FIVE AXIS MACHINING APPLICATION WITH ALPHACAM

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Abstract – The article presents the advantages of the AlphaCAM soft, what are the possibilities and the concept of this kind of work. It presents the design flexibility (a new modeling architecture—Design Flow) which is only the solid modeling architecture with the power to capture the intended design, but with the freedom to make unanticipated changes at any time during the design process. After that the paper presents the philosophy of the CAM system, its ability to perform its functions well and in time in a real application in five axis machining, stressing the advantages of the five axis machining versus three axis machining.

1. INTRODUCTION

ALPHACAM offers a lot of standard basic functions (in CAD as well as in CAM):
• automatic generation of work plans and set-up sheets,
• work plan editor with graphical display of the individual machining steps, a lot of the functions 'move', 'delete', 'insert', 'activate' and 'move to background' and others,
• editing of NC tool paths by subsequent re-entry in the machining dialog,
• styles generated for repeated technology on different contours and bodies (in milling module for example for classic 2D contour milling as well as for surface and solid bodies machining)
• Tool path associatively to contours
• CAD data exchange using interfaces (for read in for example DXF, DWG, IGS, ProE, Solidworks, Solid Edge, Inventor, Paraview, Unigraphics, VDA, Catia and others).
• bidirectional DNC program transmission between programming system and CNC control
• optional direct link to modules of Alpha CAM.
• complete mill machining with driven tools on up to 5 configurable axes (X, Z, C, Y, B).
• elimination of unnecessary cutting paths
• for lathe with sub-spindle (Z2, C2).

Any curve analytics or no analytics can be described by discreet points implicit under numerical form in a coordinate system conveniently chosen; The determination of the coordinates of these points can be done easily and fast by computers.

Machine-tools with numerical control (MUCN) are tools that “interpret” represent numbers in binary code and the program can be exported to a card control, command tape, read out in certain code[1].

The basic steps that can be followed in CAD/CAM to generate trajectory tools and make the program NC are:
• Modelling the pieces or opening files where the model are drawing.
• Choice tool and CNC
• Choice the NC equipment
• Choice blank
• Choice the surfaces to be process.
• Generate the tool operation.
• Adjustment parameters processing.
• Generate the trajectory of tools.
• Simulate the removing material.
• Generate the program CNC. [2]

2. THE METHOD

The paper presents a real application connected with a research subject contract between our University and a company who wanted to know the impact of their acquisition of a five axis machine-tool. The most interest problems for this company were: the time of manufacturing, the cost of the implementation, and the comparison between actual and future possibilities to manufacture complex technological items. It presents the steps made to be able to give a realistic answers to these questions.

The first step is to import the drawing in AlphaCAM. The window dialog to import the CAD drawing is present in the following images:

![Import CAD dialog](image1)

![Trajectory generation](image2)

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The second step is to analyze machine-tools who generate the NC program. In this case that machine is equipped with continuous motors, coupled directly to the boring spindle (Direct Drive System). The principal actuator develops low coupling, but reaches 50,000 rot/min. The machine table has the dimensions: 500x450 [mm] and execute advance moves after axes X and Y, and principal arbour after the Z axis.

The machine tool has the possibility to use 10-tools. The type tool holder is a cone HSK-E32, maximum diameter use is the 20 [mm].

The numerical control machine is a CNC command. The three steps include the choice of the billet dimensions. After an analysis by the CAD and CAM department, material was selected, a plastic roughing material with dimensions: 88x45,5x54 [mm], it is a prismatic complex piece.

The fourth step consist in selecting the technological operations to generate the final piece.

The fifth step - the tools selection:

The sixth step: the simulation.

The seventh step: edit the NC program.

programming the cutting parameters for different cutting tools, and trajectories:
In the existing technology five NC programs are generated for five catches.

The purpose of the present article is to mark out the personal results in research, implementation and determination of a five axis manufacturing application and the economic impact of this new technology.

If we use a five axis machine, the number of catches is reducing to two. The machine table can realize the rebate after the axis A and after the axis C.

In the Five Axis Machining technique, the head (principal arbour) is oriented in many series of positions and machining carried out as a set of discrete operations.

This offers a lot of advantages:
- it is convenient for machining deep cores and cavities
- short cutters give increased accuracy and higher quality surface finish
- Important time benefits through use of only one setup.

3. MAIN RESULTS

AlphaCAM offer the possibility to chose the strategy to manufacturing in five axis.

It is very important to chose the correct strategy to obtain the best results.

In this case we chose the following strategy:
1. Spiral roughing – here the tool works by orbiting around a large radius. It is a very efficient means of machining the outer profile of certain components.

2. Helical Drilling - in this strategy the tool spiral down into the components by orbiting around a fixed point along the tool axis.

This technique is particularly effective when used in combination with 3D Offset spiral Machining.

3. 3D Offset Finishing – gives an excellent surface finish because the step over is constant across all surfaces irrespective of whether they have steep walls or shallow contoured areas.

Simulation processing in five axes. Catch one.
Use a device cut time processing tool and bulk up accuracy.
Using AlphaCAM we obtain two programs NC for processing tool in five axes with two catch to set by origin.
Simulation processing in five axes. Catch one

Use options in AlphaCAM by calculating the actual processing time in each catch to compare processing in three and five axes.

Processing with CNC-machine in three axes.
The first catch
Time for catch + configure by origin = 5 min
Effective processing + change-over tool = 22 min, 23 s
The second catch
Time for catch = 2 min
Effective processing + change-over tool = 4 min, 02 s
The third catch
Time for catch + configure by origin = 5 min
Effective processing + change-over tool = 9 min, 03 s
The fourth catch
Time for catch = 2 min
Effective processing + change-over tool = 1 min, 01 s
The fifth catch
Time for catch + configure by origin = 5 min
Effective processing + change-over tool = 2 min, 39 s
Effective processing + change-over tool = 24 min, 31 s
The second catch
Time for catch + configure by origin = 2 min
Effective processing + change-over tool = 4 min, 02 s
Full time = 33 min, 35 s
Full time = 56 min, 08 s

Processing on CNC-machine tool in 5 axes:
The first catch
Time for catch + configure by origin = 3 min
Effective processing + change-over tool = 24 min, 31 s
The second catch
Time for catch + configure by origin = 2 min
Effective processing + change-over tool = 4 min, 02 s
Full time = 33 min, 35 s

Figure below represents the total caching time and the zero point setting for three axis manufacturing (1) and for five axis manufacturing (2)

If we analyze the next diagram we will see that the time difference: 22 minutes and 35 seconds represent a productivity growth of 40%, but the most important things is the high accuracy obtained.

4. CONCLUSION
The main advance of five-axis machining is the ability to save time by machining complex shapes in a single set-up.

Another benefit comes from allowing the use of shorter cutters that permit more accurate machining.

Using a CNC machine-tool in five axes we can increase the accuracy and we reduce the operation time from 56 min, 08s to 33 min, 35 sec for one piece.

REFERENCES