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GUIDE TO PROGRAMMING AND CONTROLLING CNC MILLING

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ABSTRACT

Currently, CNC machine tools all use NC program input or transfer from memory and computers to control the cutting process on centers such as milling centers. Therefore, the method of programming NC programs is a crucial step for engineers in factories producing machine parts in the mechanical industry. A specific and clear programming method is needed to facilitate accurate and rapid programming, meeting the demands of modern production and achieving high productivity. This article will focus on providing specific guidance on NC programming for all operators or controllers of CNC milling centers.

Keywords: NC programming, controller, productivity, guidance

1. INTRODUCTION

CNC machine tools all use MC program input or transfer from memory and computers to control the cutting process on CC file centers such as milling centers. Therefore, the method of programming MC programs is a crucial step for engineers in factories producing machine parts in the mechanical industry. A specific and clear programming method is needed to facilitate accurate and rapid programming, meeting the demands of modern production and achieving high productivity. This article will focus on providing specific guidance on MC programming for all operators or controllers of CNC milling centers.

Thứ tự	Nội dung công việc
1	Read detailed drawings
2	Develop machining process for the part
3	Select machine, cutting tools, fixtures, measuring tools
4	Select workpiece
5	Calculate and select cutting parameters for each machining step
6	Write NC machining program/software support
7	Run program simulation on supporting software
8	Transfer program to CNC milling machine/machining
9	Run program test using Dry run mode
10	Mount workpiece, tool, set safety modes, tool compensation
11	Run program to machine the part
12	Check product dimensions, dimensional tolerances, geometric shape, surface roughness, relative position.

METHOD

Below is an example of machining a workpiece surface as shown in the drawing to help learners understand the steps and core thinking involved in programming and controlling a CNC milling machine.

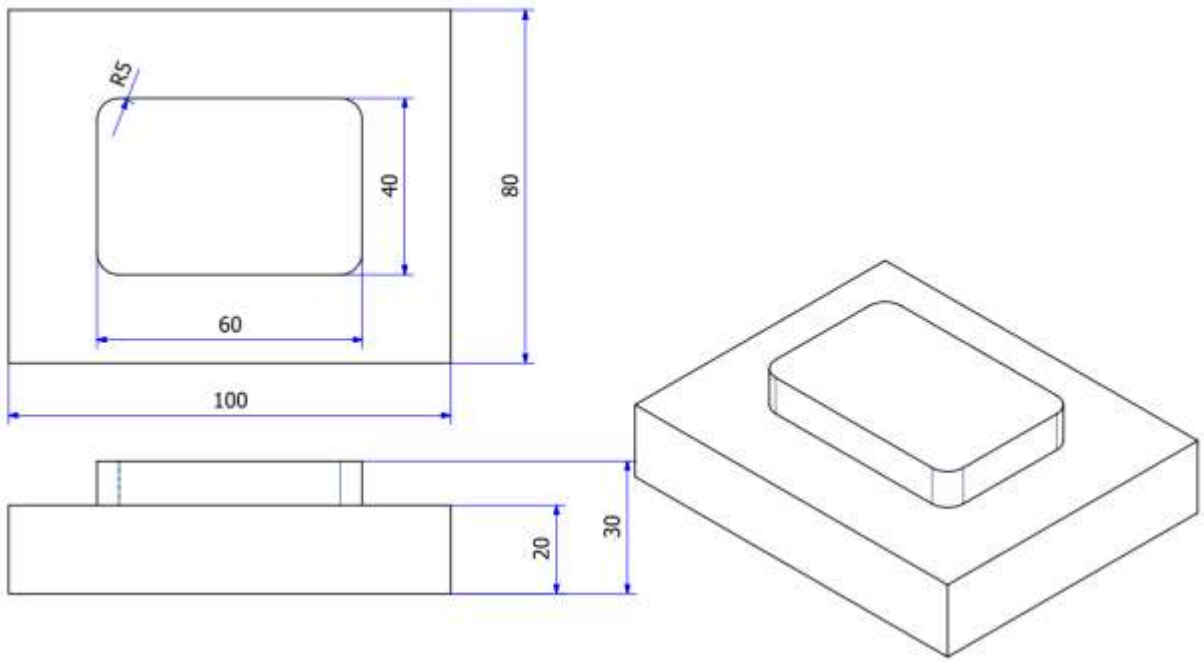


Figure 1. Detail requiring profile milling

The part needs to be machined as shown in Figure 1; the part material is 20XM, the surface dimensions must have a tolerance of +/- 0.05; and other dimensions must have a tolerance of +/- 0.2.
Select a workpiece with dimensions: 100 x 80 x 30.
Machining process:
- Step 1: Rough milling of the profile.
- Step 2: Finish milling of the profile.

Process Sheet Preparation:

Step 1: Rough milling of the profile.

Cutting parameters: End mill: D30, Vc = 80 m/min, F = 250 mm/min. Cutting depth: 2 mm; Surface allowance of the profile: 0.5 mm.

Machine	Cutting tool	Material of workpiece	S (v/ph)	F (mm/ph)	t (mm)
VMC-85S	JS212	20XM	900	250	2

The process sheet describes the toolpath of each step in the technological process. Software such as Unigraphics-NX can be used to describe toolpaths with complex shapes. If no software is used, the programming engineer needs to describe the process step using drawings in other software or by hand.

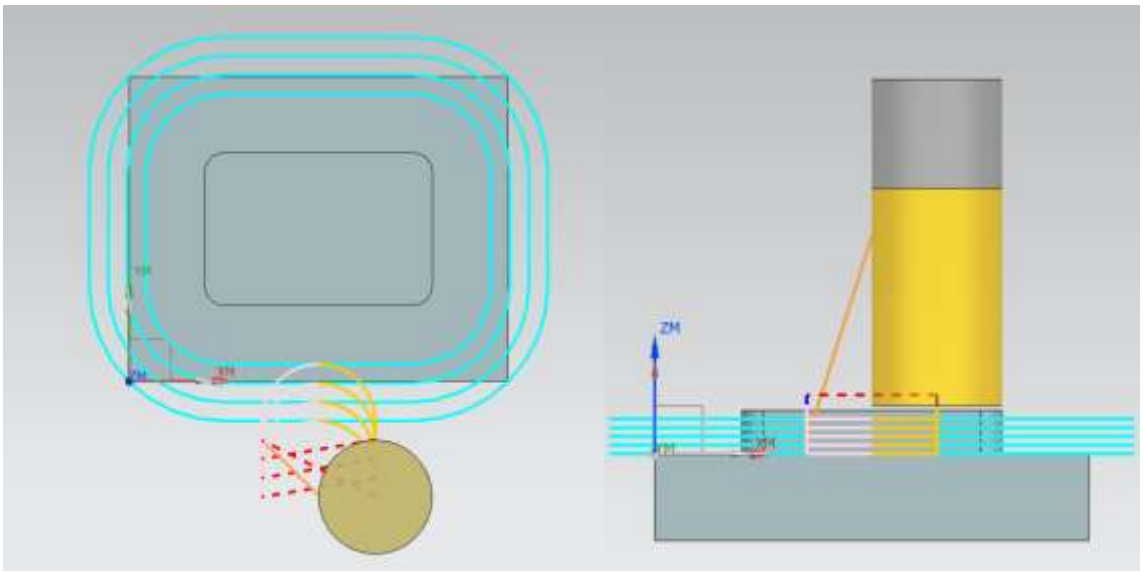


Figure 2. Description of the rough milling tool path using Unigraphics-NX 11 software.

Write a program for the rough milling step:

```
N0001 %
N0002 O0001
N0003 G40 G17 G90 G21
N0004 (Ten_buoc: PHAY THO)
N0005 (Ten_dao: T01 ---> H01)
N0006 G91 G28 Z0.0
N0007 M05 M09
N0008 T01 M06
N0009 G90 G54
N0010 S849 M03
N0011 G43 Z50. H01
N0012 M08
N0013 G00 X65. Y-30.5
N0014 Z3.
N0015 G01 Z0.0 F250.
N0016 Y-25.5
N0017 G03 X50. Y-10.5 I-15. J0.0
N0018 G01 X25.
N0019 G02 X-10.5 Y25. I0.0 J35.5
N0020 G01 Y55.
N0021 G02 X25. Y90.5 I35.5 J0.0
N0022 G01 X75.
N0023 G02 X110.5 Y55. I0.0 J-35.5
N0024 G01 Y25.
N0025 G02 X75. Y-10.5 I-35.5 J0.0
N0026 G01 X50.
N0027 G03 X35. Y-25.5 I0.0 J-15.
N0028 G01 Y-30.5
N0029 Z3.
N0030 G00 Z13.5
N0031 X65. Y-25.5
N0032 Z3.
N0033 G01 Z0.0
N0034 Y-20.5
N0035 G03 X50. Y-5.5 I-15. J0.0
N0036 G01 X25.
N0037 G02 X-5.5 Y25. I0.0 J30.5
N0038 G01 Y55.
N0039 G02 X25. Y85.5 I30.5 J0.0
N0040 G01 X75.
```

N0041 G02 X105.5 Y55. I0.0 J-30.5
N0042 G01 Y25.
N0043 G02 X75. Y-5.5 I-30.5 J0.0
N0044 G01 X50.
N0045 G03 X35. Y-20.5 I0.0 J-15.
N0046 G01 Y-25.5
N0047 Z3.
N0048 G00 Z13.5
N0049 X65. Y-20.5
N0050 Z3.
N0051 G01 Z0.0
N0052 Y-15.5
N0053 G03 X50. Y-.5 I-15. J0.0
N0054 G01 X25.
N0055 G02 X-.5 Y25. I0.0 J25.5
N0056 G01 Y55.
N0057 G02 X25. Y80.5 I25.5 J0.0
N0058 G01 X75.
N0059 G02 X100.5 Y55. I0.0 J-25.5
N0060 G01 Y25.
N0061 G02 X75. Y-.5 I-25.5 J0.0
N0062 G01 X50.
N0063 G03 X35. Y-15.5 I0.0 J-15.
N0064 G01 Y-20.5
N0065 Z3.
N0066 G00 Z13.5
N0067 X65. Y-15.5
N0068 Z3.
N0069 G01 Z0.0
N0070 Y-10.5
N0071 G03 X50. Y4.5 I-15. J0.0
N0072 G01 X25.
N0073 G02 X4.5 Y25. I0.0 J20.5
N0074 G01 Y55.
N0075 G02 X25. Y75.5 I20.5 J0.0
N0076 G01 X75.
N0077 G02 X95.5 Y55. I0.0 J-20.5
N0078 G01 Y25.
N0079 G02 X75. Y4.5 I-20.5 J0.0
N0080 G01 X50.

N0081 G03 X35. Y-10.5 I0.0 J-15.
N0082 G01 Y-15.5
N0083 Z3.
N0084 G00 Z100.
N0085 M05 M09
N0086 M30
N0087 (MACHINE TIME: 6.6 MIN)
N0088 %

Test the program using CIMCO-Edit software.

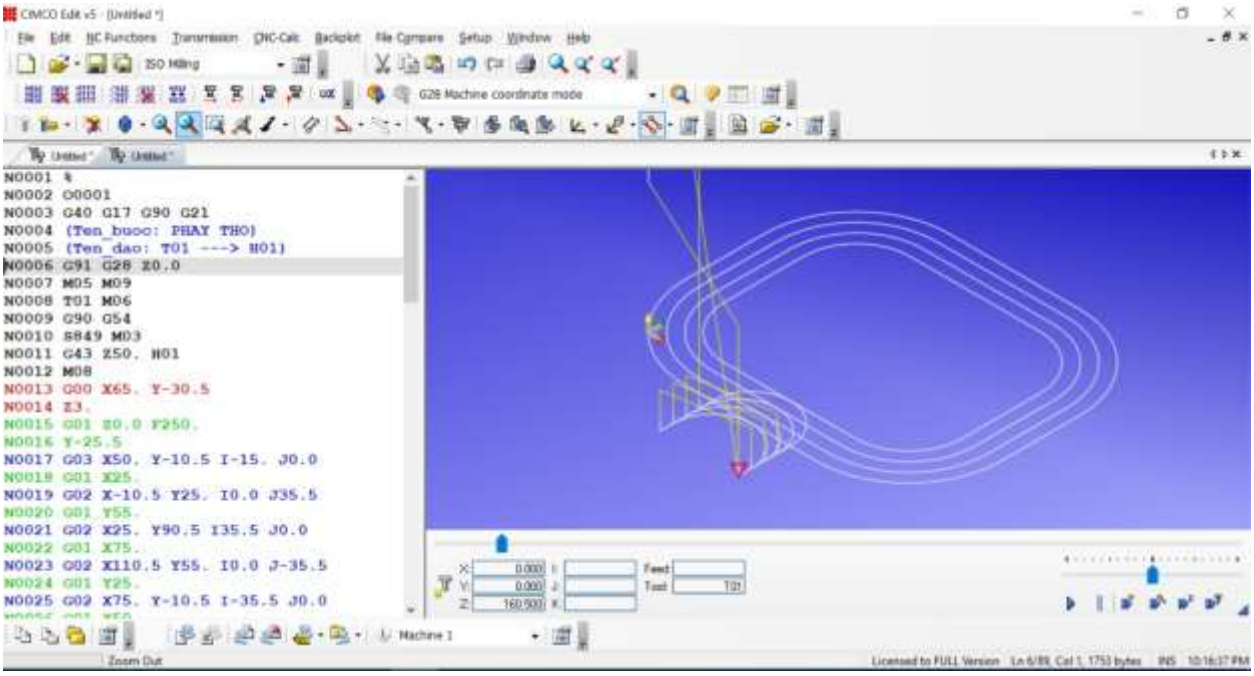


Figure 3. Checking the rough milling program using CIMCO-Edit V5 software.

Step 2: Finish milling of the profile
End mill: D20, Vc = 100 m/min, F = 180 mm/min.

Machine	Cutting tool	Material of workpiece	S (v/ph)	F (mm/ph)	t (mm)	Contour
VMC-85S	JS554	20XM	1200	250	0,5	2-12
			800	300		1-2; 12-13

Description of the tool path:

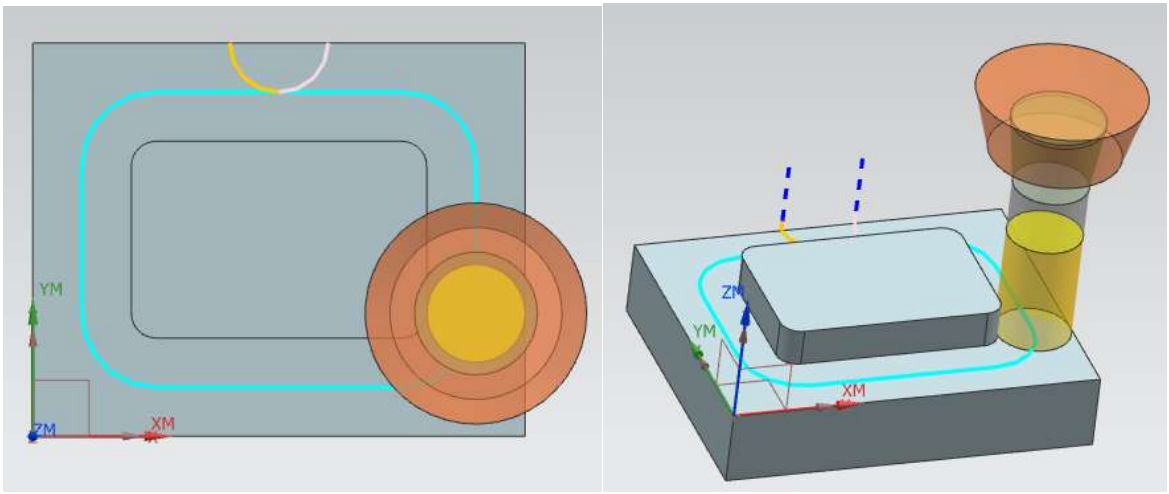
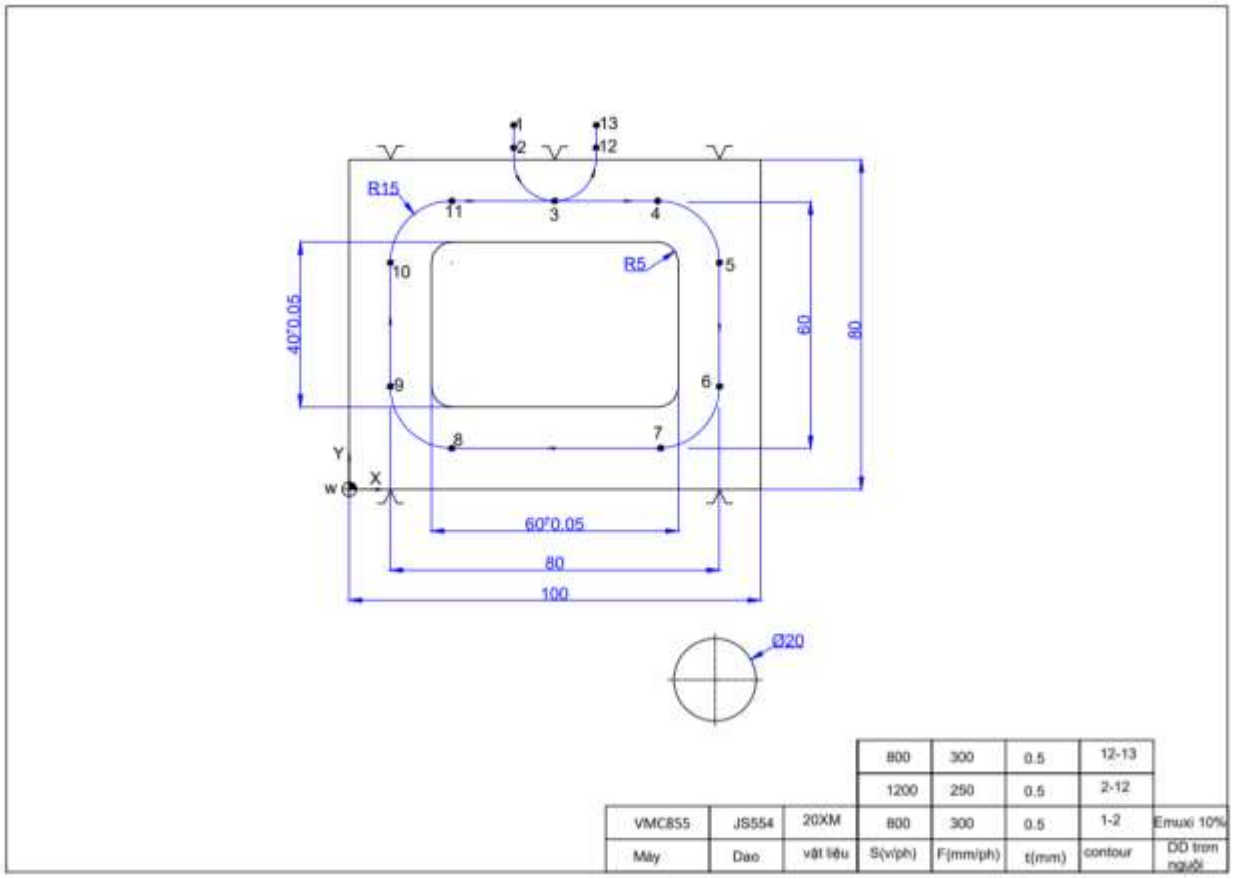


Figure 4. Description of the tool path during finish milling.

The process sheet for the finishing milling step is as follows:

After rough machining the profile, the selection of the cutting tool and cutting parameters determines the dimensional tolerance and surface roughness of the workpiece, so careful selection is necessary, or you can consult the experience of long-time engineers or refer to cutting tool documentation.

Once the selection is complete, create a process sheet by drawing in AutoCAD or on paper, resulting in the figure shown in Figure 5. From the process sheet, which contains sufficient information about the machine, cutting tool, cutting parameters, and tool path, the programmer can write an NC program according to standards to control the CNC milling machine.



N0001 %
N0002 O0002
N0003 G40 G17 G90 G21
N0004 (Ten_buoc: Phay TINH)
N0005 (Ten_dao: T2)
N0006 G91 G28 Z0.0
N0007 M05 M09
N0008 T02 M06
N0009 G90 G54
N0010 S1592 M03
N0011 G43 Z50. H01
N0012 M08
N0013 G00 X40. Y80.
N0014 Z20.
N0015 Z3.
N0016 G01 Z0.0 F180.
N0017 G03 X50. Y70. I10. J0.0
N0018 G01 X75.
N0019 G02 X90. Y55. I0.0 J-15.

N0020 G01 Y25.
N0021 G02 X75. Y10. I-15. J0.0
N0022 G01 X25.
N0023 G02 X10. Y25. I0.0 J15.
N0024 G01 Y55.
N0025 G02 X25. Y70. I15. J0.0
N0026 G01 X50.
N0027 G03 X60. Y80. I0.0 J10.
N0028 G01 Z3.
N0029 G00 Z20.
N0030 M05 M09
N0031 M30
N0032 (MACHINE TIME: 1.83 MIN)
N0033 %

After programming, the CIMCO-Edit software is used to check if the tool path is correct and accurate. Only after the program has been verified is the data transmitted to the CNC milling machine's memory to control the CNC milling machine for machining the workpiece.

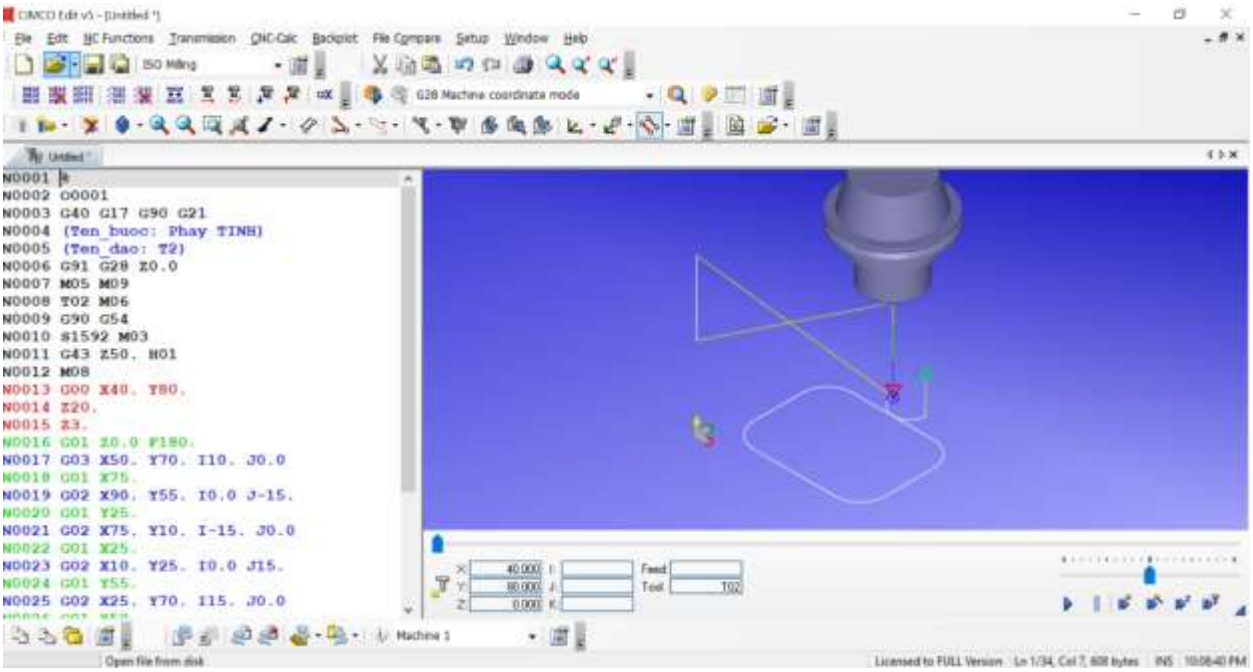


Figure 6. Checking the tool path in CIMCO-Edit V5 software.

2. RESULT

With step-by-step instructions for programming CNC control systems, specifically for CNC milling centers, we now have a concrete approach before machining parts on CNC face milling centers and CNC

milling centers. Therefore, this guide helps engineers understand the structure of an NC program and provides supporting software to control and adjust the program accurately before transferring data to CNC machines. This programming is crucial, so engineers need to learn it carefully and systematically before using CNC machines to machine parts.

3. CONCLUSION

This article provides a specific example guiding the programming of a control unit on a CNC machine. It's a useful guide for mechanical engineers in general, and those in other industries, for machining parts of various machines, automobiles, medical equipment, entertainment devices, etc. This programming approach helps control and reduce errors during automated programming with the help of CAM software.

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Author Profile

<Author Photo>

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