Using CAM software to improve productivity

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Abstract. In the paper are presents new solutions regarding milling strategies who increase the efficiency of machine tools with numerical control. To the modern machine tool solutions, new assisted programming methods have been joined to achieve better processing time and the accuracy of processed surfaces. Was underline the ability to manufacturing a special part, dedicate for aerospace area, using a modern milling strategy: adaptive milling strategy. Technological solutions who were presented, modality how was used the existed infrastructure: CNC milling centre in three axis, are the personal results of the authors, results that could be implement for different technological applications.

1. Introduction
In the aerospace area and satellite industries are used very complex parts (figure 1, figure 2) who was projected using the CAD (Computer Aided Design) software’s, take in consideration different facts like accuracy, time of functionality, forces and limitation strengths, condition of work etc.

Figure 1. Satellite example of complex part Figure 2. Planetary processional transmission

In time, it was tested different manufacturing methods with successfully results. It was used the conventional milling methods on conventional milling machine tools- sure with complicated fixtures - but with non-successful accuracy results (see figure 3).
Using of a five axis machine tools it will bring better condition and results of manufacturing of this complex part as parts of a planetary processional transmission (see figure 4).

Figure 3. Manufacturing conventional milling machine tools.

Figure 4. Five axis manufacturing.

The paper present one innovative solution of manufacturing, using a CNC milling centre in three axis, using a CAM software with real capabilities to be able to manufacturing the complex parts with a technology solution to be able to give an answer, one optimal manufacturing solution between a classical and low precision of manufacturing and one expensive one- the five axis machine tools.

The test part who was used to underline the CAM capabilities, was a successful research: planetary precesional transmissions- developed by Technical University of Moldavia, under direct coordination of Academician Ph.D. Professor Engineer Ioan Bostan [1].

Figure 5. Planetary precesional transmisions- example and the test part what was manufactured.

The interest about the this test manufacturing part is the wide range of applications:
- Planetary precesional electro-mechanical transmission for aerospace area;
- Precesional drive mechanisms for automotive area;
- Precesional mechanisms for actuating the pipeline armature;
- Precesional drive mechanisms for extracting oil from deep depths;
- Planetary precesional multipliers;
- Precesional reducers for various actuators.
2. State of the art
When we start to create a NC technology, we will make an analysis of the input data's (materials, technical drawing, the characteristics of the CNC machine-tools, cutting tools, fixtures), in relation to the final goal: accuracy, functionality, time of manufacturing, costs [13].

After that, we will define the technological process: defining the fixtures of the raw part, the operations and the technological phases, the cutting tools parameters, the control systems.

Next step will be the implementation of the workflow in the design, manufacturing and documentation [3].

In this paper it was created a new technological solution for one special part and the results followed by the conclusions. The steps what was followed for creating and defining the CAM-Part were:

- Step 1: open the part in CAD software and start CAM software (figure 6);
- Step 2: define the technology – it was selected the adaptive milling strategy.

![Figure 6. The part that will be manufacturing.](image)

The adaptive strategy attempts to specifically correct these discontinuous paths and to achieve maximum tool utilization in material removal using the specified maximum contact. The adaptive strategy was specially developed to achieve the greatest tool utilization in material removal without
critical loads. This strategy calculates optimum values for a smooth path that does not exceed the previously specified value of parameter $R$ maximum contact [4]. In particular, complete wrapping of the tool is avoided. This enables utilization of the entire cutting-edge length of the tool without exceeding the loading limits.

A significant advantage of this strategy, in addition to the much higher cutting rate, is the extended tool service life this was the reason to choose adaptive milling strategy (figure 7).

The modality used for manufacturing the part was to split the depth of the teeth in two with the maximum depth 10 mm- using adaptive milling strategy (figure 8) and taking in consideration to reduce the cutting tool wear (figure 9). The maximum contact between tool and the raw part is 25% by diameter and we will use re-roughing operation to correct the surfaces [6].

![Figure 8. The roughing operation using adaptive milling strategy.](image)

![Figure 9. Manufacturing the second part of the teeth - generation the all depth of teeth.](image)

Tool number 2 is a ball mill R6, two teeth and the milling strategy selected was “equidistant milling” and was made the semi finishing operation (figure 10).
The “Equidistant strategy” generates NC paths with constant 3D step, the generated milling paths maintain the same distance even in steep surface areas. [3]

Due to the constant 3D step, a high surface quality can be obtained with a single milling process, even in steep areas of the component. Stress on the cutter is reduced.

![Figure 10](image1.png)

**Figure 10.** The “Equidistant strategy” made with second tool ball mill R6 two teeth.

The final operation was the finishing using a ball mill cutting tool R3 and two teeth (figure 11) and the milling strategy was “Equidistant milling” but this time the step over was 0.2 mm [2].

![Figure 11](image2.png)

**Figure 11.** The ball mill cutting tool R3 used at the finishing operation.

3. Conclusions
The best way to machine a part depends on the specific geometry, the material and the available tools and machines. Technology parameters like cutting data and feed rates must be precisely adjusted to the machining operation.
In the practical test, it was compared different roughing strategies under consideration of part geometry and the technology parameters. As results, one may say that the right combination is critical. The benefits in the overall process:

- End-to-end roughing with blank tracking across machining operations;
- Optimal traverse paths;
- Long tool life;
- Increased machine run time;
- Reliable roughing.

In large components with many cavities, adaptive roughing strategies are clearly the most efficient. The practical test yielded time savings of up to 60 percent’s.

Regarding the test part that was chosen regarding to apply the benefit of CAM applications, was presented a new and interesting modality how to manufacturing one technical complex part what require a CNC milling center in five axis. Made an analyse what CNC machine tools exist and putting in value the capabilities of the CAM software and the impact of the new milling strategies was obtain the optimal manufacturing solution.

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