International Journal of Engineering & Technology, 7 (2.13) (2018) 376-380

International Journal of Engineering & Technology

Website: www.sciencepubco.com/index.php/IJET

Research Paper

Machining Process Simulation to Find NC Program and Cutting Time

Abdul Haris Nasution[1], Suhardi Napid[1], Istu Sri Poneni[1], Abdurrozzaq Hasibuan[2], Suliawati[2]

[1]Department of Mechanical Engineering, Universitas Islam Sumatera Utara, Medan, Indonesia
[2]Department of Industrial Engineering, Universitas Islam Sumatera Utara, Medan, Indonesia
**Corresponding author E-mail: aharisnst@ft.uisu.ac.id*

Abstract

To produce the bulk products in metal industry, tool path and cutting time are necessary to predict the amount of product that can be produced within a certain time (throughout the tool life). The ways used so far are to sacrifice some of the product as an experimental material. Using such a method will cause many losses, including much time to machining product by trial and error will cause the waste materials. To solve problem above, this paper described solution to get the accuracy of tool path and cutting time. The solution offered is to use software to simulate the machining process, so that losses due to time and wasted materials can be resolved.

Keywords: *Simulation, Machining Process, tool path, Machining Time*

1. Introduction

In developed countries nowadays we have developed machining industry with complete automation concerning the preparation of work piece, tool, tool holder, and its management by using computer in an integrated system called CIM (Computer Integrated Manufacturing) which consists of hard and soft technology [1], [2]. It aims, among others, to further improve the activity and productivity of the machine. An investigation by Fallbohmer on cast iron and Alloy Steel machining for die and mold manufacturing reports that conventional machining compared to machining using the Numerical Control (NC) Program can reduce machining time (20 ~ 50)% [3].

By using CIM technology product quality can be improved, repeatability of manufacture can increase the quantity, work time can be shortened, minimize human involvement, minimize work piece damaged by human error factor, improve worker safety, and efficiency can be improved [4].

2. Methodology

The simulated work piece is a cast iron with a chemical composition C = (2.5-4.0)%, Si = (1.8-3)%, Mn = 0.8%, S = (0.02 -0.25)% P = (0.02-1.0)%. Mechanical properties: Tensile Strength = 52.5 K.Psi, Compressive Strength = 164 K.Psi, Modulus of rupture = 73 K.Psi, Tension = 18.8 - 22.8 M.Psi, Torsion = 7,2 - 8,0 KPSI, Endurance limit = 21,5 K.Psi, Brinnel Hardness = 280 HB.. The desired maximum surface roughness (Ra) is 2.4 µm (*medium finish*).

The equipment used is Personal Computer (PC) with software simulation machining process. The tool used is uncoated carbide with complex chip breaker CNMG 120412 EN-TM with chemical properties: Co = 6.0%, composite carbides = 0.6%, rest and mechanical properties: HV = 1550, Tool holder PCLN / R 2525 M12-T with angle Kr = 95^0 [5].

The method used is to design a working drawing with CAD software and then proceed with pulley machining process design is done by using machining features that have been standardized[6][7]. The machining features are then incorporated into the machining simulation program [8][9]. There is some machining features that standardized:

1. The machining feature of the finish, machining on the side of the work piece, machining process is done by cutting the work piece to change the diameter of the work piece to ***b*** mm along ***a*** mm (figure 1). The NC program used for the process is shown in Table 1.

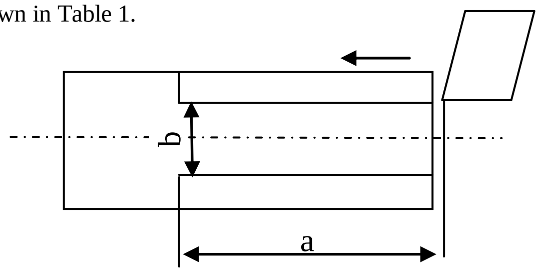

Fig 1: Machining Features

Table 1: NC Program of *Finish* Machining Features

N	G	X	Z	F
…	…	…	…	…
…	01	b x 1000	-(a x 1000)	…
…	…	…	…	…

2. Groove machining feature (sloting), machining on work piece to make groove with diameter **b** mm and width **c** mm (figure 2). NC program for the machining process is shown in table 2.

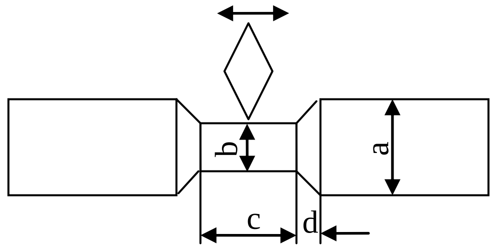

Fig 2: Groove Machining Features

Table 2: NC Programe of *Groove* Machining Features

N	G	X	Z	D3	D5	F
…		…		…		
…	86	bx1000	-(c+d)x1000	1	2	…
…	01	ax1000	0	…	…	…
…	01	bx1000	-(dx1000)	…	…	…
…	01	bx1000	-(c+d)x1000	…	…	…
…	01	ax1000	-(c+2d)x1000	…	…	…
		…		…	…	…

3. Face machining feature, is machining feature for cutting at-work piece tip (from side of work piece to center point) as shown in figure 3. NC program for machining process as shown in table 3.

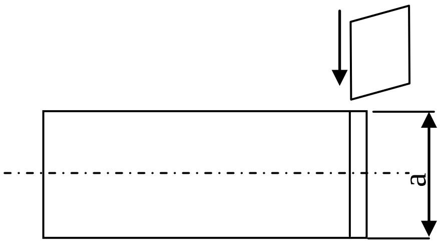

Fig 3: Face Machining Features

Table 3: NC Program of Face Machining Features

N	G	X	Z	F
…	…	…	…	…
…	01	-(½a x 1000)	0	…
…	…	…	…	…

3. Results and Discussion

The machining performed for each pulley product is carried out in two machining stages. ie the machining of part 1 (figure 4) and the machining of the other part, which is part 2 (figure 5). The machining of the pulleys that is:

a. Part 1 consists of machining features: face, finish and face.

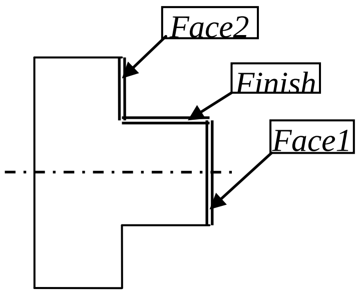

Fig 4: Machining Features on Machining Part 1

b. Part 2 consists of machining features: *finish* and *Groove*.

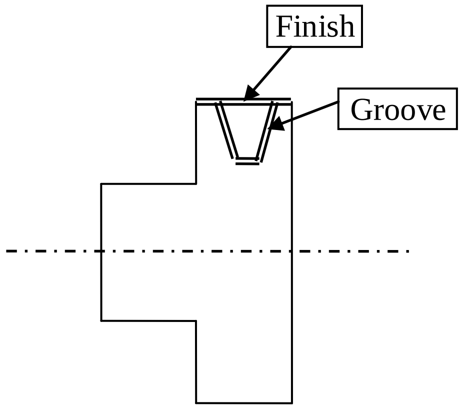

Fig 5: Machining Features on Machining Part 2

Pulley Cutting Simulation

Machining Simulation Part 1
In machining part 1 is done machining by entering data as follows: tool type and geometry, cutting conditions, tool path.

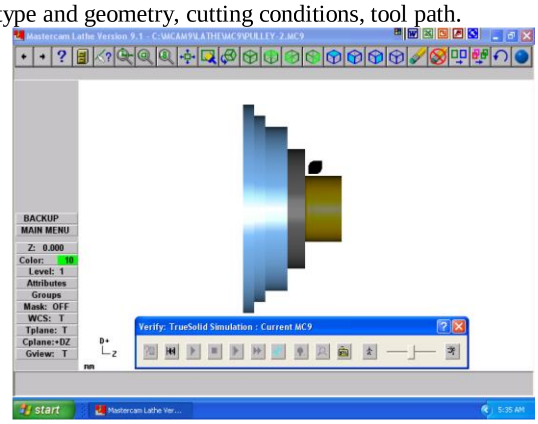

Fig 6: Pulley Machining Simulation Part -1

From figure 7. Obtained the time of *face 1* machining = 5 seconds.

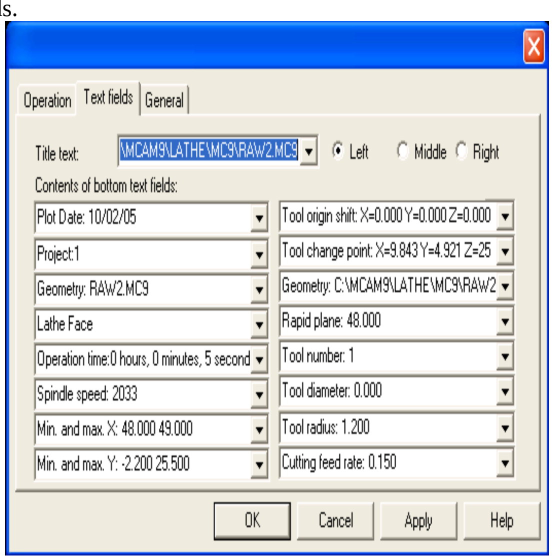

Fig 7: Face 1 Machining time on Machining Part 1

From Figure 8, Obtained the time of finish machining = 5 seconds.

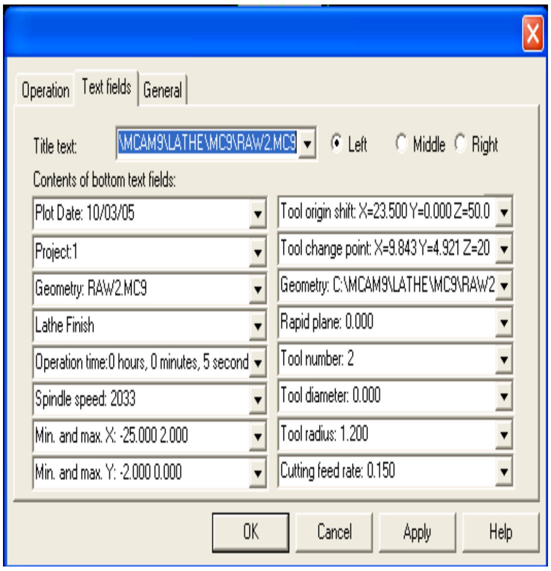

Fig 8: *Finish* Machining Time on Machining Part 1

From Figure 9. Obtained the time of machining *face2* = 7 seconds.

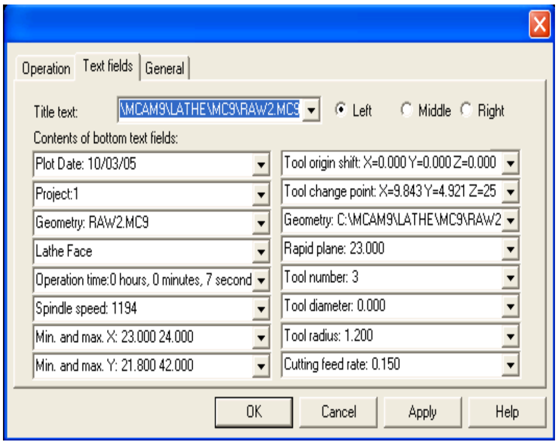

Fig 9: *Face 2* Machining Time on Machining Part -1

NC Part 1 pulley machining program
%
O0001
G21
(PROGRAM NAME - RAW2-AA DATE = DD-MM-YY - 03-10-05 TIME = HH: MM - 00:01)
(TOOL - 1 OFFSET - 1)
(OD ROUGH RIGHT - 80 DEG. INSERT - CNMG 12 04 12 EN TM)
G0 T0101
G97 S2033 M03
G0 G53 X51. Z48. M8
G99 G1 X-4.4 F.15
Z49.
M9
G28 U0. W0. M05
T0100
M01
(TOOL - 2 OFFSET - 1)
(OD ROUGH RIGHT - 80 DEG. INSERT - CNMG 12 04 12 EN TM)
G0 T0201
G97 S2033 M03
G0 G53 X0. Z0. M8
Z2.
X-4.
G1 Z0. F.15
Z-25.
X-1.172 Z-23.586
M9
G28 U0. W0. M05
T0200
M01
(TOOL - 3 OFFSET - 3)
(OD ROUGH RIGHT - 80 DEG. INSERT - CNMG 12 04 12 EN TM)
G0 T0303
G97 S1194 M03
G0 G53 X84. Z23. M8
G1 X43.6 F.15
Z24.
G0 X46.233
M9
G28 U0. W0. M05
T0300
M30 %

Machining Simulation Part 2

After the machining simulation of part 1 is completed, the machining simulation of part 2, ie the groove making (figure 10) for the purpose of obtaining machining operation and NC Program.

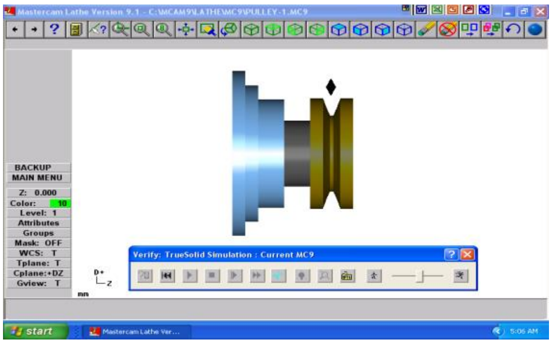

Fig 10: Pulley Machining Simulation Part 2

Figure 11 Obtained the time of *finish* machining = 9 seconds.

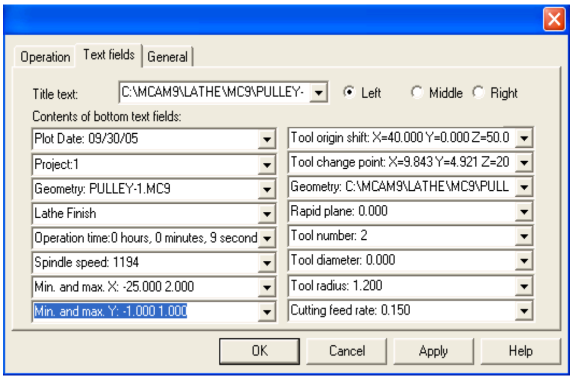

Fig 11: *Finish* Machining Time on Machining Part 2

Figure 12, Obtained the time of *groove* machining = 1 minute, 33 seconds.

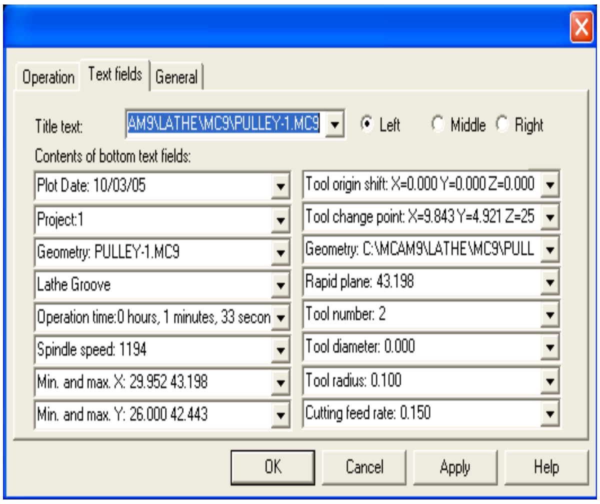

Fig 12: *Groove* Machining Time on Machining Part 2

NC program of Pulley Machining Part 2

```
$RAWMAT2.MIN%
O0001
(PROGRAM NAME - RAWMAT2 )
(DATE=DD-MM-YY - 30-09-05 TIME=HH:MM -
01:20 )
( TOOL - 1  OFFSET - 3 )
(OD ROUGH RIGHT - 80 DEG. INSERT - CNMG 12
04 12 EN-TM )
G0 X170. Z200.
T0203
G97 S1194 M03 M41
G0 X0. Z0.
Z2.
X-2.
G95 G1 Z0. F.15
Z-25.
X.828 Z-23.586
G0 X2.
Z-23.
G0 X170. Z200.
M05
M01
( TOOL - 2  OFFSET - 2 )
(OD GROOVE CENTER - NARROW    INSERT –
 CNMG120412 EN TM )
G0 X250. Z250.
T0102
G97 S1194 M03 M41
G0 X83.975 Z36.575
G95 G1 X50.4 F.1
G0 X83.975
Z34.584
G1 X53.922
X51.391 Z34.971
G3 X50.4 Z35.64 I.205 K.669
G1 Z36.575
G0 X83.975
Z`38.566
G1 X53.922
X51.391 Z38.179
G2 X50.4 Z37.51 I.205 K-.669
G1 Z36.575
X50.798 Z36.376
G0 X83.975
Z32.592
G1 X66.949
X53.922 Z34.584
X54.32 Z34.783
G0 X83.975
Z40.558
G1 X66.949
X53.922 Z38.566
X54.32 Z38.367
G0 X83.975
Z30.601
G1 X79.975
X66.949 Z32.592
X67.347 Z32.791
G0 X83.975
Z42.549
G1 X79.975
X66.949 Z40.558
X67.347 Z40.359
G0 X83.975
Z28.995
X82.687
G1 X79.858 Z30.41
X51.274 Z34.779
G3 X50. Z35.64 I.263 K.861
G1 X50.5 Z35.39
G0 X82.687
Z44.155
G1 X79.858 Z42.74
X51.274 Z38.371
G2 X50. Z37.51 I.263 K-.861
G1 Z37.29
X50.5 Z37.54
G0 X82.687
G0 X250. Z250.
M05
M02
%
```

Testing of simulation result by experimental.

The simulation result of machining process by using computer software obtained simulation cutting time, also obtained NC program which is then inputted into CNC machine to perform machining operation of product. From the results of CNC cutting operations are also obtained cutting time per product. In table 4 can be seen the differences in time of machining simulation and time of real machining are very thin.

Table 4: Machining Time of Simulation Compared with Real Time Machining

CC	V	F	A	t Simu-lation	t Real
1	300	0,15	0,5	0:02:53	0:02:51
2	300	0,15	1	0:01:59	0:01:58
3	300	0,25	0,5	0:01:43	0:01:43
4	300	0,25	1	0:01:11	0:01:12
5	500	0,15	0,5	0:01:43	0:01:43
6	500	0,15	1	0:01:12	0:01:12
7	500	0,25	0,5	0:01:03	0:01:04
8	500	0,25	1	0:00:42	0:00:44

In Figure 13, it can be seen more clearly the difference in graph of machining time of each cutting condition from machining operation simulation and from CNC machining operation (experimental) that the differences are very thin.

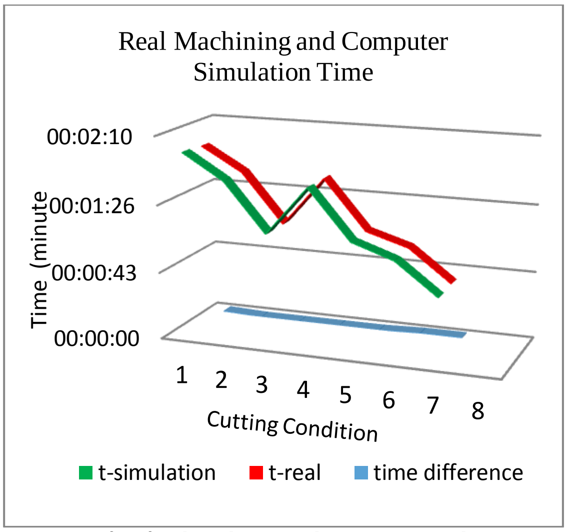

Fig 13: Grafic of real machining and Computer Simulation Time

4. Conclusion

By entering the tool path, cutting condition, tool type and material type of object work on the simulation software, then the simulation of the cutting process can be programmed. From the execution of the simulation program obtained tool path and NC program which later can be inputted on CNC lathe for application of actual cutting process. Comparison of cutting time obtained from cutting using computer simulations by cutting on CNC machines has no significant difference.

References

[1] S. Zivanovic, "Machining simulation and verification of tool path for CNC machine tools with serial and hybrid kinematics Machining Simulation and Verification of Tool Path for CNC Machine Tools with Serial and Hybrid Kinematics," no. June, 2017.
[2] K. F. Ehmann, S. G. Kapoor, R. E. DeVor, and I. Lazoglu, "Machining Process Modeling: A Review," *J. Manuf. Sci. Eng.*, vol. 119, no. 4B, p. 655, 1997.
[3] P. Fallböhmer, C. A. Rodríguez, T. Özel, and T. Altan, "High-speed machining of cast iron and alloy steels for die and mold manufacturing," *J. Mater. Process. Technol.*, vol. 98, no. 1, pp. 104–115, 2000.
[4] S. Journal, "Turning points in," vol. 38, pp. 225–229, 1999.
[5] "CUTTING TOOLS MAIN CATALOGUE." .
[6] W. Xiankui, L. C. Maw, L. Zhizhong, and Z. Yuyun, "THCAPP : Computer Aided Process Planning System in an Integrated Environment * 2 Part Modeling," *Tsinghua Sci. Technol.*, vol. 1, no. 2, pp. 119–123, 1996.
[7] A. A. Chowdhury and A. M. Mazid, "Computer Integrated Manufacturing education to Mechanical Engineering students: Teaching, research and practice," *2009 IEEE Int. Conf. Ind. Technol.*, no. March, pp. 1–5, 2009.
[8] B. Y. Lee, Y. S. Tarng, and H. R. Lii, "An investigation of modeling of the machining database in turning operations," *J. Mater. Process. Technol.*, vol. 105, no. 1–2, pp. 1–6, 2000.
[9] R. B. Jerard, R. B. Jerard, B. K. Fussell, B. K. Fussell, M. T. Ercan, and M. T. Ercan, "On-Line Optimization of Cutting Conditions for NC Machining," pp. 1–11, 2001.