocket contour as shown in the figure 6, the obtained process time is 05:06 and processed surface roughness have a acceptable quality.

3.4 Pocket milling using “concentric in” strategy

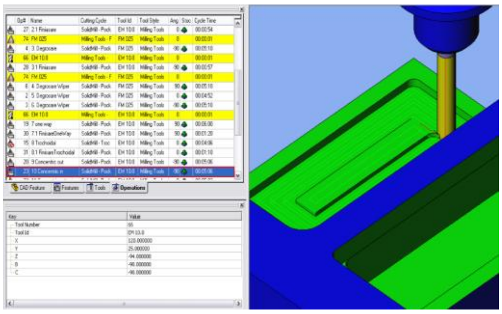


Fig. 6. Pocket milling using “concentric out” strategy.

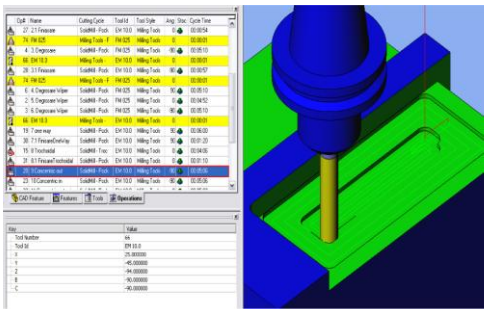


Fig. 7. Pocket milling using “concentric in” strategy.

These two patterns offset the shapes of the part profiles (outer and inner) to create the tool path. Concentric In starts at the outer profile and creates cutting passes toward the center of the part. Concentric Out starts at the center of the part and creates cutting passes toward the outer profile.

3.5 Pocket milling using “concentric in spiral mode” strategy

In this strategy of manufacturing, the movements are similar whit that presented in section 3.3 but the tool will be moving in a spiral not a plan, the differences appear to decrease the processing time of 5:03 minute, and surface quality after processing cutting tool wear is good.

Haw was presented in Sections 3.3 and 3.4 the two strategies have the same results and the same it is in case of the strategy concentric in spiral mode and concentric out spiral mode have identical results. [6].

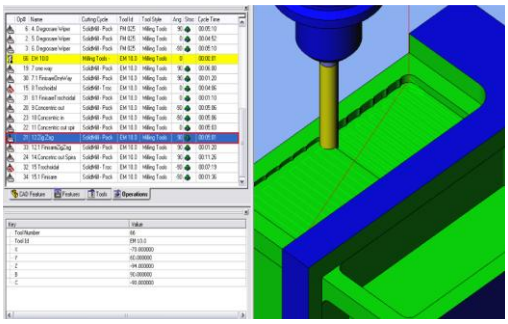


Fig. 8. Pocket milling using “concentric in spiral mode” strategy.

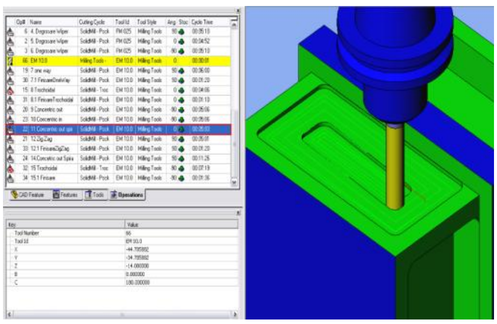


Fig. 9. Pocket milling using ““zigzag” strategy” strategy.

3.6 Pocket milling using "zigzag" strategy

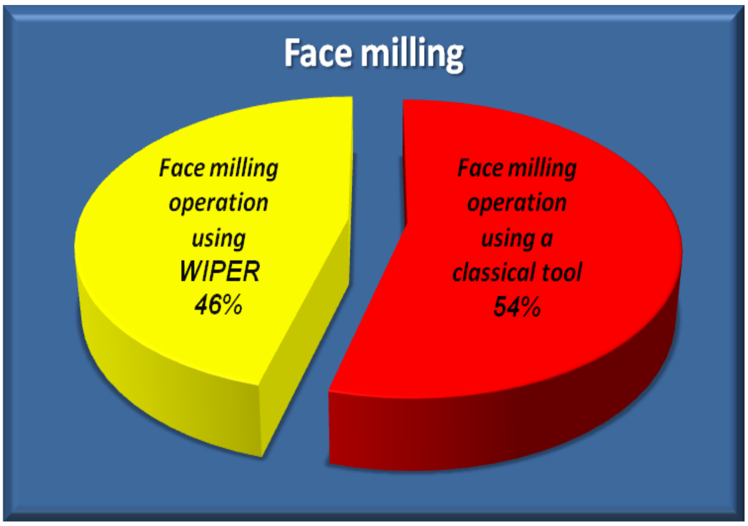
Advance the work of the strategies is in the form of zigzag means that the movement of cutting tool from right to left and from left to right, with a processing time of 05:01 but the surface quality is requiring a further finish operation when processing time up to 06:21 minutes, and tool wear is very pronounced.

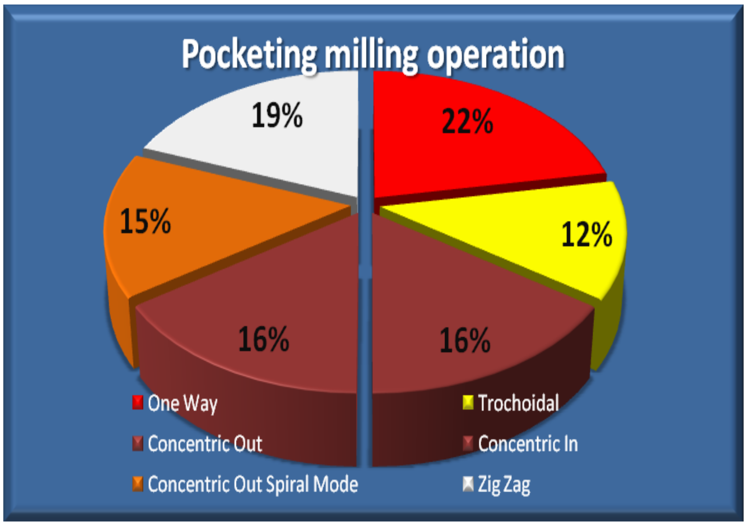
Complete simulation in virtual manufacturing processing

Complete process simulation including the simulation of machine tools, clamping devices and the cutting processing of the integral parts which involving a virtual manufacturing simulation of the process [3, 4, 5].

After building the technological route in ESPRIT CAM software that can make a simulation to be able to see various errors and will be able to make various tests such as:

- analyze programming errors;
- route optimization processing tools;
- the strategies of processing optimization;
- analyzing cutting conditions;
- analyzing the volume of material removed;
- cycle time analysis;
- lower production costs in product launch.





Conclusions

The face milling operation:

- WIPER plate roughness is obtained with R_a = 0.8 mm, compared to R_a = 3.6 mm when using a conventional tool.
- WIPER plate processing time is about 8% lower than if using a classic tool when required additional finishing operation, using a second cutting tools and other customs.

In the pocketing milling operation, trochoidal strategy is the best milling processing:

- less processing time,
- processed surface roughness Ra <0.8 mm,
- lower tool wear.

Other strategies that can be used in the processing and times are relatively small, have a good roughness and tool wear is low:

- concentric out spiral mode,
- concentric in spiral mode.

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