CAM STRATEGIES POSSIBILITIES IN SCULPTURED SURFACE MACHINING USING ART CAD/CAM SOFTWARE

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Abstract

Submitted article is focused to describe and reveal possibilities of CAM strategies of Art CAD/CAM softwares. ArtCAD/CAM softwares are special CAD/CAM sytems aimed to design and produce Art sculptured surfaces. This softwares disposes of CAD modul with special features and CAM modul with adequate CAM strategies. Most common think is that for machine sculptured surfaces powerfull CAM software is neccesarry. However many Art works eg. coins or medals are not to difficult shaped and in fact 2.5D machining is enough. The question is that if CAM module of Art CAD/CAM system ArtCAM Pro can produce equal toolpaths in comparison to CAM software PowerMill 2010. An article describes possiblities, advantages and disadvantages of both CAM softwares in sculptured surface memmorative coin model production.

Key words

CAM strategies, Art CAD/CAM, sculptured surface, machining

Introduction

In last years there is a tendency to integrate more CA technologies into one software application, which will combine advantages of both. At nowadays the biggest progress can be shown in the field of CAD/CAM systems. CAD/CAM systems introduces real integration of two main CA technologies, CAD (Computer Aided Design) and CAM (Computer Aided Manufacturing). Integration of these two technologies is in fact reasoned and expected step due to its very close dependacne on each other. Therefore many CAD/CAM systems appeares on market with various level of possibilities and various purpose of use. Beside systems focused on design and production of machine engineering parts, CAD/CAM systems for other fields of production rose up. However not only in technical science, CAD/CAM softwares sunk into artistic production also. Based on their exploitation in art, they can be called Art CAD/CAM systems.

We can recognize several types of Art CAD/CAM systems today. The dividing can be based on how they was developed from. Some of them was developed from CAD/CAM systems for machine engineering in the way that some features was removed and some new features was added. Another was developed directly as an Art CAD systems, later expanded to CAD /CAM sytems. In this way there are two methods of expasion. First method was to develop independent Art CAD system and then use another already developed CAM system and put it together or vice versa. Another method was not to develop stand alone Art CAD system but directly develop CAD/CAM system. Based on upshown, most used Art CAD/CAM softwares from each group are listed below [1].

1. Delcam ArtCAM Pro 2008
2. BitCAM Gold Software V.4
3. BobCAD BobART version 23
4. Graphitech Cimagraphi version 8
5. Delft Spline Systems Deskproto version 5.0
6. SA International Enroute Software version 4
7. CNC Software Inc. Mastercam Art X3
8. GRZ Software MeshCAM Art V2 Built 7283
9. MecSoft RhinoART 1.0
10. Vision Numeric Type3 TypeEdit
11. Vectric VCarve PRO

Art CAD/CAM softwares differs from mechanical ones in various ways. First difference is in tools and features that it consist of. Typical for Art CAD/CAM systems is absence of tools such as meter or angle setting and features like bonding or associativity typical for standard CAD systems used in mechanical engineering. For art prodction these tools are not necessary. On the other hand more new tools are avaible in Art CAD/CAM systems such as sculpting or blur similar to graphic softwares like Photosop or Corel Draw in order to create required shape of model surface.

Basic principle of creating a model in Art CAD/CAM software is common for all here written softwares. In the next it will be illustrated in ArtCAM Pro. There are two different ways to create a model. First way is to create a model using tools of software like in standard CAD software. Problem with this method is that it is very hard to create diffcult shapes in short time. Another method is based on recognizing color depth of imported Picture. Each color of the imported Picture is given specific high in model. That means when Picture consists of three colors, red, blue and white and required high of model is for example 3mm, white colored parts of the Picture will rise up to 3 mm high, blue ones to 2mm high and red ones to 2,5 mm depending on their realtion to the white ones. ArtCAM sets up the high automacitally depending of the color hue, lightnees and saturation. Ofcourse it is possible to set up specific high value for each colour. However this is possible only in very easy pictures with low number of colors. When Picture has more colors it is very hard to set up specific high to each color. And as is common in past was used at least 256 color depth, at nowadays 32 millions and more. So that is no possible to set up high for each color independently. For this reason is good , if it is possible and not degrade the picture, lower the color dept. Usually combination of these two metohds is used. Import Picture, draw base lines to set up the shape and finish the model with sculpting and other specific tools of a modeler [1].

Experimental

Fig. 1 *Coin model*

In machining of sculptured surfaces powerfull CAM system is appropriate. However many Art CAD/CAM systems dispose of very simple CAM system. Usually this CAM modules are created only to machine in 2D or to engrave. Only few Art CAD/CAM systems own adequate CAM strategies for sculptured surfaces machining. Hence that Delcam PowerMill will be used as powerfull CAM system to compare possibilities of Delcam ArtCAM Pro. Presumption is that for making of model of commemorative coin, which production in fact 2,5D machining covers, CAM modul of ArtCAM is enough and strategies and generated toolpaths are equal to the ones from PowerMill. In this case very important thing is of course the postprocessor that is used to generate toolpath. Due to both softwares are from the same company it can be considered that the posprocessors are very close to each other. To eliminate differences in specification of postprocessors same heidenhein code for toolpath generation is used in both CAM softwares. For model making Eagle 1000 CNC machine was used.

EAGLE 1000 MACHINE DATA Table 1

Description	EAGLE 1000VMC
Table dimensions	1200 x 450 mm
Max weight of workpiece	600 kg
axis X	1020 mm
axis Y	510 mm
axis Z	510 mm
Clamping system	7/24 (ISO 40)
Spindle revs	80 - 10000 rpm
Rapid Movement speed X/ Y/Z	30/30/18 m/min
Cutting feedrates	1 - 7600 mm/min
Positioning accuracy	± 0.005mm
Repeatable accuracy	±0.003mm

CAM strategies in ArtCAM are divided into two main groups. This groups are called 3D and 2D machining. Group called 2D strategies consists of carving strategies and it is not

suitable for sculptured surface machinig. Also some drilling cycles are in this group and special strategy laser cutting machines [2]. The second group is focused on 3D machining. There are more strategies to select. First of them is strategy called machine relief. This strategy is equal to constant Z machinig strategy in Powermill and it was used in this work. One difference according to PowerMill is that after selecting this strategy there is a selection of offset or raster strategy however this is neglible for machining. Other AtCAM strategies are feature machining, 3D cut-out and 3D rest machining. For tools setting are avaible libraries with tools. This part is not so huge as in powermill but for purpose of 2,5 D machinig it is enough. There are possibilities to set up tool parameter , paramters for tool holder are missing.

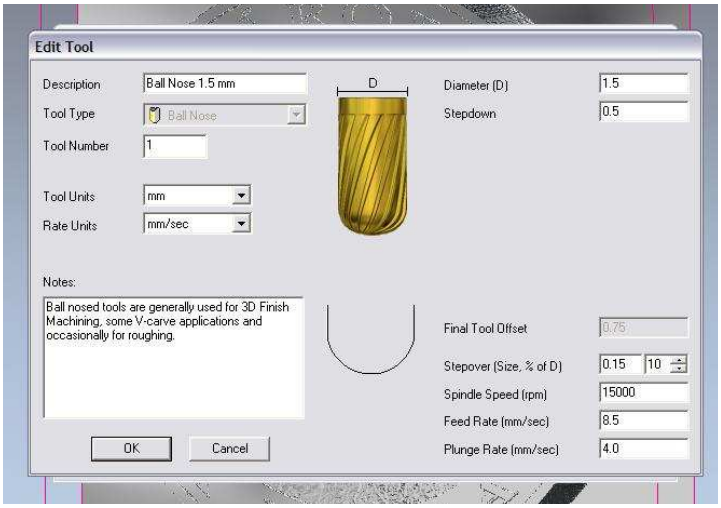

Fig. 2 *Tool set-up in ArtCAM*

For machining following tools and strategies were used. Material: gypsum, tool diamaters: 10,5 and 2 mm. Constatnt Z strategy was used both for roughing and finishing. Athough maximum cutting depth was 1 mm so roughing in this case means machinig with tool diameter of 10 mm but in the same depth of 1 mm as finishing. Finishing than means smaller diameter tools were used and only unmachined areas was machined. For first time raster and for second time offset. Other machining parameters were as following:

Roughing:	Rotational speed : 3000 ot.min.$^{-1}$
	Feed speed : 935 mm.min.$^{-1}$
	Tool : diameter 10mm
Semi-finishing:	Rotational speed : 6000 ot.min.$^{-1}$
	Feed speed : 1000 mm.min.$^{-1}$
	Tool : diameter 5mm
Finishing:	Rotational speed : 6000 ot.min.$^{-1}$
	Feed speed : 4000 mm.min.$^{-1}$
	Tool : diameter 2mm

Total machining time for ArtCAM strategies was 3h 15 min. Total machining time for PowerMill strategies was 3h 35 min. The difference between times is due to differences of NC code. NC code from PowerMill was all-in-one, that means all steps for roughing, semi-finishing and finishing were carried out in one file. From ArtCAM each separate operation was in standalone NC file. Machine times can be lowered using optimalisation of tool moves. Both CAM softwares made some functionless moves. This is a task for software producer to improve the core of mathematical modul to optimalise path generation.

Fig. 3 *Machining with raster strategy*

Conclusion

There is a difference between strategies in PowerMill and ArtCAM. PowerMill as a full capability CAM software has a lot of strategies and offers machining complete in 3D with strategies for five axis milling machines [3]. However all this capability of PowerMill is not necessary for machining 2,5 D sculptured surface. So the result is that ArtCAM CAM strategies fully satisfies the field of 2,5D machining and moreover, it has an advantage than Powermill. As was upwritten PowerMill is an independent CAM software. That means models must be created in another CAD or CAD/CAM software. In this case, model was made in ArtCAM. As export file from ArtCAM was used *.stl file. That means models surfaces was transformed to triangle mesh and this mesh was loaded into powermill. Expected fact is that triangle mesh lower quality of models surface. Although in resolution used in experiment this fact is negligible, but what is important is the fact that the model is created from triangles. The trasformation causes lost of information about individual surfaces so in powermill the model behave like one big surface. This is a big disadvantage in comprasion to original model in ArtCAM. In ArtCAM it is possible to select each individual surface a if it is necessary select different strategy for them. Also it is possible to use vectors and machine along vectors (Pic.4).

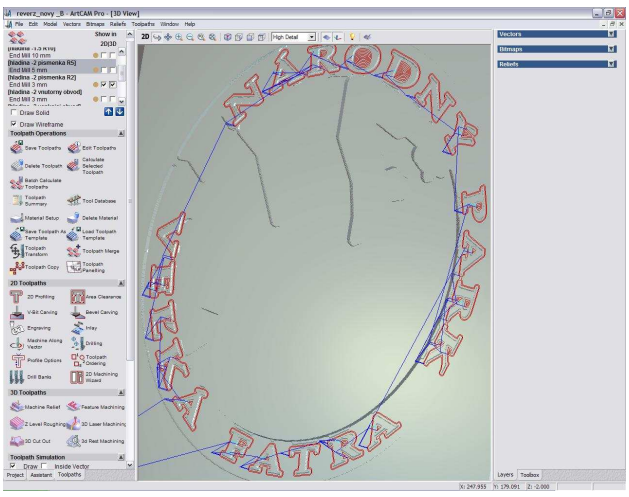

Fig. 4 *Machining along vectors*

This experiments demonstrated that ArtCAM CAM strategies fully satisfies requirements of 2,5 D machining. The difference between surface made using the strategies from Powermill and the strategies from ArtCAM is not recognizable. Both softwares can generate various toolpathts for face milling of coin model (raster, ofset, ..) and both generated NC files are equal. There were only differences in machinig times caused due to facto f copying NC codes. The reason was that NC code made from powermill was all-in-one and from ArtCAM more NC codes were made so that causes longer time for ArtCAM machining.

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References:

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[2] ArtCAM, <http://www.artcam.com>
[3] Excersises for Powermill 9 - five axis machining. User Guide, Birmingham: Delcam Plc, 2006

Technical parameters of the devices were extracted from manuals and user guides. On the basis of that, the tables were created.