cnc webschool
knowledge to improve

Appendix 2: Programming on Siemens Control

Helical and Thread Mill Interpolation

Paper Size: 170x244mm (Book Size)

Contents

1.1 Introduction

The helical path is carried out by synchronising the circular movement of the tool or of the part with contemporary translation along another axis which is perpendicular to the circle described.

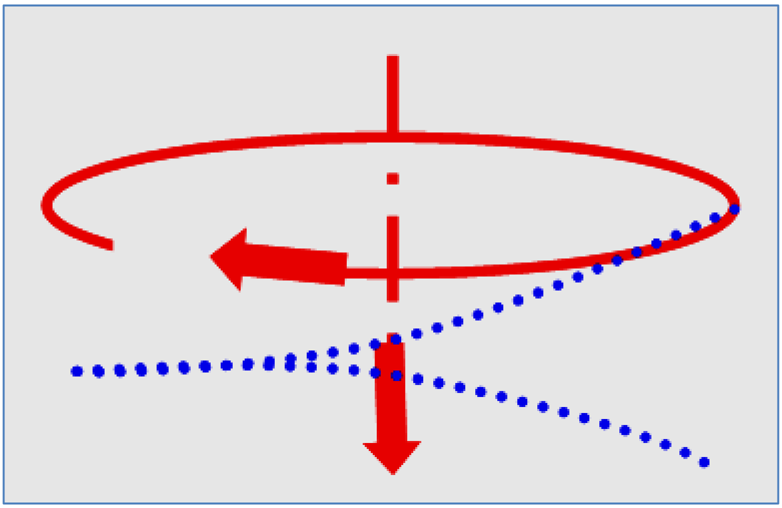

Fig. 1. Helical path

Helical interpolation may be needed for:

- enlargement of holes,
- counterbores,
- milled threads,
- bush lubrication channels.

Before proceeding, it is necessary to have a good understanding of the following topics:

- interpolation concept (Paragraph 4.8)
- programming of a circle arc (Chapter 13)
- work plane definition (Paragraph 13.4)

Based on the type of machine available and the number of axes which may be used, the helical profile may be carried out by interpolation of different axes.

1.2 Helical Interpolation in a Lathe Using the Z-C Axes

In a lathe that has an X-axis, a Z-axis, C-axis and motorised tools, the helical path may be carried out exclusively along the Z-axis.
The circular movement is obtained through spindle rotation while translation perpendicular to the circle happens along the Z-axis.

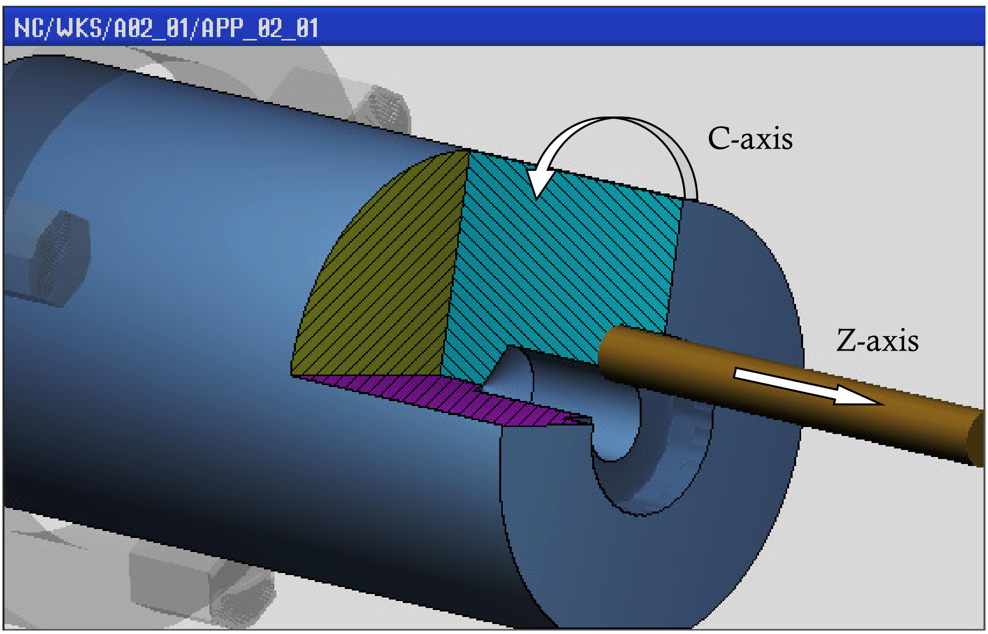

Fig. 2. Helical path obtained in C-Z interpolation

In the following program, a helical milling is carried out **to produce a counterbore** of 25 mm depth and diameter 22.5 mm.

On block N240 the main spindle is positioned at 0 degrees.
On block N260 the mill is positioned at X0.
On block N290 the mill is positioned at Z0 to then enter the material in helical interpolation.
On block N310 the spindle starts by turning 1800 degrees (i.e. 5 complete turns) while the Z-axis translates so as to arrive at the final position Z-25. At every turn the mill enters the material by 5mm.
To lessen the depth of the pass, one need only increase the number of spindle rotations.

```
…
N190 ; Z-C HELICAL PROFILE EXECUTION START
N200 M70
N210 T15 D1 G0 Y0 ;MOTORISED MILL D10
N220 SETMS(3)
N230 G95 S1500 M3
N240 G0 SP1=0 ; ANGULAR POSITION OF THE SPINDLE AT 0°
N250 G0 Z10
N260 G0 X0
N270 G0 Z2

N280 G17
N290 G1 Z0 G95 F0.2
N300 G1 X22.5 F0.1 G41
N310 G1 Z-25 SP1=IC(1800) F0.013 ; SPINDLE ROTATION CONTEMPORY TO TRANSLATION ALONG Z
N320 SP1=IC(360) ; FLATTENING OF THE BASE
N330 G1 X0 F1 G40
N340 G18

N350 G0 Z200
N360 G0 X200
…
```

For more details on the following topics see the paragraph or chapter below indicated:

- activation and use of the C-axis (Paragraph 27.3.1),
- use of tool radius compensation (Chapter 15)
- calculation of manual feed (27.2.2 fig. 173)

1.3 Helical Interpolation in a Lathe Using the X-Y-Z Axes

In a lathe that has an X-axis, a Z-axis, C-axis and motorised tools, the helical path may be carried out along all axes changing the plane on which the circle is described.

The circular movement is obtained by interpolation of the two axes belonging to the defined plane (in the following example the G19 plane has been defined in that the circular interpolation is programmed on the Y-Z plane), the translation perpendicular to the circle occurs on the third axis, that perpendicular to the plane (in this example the X-axis).

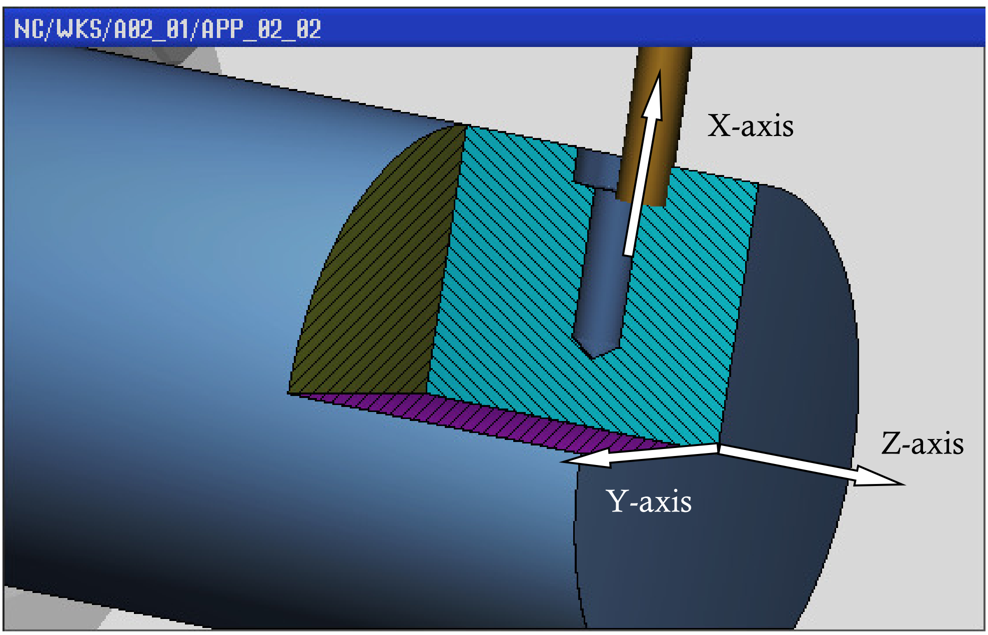

Fig. 3. Helical path obtained in X-Y-Z interpolation

```
…
; HELICAL INTERPOLATION
N190 T8 D1 G0 Y0 ;MILL D.8
N200 G95 S2200 M3 F0.1
N210 G0 Z-23 ;CENTRE OF THE HOLE
N220 G0 X82
N230 G1 X80
N240 DIAMOF
N250 G1 Z-15 G42 ;RADIUS COUNTERBORE 8
N260 G2 K=-8 X=IC(-2)
N270 G2 K=-8 X=IC(-2)
N280 G2 K=-8 X=IC(-2)
```

```
N290 G2 K=-8 X=IC(-2)
N300 G2 K=-8 X=IC(-2)
N310 G2 K=-8 ; FLATTENING OF THE BASE OF THE COUNTERBORE OF
DIAMETER 60MM
N320 G1 Z-23 G40

N330 G0 X200
N340 G0 Z200
…
```

The use of the function DIAMON/DIAMOF is described in Paragraph 10.4.

1.4 Helical Interpolation in a Mill

In a mill the concept is identical to that of the Y-axis lathe seen in the previous paragraph; the only difference is in the definition of the work plane on which the circular interpolation is carried out. In this case the work plane used is defined by the function G17 (X-Y plane).

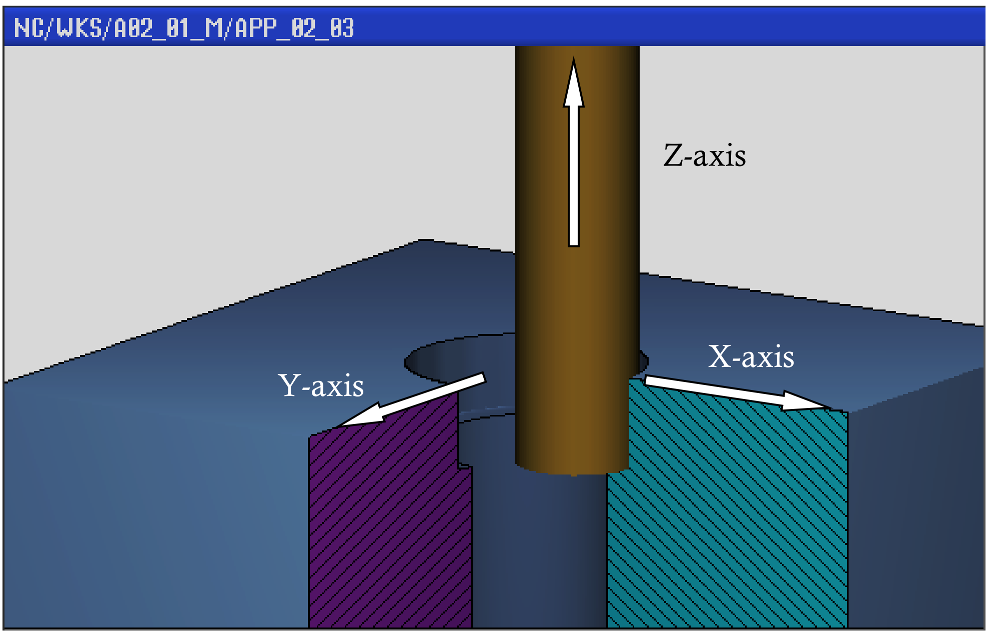

Fig. 4. Helical path obtained in X-Y-Z interpolation

```
…
N120 ; Z-C HELICAL PROFILE EXECUTION START
N130 T="CUTTER 16" D1 M6 G0 Y0 ;MILL D16
N140 G95 S1550 M3
N150 G0 X0 Y0
N160 G0 Z10

N170 G17
N180 G1 Z0 G95 F0.2

N190 G1 X15.75 G41 ;WIDENING TO DIAMETER 31.5
N200 G3 I=-15.75 Z=IC(-4)
N210 G3 I=-15.75 Z=IC(-4)
N220 G3 I=-15.75 Z=IC(-4)
N230 G3 I=-15.75 Z=IC(-4)
N240 G3 I=-15.75 Z=IC(-4)
```

```
N250 G3 I=-15.75 Z=IC(-4)
N260 G3 I=-15.75; FLATTENING OF THE BASE
N270 G1 X0 G40

N280 G0 Z500
…
```

To carry out the helical path rotating clockwise, program as follows:

```
…
N190 G1 X15.75 G42 ;WIDENING TO DIAMETER 31.5
N200 G2 I=-15.75 Z=IC(-4)
N210 G2 I=-15.75 Z=IC(-4)
N220 G2 I=-15.75 Z=IC(-4)
N230 G2 I=-15.75 Z=IC(-4)
N240 G2 I=-15.75 Z=IC(-4)
N250 G2 I=-15.75 Z=IC(-4)
N260 G2 I=-15.75; FLATTENING OF THE BASE
N270 G1 X0 G40
…
```

1.5 Carrying Out a Thread Mill

A threading operation may be carried by milling, using special tools called thread mills.

These are mills on the cutting edge of which the thread template is impressed. The path to be carried out is helical.

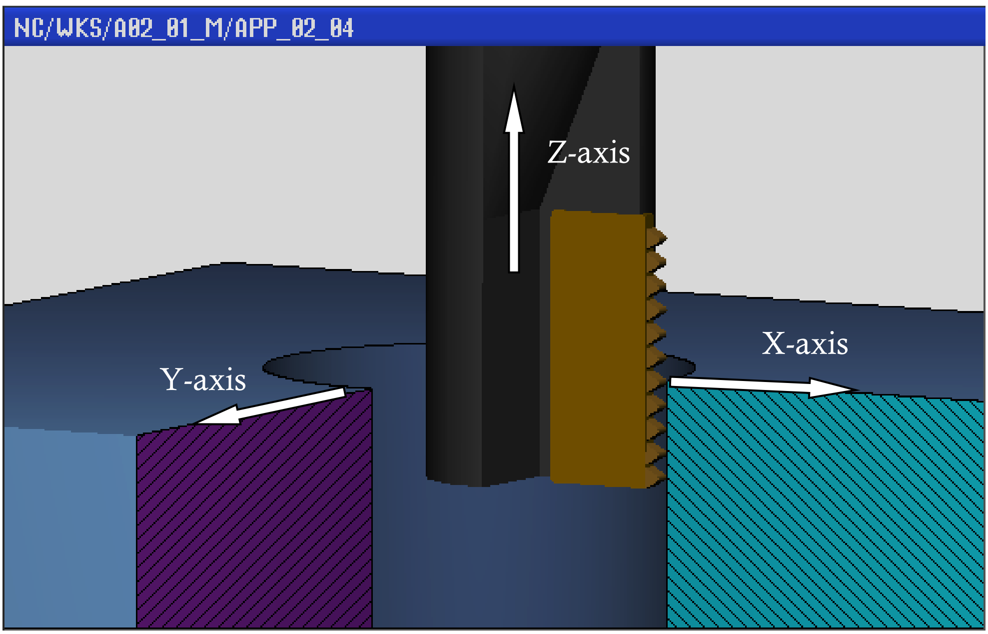

Fig. 5. Execution of thread using a thread mill

```
…
N280 T="THREAD CUTTER" D1 M6 G0 Y0 ;THREADMILL M36X4
N290 G95 S1680 M3
N300 G0 X0 Y0
N310 G0 Z10

N320 G17
N330 G1 Z-10 G95 F0.4
N340 G1 X15.75 G42
N350 G2 X-18 Y0 I=-16.5 J0 Z=IC(-2)
N360 G2 I=18 Z=IC(-4)
N370 G2 X15 Y0 I=16.5 Z=IC(-2)
N380 G1 X0 G40
N390 G0 Z500
…
```

The thread mill carries out the following path:

- on block N330, the mill is positioned at the correct depth, which depends on how many threads the operator chooses to mill in one turn **(Fig.5)**.
- block N340, the mill is placed upon the wall of the hole activating the tool radius compensation **(Fig.6-1)**,
- block N350, the mill enters with an arc of 180° up to the finished depth to be milled, contemporarily the mill translates along the Z-axis a half pass **(Fig. 6-2)**,
- block N360 the mill executes a complete turn and translates an entire pass **(Fig. 6-3)**,
- block N370 the mill exits the thread with an arc of 180° translating a half pass **(Fig. 6-4)**,
- the mill returns to the centre of the hole deactivating the tool radius compensation.

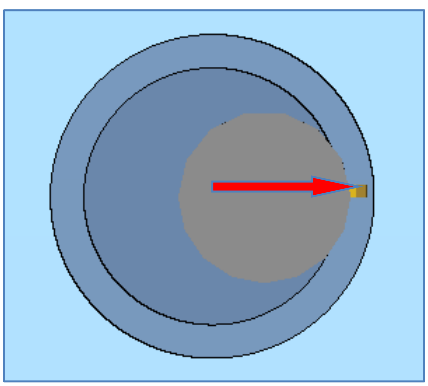

Fig. 6-1

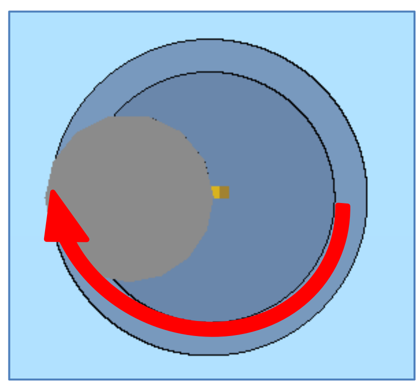

Fig. 6-2

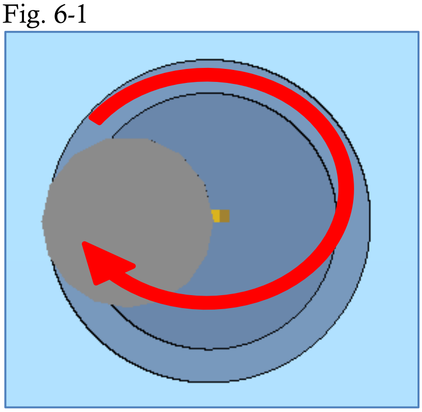

Fig. 6-3

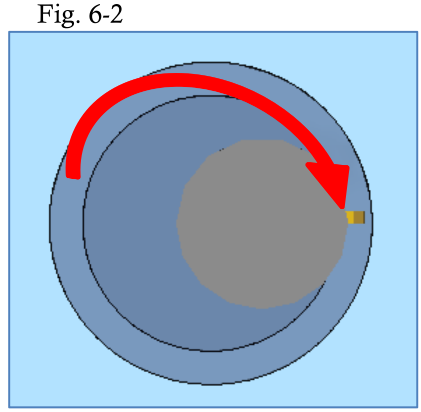

Fig. 6-4