

ASPECTS CONCERNING THE SIMULATION OF ROUGHING SCULPTURAL WOODEN SURFACES IN THE CONCEPT OF 5-CNC AXES

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Abstract

This paper proposes a roughing operation simulation using the program Sprut CAM which is destined to generate CNC programs for the three-dimensional milling processing of parts regardless their geometrical complexity.

The simulation results were realized using the program SprutCAM obtained from the Faculty of Engineering "Hermann Oberth", Sibiu, the department of industrial machines and equipment, and the simulations, right from the beginning, were made under the careful guidance of Prof. PhD. Eng. Radu Breaz from the University Lucian Blaga of Sibiu.

The simulation allows various types of viewing, as well as the tools' modification of trajectory, i.e. the intervention in the NC program.

The program offers the possibility to simulate programmed processing operations, using an embedded simulator.

Key word: wooden sculptural surfaces, CNC, roughing operation, cylindrical mill, equipment Fanuc.

INTRODUCTION

Processing of complex parts on a numerically controlled tool machine (CNC) involves the generation of a NC code that contains, in a numerically codified form, the commands for moving the machine's slates and/or tools on the necessary trajectories to obtain the form of the finished piece.

(Curilă S., et al.2008, Curilă, et al., 2008)

In the computer-aided processing (CAM), which involves the use of a type of program like Sprut-CAM, the stages to be followed to obtain the NC code are:

Stage 1: the graphical representation of the piece (model):

- The creation of the geometrical 3D model of the piece by means of a design/modeling external assisted program (CAD - direct introduction of the model);
- The realization of the geometrical model can be achieved by 2D (from the drawing) or 3D scanning (on an existing physical model of the piece, using special scanners);
- The import of the model from the CAD program (DXF, IGES file or other supported formats);

As it can be seen, the geometrical model of the piece is done indirectly, outside the SprutCAM package, but possibilities of direct modelling are present in the program.

At the end of this stage, a graphic file containing the complete information about the geometry of the piece (the model) will be obtained.

Stage 2: defining the tool trajectory by selecting the geometry of the piece:

- Select outlines
- Select entities island/pocket type;

- Select hole structures;
- Select surfaces;
- Select volumes;

At the end of this step the SprutCAM program has information about the geometrical elements which will be processed (the answer to the question WHAT will be processed).

Stage 3: defining of the processing parameters

- Technological information of the tool (type, speed, advance);
- Defining the semi-finished piece;
- Processing strategy (zigzag pocket type processing, spiral type processing, parameters of the roughing processing, parameters of the finishing processing, etc.).

Stage 4: The processing simulation

- Obtaining of a graphical representation of the tools' movement and of the realized processing;
- The simulator allows defining and visualizing of the post-tools used;
- As a result of the simulation, the CL Data will be obtained, which contains all the data relating to the tool's movement and processing sequences;
- The simulation allows identifying of possible collisions and offers the possibility to modify the command file CLDATA generated with the purpose of eliminating these collisions.

Step 5: Modifying the processing sequences

- The SprutCAM program allows changes in the file CL Data.

Step 6: The post-processing

- Converting the CL Data file in NC format specific for a particular type of equipment (The program SprutCAM includes a vast library of over 100 post-processors);
- The program allows the creation of post processors, if they can't be found in the default library;
- The information is filtered and formatted according to the NC code accepted by the equipment, taking into account the specific parameters of the machine on which the processing will be conducted (workspace, revolution and advances speed limitations, tools, etc.).

The roughing operation involves the material removal of the semi-finished parts. This operation is performed in three ways, namely:

- The "Waterline" Roughing – the material removal of the semi-fabricated parts outside of the 3D parts' model. The material is removed by the horizontal movement of the tool (XY) at different Z quotas (level curves). (Răcășan S. 2011, Ganea, M. 2010)
- The "Plane" Roughing – Implies the removal of material of the semi-fabricated parts outside of the 3D parts' model. The working sections are located in parallel vertical planes. The result of the processing is usually closer to the final shape of the finished parts than the result achieved by "Waterline" roughing with the same parameters.
- The "Drive" Roughing – the removal of the material between the model and semi-fabricated parts is done through separated passes. Depending on the operation's parameters, the passes are located either vertically, or in the vertical cylinders whose shape and location are defined by the directorial curves of the model. The result of the processing is often very close to the shape of the finished parts, but because of the unequal value of additional processing on different passes, it is not always possible to obtain an optimal processing time. (Răcășan, 2011, Ganea, 2010)

MATERIAL AND METHOD

The simulation results were realized using the program SprutCAM obtained from the Faculty of Engineering "Hermann Oberth", Sibiu, the department of industrial machines and equipment, and the simulations, right from the beginning, were made under the careful guidance of Prof. PhD. Eng. Radu Breaz from the University Lucian Blaga of Sibiu. (Derecichei Laura 2014)

The SprutCAM package is a 32-bit software application, running under the operating systems Windows 95/98/NT/2000/XP, created by the company Sprut Technologies (<http://www.sprutcam.com>, <http://www.sprut.co.uk>) and marketed in Romania by the company S.C. Regel Tech S.R.L. (<http://www.regel-tech.ro>). (<http://www.sprutcam.com/sprutcam-and-solutions/sprutcam/geometrical-model>, <http://www.sprutcam.com/sprutcam-and-solutions/sprutcam/machining-methods>, <http://www.sprutcam.com/sprutcam-and-solutions/sprutcam/technological-machining>)

SprutCAM can generate programs for milling tools machines (CNC machining centers with up to 5 numerically controlled axes; three translational axes and two rotary axes).

(<http://www.sprutcam.com/sprutcam-and-solutions/sprutcam/purpose>, <http://www.sprutcam.com/sprutcam-and-solutions/sprutcam/postprocessors>)

The SprutCAM program can be used in applications such as:

- Processing of the molds;
- Processing of some complex parts in the aerospace industry;
- Processing of some parts of the wood-working industry and of wooden musical instruments; (<http://www.sprutcam.com/>)

Select model called "panda.stl". After importing on the screen the next image should be displayed, shown in Figure 1.

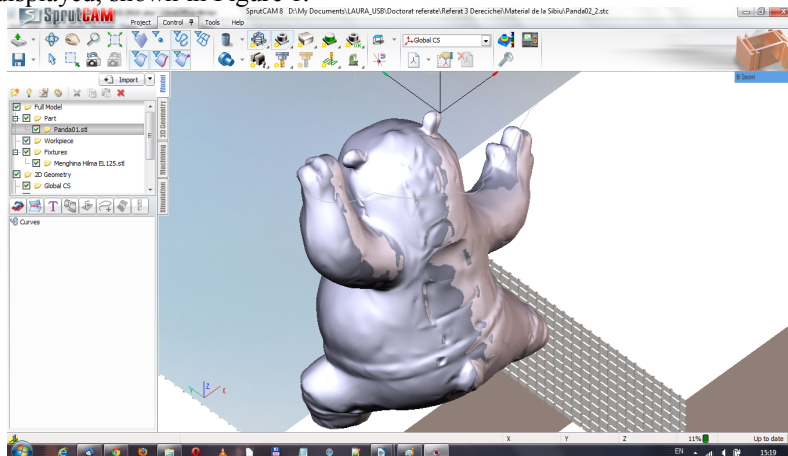


Fig. 1 Geometrical model after the origin modification of the coordinate system

The first operation whose execution will be programmed is a roughing operation type level curve, "Waterline roughing" (Fig. 2), which is probably the most used between roughing operations. (Derecichei Laura et al., 2013, Derecichei Laura, et al., 2013)

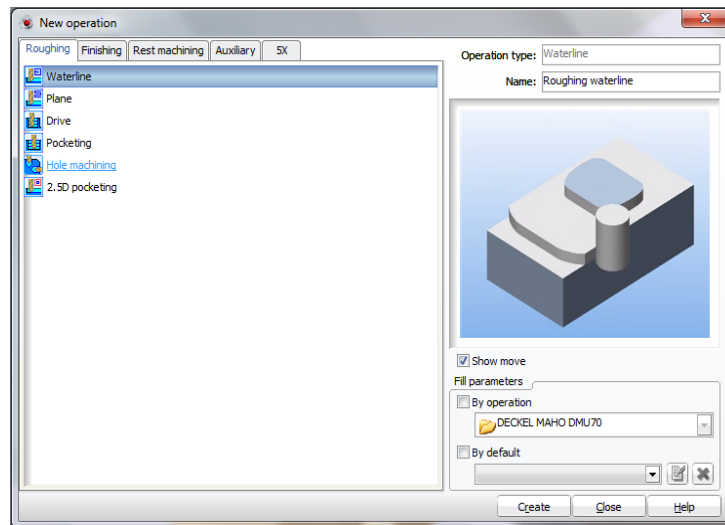


Fig. 2 Selecting the roughing operation level curve type (“Roughing Waterline”)

The process of parameters’ modification can be done by selecting and modifying from left towards right of the parameter groups of the dialog box that opens after clicking the "Parameters" button. The Execution from left to right is a recommended approach, but not mandatory, the user being allowed to change the parameters in the desired order. (Ganea, 2010)

If we are clicking the "Tools" button, the dialog box shown in Figure 3 will appear on the screen. As it can be observed, the program has a configurable library of tools of which we can select the desired tool, or we can define a new tool that can be saved in library for subsequent use. The type of tool proposed by the program will be selected, frontal cylindrical mill (“Cylindrical mill”) and the diameter will be changed to $D = 20$ mm and the length to $L = 120$ mm. (Ganea M., 2010, Ganea, M., 2010, Ganea O., 2007.)

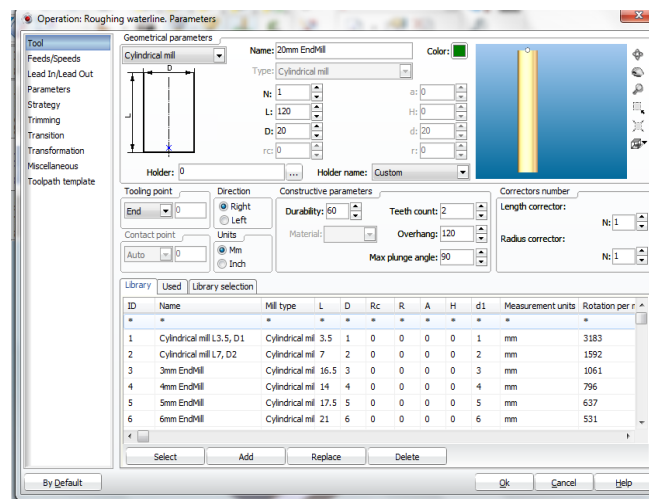


Fig. 3 Defining the parameters for the roughing tool

The next stage involves defining the splitting regime parameters by clicking on the "Feedrate" button. The splitting speed can be defined directly or a turning speed value can be introduced, the splitting speed being automatically calculated. A speed of 200 rev / min, which will lead to a splitting speed of 12.566 m / min, according to Figure 4 will be introduced. An advance speed of 200 mm / min will be selected and then the values will be confirmed by clicking the "OK" button. (Ganea M., et all - 2010, Ganea M., et all – 2000)

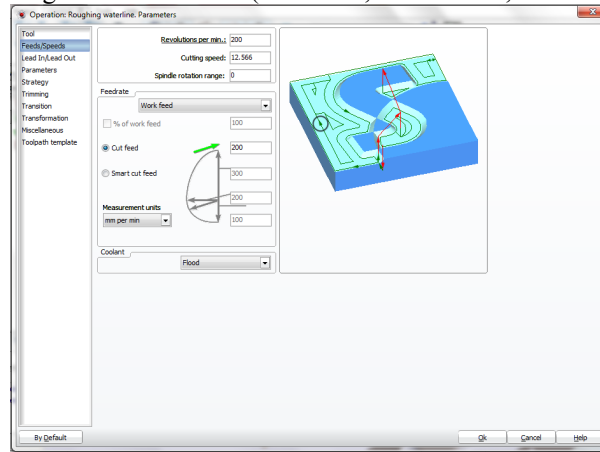


Fig. 4 The splitting regime parameters for roughing

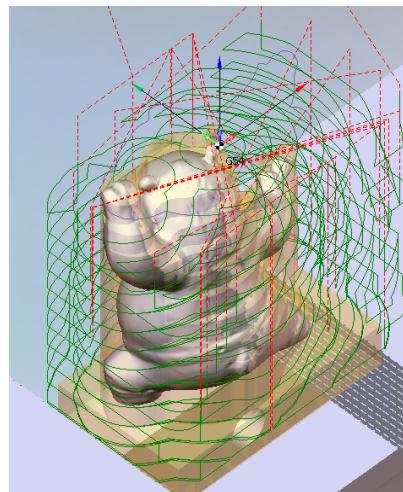


Fig. 5 The toolpath calculation for roughing with the program SprutCam

RESULTS AND DISCUSSIONS

The images shown on the screen after running the roughing processing simulation, are shown in the figures below. The simulation allows various types of viewing, as well as the tools' modification of trajectory, i.e. the intervention in the NC program. (Derecichei, et al., 2013, Derecichei, 2013, Lustun, et al., 2012)

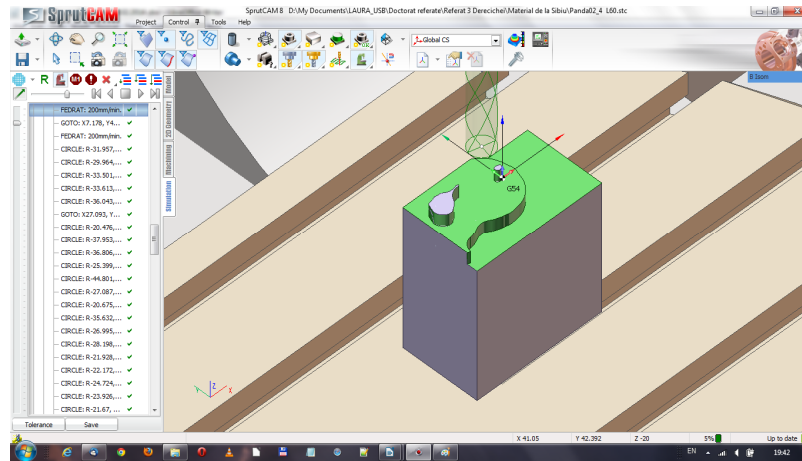


Fig. 6 Piece after the roughing operation simulation

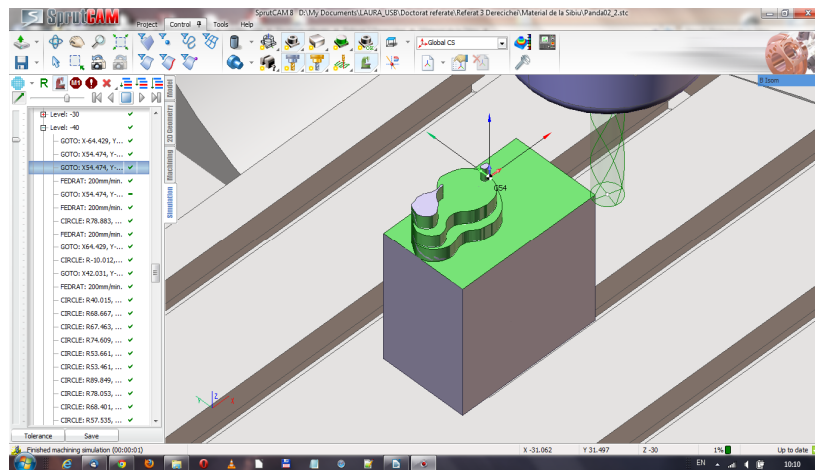


Fig. 7 Piece after the roughing operation simulation

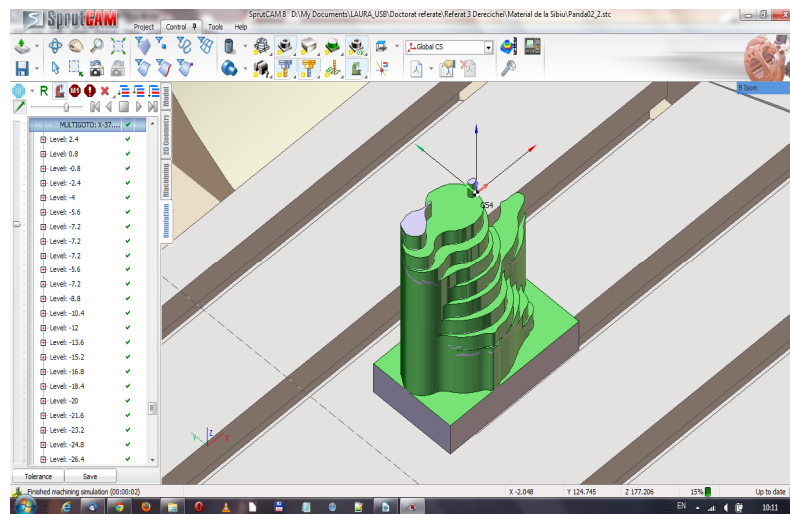


Fig. 8 Piece after the roughing operation simulation

Generating the NC program requires to return to the menu “Machining” and to click the “Postprocessor” button. As a result to this, the window “NC-program generation” will appear on the screen. From this window it is possible to select the equipment type and file name in which it is desired to save the generated NC program. (Marciniak K. – 1991) Continue by clicking on the “Run” button to launch the program generation. The NC code will be displayed in the window and will also be saved in a file with a specific extension for each type of equipment. The NC code generated for an equipment FANUC (30i)_Mill is presented in the Figure 9. (www.gefanuc.com;))

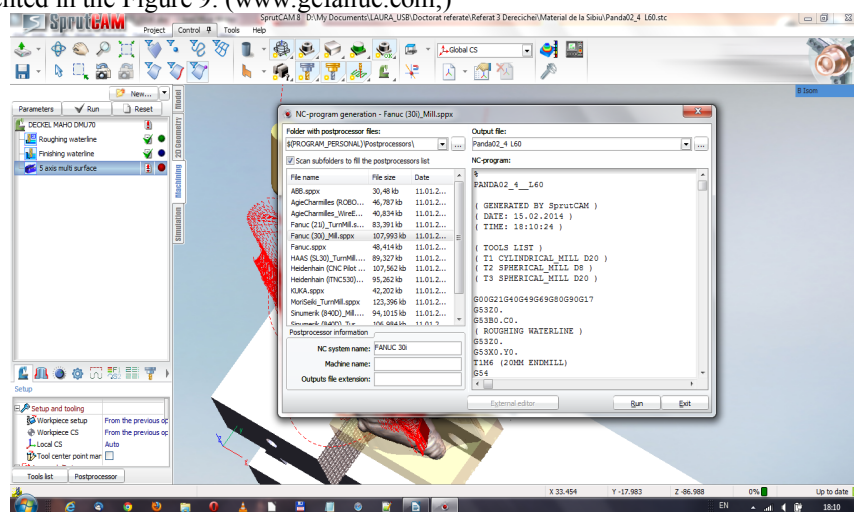


Fig. 9 Generating of the NC program for a Fanuc (30i)_Mill equipment

PANDA

(GENERATED BY SprutCAM)
 (DATE: 27.02.2014)
 (TIME: 15:01:02)

(TOOLS LIST)
 (T1 CYLINDRICAL_MILL D20)
(T2 SPHERICAL_MILL D8)
 (T3 SPHERICAL_MILL D30)

G00G21G40G49G69G80G90G17
 G53Z0.
 G53B0.C0.
 (ROUGHING WATERLINE)
 G53Z0.
 G53X0.Y0.
 T1M6 (20MM ENDMILL)
 G54
 G68.2X0.Y0.Z0.I0.J0.K360.
 G53.1
 G17
 S200M3
 G00G43H1X64.429Y-32.402Z10.B0.C0.
 Z5.
 M8
 G01G94Z-10.F200
 G02X56.236Y-42.251I-59.555J41.208
 X55.153Y-42.392I-1.758J9.266
 G01X40.619
 G03X60.769Y-19.032I-36.27J51.657
 X64.429Y-9.948I-55.493J27.635
 G01Y26.499
 G03X56.968Y42.088I-57.936J-18.15
 X55.08Y42.392I-2.585J-10.018
 G01X44.088

.....
 (5 AXES MULTI SURFACE)
 X-81.191Y47.382Z-13.743B-19.016C-73.65
 X-81.983Y47.377Z-14.016B-18.989C-72.497
 X-82.806Y47.352Z-14.299B-18.97C-71.342
 X-83.66Y47.308Z-14.592B-18.958C-70.184
 X-84.543Y47.245Z-14.895B-18.952C-69.026
 X-85.455Y47.163Z-15.208B-18.955C-67.868
 X-86.393Y47.061Z-15.531B-18.964C-66.71
 X-87.358Y46.94Z-15.865B-18.98C-65.553
 X-88.347Y46.801Z-16.209B-19.004C-64.399
 X-90.181Y46.334Z-16.831B-18.922C-61.56
 X-92.18Y45.752Z-17.513B-18.884C-58.703
 X-93.857Y45.082Z-18.073B-18.796C-55.964
 X-90.005Y45.358Z-16.697B-18.267C-58.019

(<http://www.sprutcam.com/sprutcam-and-solutions/sprutcam/postprocessors>)

CONCLUSIONS

The main features which separate SprutCAM from other programs of the same class are:

- The possibility to access components of an imported geometrical model and their modification: scaling, shifting, spins, projections, modification of the origin of the coordinated axes;
- Possibility of developing a technological model based on the imported geometrical model ;
- The existence of an advanced set of functions for controlling the process parameters;
- Defining possibilities of initial semi-finished parts of various forms (prismatic, cylindrical, semi-finished molded parts, semi-finished parts obtained by extrusion, semi-finished parts defined as independent geometrical models);
- Restricted areas of the processing may be defined (for attaching the fixing systems of the parts on the machine's table).

The program offers the possibility to simulate programmed processing operations, using an embedded simulator. SprutCAM also offers the opportunity to develop post-processors for any CNC system, by the "Invariant Postprocessor" feature.

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21. <http://www.sprutcam.com/sprutcam-and-solutions/sprutcam/purpose>
22. <http://www.sprutcam.com/sprutcam-and-solutions/sprutcam/postprocessors>
23. <http://www.sprutcam.com/>