

Study to Determine the Optimum Method in Writing a CNC Milling Program for a Specific Product

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ABSTRACT

The trend towards automation of production equipment is having great demands from people. Since the early 1970s, manufacturers have worked to increase productivity, quality, process capability, reliability and flexibility. They used technologies to improve quality and productivity. This study studies the differences of a few CNC milling program – relating to time scale and machining accuracy. For experiment, a few programs are being written to machining a simple product. Each program has its own features. By running all the written programs, the effectiveness and goodness of each program could be analyzed. On the other hand, by machining the product and testing them, the product accuracy also can be analyzed. The results show that, the number of command lines will affect the simulation time. More command lines in the program will need more time in running the simulation. Besides that, results show that using the Canned Cycle command will give a more accurate machining compared to those conventional and CAD/CAM method

Keywords: CNC, milling program, optimum method

OBJECTIVE AND SCOPE

The objective of this study is to write and analyze CNC milling programs to get the optimum program that will be used for machining a specific product.

To achieve the objective, a few scopes have been determined:

- i. Write programs to machine a simple product using a CNC milling machine
- ii. Analyzes the effectiveness and goodness of the program.
- iii. Analyzes only for the accuracy of size and time scale of the product.

METHODOLOGY

This study is to determine the optimum method in writing a CNC milling machine program for a specific product. To do this study, a few conditions and factors have been evaluated to determine the efficiency of

the program. The following are procedures that are used to achieve the objective of this study.

- i. Design a product sample.

A product sample is designed with the length of 100 mm, width of 60 mm and height of 50 mm. Aluminum is used to machine out the product sample. The product sample is designed with 2 holes drilling operation, and a pocket milling operation with 4 fillets at each corner.

- ii. Write a few programs to machine the product sample using CNC milling machine.

In the modern technology, there are many ways of writing a CNC program. In writing up programs for this study, the conventional method, Canned Cycle and CAD/CAM are used. Different programs are written using each method to machine the product. Finally,

programs are analyzed for their efficiency.

iii. Analyzing the program

First, the programs are transferred to the machine for cutting simulation. A few factors are considered in analyzing the programs, such as the number of program lines and simulated cycle time. The tool-traveling path and tool changes positions are also analyzed because these factors will affect the effectiveness and the goodness of the program.

iv. Improve the efficiency and the goodness of the previous program.

An improved program with less number of program lines, better tool-traveling path, less number of tool changes needed, possible tool changes at any position and most important shorter cycle time is developed.

v. Run test on the improved program.

The optimum program is transferred to the machine. Before the actual machining process to be processed, a cutting simulation has to be done to make sure that actual machining process will run well without any error.

vi. Machine the product sample using the new program.

The machine has to be setup before being used. The tooling library has to be defined. Then, the workpiece will be clamped to the machining table. The workpiece origin has to be defined. Then, the actual machining can begin. Finally, the actual machining cycle time is taken.

vii. Analyze the accuracy of size and time scale of the product sample.

The products are measured for the size accuracy. A cycle time comparison is made for different program in order to calculate the differences of

simulation and actual machining time of the product

RESULT AND DISCUSSION

There are five programs that is run using CNC milling machine. All the programs produce the same product approximately - in term of their shapes. Each program has its own features. Below are the main features of each program

Program 1: Conventional method

Program 2: Canned Cycle method

Program 3: No tool change method

Program 4: No tool change and Canned Cycle method

Program 5: CAD/CAM (MasterCAM software)

Time Scale Results

There are five programs that had been run in the lab using CNC milling machine. All the programs are run twice on the workpiece. Each time before running the program, a simulation has to be conducted for checking. After the simulation is run, the simulation time has been taken. After the simulation, the workpiece is clamped using the hydraulic vise. The machine is setup with the entire tools library and the zero origin point of the workpiece have been determined. After all the programs have been run, the time scale results are shown on Table 1 and Table 2.

As shown on Table 1 and Table 2, the first and second trial of simulation for program 2 with 33 numbers of command lines will gave the shortest simulation time of 1 minutes and 47 second. The longest simulation time was at 3 minutes and 33 second from program 5 with 157 numbers of command lines.

In the actual time scale, program 1 with 94 numbers of command lines had produced the product with the shortest time of 14 minutes and 49 second. This is because program 1 has a better cutting path. In program 1, no need of

repeating the cutting path. It has a bigger or correct tool size for each cutting path and operation. Meanwhile program 4 has 45 numbers of command lines will need the longest time which is 26 minutes and 10 second to produce the product.

calibrations. There were four dimension parameters namely Outer Fillet, Inner Pocket, Big hole and Small hole.

Dimensions Accuracy Results

All the products have been measured using a digital Vernia caliper. The result of all the measurement is an average value from 3-time of

Table 1: Data of five program that have been run (first trial)

	Program 1	Program 2	Program 3	Program 4	Program 5
No. of lines	94	33	73	45	157
Simulation	2:40	1:47	1:54	1:52	3:22
Actual	14:49	17:23	24:12	26:10	19:54

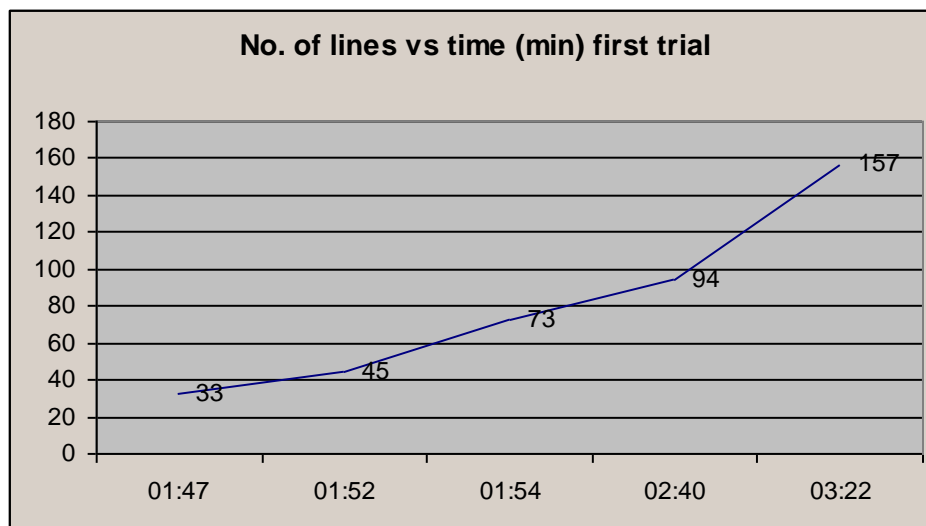


Figure 1: Number of command lines vs Time (minute) for first trial

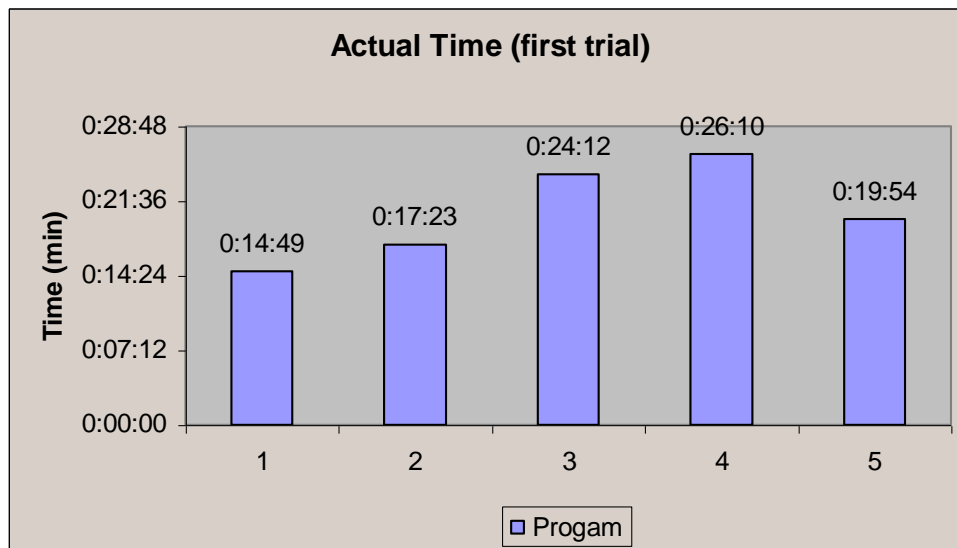


Figure 2: Time (minute) vs Program for first trial

Table 2: Data of five program that have been run (second trial)

	Program 1	Program 2	Program 3	Program 4	Program 5
No. of lines	94	33	73	45	157
Simulation	2:40	1:45	1:55	1:52	3:21
Actual	14:07	17:21	24:09	26:12	19:45

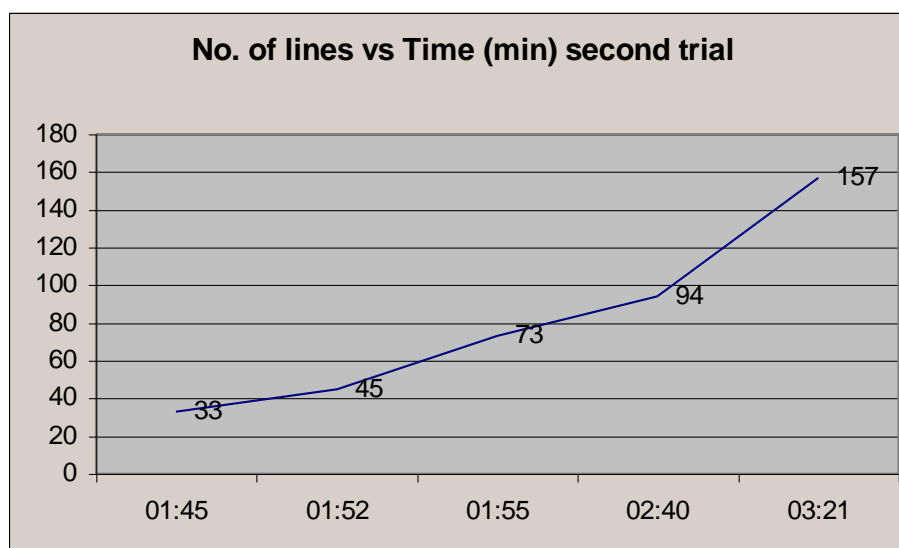


Figure 3: Number of command lines vs Time (minute) for second trial

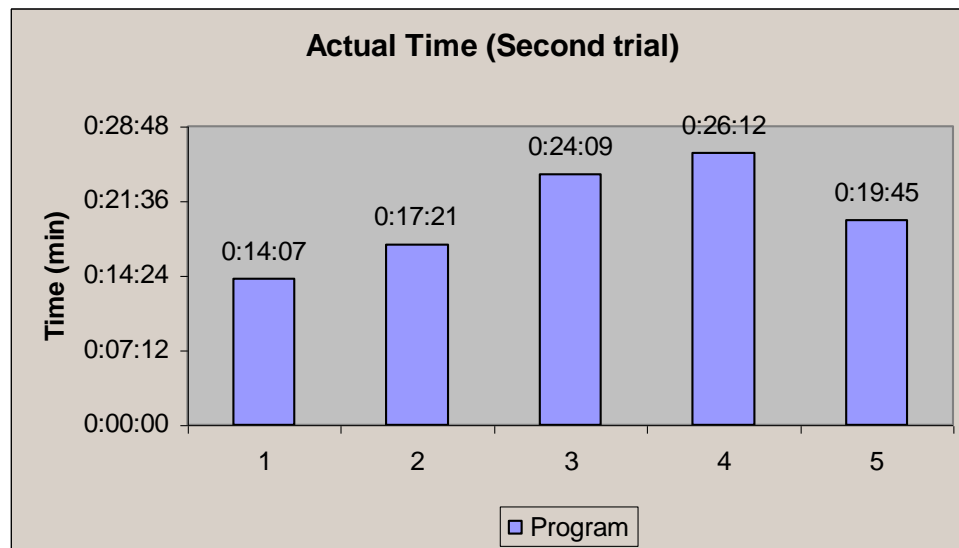


Figure 4: Time (minute) vs Program for second trial

Comparison between the four parameters of each program can be made based on the chart. All the measurements are in millimeters.

In workpiece dimension, and generally all the programs are able to produce the same product. Based on the result of the dimension accuracy test, the most accurate outer fillet is measured at 80.02 mm by 40.02 mm. For the case of inner pocket, the most accurate is measured at 30.00 mm by 60.01 mm. The most accurate big hole measured is 20.00 mm and small hole was 9.98 mm.

Besides that, all the highlighted value in the table are considered as an accurate machining with the tolerance of ± 0.05 mm. In the inner pocket parameters, program 2 and 4 showed an accurate machining. Both programs are using the Canned Cycle command to machine the inner pocket.

Program 2, 3 and 4 uses the Canned Cycle command to machine and drill the big and small counter bore hole. The result showed that those three programs are more accurate compared to the program 1 and 5 machining.

Extra Canned Cycle Results

An extra experiment has been conducted on the Canned Cycle command to determine the effect on time scale by changing the input parameters. Program 2 is used as the baseline for this extra experiment. In the Canned Cycle command, there were this parameters know as "tool offset". Only the CNC pocket milling operations have these parameters. There are refer as "I" in the line of command as show:
 N26 G87 X60 Y30 Z-5 B2 R5 I50 J-1 K2.5
 N28 G89 Z-5 B2 R10 I50 J-1 K2.5 F50

The extra experiment had changed the "tool offset" parameters (I) from 50% to 100% and the difference is shown in the Table 3.

Table 3: Data of five programs for extra canned

Program	Trial	Outer Fillet		Inner Pocket		Big	Small
1	1 st	80.17	40.11	30.04	60.08	19.80	9.95
	2 nd	80.14	40.11	30.02	60.09	19.84	9.96
2	1 st	80.17	40.12	30.00	60.01	19.95	9.98
	2 nd	80.15	40.14	29.99	59.99	20.00	9.95
3	1 st	80.03	40.00	30.01	60.09	19.95	9.97
	2 nd	80.03	40.02	30.02	60.07	19.99	9.95
4	1 st	80.04	40.03	29.99	60.01	19.94	9.95
	2 nd	80.02	40.02	30.00	60.01	19.95	9.95
5	1 st	80.18	40.12	30.03	60.08	20.02	10.05
	2 nd	80.15	40.10	30.03	60.07	20.03	10.04

Table 4: Data of time scale result (extra canned program)

	Program 2	Program 2(extra)	Different
Simulation	1:45	1:08	0:37
Actual	17:21	15:50	1:31

By changing the “tool offset” parameters, the result of the program showed a shorter production time compared to the unchanged program.

CONCLUSION AND SUGGESTION

According to the result time scale, the number of command lines had affected the simulation time. The time scale results findings showed that program 2 with 33 numbers of command lines give the shortest simulation time. Program 2 has the least command lines among the other programs. Based on the result, it is clear that more command lines in the program will need more time in running the simulation.

The findings conclude that program 4 produces the most accurate product in term of dimension. This program is written by using Canned Cycle command, and we can conclude Canned Cycle command produces a more accurate product compared to conventional and CAD/CAM method. And also to improve the actual machining time

when using the Canned Cycle command, the “tool offset” parameters have to be set higher.

In this study, the focus was on the product that has been designed. The suggestion of future study is to design a product with more command such as tapping cycle, reaming cycle, boring cycle and many others CNC command. Furthermore, the extra experiment on the inner pocket machining can also be used as a further study. There are also so many other parameters in Canned Cycle that can be changed in order to be more studied such as the differences between “J” and “F” parameters

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