PARAMETRIZED APPLICATION PROGRAMMING FOR MANUFACTURE OF SEMI-CYLINDRICAL SURFACES IN CNC MACHINES.

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Abstract. The computer numerical control (CNC) machines can be programmed. They have functions that help to get different surfaces of varied geometry in the manufacturing process of mechanical parts. This research has the purpose to present a methodology of application of the resources of parametrized programming for the developing of manufacturing cycles to a machine (CNC). The parametrized programming seems to be an efficient tool to implement routines that the machine does not have. By using traditional programming resources, it reduces the number of programming lines in relation to more used methods. This work shows a technique that increases the machine operational efficiency by increasing the programming resources, and also adds value to the use of the machine in the operational production process.

Keywords*: computer numerical control, parametrized programming, manufacturing cycles, manufacture*

1. INTRODUCTION

Machinery in need of positioning, velocity and acceleration control can be automated by a computerized numerical control (CNC). Currently, machine tool driven by CNC, equipment are widely used in production systems. Drills, punching, brakes, lathes, milling and boring are some examples (Lynch, 1997).

To produce a machined part with a machine controlled by CNC, several procedures are needed. One key is the development of the CNC. This program contains geometrical information and technology for machining planned and should provide good quality of finish, reducing operational cost and reducing the time of operation.

The CNC programming is done with various techniques, depending on the available financial and technological level, and may be from the manual entry of data, directly in charge of the machine, even the most advanced techniques, such as CAD / CAM (Computer Aided Design / Manufacturing Computer-assisted), which includes the steps of design and manufacturing. The software CAD / CAM files, process design of parts in CAD systems to automatically retrieve the CNC program, allow the simulation of machining with selection of tools and transmit the commands to the machine at the time of production.

Despite the efficiency of CAD / CAM, programming manual is very used, mainly in the programming of regular geometries. In this form of programming, there are functions that help the programmer. Examples of these functions are the machining cycles for roughing operations and implementation of regular cavities or bumps.

The program is a parameterized form of advanced programming guide that allows CNC programs included in mathematical calculations, computational variables and conditional deviations. This allows implementing algorithmic logic in the operation of the machine control number (Lynch, 1997).

Many CNC machines do not support modern programming by limiting the ability of memory, as they were originally designed for a programming manual containing a few lines of command capable of producing simple geometries. The modern programming techniques and automated, which facilitates more complex geometries, become difficult to be applied to these machines by generating extensive CNC programs. Furthermore, the need for labor and the need for qualified purchase of equipment (computers) and software for high cost, are limitations that impede investment in these technologies, especially for small and medium businesses (Gibbs, 1994).

This work aims to propose a methodology to increase the capability of CNC machines through the application of resources in the development of parameterized programming of machining cycles.

This study has been a reference to the application of a programming technique that although little publicized, when used properly can generate routines for standard or parameterized geometries.

The proposed methodology is demonstrated by using routines implemented in the command of a vertical machining center with CNC control, belonging to the Center for Automation and Manufacturing Processes, Universidade Federal de Santa Maria (Nafa / UFSM).

2. METHODOLOGY

2.1. Semi-Cylindrical Cavity subtitles

This cycle of machining aims to form a circular feature. Different techniques can be used. In such a case, the cycle has studied the rectangular cavity, a subroutine already studied, which is the basis to complete the profile. This cycle is performed in layers, with reduction of area at each step in the direction of (Z). As is shown in Figures 1 and 2.

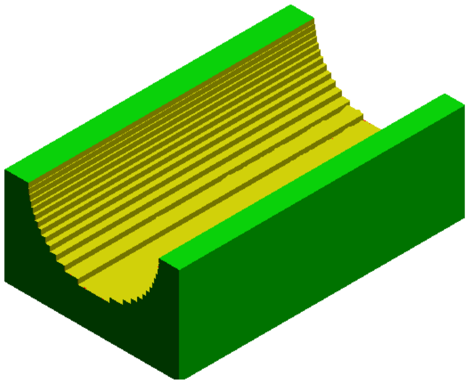


Figure 1 - Rip semi-circular

Each increment of the depth it recalculates the value of length, and applies the movement cycle rectangular cavity, as proposed previously. This process is used to limit the height of the semi-circle. In Figures 2, 3 and 4, we geometries for mathematical development.

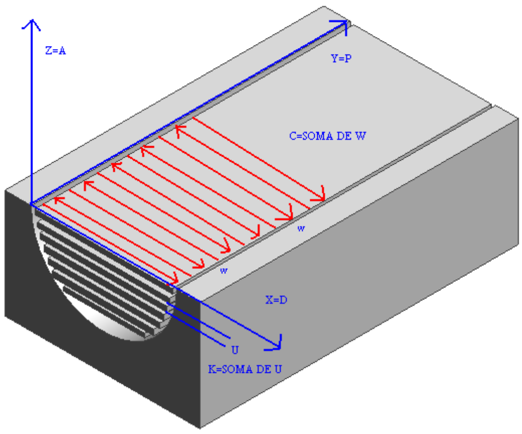


Figure 2 - Scheme for the development of semi-circular profile

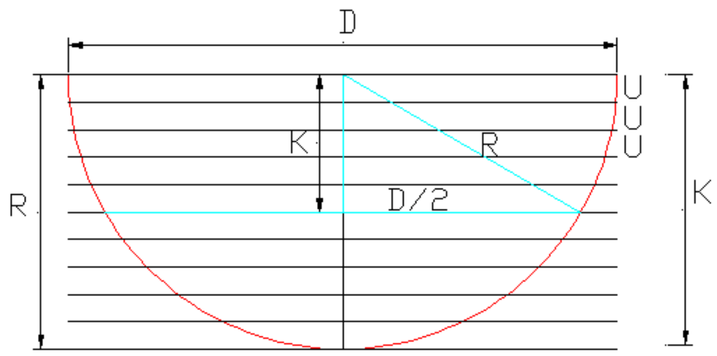


Figure 3 - Front view of semi-circle profile

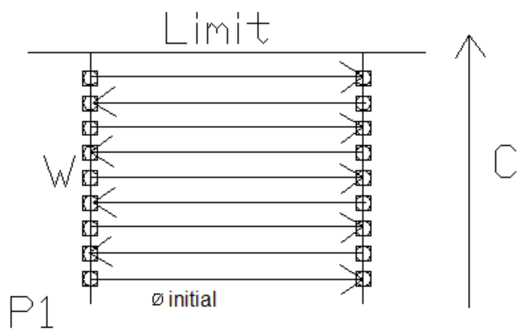


Figure 4 - Top view of the movement of the tool

The triangle depicted in Figure 5, is the geometric variables used to determine the algorithm being implemented.

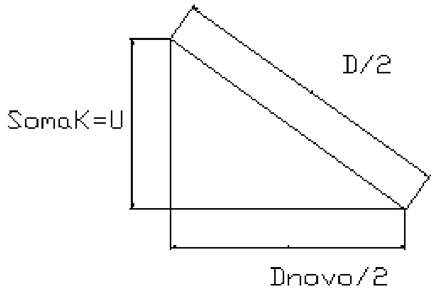


Figure 5 - Triangle from the Figure 3

The Equation (1), represents the value calculated for half the length of each new rectangular area. This new diameter is subtracted from the original to obtain the new point in (X), as shown in Equation (2).

$$\left(\frac{D}{2}\right)^2 = \left(\frac{Dn}{2}\right)^2 + K^2$$

$$Dnovo = \sqrt{\left(\left(\frac{D^2}{4}\right) - C^2\right) * 4} \qquad (1)$$

$$Xnovo = (((Dnovo - R)/2) * B) \qquad (2)$$

Figure 6 shows the layout of the tool. Table 1 lists the variables necessary to program the routine of the machining cavity semi-circular.

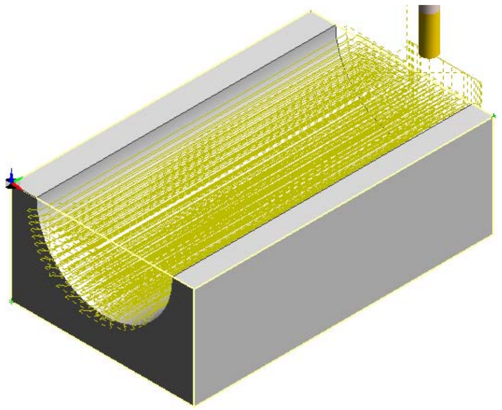


Figure 6 - Primitive path tool for machining the part

Table 1 - Variables for the program rip cylindrical

Variables	Definition
D	Length
L	Larger
P	Depth
W	Cutting Width
U	Depth of Cut
C	Count (Y)
B	Inverter
R	D/2
K	Counter (Z)

Algorithm

To use this course of machining, the programmer needs to position the tool at point P1. Starting the cycle the tool advances the value of the value (X) which is the length represented by the diameter (D) represented in the flowchart of Figure 43. The value of (X) is applied to inverter. If the value of (Y) is not the most, forward (W) which is the width of cut. When reached the value of (Y) than occurs in a last movement (Y) maximum. If the (Z) maximum was not reached, return to the X, Y start and calculate the new value for (D) by Equation (1), and the new value for the initial point (X) by Equation (2). Goes to the new value of (X) and redirects to the beginning of the module. If the (Z) is maximum is reached the end of the program.

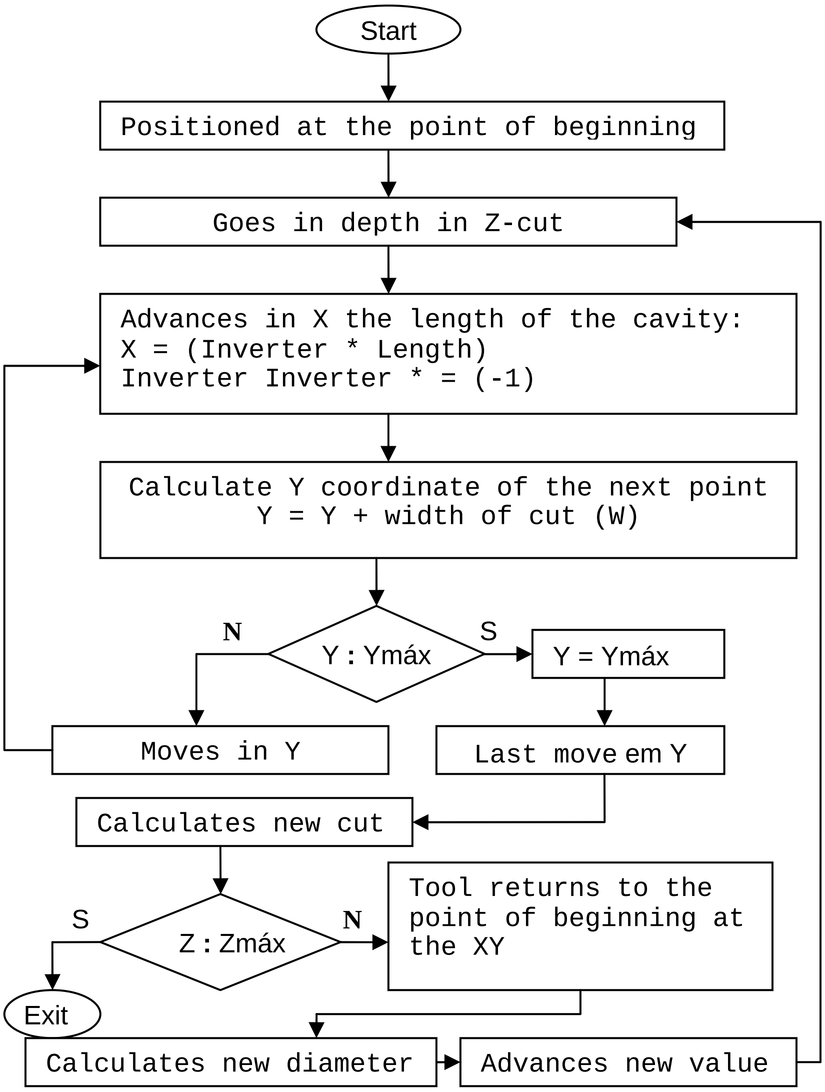


Figure 7 - Flowchart semi-cylindrical cavity

2. RESULTS AND DISCUSSION

The proposed program in the CNC language parameterized to achieve the cycle conical cavity is described in Table 2.

Table 2 - Parametric Programming for CNC tear similar circular

Codes	Overview
G39 C0 B1 K0	Variables
N4 G01 Z-(LU)	Initial Depth
N1 G01 X(LX*LB)	Value along the x
G39 B(LB-1)	Exchange inverter
M (LE(LY-LC)) H2	If the difference is less zero
G01 Y(LW)	Advance Tool
G39 C(LC+LW)	Count y
H1	Redirect
N2 G00 Z(LU/4)	Get the piece
G00 Y-(LC-LW)	Returns and initial
G39 K(LK+LU)	Meter z
M (LE(LZ-LK)) H3	Difference is less equal zero
G39 D(SQR(((D2/4-C2)*4)	Calculates new d
G00 X(((LD-LR)/2)*B)	Placement new
G39 C0 X(LD)	Receive variable
G00 Z(LK)	Goes z
H4	Redirect
N3 G00 Z0 M2	End

Figure 8 and 9 show the control program of simulating the cylindrical cavity as required in programming. Figure 10 shows the program generated by CAD / CAM for the cylindrical cavity.

Figure 8 - Graphic simulation of the circular cavity (X, Y)

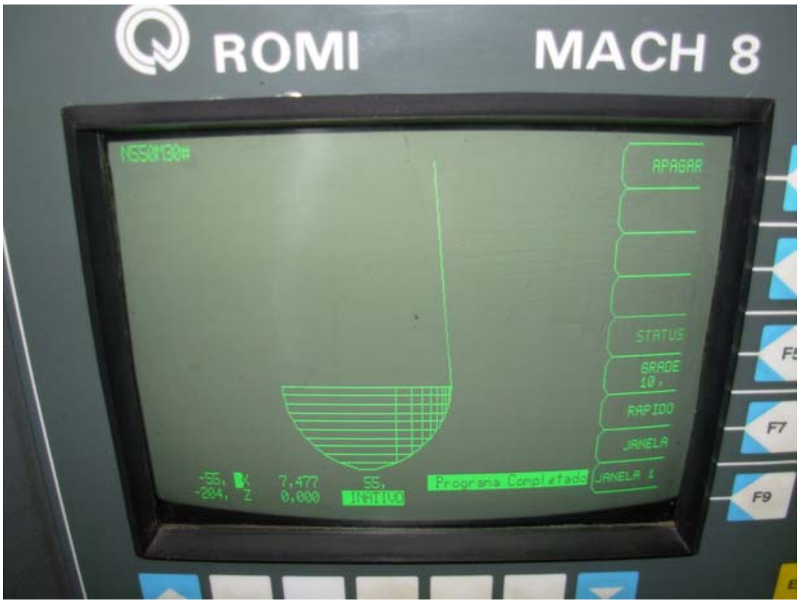
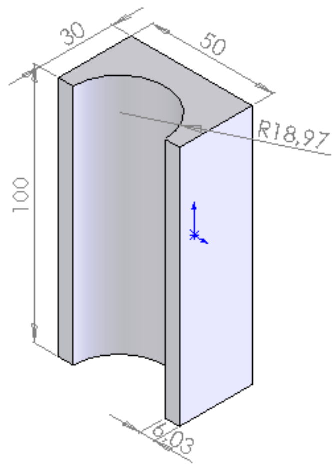


Figure 9 - Graphic simulation of the circular cavity (X, Z)

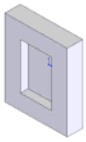
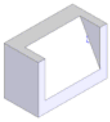
```
%
N1 G20 G90 G40
N2 G10 P1 Z0.0 R0.1181 T00
N3 G10 L2 P1 X0.0 Y0.0 Z0.0 (Top)
N4 (ROUGHING OPERATION)
N5 G28 G91 Z0
N6 G28 X0 Y0
N7 G90
08 T00 (USER DEFINED)
N9 G54 M06
N10 T00 M01
N11 S2000 M3 M41 M9
N12 G0 X1.3226 Y4.7772
N13 G43 Z0.1969 H00 M7
N14 Z-0.0394 F196.75
N15 G1 Z-0.0787 F98.38
N16 Y4.7376 F196.75
N17 X1.3249 Y4.7189
N18 G17 G2 X1.3304 Y4.621 R1.2058
N19 G1 X1.33 Y-0.0247
N20 G2 X1.3248 Y-0.1014 R0.9584
N21 G1 X1.3227 Y-0.1175
N22 X1.3226 Y4.7376
N23 X1.2367 Y4.7375
N24 G3 X1.2079 Y4.7024 R0.0315
N25 G2 X1.2123 Y4.6232 R1.0968


N1916 G00 Z20.0 M09
N1917 Z0 H00 M19
N1918 M30
%
```




```
%
N1 G99
N2 G71
N3 T1 M6
N4 O1
N5 G00 X0.Y0.Z0.
N6 G39 R20. Y100. Z30. W5. U5. P1
N7 M2
%
```

Figure 10 - Program created by CAD / CAM for the cylindrical cavity

Table 3 shows the number of lines generated by CAD / CAM system and the system of parameterized programming. Using a cutting tool of 14 mm and with different depth of cut 2mm and 0.5mm.

GEOMETRY	CAD/CAM	PARAMETERIZED
	Dimensions : X40.Y60.Z20. For depth of cut U=2. Generated ***172*** lines For depth of cut U=0.5 Generated ***607*** lines	Dimensions: Any Programmed with ***13*** lines
	Dimensions : X80.Y30.Z53. For depth of cut U=2. Generated ***1481*** lines For depth of cut U=0.5 Generated ***6052*** lines	Dimensions: Any Programmed with ***15*** lines
	Dimensions : R50.C25.Z10. For depth of cut U=2. Generated ***645*** lines For depth of cut U=0.5 Generated ***2462*** lines	Dimensions: Any Programmed with ***17*** lines
	Dimensions : R200.C30.A0.B360. For depth of cut U=2. Generated ***993*** lines For depth of cut U=0.5 Generated ***4130*** lines	Dimensions: Any Programmed with ***23*** lines
	Dimensions : R50.A0.B360.H30. For depth of cut U=2. Generated ***433*** lines For depth of cut U=0.5 Generated ***1778*** lines	Dimensions: Any Programmed with ***13*** lines
	Dimensions : D40.Y100.Z30. For depth of cut U=2. Generated ***1918*** lines For depth of cut U=0.5 Generated ***7747*** lines	Dimensions: Any Programmed with ***17*** lines

2.2. Restrictions of cycling

Although not expected to finish parameters, conditions of reduced cutting width and depth of cut can be generated in the last pass of thinning, when properly defined parameters. The compensation of the tool can be done inside the loop with the entry ramp depending on the type of tool used.

3. CONCLUSION

The methodology has shown that parameterized programming on CNC equipment is a useful technique to increase the flexibility and capability of production systems. Compared with the generation of CNC programs using CAD / CAM systems, the proposed method has advantages in the manufacture of similar geometries. When changes in the dimensions of a geometry in the CAD / CAM system is to restart the whole process, or redesign the part in CAD, load the file in CAD / CAM, machining and set parameters for generating new program. In the proposed system, these steps are unnecessary because the user specifies the new geometry of the cut only by redefining the parameters of the cycle.

Comparing the size of CNC programs generated by the two processes by observing the number of blocks. The significant difference in the size of the programs implies a lesser need for the control memory for programs generated by machining cycles parameterized. In commands with limitations in memory capacity, this feature more storage capacity means the number of programs.

Another advantage is that we can see that the cycles available on CNC machines are hard on the sequence of machining. The proposed technique allows the generation of new machining cycles for the same geometry, with free setup. Some courses available on command, for example, can run only in the machining mode concordant or discordant. To reverse the condition available, simply set a new cycle with reversed sequence of machining on the original.

Although the geometries are analyzed relative simplicity of the technique of combination of these routines, and the cycle of multiple elliptical cavities, shown to be a possibility of developing more elaborate routines. However, the limitation to program more complex geometries and complex programming, disadvantages are found in the system of parameterized programming.

4. REFERENCES

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