SIEMENS

SINUMERIK Operate

Cycle 800

ADVANCED

SINUMERIK 828D/840D sl

Edition 2019.01
Training Manual

SIEMENS

SINUMERIK

Cycle 800 ADVANCED

Valid for:

SINUMERIK 828D	**SW4.8**
SINUMERIK 840D sl	**SW4.8**

M102
Sinumerik Operate

Swiveling with CYCLE800

Module Description:

This module introduces CYCLE800.
3+2 swiveling with this CYCLE800 is shown.
The respective setting options are discussed.

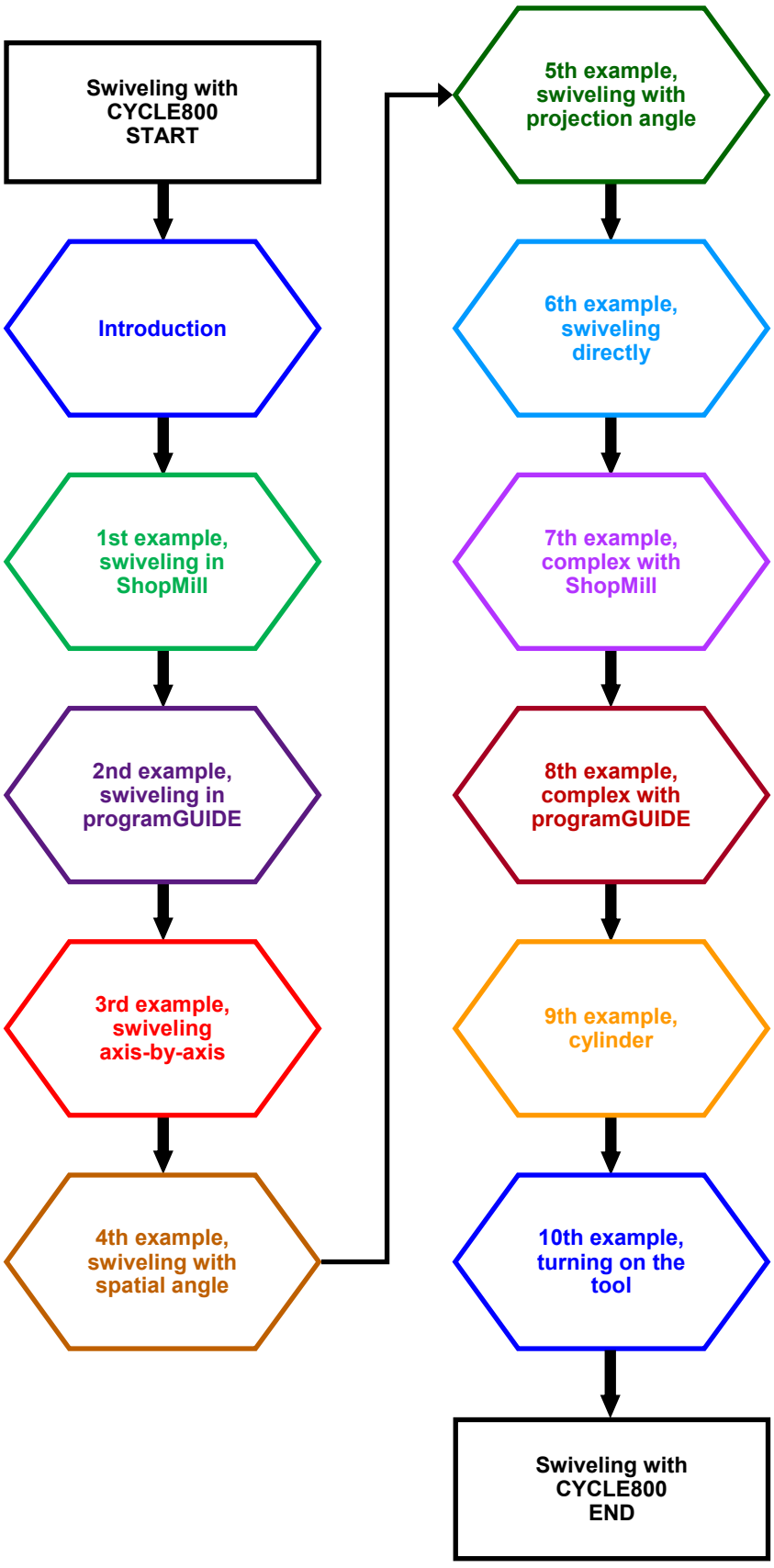
Module Objective:

After working through this module, you know the CYCLE800 from Siemens with all its input options.

Content:

Introduction
- "**CYCLE800**" settings
- Swiveling in "**JOG**"
- "**Axis-by-axis**" swiveling
- "**Spatial angle**" swiveling
- "**Projection angle**" swiveling
- "**Direct**" swiveling
- "**Turn on**" tool

Sinumerik

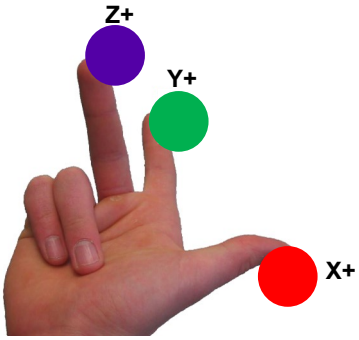

Swiveling with CYCLE800 START
Introduction
1st example, swiveling in ShopMill
2nd example, swiveling in programGUIDE
3rd example, swiveling axis-by-axis
4th example, swiveling with spatial angle
5th example, swiveling with projection angle
6th example, swiveling directly
7th example, complex with ShopMill
8th example, complex with programGUIDE
9th example, cylinder
10th example, turning on the tool
Swiveling with CYCLE800 END

Notes:

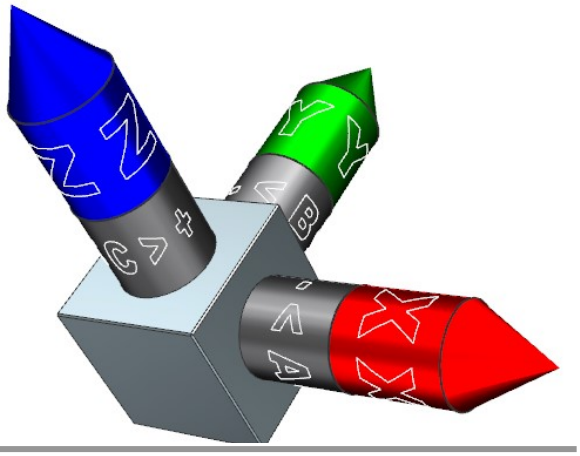
Introduction:

This module concerns "CYCLE800".
This simplifies programming for 3+2 axis machining, also called 2½D machining. This is equivalent to working in swiveled planes.
If a milling machine has one or two additional rotary axes, an oblique plane can be defined in space and the tool set perpendicular to it.

The "right-hand rule" described in the previous M101 module serves as basis.

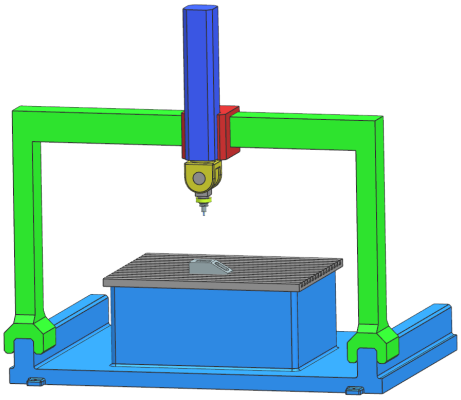


The resulting linear and rotary axes are shown in the right-hand graphic using a coordinate cube.

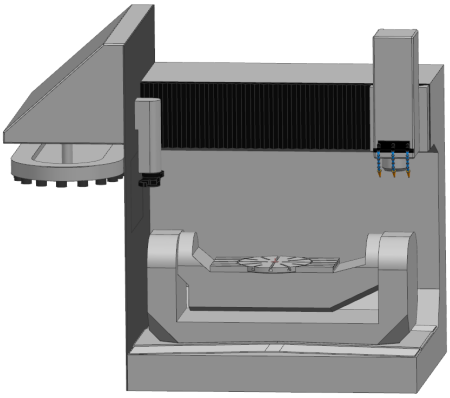


Irrespective of the associated machine kinematics

Type T (T= Tool)



Type P (P= Part)



or whether a combination of both.

The swivel axes are always rotated so that the machining plane is perpendicular to the tool axis for the subsequent machining.
The direct programming of rotary axes is a special case.

"**CYCLE800**" is responsible for this.

Notes:

CYCLE800

This cycle is also a subprogram that accesses data which was commissioned so that the programming and application are optimized and simplified for operators and programmers.

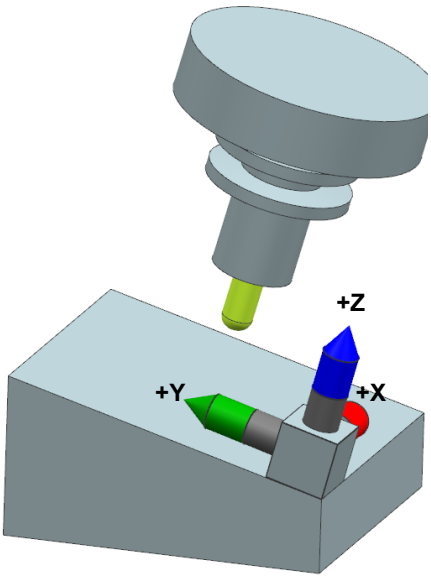
The cycle, however, is not essential for swiveling. Examples without "CYCLE800" were shown in the previous module.

This module shows examples for working with "CYCLE800".

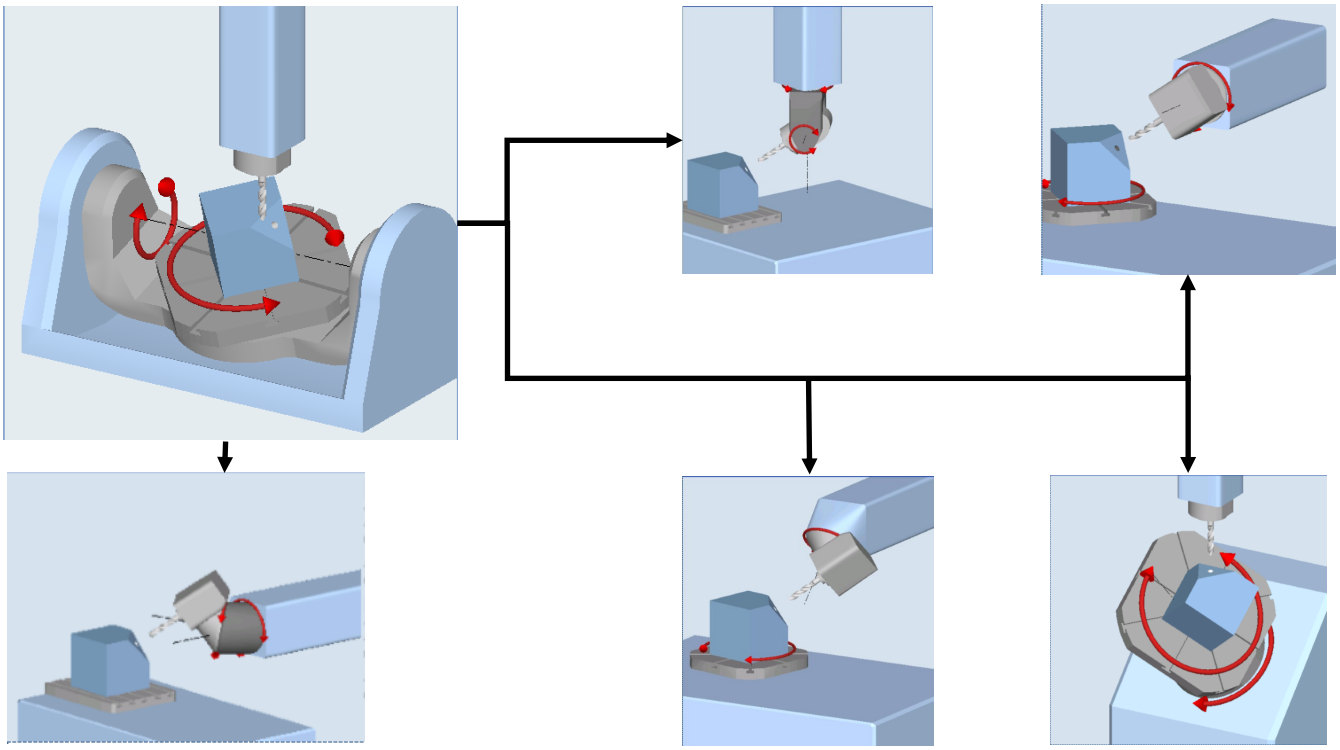
You can use swivel heads or swivel tables to set up and machine oblique planes. Swiveling is possible in JOG mode as well as in AUTOMATIC mode. Swivel operation parameter assignment and programming are facilitated by the clearly laid out graphics.

You can either program all the swivel axes directly on the machine (A, B, C) or you can simply specify the rotations around the geometry axes (X, Y, Z) of the workpiece coordinate system as described in the relevant workpiece drawing. The rotation of the workpiece coordinate system in the program is then automatically converted to a rotation of the relevant swivel axis of the machine during machining.

The swivel axes are always rotated in such a way that the machining plane is perpendicular to the tool axis for machining. The machining plane is then fixed during the machining.
When the axes are swiveled, the active zero points and tool offsets are automatically converted for the swiveled state, resulting in a new coordinate system.



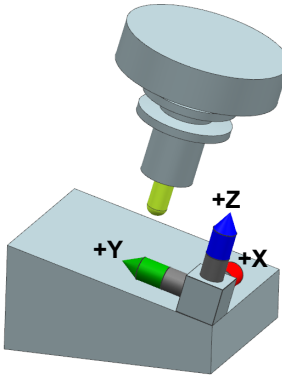
The input screen of "CYCLE800" represents the machine kinematics.



Die Eingabemasken und Möglichkeiten werden anhand der nachfolgenden Beispiele Schritt für Schritt erklärt und praktisch angewendet.

Notes:

The machining plane is then fixed during the machining.



All this is implemented via "CYCLE800".

The term "CYCLE800" does not appear in ShopMill.

However, because this cycle permits swiveling, it is used completely for this purpose.

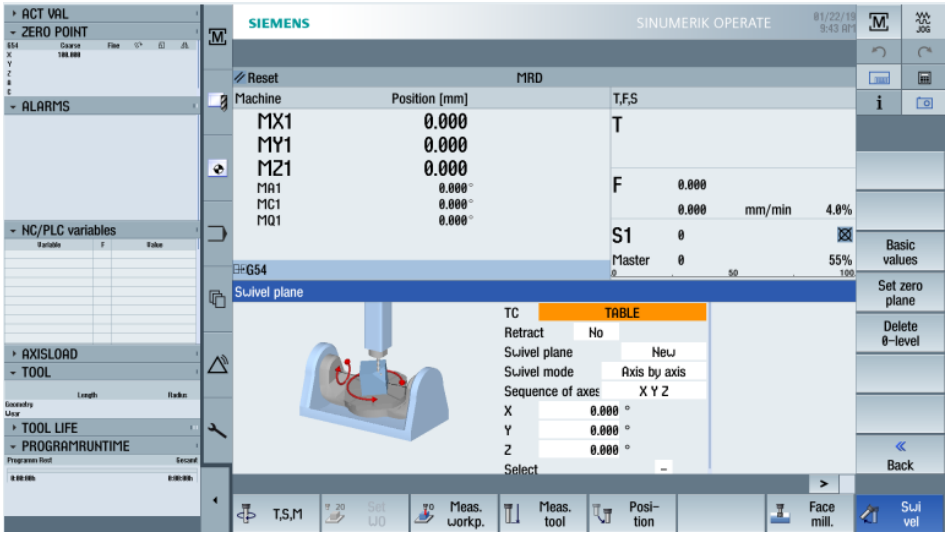
Pressing

opens the input screen for swiveling in JOG.

If no TC (Tool Carrier) that contains the machine kinematics for swiveling is selected, this field remains empty.

Notes:

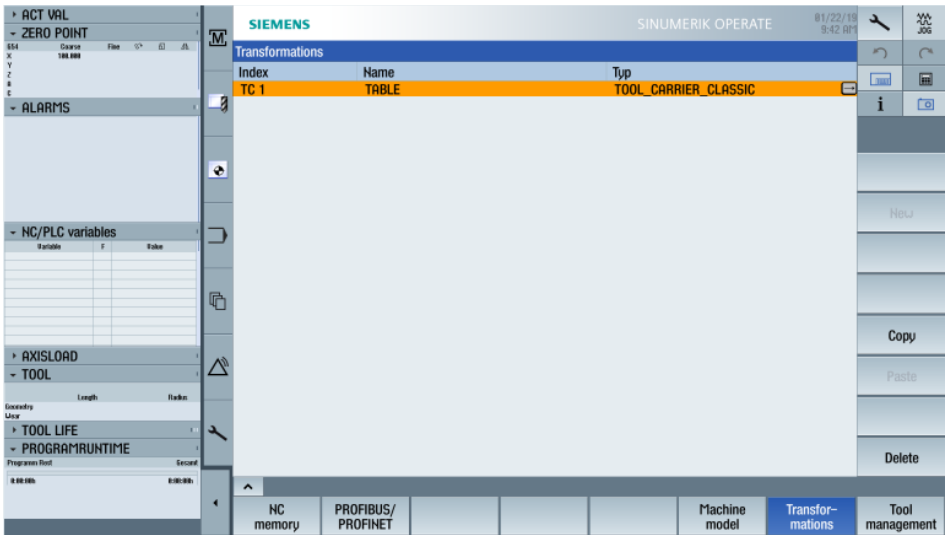
Only when a TC is selected does the input screen with the appropriate kinematics open.



The TC, beginning with the name through to the parameterization, is normally commissioned by the manufacturer. This is not the basis this module, but rather of the commissioning.

To simplify understanding, the function of a Tool Carrier as of version 4.8 is described in detail.

Pressing 



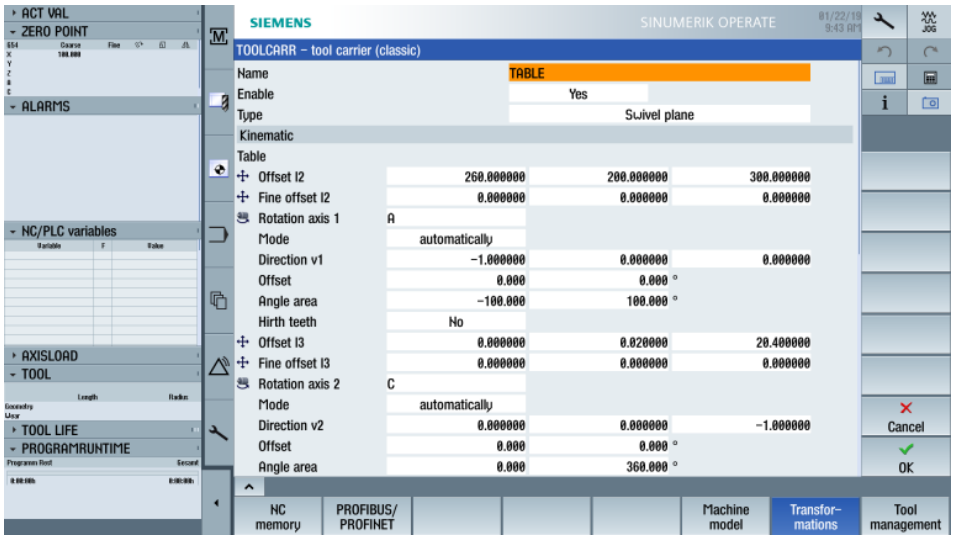
opens the Tool Carrier. The name of the TC ("TABLE") is arbitrary. If necessary, several Tool Carriers can also be created, for example, when a replaceable head is used for machining.

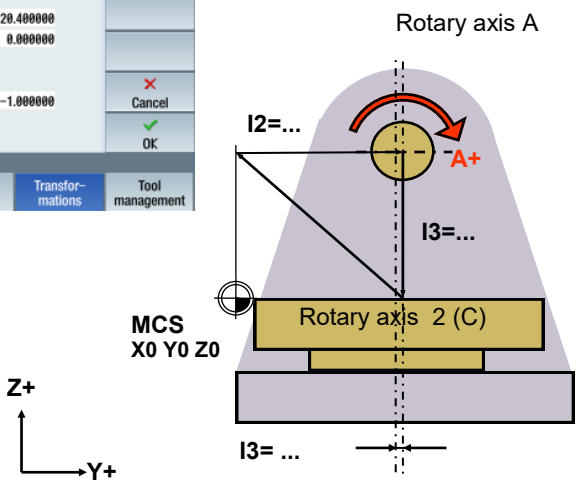
Caution:

Alle geänderten Daten sind sofort aktiv.

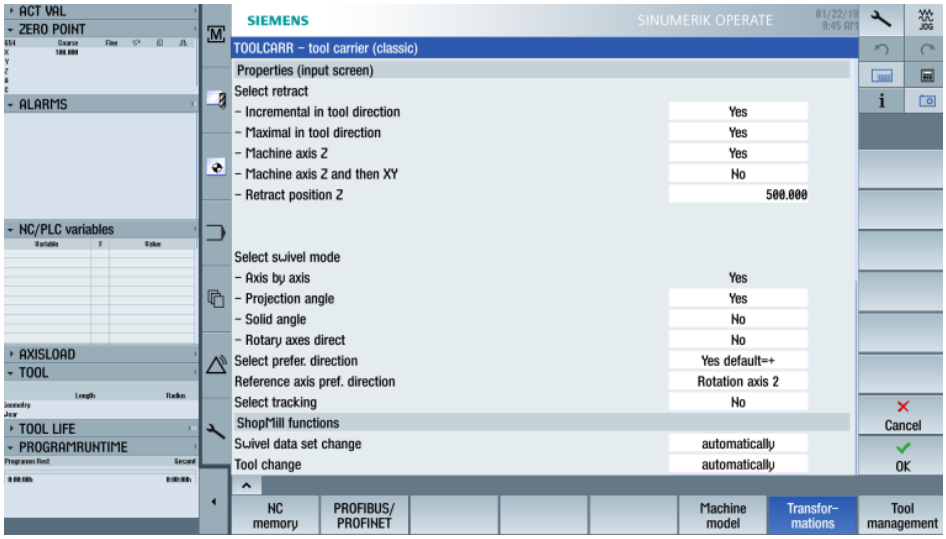
Notes:

The complete mathematics of the machine axes are stored in the Tool Carrier.





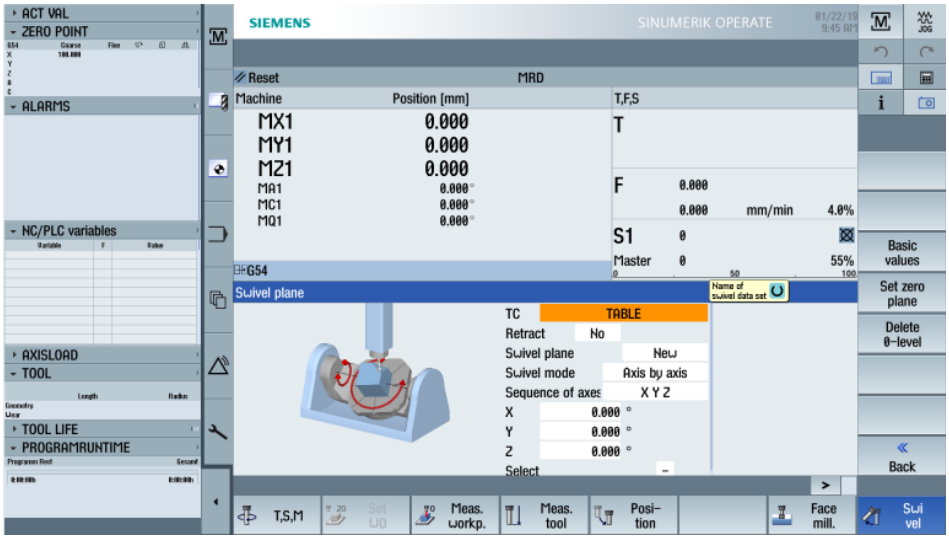
In addition to the values for the axis measurement, machine-related strategies are also specified in the Tool Carrier.
Such strategies are normally made by the machine manufacturer / distributor.



Notes:

Pressing   

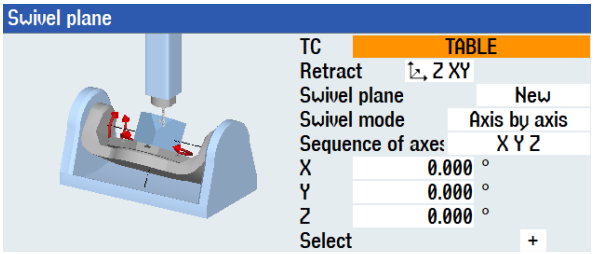
opens the screen for swiveling the plane in the "Jog" operating area.



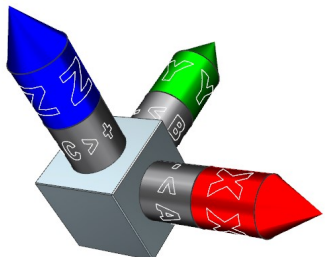
Es können hier unabhängig von einem Programm die Achsen geschwenkt werden.

The axes can be swiveled in two ways.

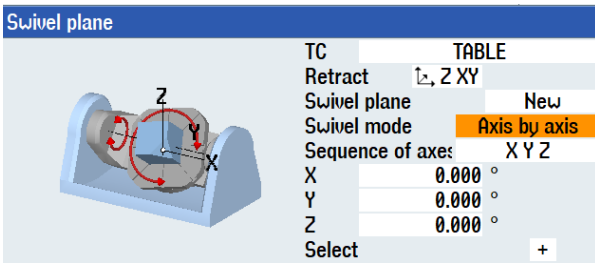
Specify the X, Y or Z axes in various



sequences by entering a degree,

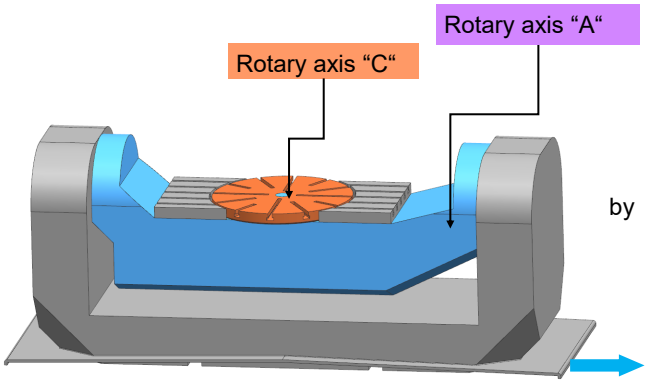


or by the



direct selection of an axis

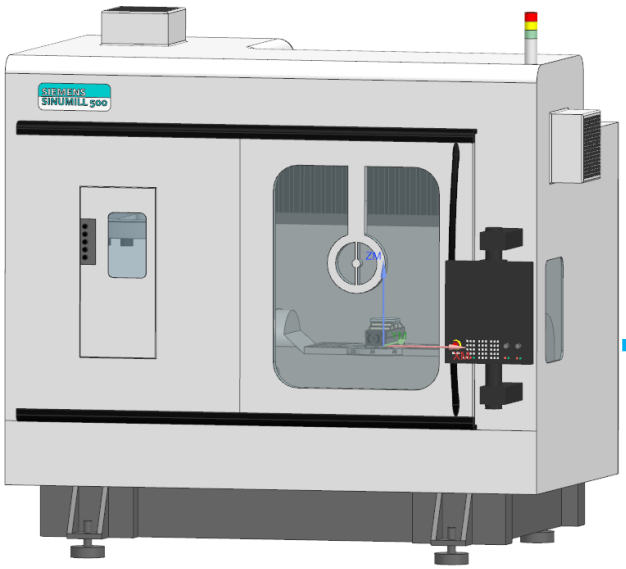
en-terng a degree.

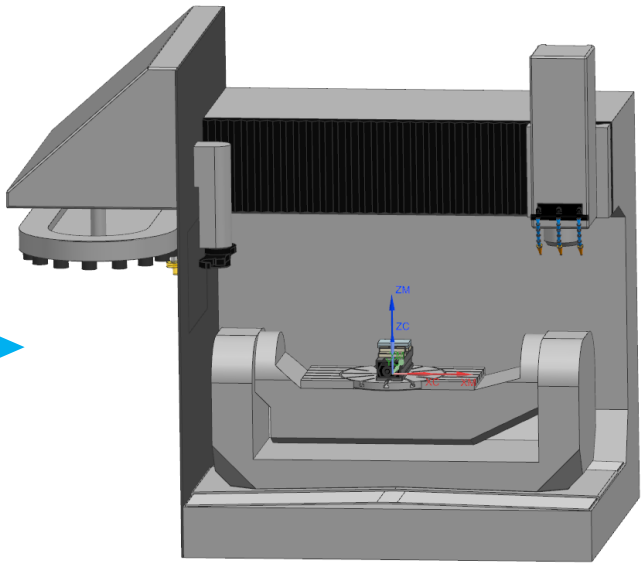


by

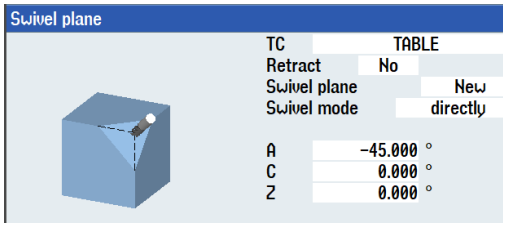
Notes:

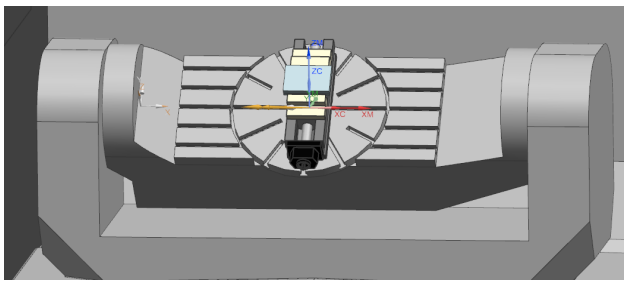
This manufacturer-neutral machine tool forms the basis of the 5-axis and the CAM documentation from Siemens.

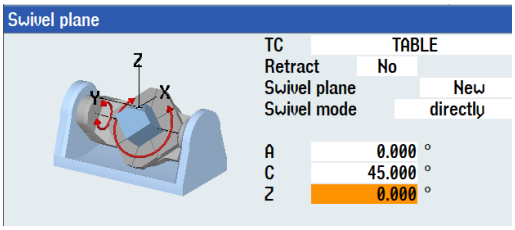


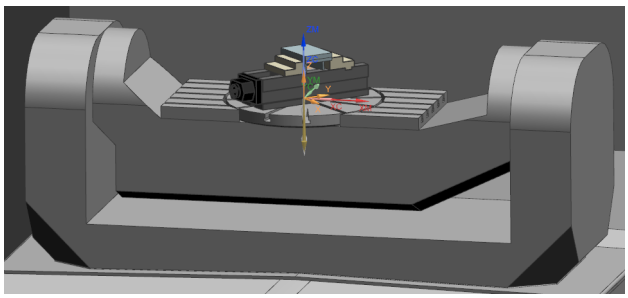


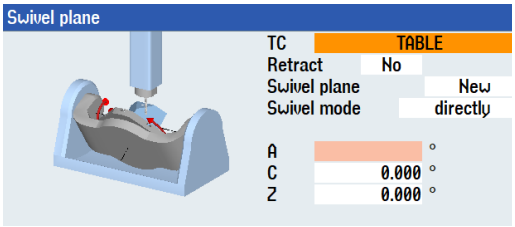
Familiarize yourself with the swiveling of axes on a real or virtual machine.











With the "additive" swivel plane, the following swiveling adds to the previous one.

Notes:

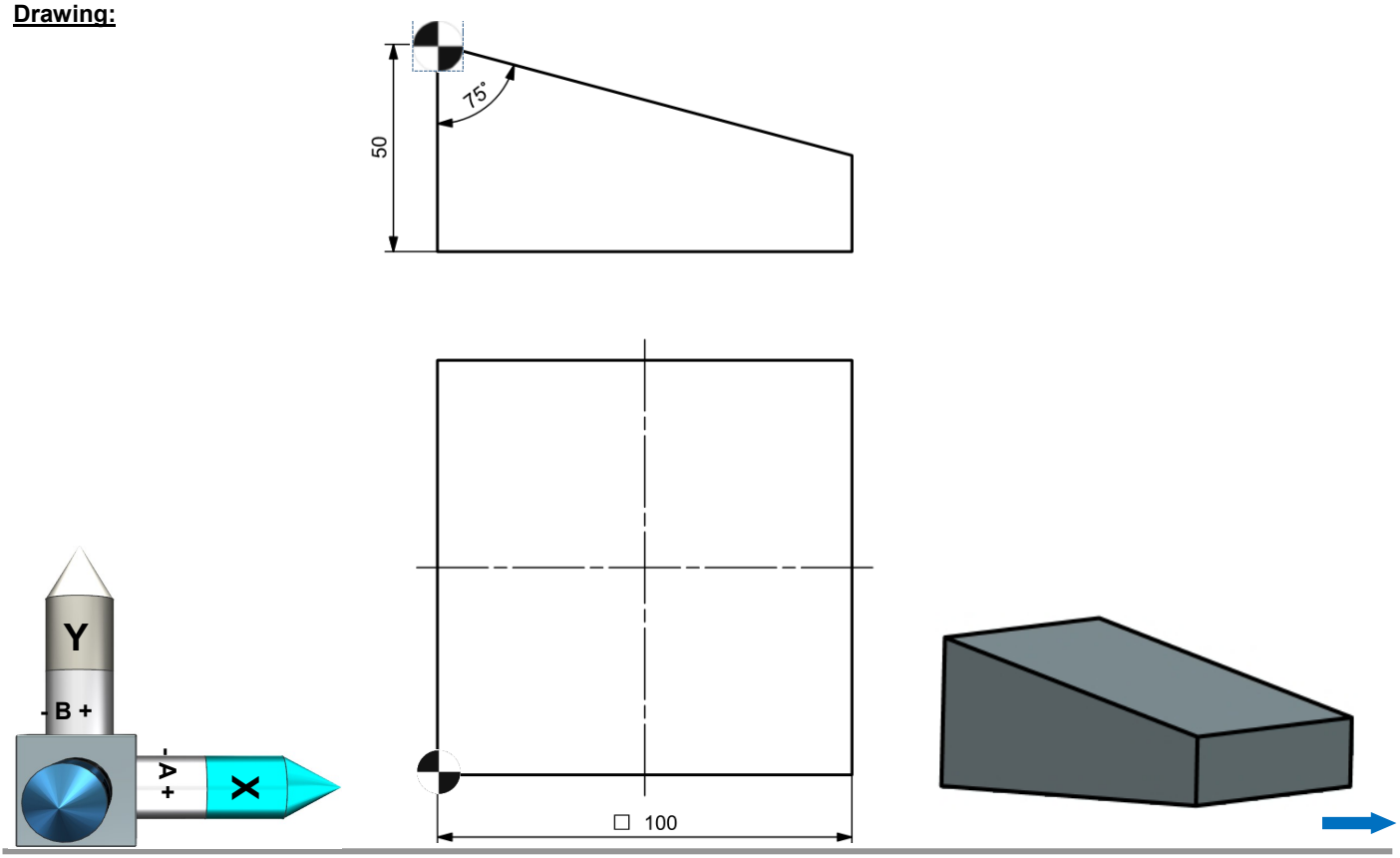
1st example, swiveling in ShopMill

Task:

The blank for the program example has the dimensions 100x100x52 mm

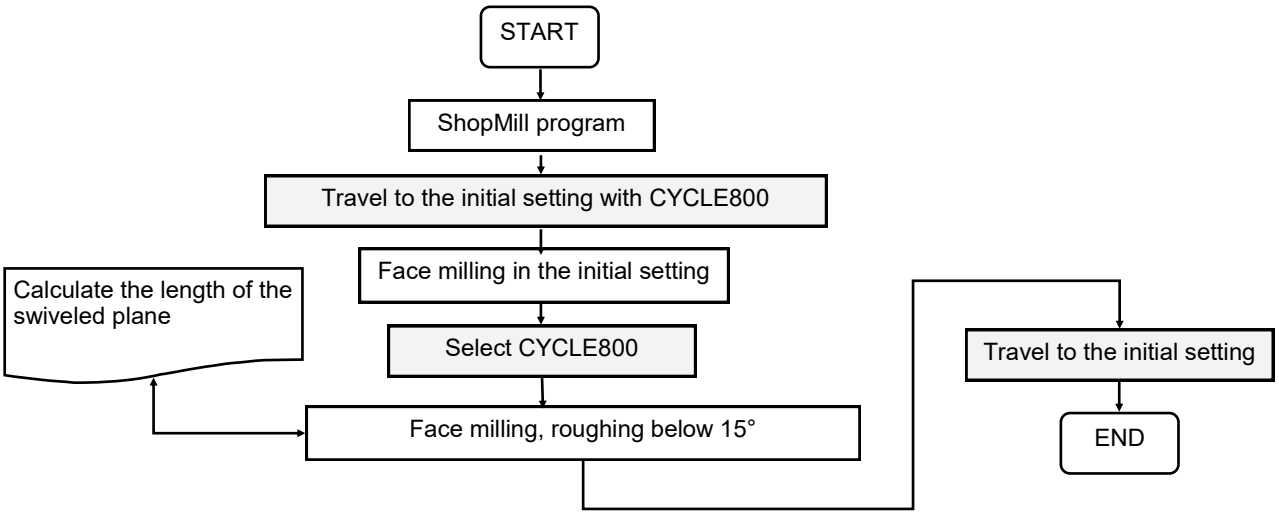
⇒ Programming in ShopMill
⇒ Travel machine to the initial setting
⇒ Face milling of the workpiece in the initial setting at a height of 50 mm
⇒ Swivel the workpiece and calculate the required infeed
⇒ Face milling of the workpiece in the swiveled state
⇒ Travel machine to the initial setting

Drawing:



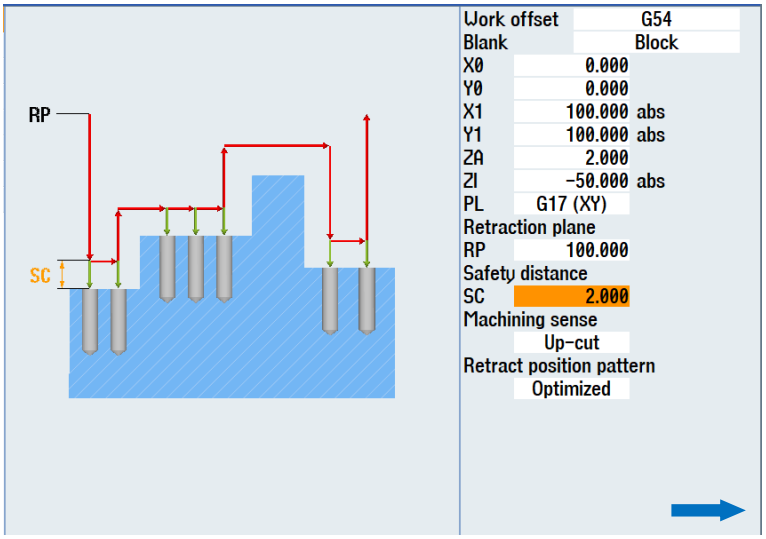
Notes:

Flow diagram:



After creating a new ShopMill program

and programming the program header,

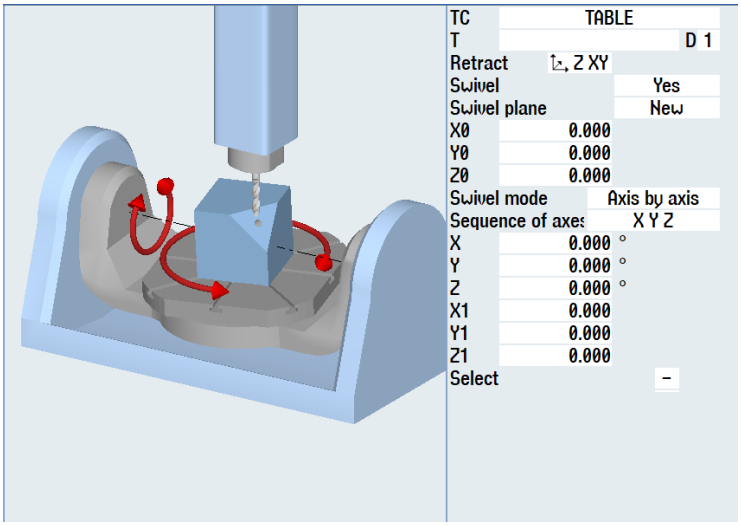


Notes:

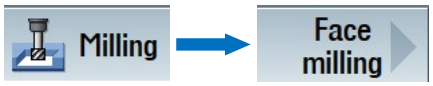
face cutting is performed in the initial setting.

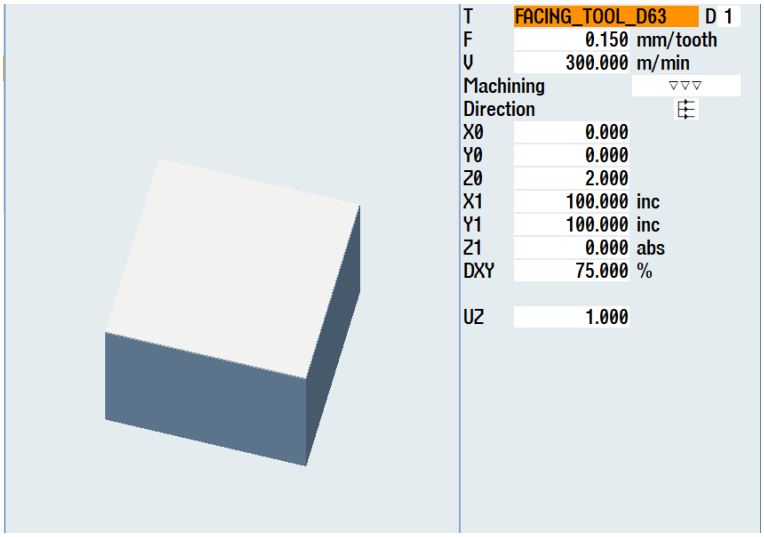
After pressing

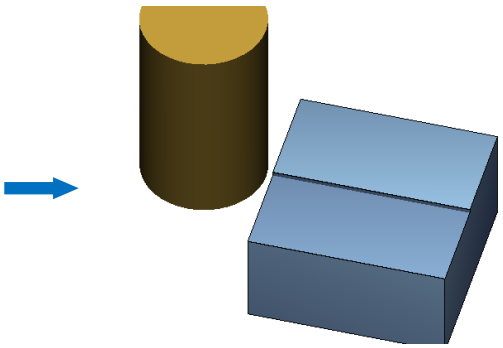
the machine with selected swivel data set is in the initial setting.



After pressing

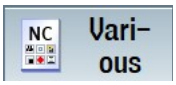




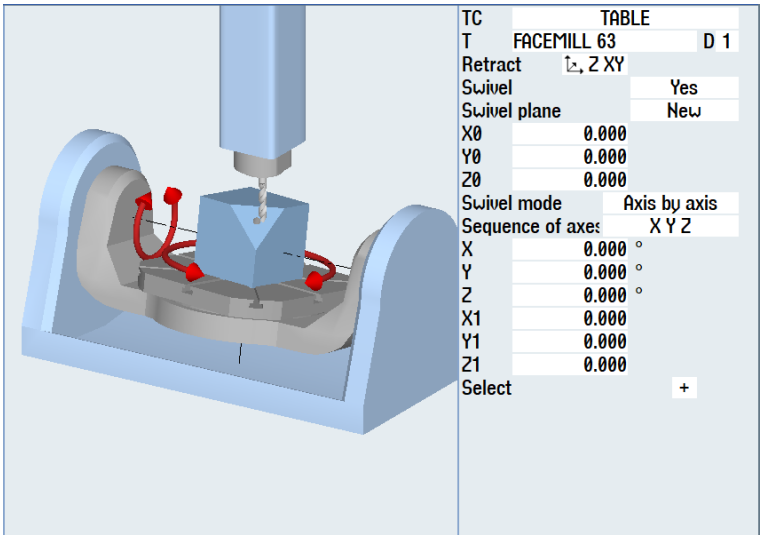


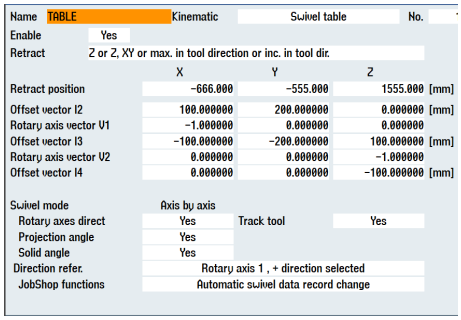
face milling in the initial setting is programmed.

Notes:

After pressing 


the input screen for "CYCLE800" opens and the first swivel is programmed.

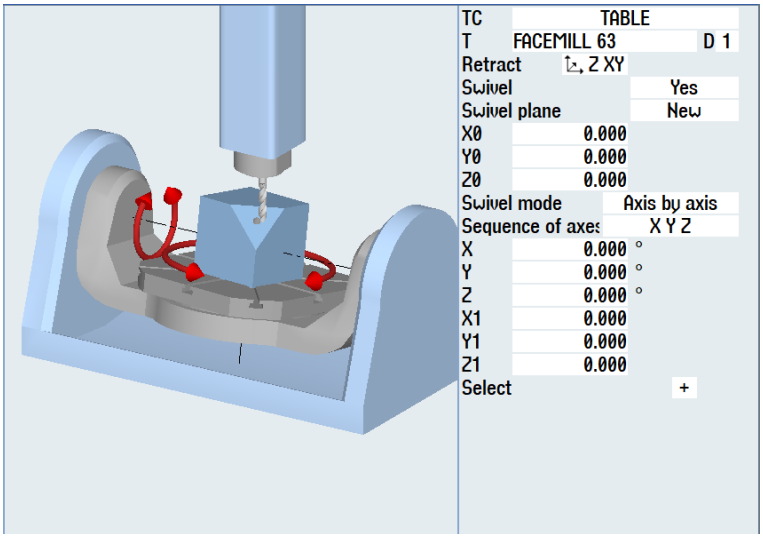


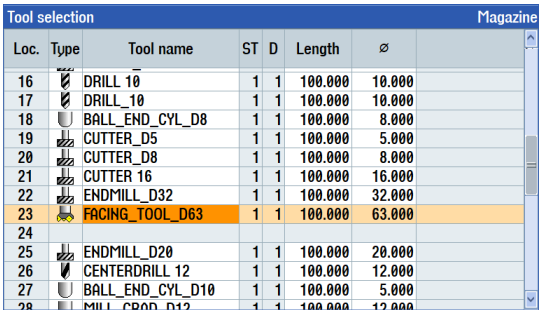


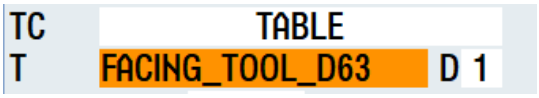
The desired "Tool Carrier" is selected with the first input field "TC".

If there are several Tool Carriers, the most recently programmed one is active.

In "CYCLE800" with ShopMill, the tool - as always in ShopMill - is selected directly in the input screen.



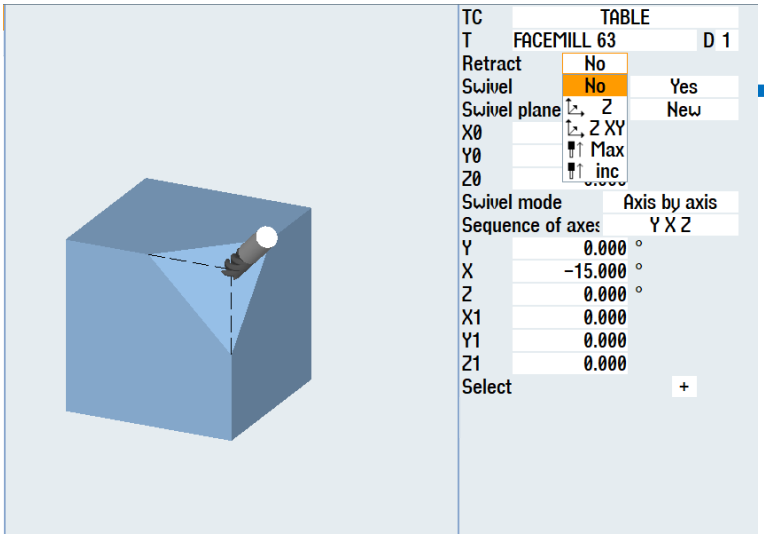


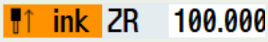


If the input field remains empty, the previous active tool is taken.

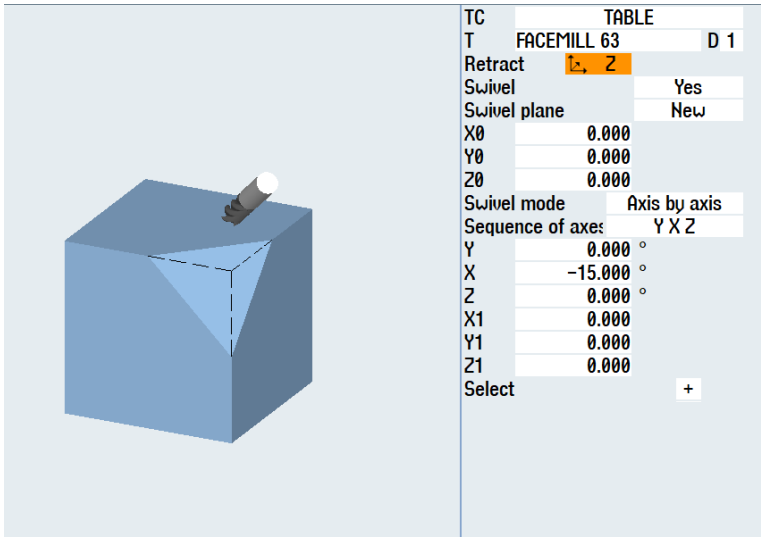
Notes:

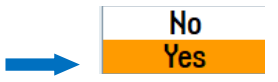
The "retract" possibilities are:

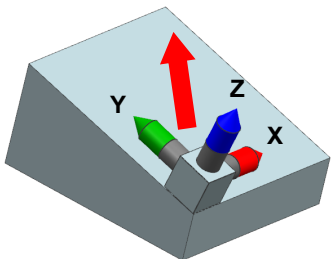


Com-	Explanation
No	**No retract performed before swiveling.**
Z	**Retract in the direction of machine axis Z. The retract length is that selected in the program header.**
ZXY	**Retract in the direction of machine axis Z, and then in X and Y.**
MAX	**Maximum retract in the tool direction.**
INK	**The retract length is entered via an input field in the cycle.** 

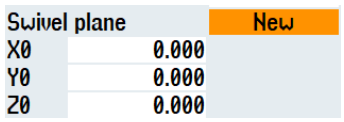
For "**Swivel**", select "**Yes**".
This implements physical swiveling on the machine.
Swiveling is not performed for "**No**".
This is used, for example, when only a position should be calculated, after which a further swiveling follows.
This programming is explained in the following examples.







If swiveling requires that the position of the coordinate system is moved, this is performed for each axis via the **X0**, **Y0** and **Z0** parameters.

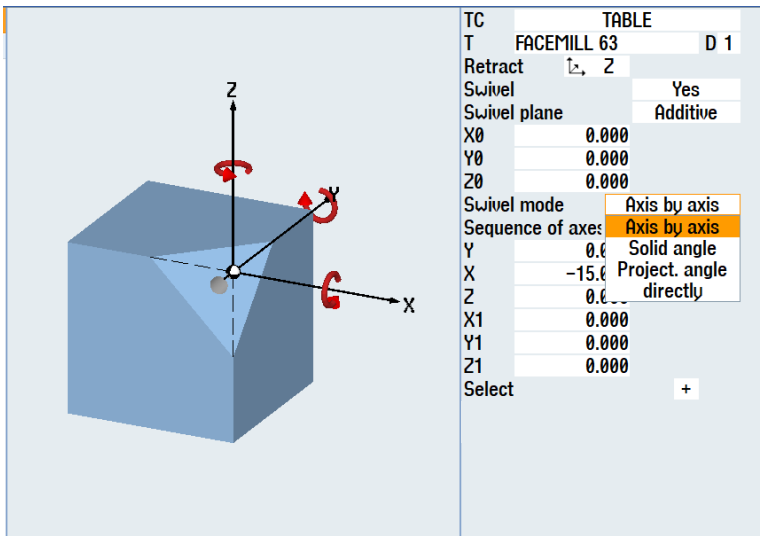


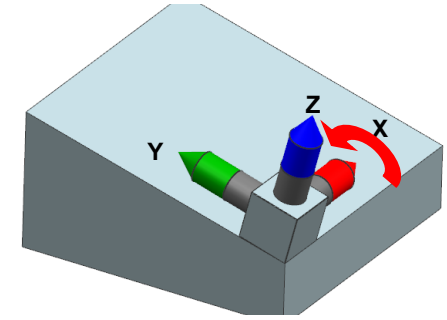
If you want to build on a previous swivel plane, selecz.

The following examples are programmed with this selection.

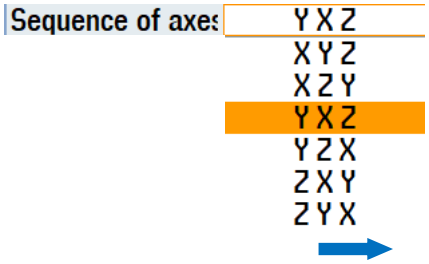
Notes:

Swiveling is normally performed "axis-by-axis". Consequently, this is used in most examples.

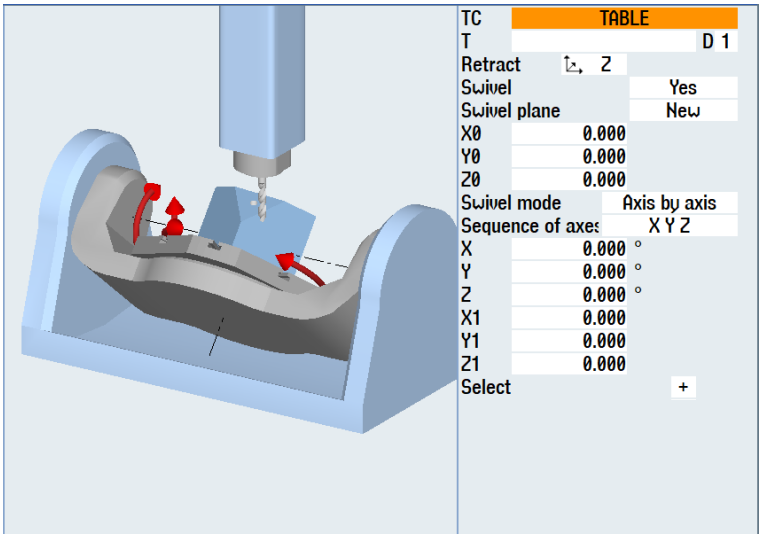


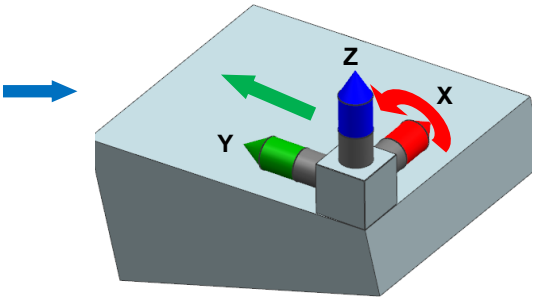


The axis sequence is generally arbitrary.



After the rotation, a further movement can be programmed via **X1, Y1, Z1**.

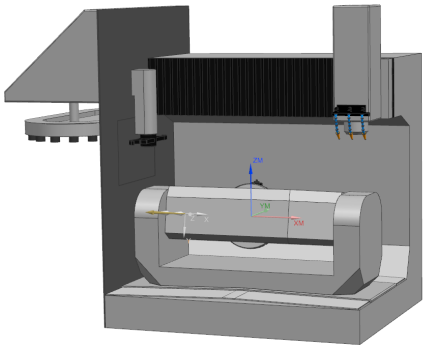




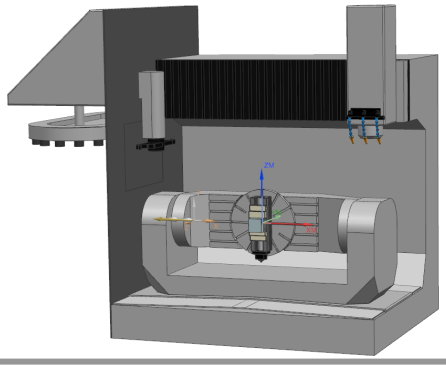
Notes:

The swivel direction can be specified in the last input field of the cycle.
There are always two directions that mathematically lead to the result. Plus (+) and minus (-).
The operator can select to achieve an optimum view of the workpiece.

Select −

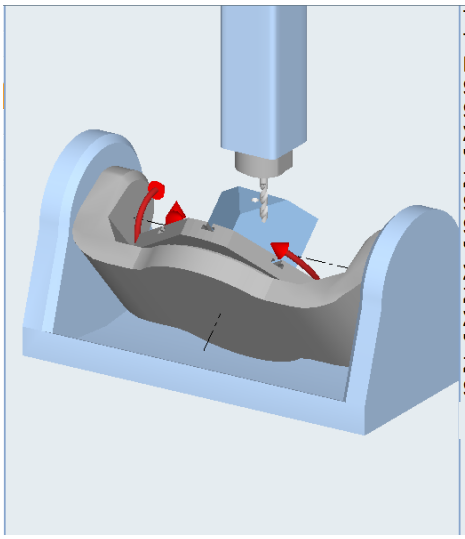


Select +



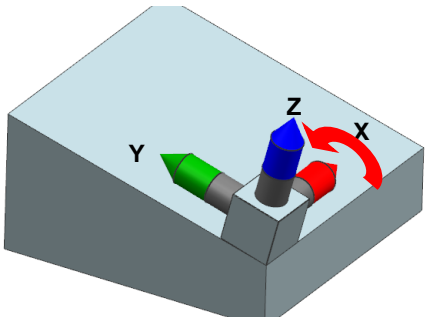
"+" is used for programming in the examples.

In this example, swiveling is made at the Z axis.



TC	TABLE	
T	FACEMILL 63	D 1
Retract	Z XY	
Swivel	Yes	
Swivel plane	New	
X0	0.000	
Y0	0.000	
Z0	0.000	
Swivel mode	Axis by axis	
Sequence of axes	Y X Z	
Y	0.000	°
X	-15.000	°
Z	0.000	°
X1	0.000	
Y1	0.000	
Z1	0.000	
Select	+	

The position of the workpiece zero point remains unchanged.

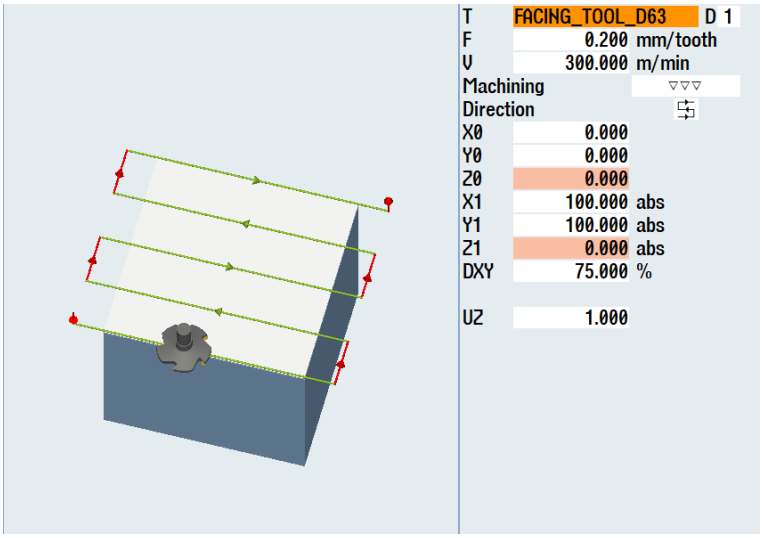


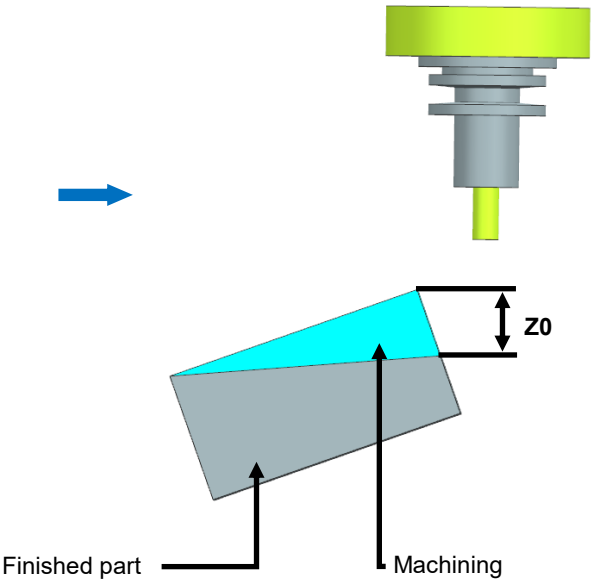
P	Program header	G54 Block
	Swivel plane	X=0 Y=0 Z=0 Z XY
	Face milling	T=FACEMILL 63 F=0.125/t V=650m X0=0 Y0=0 Z0=2 Z1=0
	Swivel plane	Y=0 X=-15 Z=0 T=FACEMILL 63 Z XY
END	End of program	

The swivel cycle is transferred to the program.

Notes:

After swiveling, the face milling cycle for milling the oblique surface opens again.
The start plane "**Z0**" must now be calculated.





The values for the traversal paths are calculated with the angle functions.

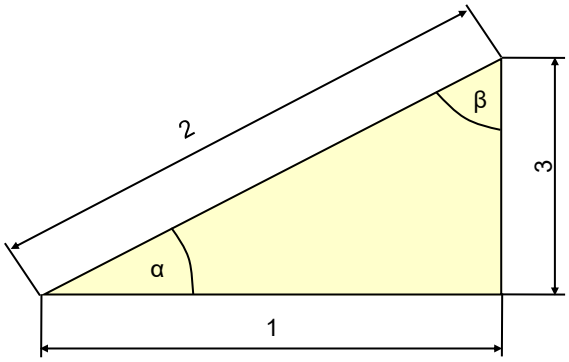
1 Adjacent (AK)

2 Hypotenuse (H)

3 Opposite (GK)

α Angle

β Angle



Sine function

$$\sin\alpha = \frac{GK}{H} \qquad H = \frac{GK}{\sin\alpha} \qquad GK = \sin\alpha * H$$

Cosine function

$$\cos\alpha = \frac{AK}{H} \qquad H = \frac{AK}{\cos\alpha} \qquad AK = \cos\alpha * H$$

Tangent function

$$\tan\alpha = \frac{GK}{AK} \qquad AK = \frac{GK}{\tan\alpha} \qquad GK = \tan\alpha * AK$$

Notes:

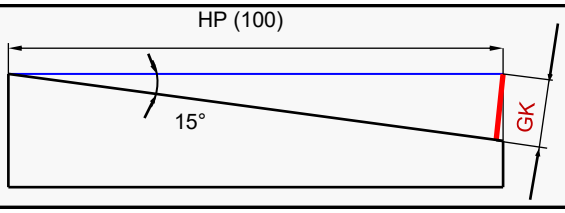
Based on the current example, the following calculation results:

Note: (Calculation of the "**Z0**" parameter)

sin α = GK / HP → sin 15 = GK / 100

GK = sin 15 * 100

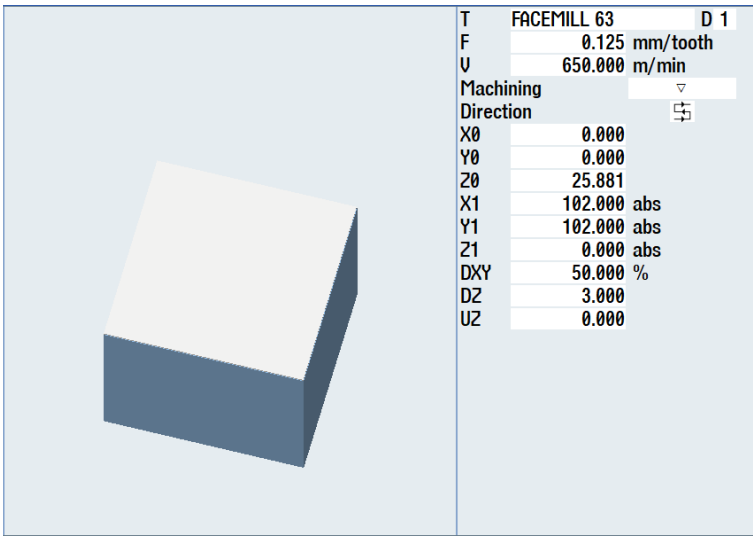
⇒ GK = **25.882**



The calculation can be performed externally or directly in the input field.

After opening the face milling cycle,

the calculated value can be entered in the input field directly as value



or as calculated formula. The result is then automatically the value for "**Z0**".
For the values "**X1**" and "**Y1**", a protrusion of 2 mm is programmed (empirical values).

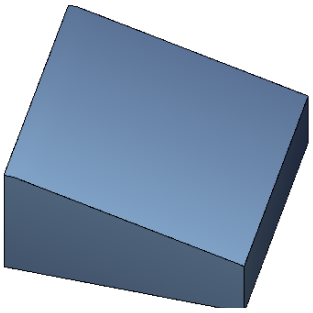
GK = sin 15 * 100 → Z0 SIN(15)*100

Notes:

After machining, the initial setting is programmed and the "**TC**" deselected via "**CYCLE800**".

The program is now fully created.

P	Program header	G54 Block
	Swivel plane	X=0 Y=0 Z=0 Z XY
	Face milling ▽	T=FACEMILL 63 F=0.125/t V=650m X0=0 Y0=0 Z0=2 Z1=0
	Swivel plane	Y=0 X=-15 Z=0 T=FACEMILL 63 Z XY
	Face milling ▽	T=FACEMILL 63 F=0.125/t V=650m X0=0 Y0=0 Z0=25.881
	Swivel plane	X=0 Y=0 Z=0 T=ENDMILL_D8 Z
	Swivel plane	Z XY TC=0
END	End of program	



2nd example, swiveling in programGUIDE

The workpiece for the "1st example" is now created as G-code program.

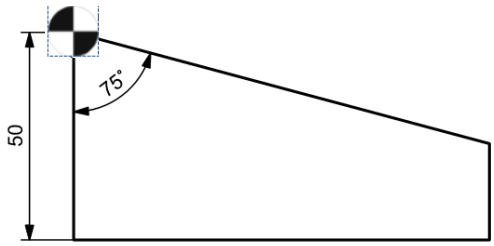
Task:

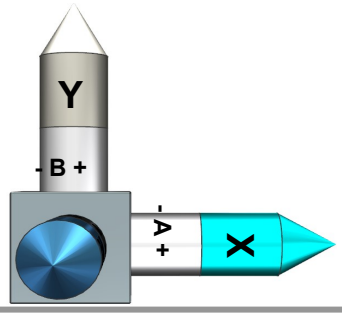
The blank for the program example has the dimensions 100x100x52 mm

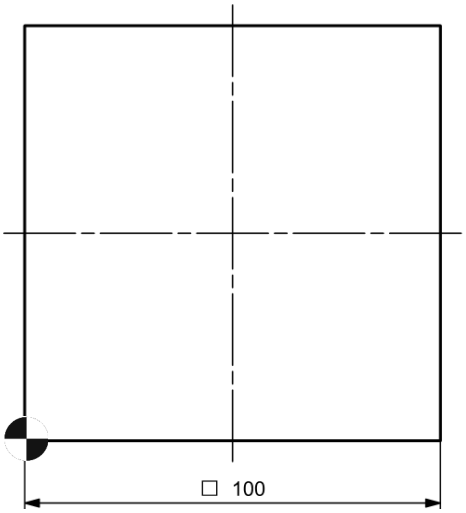
⇒ Programming in programGUIDE
⇒ Travel machine to the initial setting
⇒ Face milling of the workpiece in the initial setting at a height of 50 mm
⇒ Swivel the workpiece and calculate the required infeed
⇒ Face milling of the workpiece in the swiveled state
⇒ Travel machine to the initial setting

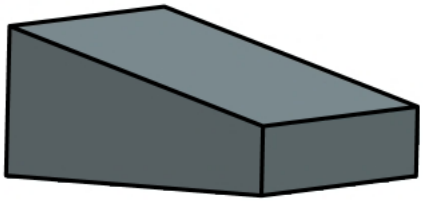
Notes:

Drawing:

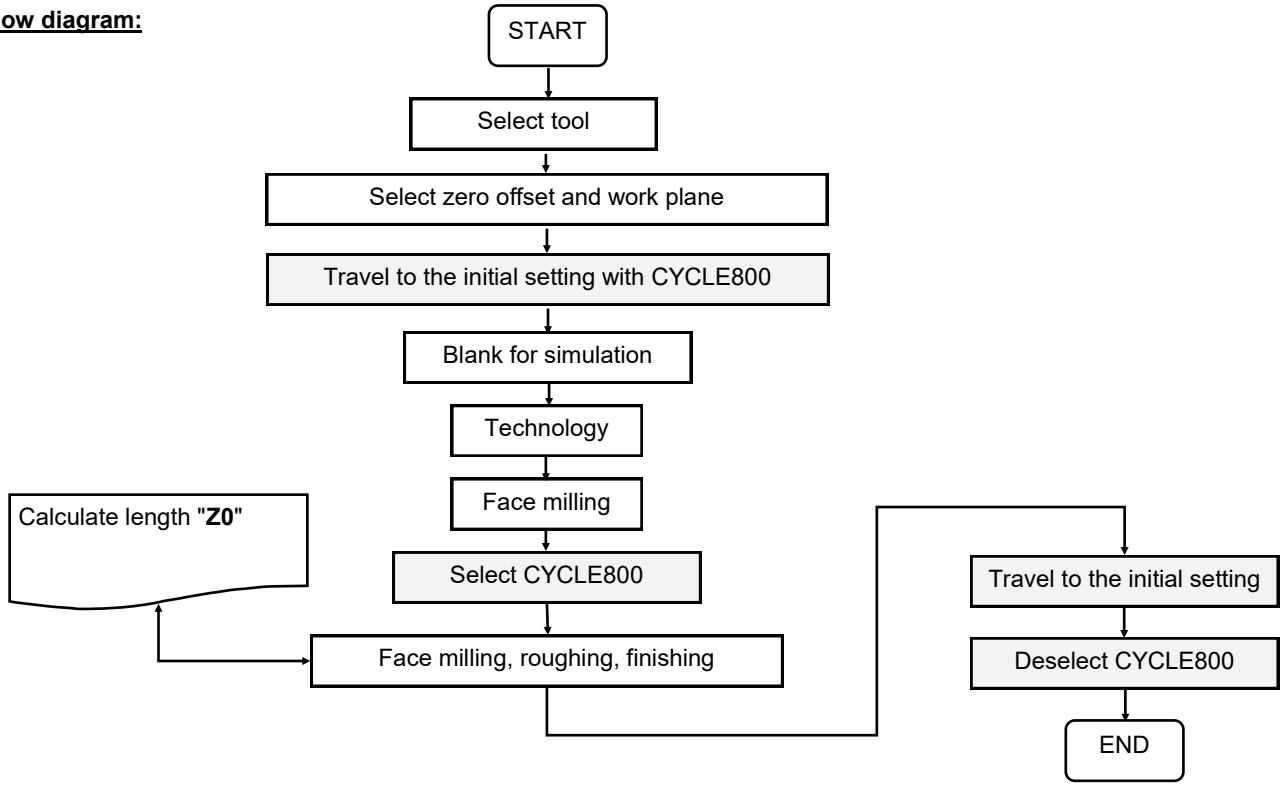






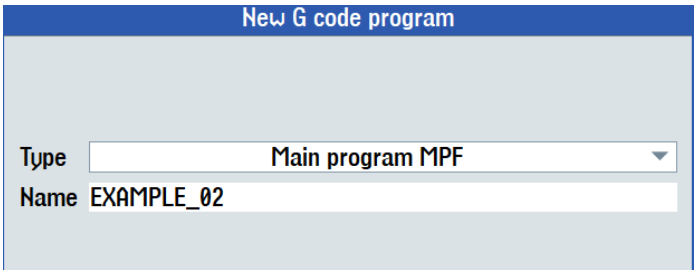


Flow diagram:



Notes:

After creating a new G-code program,

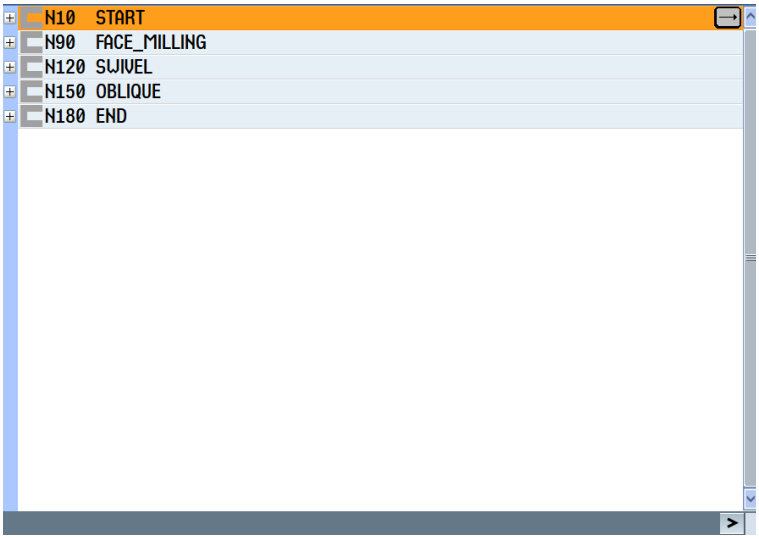


describe a block structure for this G-code program.

Function	Block name
Start commands	START
Face milling initial setting	FACE_MILLING
Swivel plane	SWIVEL
Mill oblique surfaces	OBLIQUE
End commands	END

After pressing 

the individual blocks in the program are created.



The blocks improve the clarity of the program.
Consequently, all G-code programs are programmed as blocks in the training modules.

Notes:

The program header is programmed in the "**START**" block.

```
N20 G54 G17 G90 G40
N30 CYCLE800(2,"TABLE",200000,57,0,0,0,0,0,0,0,0,1,,1)
N40 WORKPIECE(,"C",,"BOX",64,2,-50,-
80,0,0,100,100)
N50 T="ENDMILL_D32"
N60 M6
N70 D1
N80 S5000 M3
```

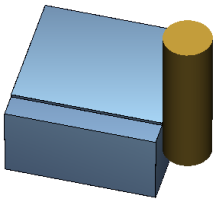
```
N10  START
N20 G54 G17 G40 G90¶
N30 CYCLE800(2, "TABLE", 200000, 57, 0, 0, 0, 0, 0, 0, 0, 0, 1, 100, 1)¶
N40 WORKPIECE(, "C", , "BOX", 112, 2, -50, -80, 0, 0, 100, 100)¶
N50 T="FACEMILL 63"¶
N60 M6¶
N70 S2000 F1000 M3¶
N80  End of group
```

It is important that travel to the "**Initial setting**" is always programmed before the first machining block with "**CYCLE800**".

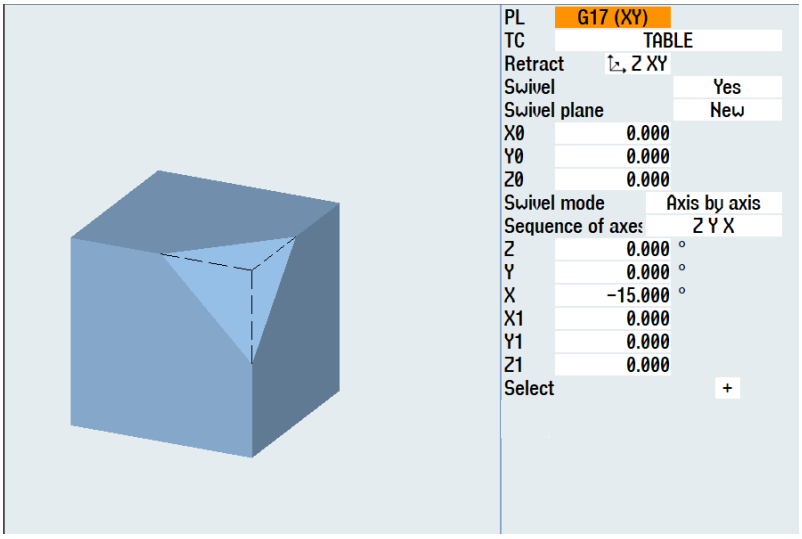
The face milling in the initial setting is programmed in the "**FACE_MILLING**" block.

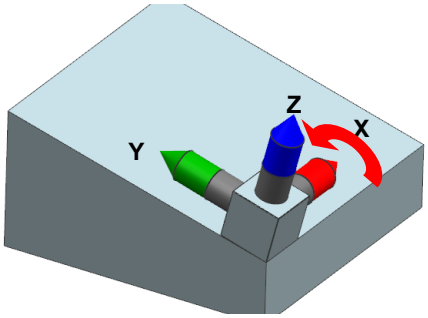
```
N100 G0 X5 Y5 Z5
N110 CYCLE61
(10,1,5,0,0,0,100,100,1,50,0,2000,32,0,1,10)
N120 G0 Z200
```

```
N90  FACE_MILLING
N100 G0 X5 Y5 Z5¶
N110 CYCLE61(10, 2, 5, 0, 0, 0, 100, 100, 3, 75, 0, 2000, 31, 0, 1, 10)¶
N120 G0 Z200¶
N130 End of group
```



The swiveling of the plane defined in the "**PL**" field is programmed in the "**SWIVEL**" block.



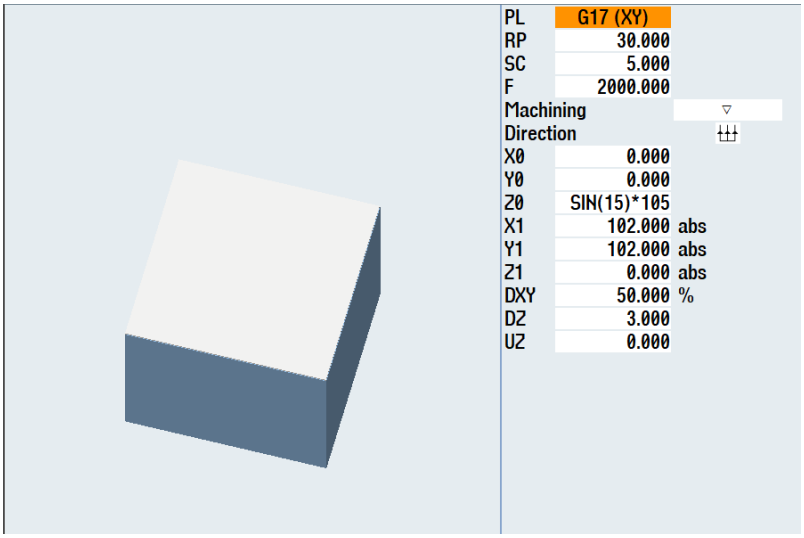


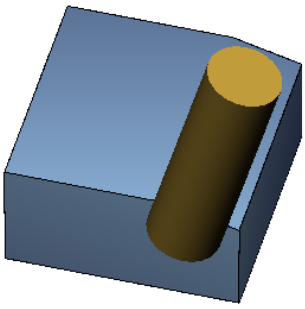

```
N160 CYCLE800(2,"TABLE",200000,27,0,0,0,0,15,0,0,0,0,1,,1)
```

```
N140 SWIVEL
N150 CYCLE800(2, "TABLE", 200000, 27, 0, 0, 0, 0, 0, -15, 0, 0, 0, 1, 100, 1)¶
N160 End of group
```

Notes:

The oblique surface is programmed in the "**OBLIQUE**" block.





The "**Z0**" start plane is calculated with the formula programmed directly in the associated input field. The value 105 used here includes the tool protrusion in the calculation.

```
CYCLE61(100,SIN(15)*105,1,0,100,0,0,100,5,5,0.2,3000,21,0,1,11000)
```

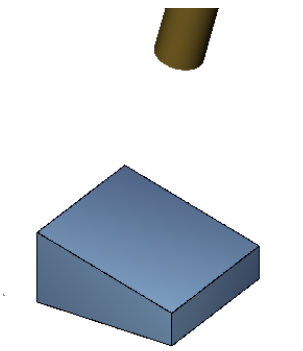
```
N170 OBLIQUE
N180 CYCLE61(30, 25.881, 5, 0, 0, 0, 102, 102, 3, 50, 0, 2000, 31, 0, 1, 11010)¶
N190 End of group
```

The program end is programmed in the "**END**" block.

```
N210 CYCLE800(2,"TABLE",200000,57,0,0,0,0,0,0,0,0,1,100,1)
N220 CYCLE800(2,"0",200000,57,0,0,0,0,0,0,0,0,1,100,1)
N230 M30
```

```
N200 END
N210 CYCLE800(2, "TABLE", 200000, 57, 0, 0, 0, 0, 0, 0, 0, 0, 1, 100, 1)¶
N220 CYCLE800(2, "0", 200000, 57, 0, 0, 0, 0, 0, 0, 0, 0, 1, 100, 1)¶
N230 M30¶
```

The program is fully programmed.



Notes:

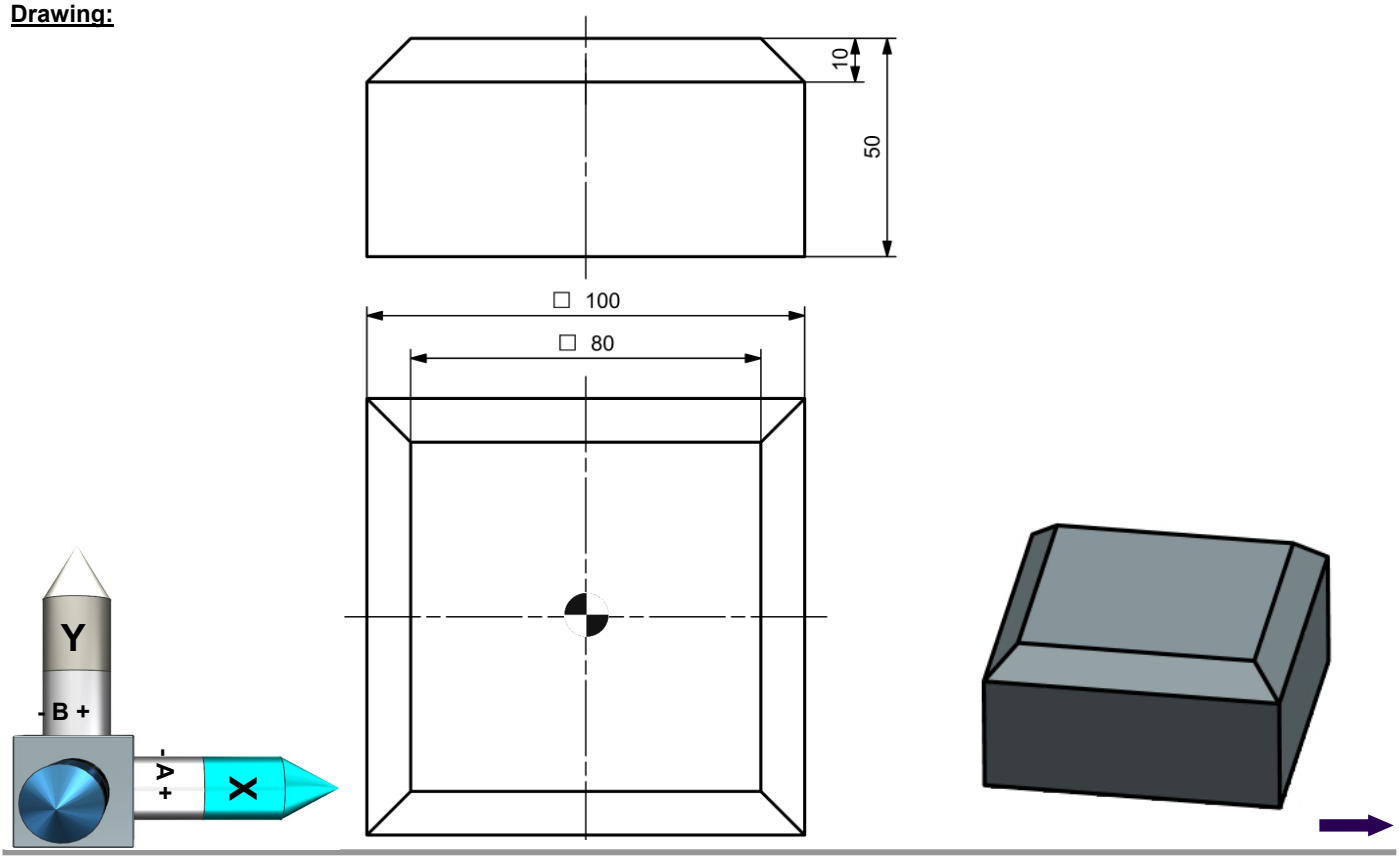
3rd example, swivelling axis-by-axis

Task:

The blank for the program example has the dimensions 100x100x50 mm

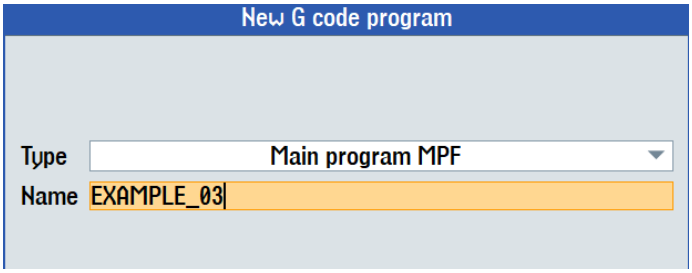
⇒ Programming in programGUIDE
⇒ Programming chamfers with "**Axis-by-axis swiveling**"

Drawing:



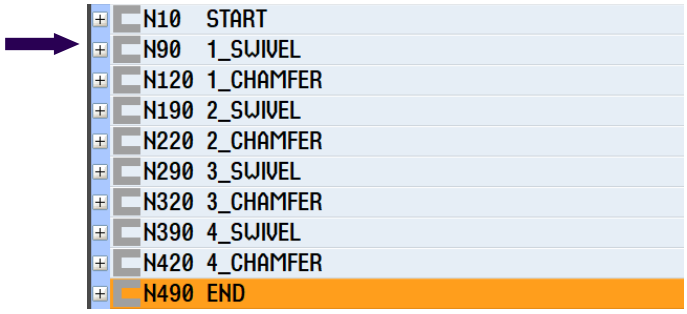
Notes:

After creating a new G-code program,



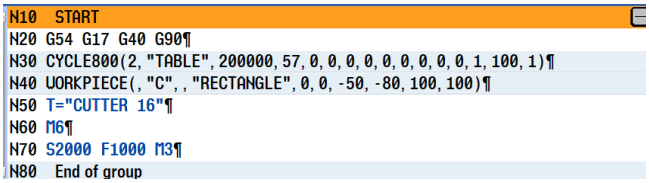
a new block structure for this G-code program is programmed.

Function	Block name
Start commands	START
1st swivel	1_SWIVEL
1st operation	1_CHAMFER
2nd swivel	2_SWIVEL
2nd operation	2_CHAMFER
3rd swivel	3_SWIVEL
3rd operation	3_CHAMFER
4th swivel	4_SWIVEL
4th operation	4_CHAMFER
End commands	END



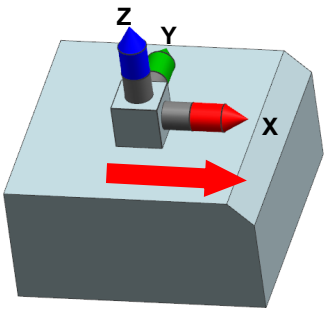
The "**START**" block is programmed.

```
N20 G54 G17 G40 G90
N30 CYCLE800(2,"TABLE",200000,57,0,0,0,0,0,0,0,0,0,1,100,1)
N40 WORKPIECE(,"C",,"RECTANGLE",0,0,-50,-80,100,100)
N50 T="CUTTER 16"
N60 M6
N70 S2000 F1000 M3
```

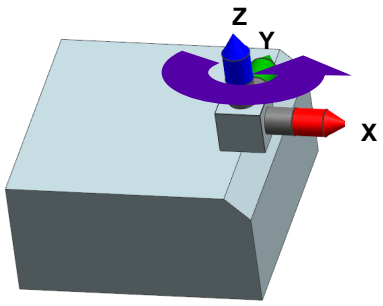


1st step: Move the coordinate system from the center to the point where the edge should result.
2nd step: Always rotate at the center point.
3rd step: Swivel by 45°.

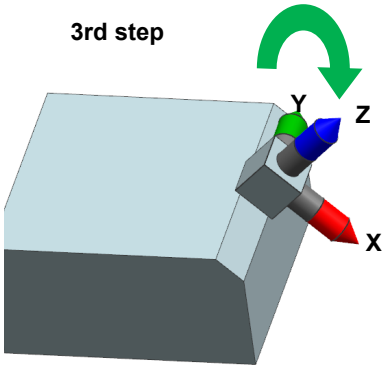
1st step



2nd step



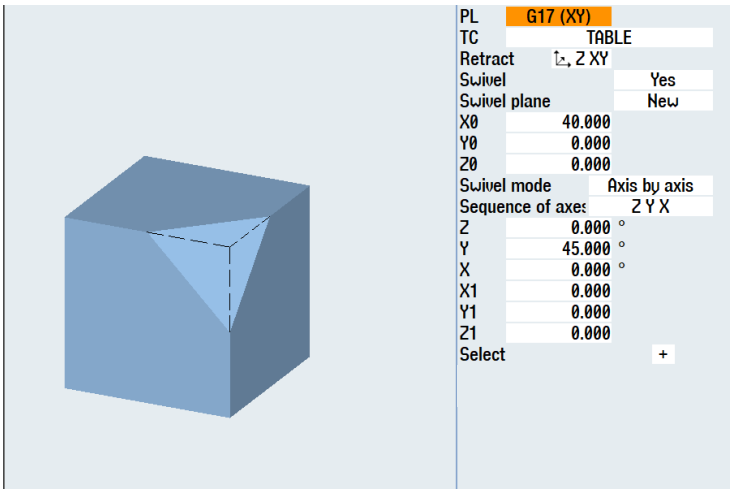
3rd step



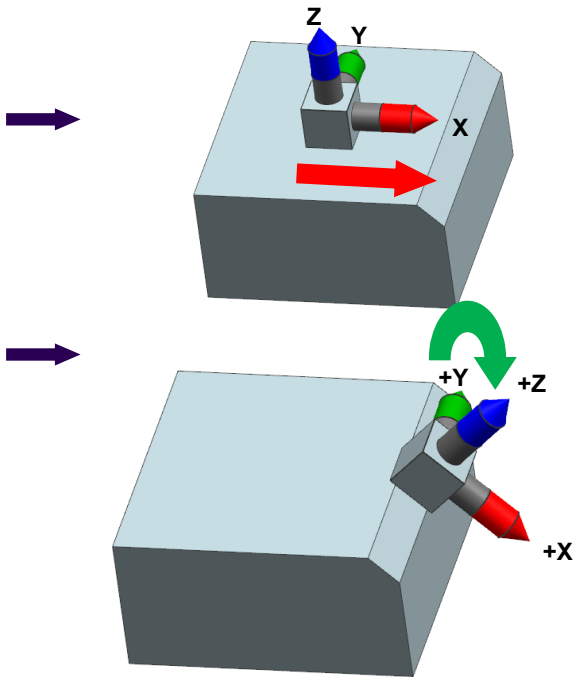
0°, 90°, 180°, 270°

Notes:

In the first step, move the coordinate cross to the swivel point (chamfer start).
The coordinate cross is then swiveled by 45°.



PL	G17 (XY)
TC	TABLE
Retract	⌞, Z XY
Swivel	Yes
Swivel plane	New
X0	40.000
Y0	0.000
Z0	0.000
Swivel mode	Axis by axis
Sequence of axes	Z Y X
Z	0.000 °
Y	45.000 °
X	0.000 °
X1	0.000
Y1	0.000
Z1	0.000
Select	+



Pressing

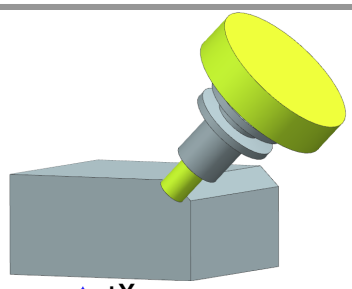
accepts the values in the "**1_SWIVEL**" block.

```
N90  1_SWIVEL
N100 CYCLE800(2, "TABLE", 200000, 27, 40, 0, 0, 0, 45, 0, 0, 0, 0, 1, 100, 1)¶
N110 End of group
```

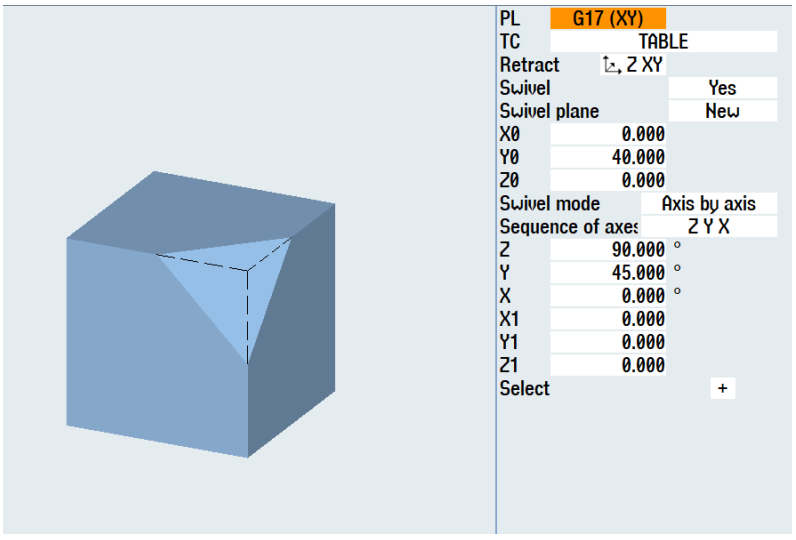
The first chamfer is programmed in the "**1_CHAMFER**" block.

```
N130 G0 X8 Y-65 Z100
N140 G0 Z5
N150 G1 Z0
N160 G1 Y65
N170 G0 Z100
```

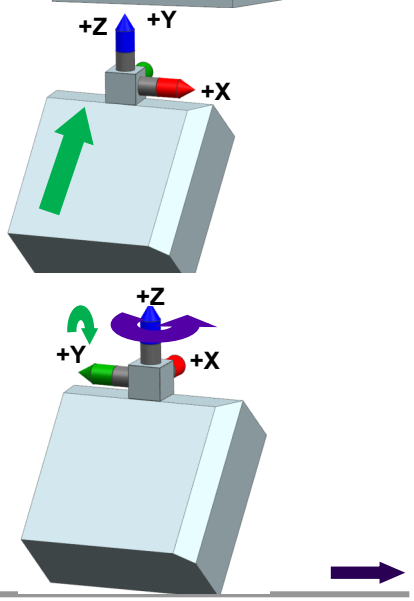
```
N120 1_CHAMFER
N130 G0 X8 Y-65 Z100¶
N140 G0 Z5¶
N150 G1 Z0¶
N160 G1 Y65¶
N170 G0 Z100¶
N180 End of group
```



The second swivel is programmed in the "**2_SWIVEL**" block.



PL	G17 (XY)
TC	TABLE
Retract	⌞, Z XY
Swivel	Yes
Swivel plane	New
X0	0.000
Y0	40.000
Z0	0.000
Swivel mode	Axis by axis
Sequence of axes	Z Y X
Z	90.000 °
Y	45.000 °
X	0.000 °
X1	0.000
Y1	0.000
Z1	0.000
Select	+

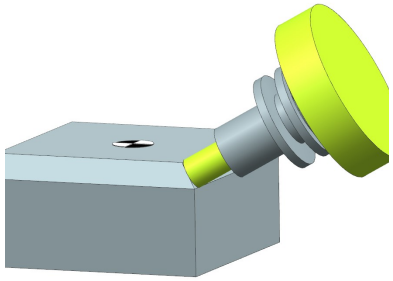


Notes:

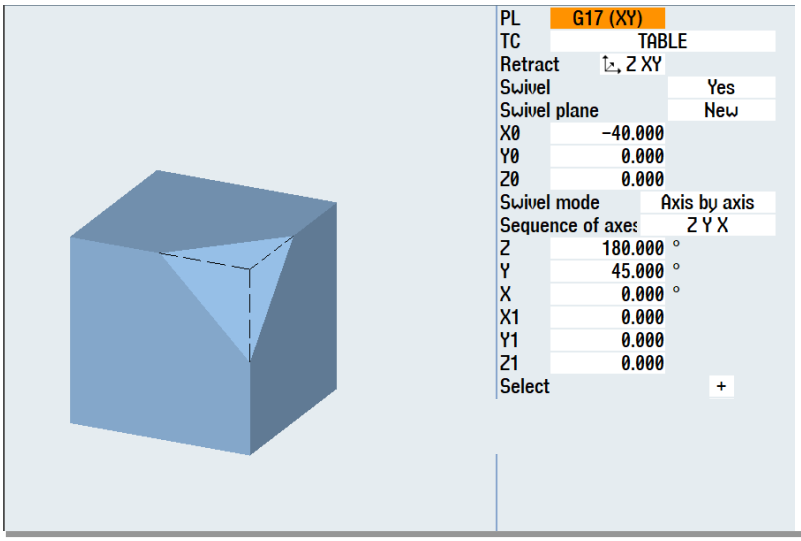
The second chamfer is programmed in the "**2_CHAMFER**" block. It corresponds exactly to the first programming for "**1_CHAMFER**". Only the coordinate system is rotated by "**Z**".

```
N230 G0 X8 Y-65 Z100
N240 G0 Z5
N250 G1 Z0
N260 G1 Y65
N270 G0 Z100
```

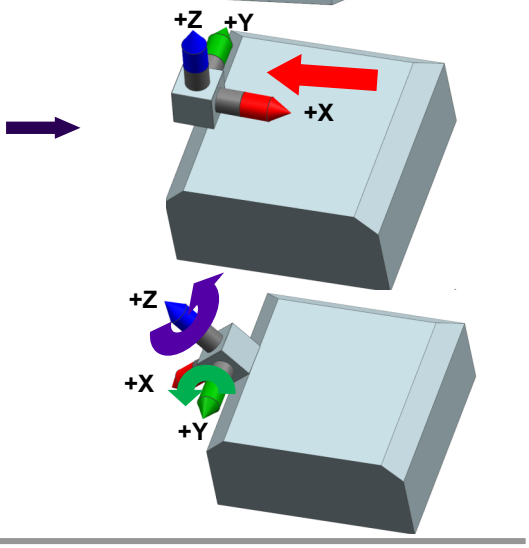
```
N220 2_CHAMFER
N230 G0 X8 Y-65 Z100¶
N240 G0 Z5¶
N250 G1 Z0¶
N260 G1 Y65¶
N270 G0 Z100¶
N280 End of group
```



The swivel is programmed in the "**3_SWIVEL**" block.



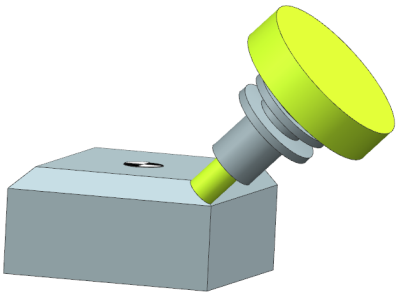
PL	G17 (XY)
TC	TABLE
Retract	Z XY
Swivel	Yes
Swivel plane	New
X0	-40.000
Y0	0.000
Z0	0.000
Swivel mode	Axis by axis
Sequence of axes	Z Y X
Z	180.000 °
Y	45.000 °
X	0.000 °
X1	0.000
Y1	0.000
Z1	0.000
Select	+



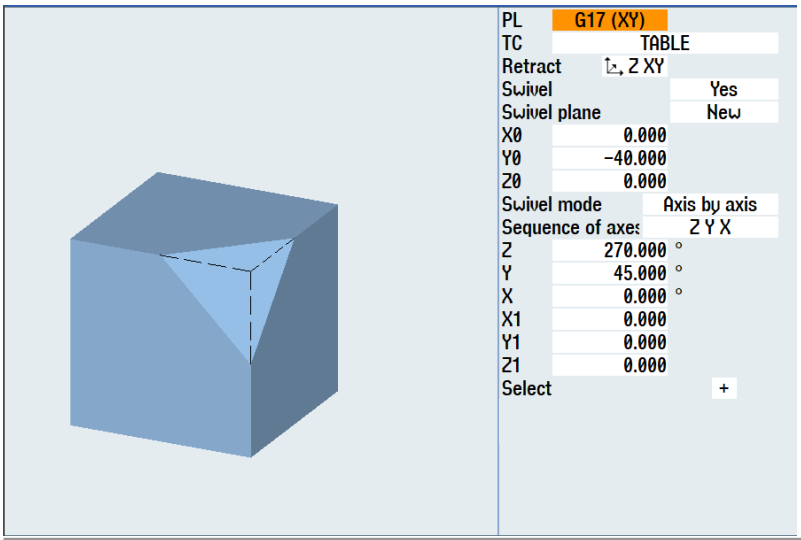
The third chamfer is programmed in the "**3_CHAMFER**" block.

```
N330 G0 X8 Y-65 Z100
N340 G0 Z5
N350 G1 Z0
N360 G1 Y65
N370 G0 Z100
```

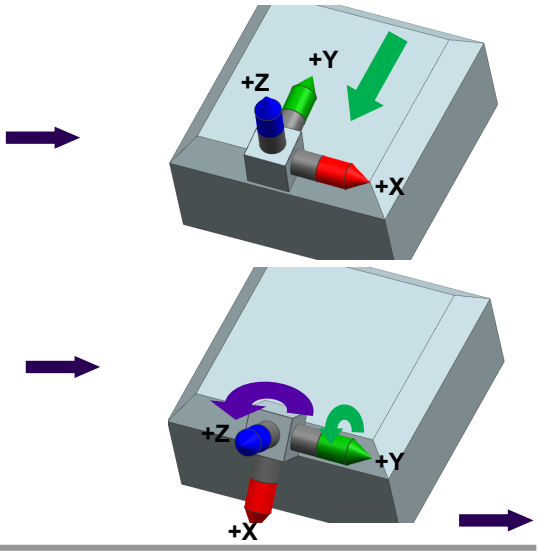
```
N320 3_CHAMFER
N330 G0 X8 Y-65 Z100¶
N340 G0 Z5¶
N350 G1 Z0¶
N360 G1 Y65¶
N370 G0 Z100¶
N380 End of group
```



The swivel is programmed in the "**4_SWIVEL**" block.



PL	G17 (XY)
TC	TABLE
Retract	Z XY
Swivel	Yes
Swivel plane	New
X0	0.000
Y0	-40.000
Z0	0.000
Swivel mode	Axis by axis
Sequence of axes	Z Y X
Z	270.000 °
Y	45.000 °
X	0.000 °
X1	0.000
Y1	0.000
Z1	0.000
Select	+

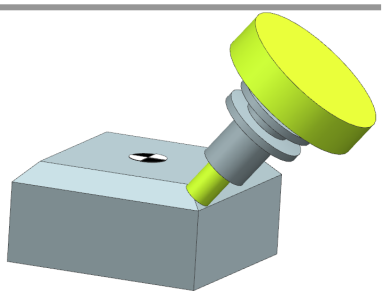


Notes:

The fourth chamfer is programmed in the "**4_CHAMFER**" block.

```
N430 G0 X8 Y-65 Z100
N440 G0 Z5
N450 G1 Z0
N460 G1 Y65
N470 G0 Z100
```

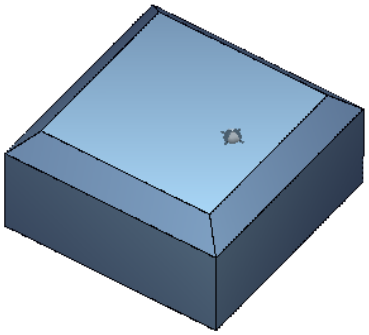
```
N420 4_CHAMFER
N430 G0 X8 Y-65 Z100¶
N440 G0 Z5¶
N450 G1 Z0¶
N460 G1 Y65¶
N470 G0 Z100¶
N480 End of group
```



In the "**END**" block, "CYCLE800" travels to the initial setting and the Tool Carrier is deselected.

The program is now fully created.

```
N490 END
N400 CYCLE800(2, "TABLE", 200000, 57, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1, 100, 1)¶
N410 CYCLE800(1, "0", 200000, 57, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1, 100, 1)¶
M30¶
N500 End of group
```



How the axes are swiveled on the machine is immaterial for this programming.

Only rotations at the axes of the coordinate system are considered.

The control then implements this on the machine.

4th example, swiveling with spatial angle

The **spatial angle** is the three-dimensional counterpart of the normal two-dimensional angle.

With regard to CNC technology, this describes the position of the workpiece coordinate system by the spatially-fixed coordinate system.

This is independent of the actual machine axes.

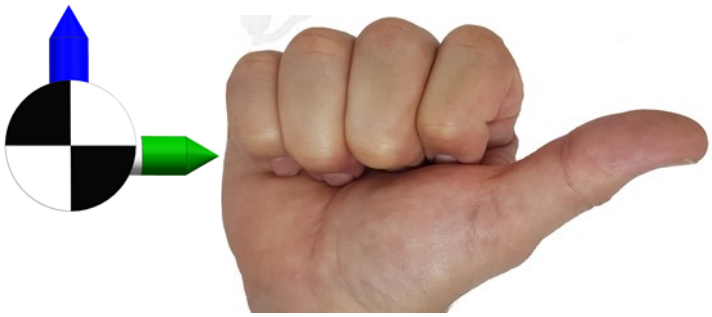
This has the advantage that the angle values can be taken directly from the drawing.
The position is determined by two spatial angles.

The rotation direction of the two spatial angles can also be determined with the "right-hand rule".

- The thumb points in the positive axis direction.

- The bent fingers point in the positive rotation direction.

SINUMERIK converts the spatial angle relative to the associated machine kinematics in the machine axis angle.



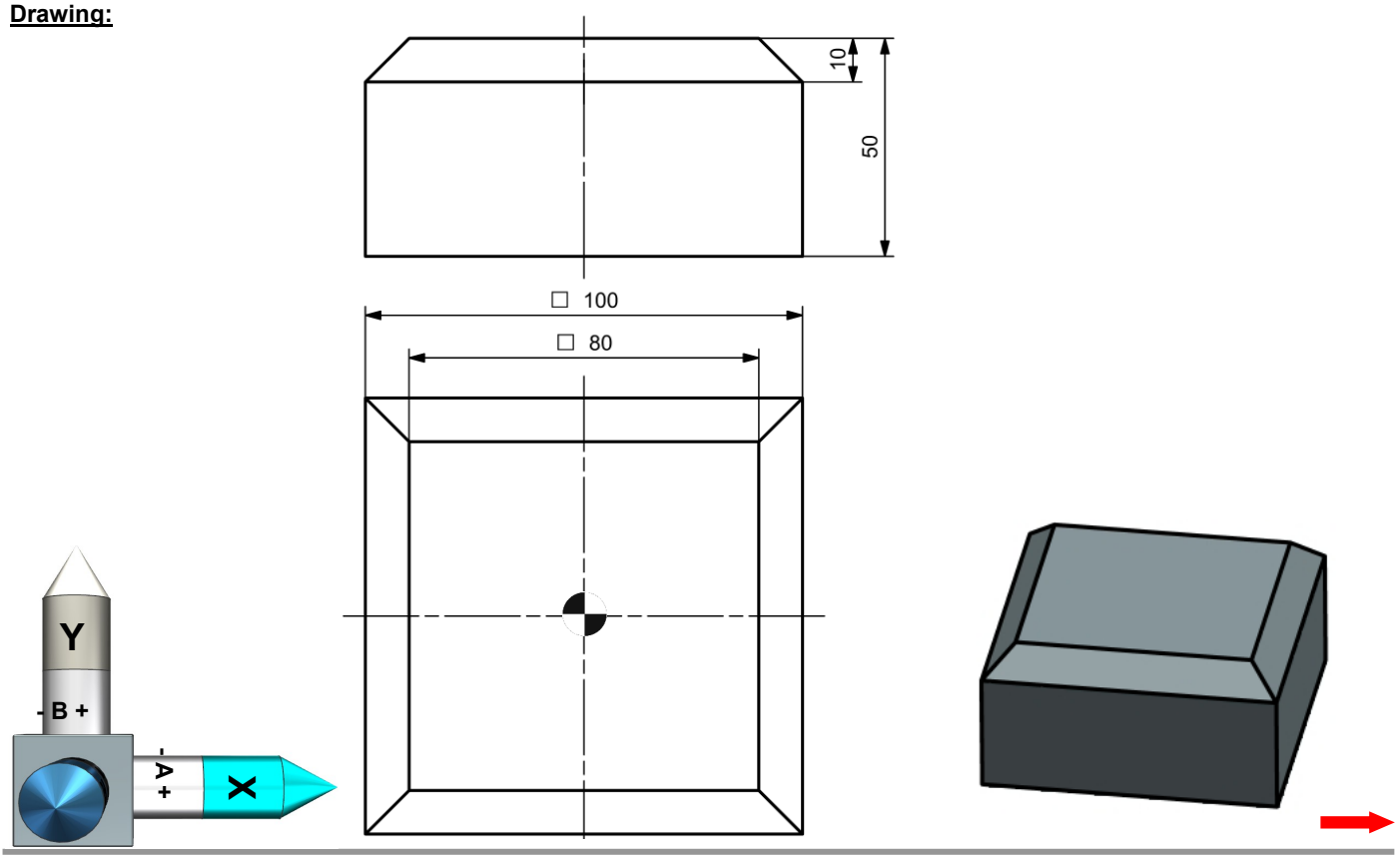
Notes:

Task:

The blank for the program example has the dimensions 100x100x50 mm

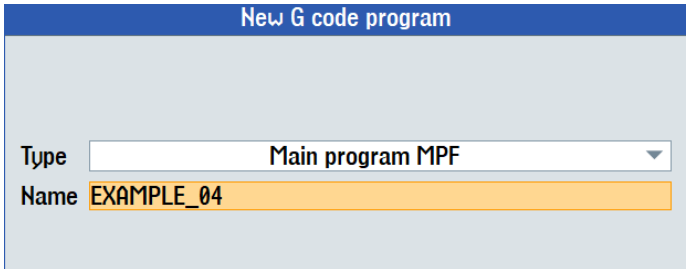
⇒ Programming in programGUIDE
⇒ The program is programmed on the basis of spatial angles.

Drawing:



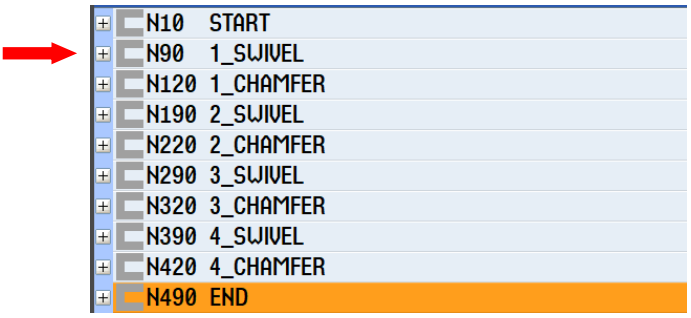
Notes:

After creating a new G-code program,



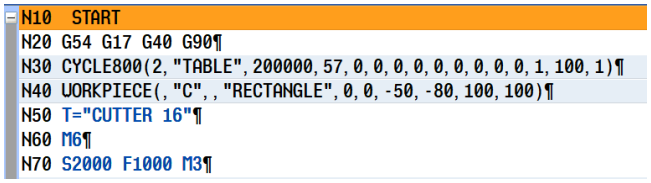
describe a block structure for this G-code program.

Function	Block name
Start commands	START
1st swivel	1_SWIVEL
1st operation	1_CHAMFER
2nd swivel	2_SWIVEL
2nd operation	2_CHAMFER
3rd swivel	3_SWIVEL
3rd operation	3_CHAMFER
4th swivel	4_SWIVEL
4th operation	4_CHAMFER
End commands	END

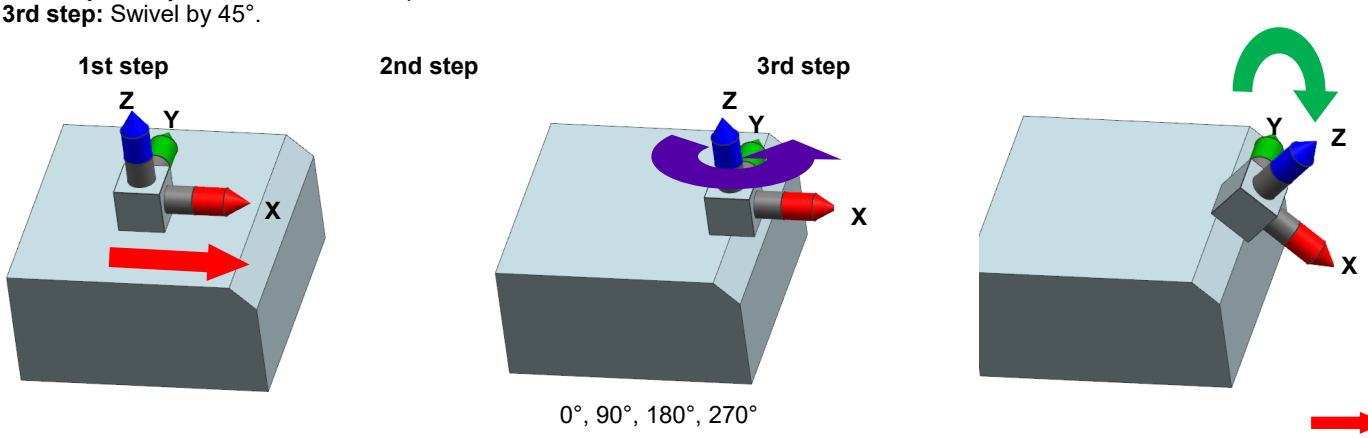


The "**START**" block is programmed.

```
N20 G54 G17 G40 G90
N30 CYCLE800(2,"TABLE",200000,57,0,0,0,0,0,0,0,0,1,100,1)
N40 WORKPIECE(,"C",,"RECTANGLE",0,0,-50,-80,100,100)
N50 T="CUTTER 16"
N60 M6
N70 S2000 F1000 M3
```



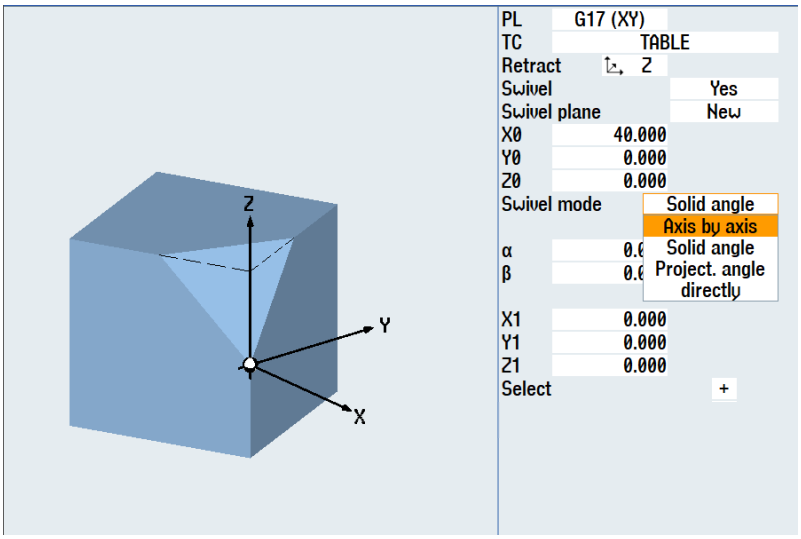
1st step: Move the coordinate system from the center to the point where the edge should result.
2nd step: Always rotate at the center point.
3rd step: Swivel by 45°.



0°, 90°, 180°, 270°

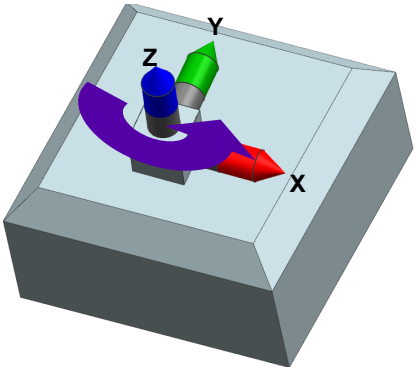
Notes:

The spatial angle is selected in "CYCLE800".



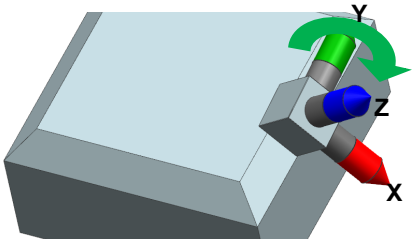
Alpha specifies the rotation angle in the X/Y plane (at the Z axis).

α 0.000 °



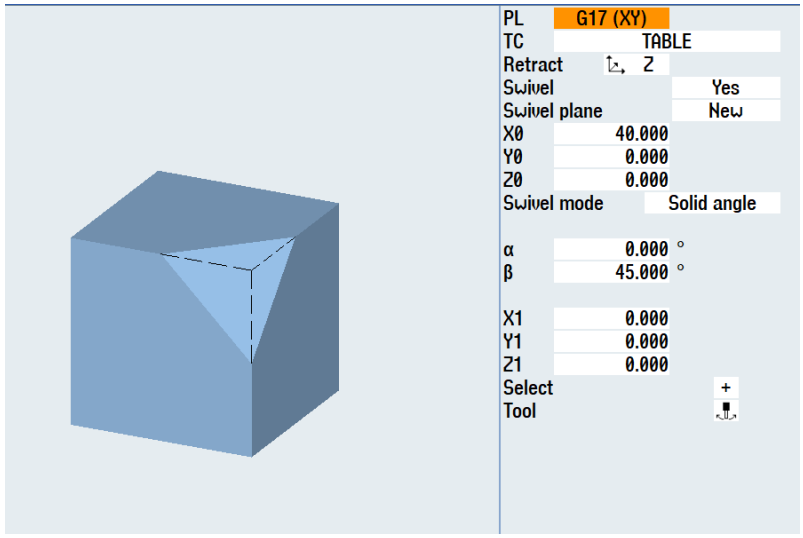
Beta specifies the rotation angle in space (rotation at the new Y axis).

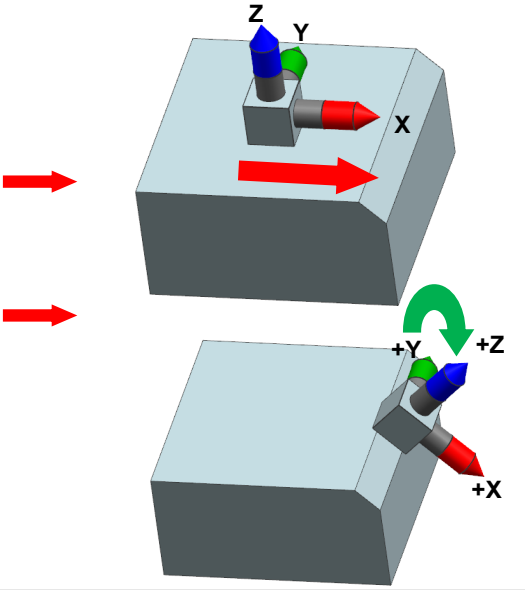
β 0.000 °



In the **first** step, the coordinate cross is moved to the swivel point (chamfer start).

The coordinate cross is then swiveled by 45° at beta in space.





Notes:

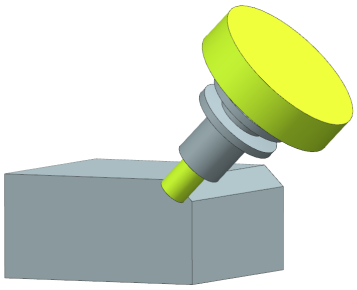
Pressing  accepts the values in the "**1_SWIVEL**" block.


```
N90  1_SWIVEL
N100 CYCLE800(1, "TABLE", 200000, 64, 40, 0, 0, 0, 45, , 0, 0, 0, 1, 100, 1)¶
N110 End of group
```

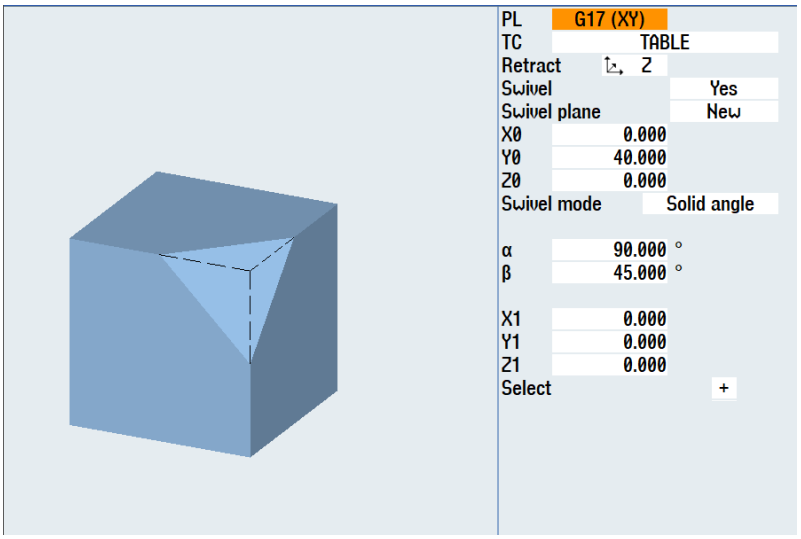
The first chamfer is programmed in the "**1_CHAMFER**" block.

```
N130 G0 X8 Y-65 Z100
N140 G0 Z5
N150 G1 Z0
N160 G1 Y65
N170 G0 Z100
```

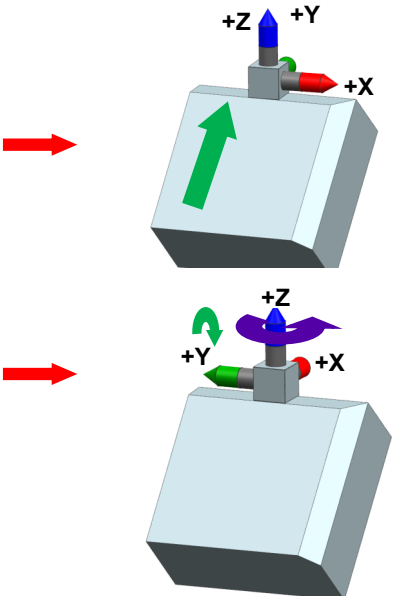
```
N120 1_CHAMFER
N130 G0 X8 Y-65 Z100¶
N140 G0 Z5¶
N150 G1 Z0¶
N160 G1 Y65¶
N170 G0 Z100¶
```



The second swivel is programmed in the "**2_SWIVEL**" block.



PL	G17 (XY)
TC	TABLE
Retract	Z
Swivel	Yes
Swivel plane	New
X0	0.000
Y0	40.000
Z0 0.000
Swivel mode Solid angle
α 90.000 °
β 45.000 °
X1 0.000
Y1 0.000
Z1 0.000
Select +



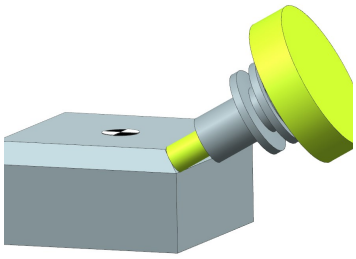
α	90.000 °
β	45.000 °

Notes:

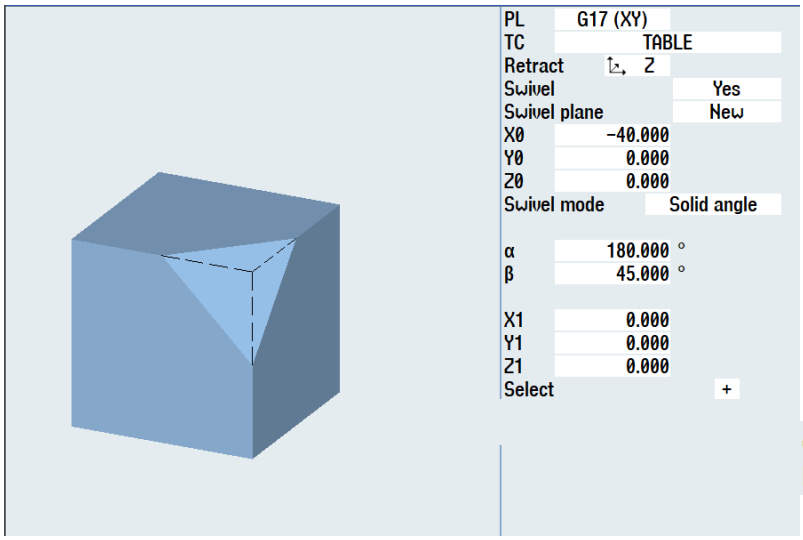
The second chamfer is programmed in the "**2_CHAMFER**" block. It corresponds exactly to the first chamfer.

```
N230 G0 X8 Y-65 Z100
N240 G0 Z5
N250 G1 Z0
N260 G1 Y65
N270 G0 Z100
```

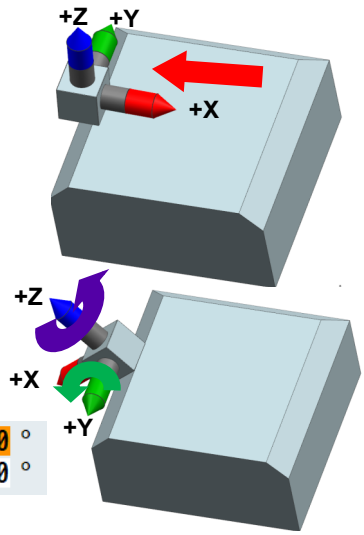
```
N220 2_CHAMFER
N230 G0 X8 Y-65 Z100¶
N240 G0 Z5¶
N250 G1 Z0¶
N260 G1 Y65¶
N270 G0 Z100¶
N280 End of group
```



The swivel is programmed in the "**3_SWIVEL**" block.



PL	G17 (XY)
TC	TABLE
Retract	Z
Swivel	Yes
Swivel plane	New
X0	-40.000
Y0	0.000
Z0	0.000
Swivel mode	Solid angle
α	180.000 °
β	45.000 °
X1	0.000
Y1	0.000
Z1	0.000
Select	+

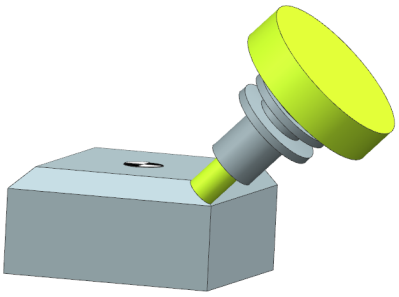


α	180.000 °
β	45.000 °

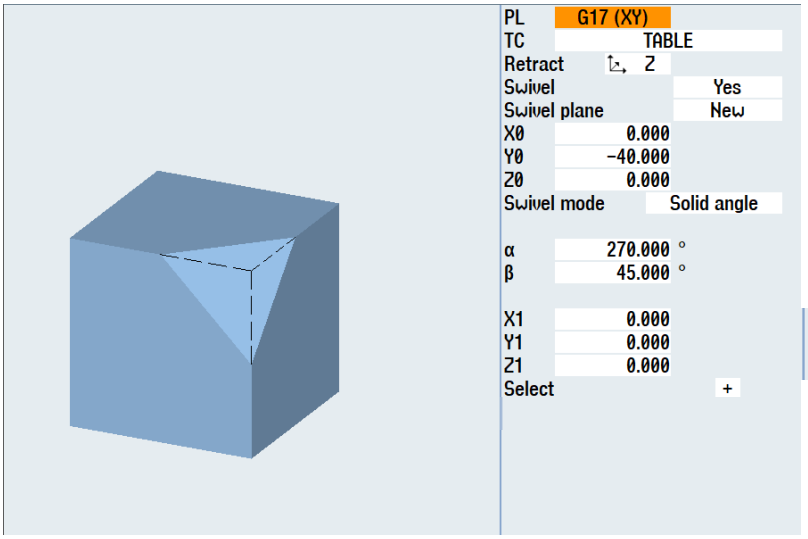
The third chamfer is programmed in the "**3_CHAMFER**" block.

```
N330 G0 X8 Y-65 Z100
N340 G0 Z5
N350 G1 Z0
N360 G1 Y65
N370 G0 Z100
```

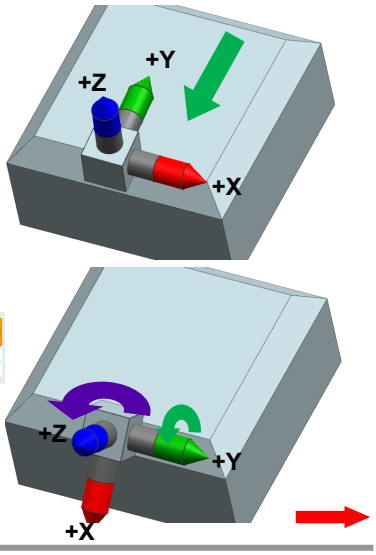
```
N320 3_CHAMFER
N330 G0 X8 Y-65 Z100¶
N340 G0 Z5¶
N350 G1 Z0¶
N360 G1 Y65¶
N370 G0 Z100¶
```



The swivel is programmed in the "**4_SWIVEL**" block.



PL	G17 (XY)
TC	TABLE
Retract	Z
Swivel	Yes
Swivel plane	New
X0	0.000
Y0	-40.000
Z0	0.000
Swivel mode	Solid angle
α	270.000 °
β	45.000 °
X1	0.000
Y1	0.000
Z1	0.000
Select	+



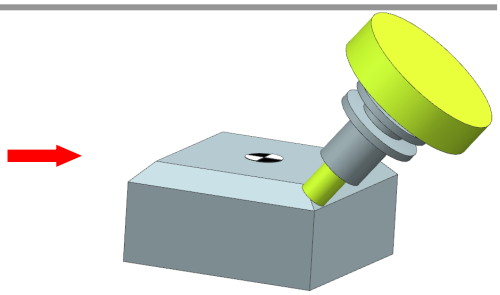
α	270.000
β	45.000

Notes:

The fourth chamfer is programmed in the "**4_CHAMFER**" block.

```
N430 G0 X8 Y-65 Z100
N440 G0 Z5
N450 G1 Z0
N460 G1 Y65
N470 G0 Z100
```

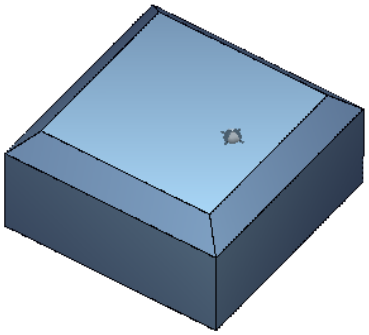
```
N420 4_CHAMFER
N430 G0 X8 Y-65 Z100¶
N440 G0 Z5¶
N450 G1 Z0¶
N460 G1 Y65¶
N470 G0 Z100¶
N480 End of group
```



In the "**END**" block, "CYCLE800" travels to the initial setting and the Tool Carrier deselected.

The program is now fully created.

```
N490 END
N500 CYCLE800(2, "TABLE", 200000, 57, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1, 100, 1)¶
N510 CYCLE800(1, "0", 200000, 57, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1, 100, 1)¶
N520 M30¶
```



5th example, swiveling with projection angle

The blank for the program example has the dimensions 100x100x50 mm

⇒ Programming in programGUIDE
⇒ The program is programmed on the basis of projection angles

The projection angle is used for rectangular workpieces.

The projection angle also consists of angles that build on each other.

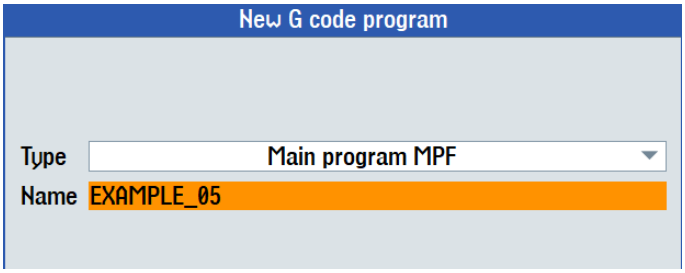
The angles Xα **and** Yα **always refer to the non-rotated coordinate system.**

The angle Zβ **refers to the rotated coordinate system.**

Xα	0.000	°
Yα	0.000	°
Zβ	0.000	°

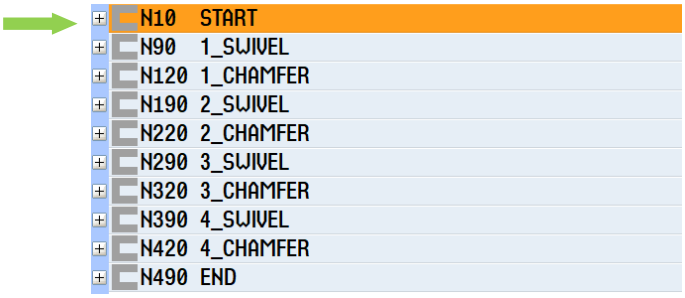
Notes:

After creating a new G-code program,



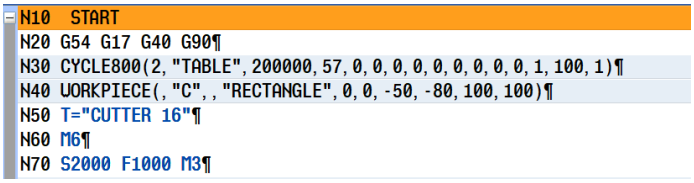
describe a block structure for this G-code program.

Function	Block name
Start commands	START
1st swivel	1_SWIVEL
1st operation	1_CHAMFER
2nd swivel	2_SWIVEL
2nd operation	2_CHAMFER
3rd swivel	3_SWIVEL
3rd operation	3_CHAMFER
4th swivel	4_SWIVEL
4th operation	4_CHAMFER
End commands	END



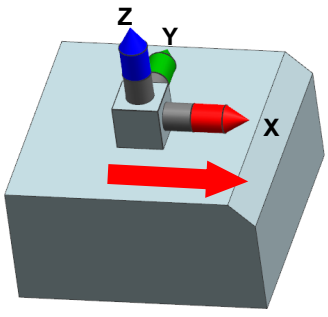
The "START" block is programmed.

```
N20 G54 G17 G40 G90
N30 CYCLE800(2,"TABLE",200000,57,0,0,0,0,0,0,0,0,0,1,100,1)
N40 WORKPIECE(,"C",,"RECTANGLE",0,0,-50,-80,100,100)
N50 T="CUTTER 16"
N60 M6
N70 S2000 F1000 M3
```

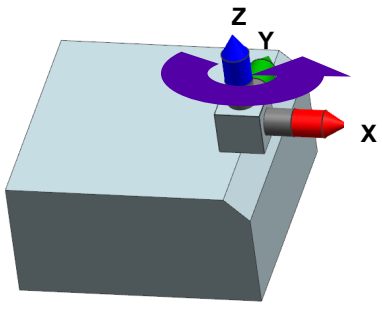


1st step: Move the coordinate system from the center to the point where the edge should result.
2nd step: Always rotate at the center point.
3rd step: Swivel by 45°.

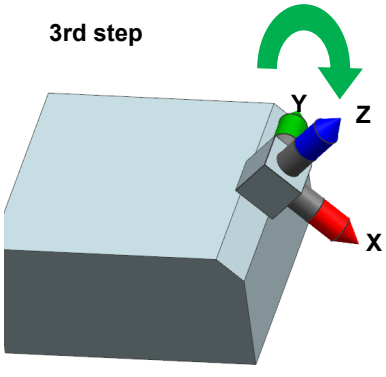
1st step



2nd step



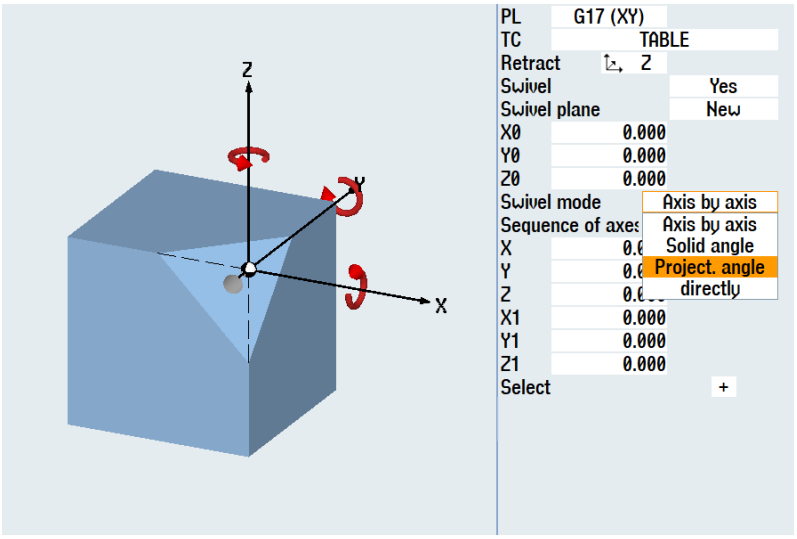
3rd step



0°, 90°, 180°, 270°

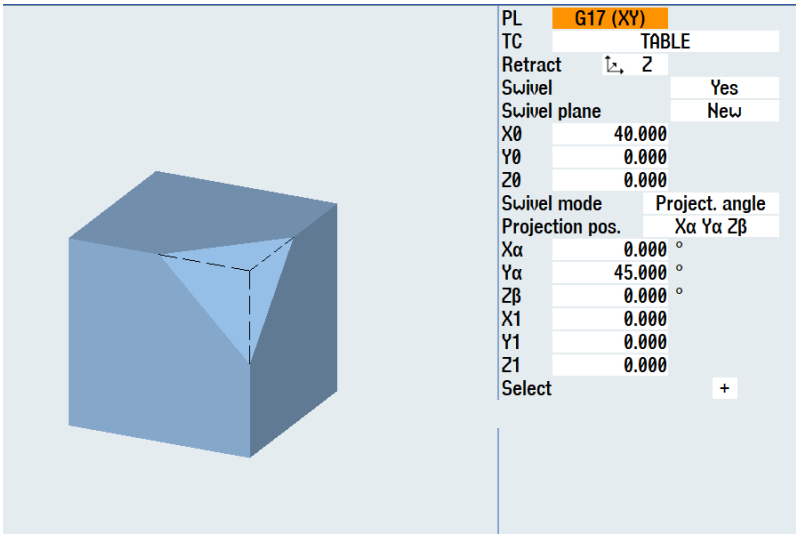
Notes:

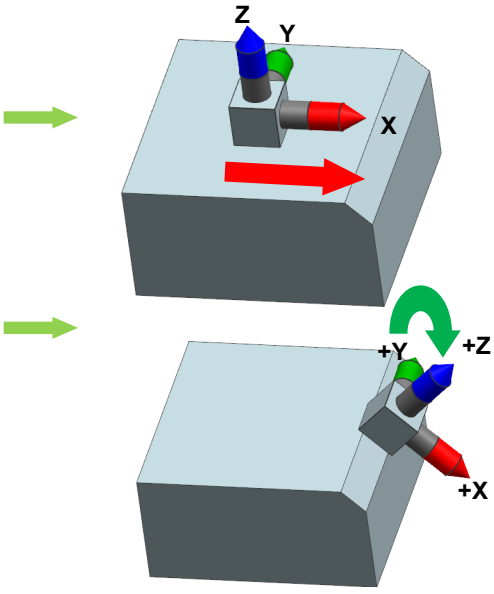
The projection angle is selected in "CYCLE800".



In the first step, move the coordinate cross to the swivel point (chamfer start).

The coordinate cross is then swiveled by 45°.





Notes:

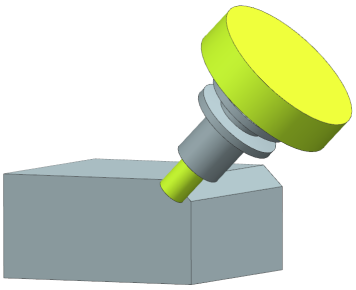
Pressing  accepts the values in the "**1_SWIVEL**" block.


```
N90  1_SWIVEL
CYCLE800(1, "TABLE", 200000, 185, 40, 0, 0, 0, 45, 0, 0, 0, 0, 1, 100, 1)¶
N110 End of group
```

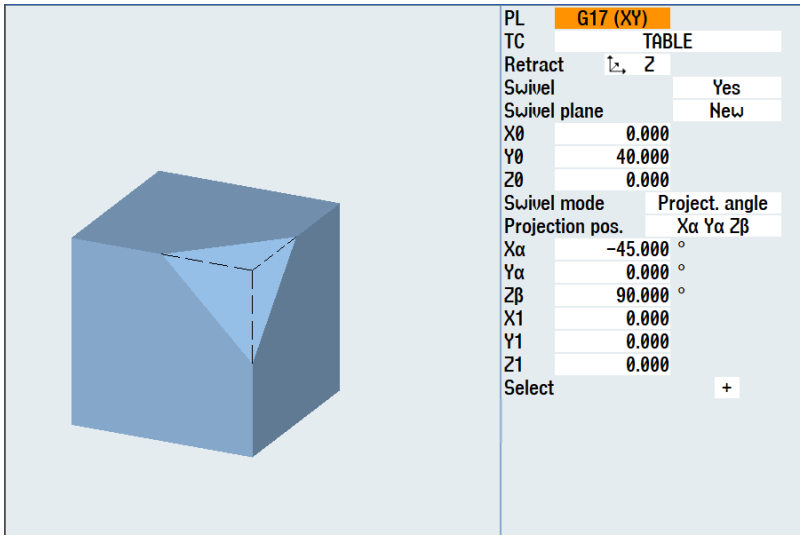
The first chamfer is programmed in the "1_CHAMFER" block.

```
N130 G0 X8 Y-65 Z100
N140 G0 Z5
N150 G1 Z0
N160 G1 Y65
N170 G0 Z100
```

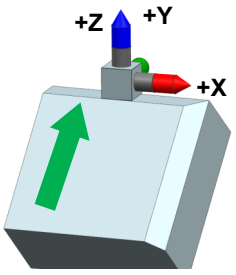
```
N120 1_CHAMFER
N130 G0 X8 Y-65 Z100¶
N140 G0 Z5¶
N150 G1 Z0¶
N160 G1 Y65¶
N170 G0 Z100¶
```

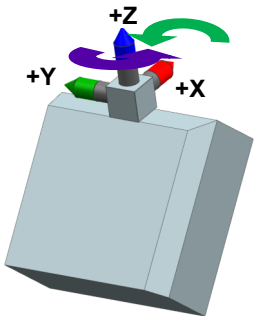


The second swivel is programmed in the "**2_SWIVEL**" block.



PL	G17 (XY)
TC	TABLE
Retract	Z
Swivel	Yes
Swivel plane	New
X0	0.000
Y0	40.000
Z0	0.000
Swivel mode	Project. angle
Projection pos.	Xα Yα Zβ
Xα	-45.000 °
Yα	0.000 °
Zβ	90.000 °
X1	0.000
Y1	0.000
Z1	0.000
Select	+





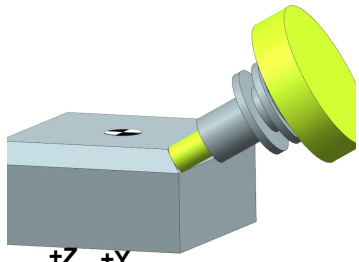
Xα	-45.000 °
Yα	0.000 °
Zβ	90.000 °

Notes:

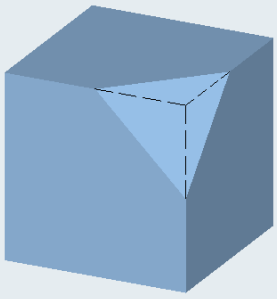
The second chamfer is programmed in the "**2_CHAMFER**" block. It corresponds exactly to the first programming for "1_CHAMFER".

```
N230 G0 X8 Y-65 Z100
N240 G0 Z5
N250 G1 Z0
N260 G1 Y65
N270 G0 Z100
```

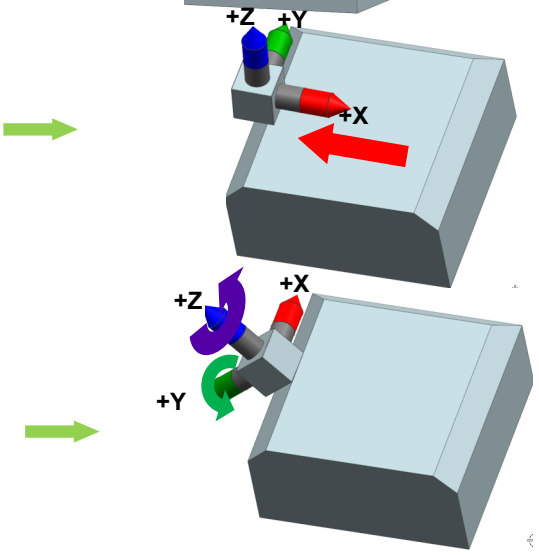
```
N220 2_CHAMFER
N230 G0 X8 Y-65 Z100¶
N240 G0 Z5¶
N250 G1 Z0¶
N260 G1 Y65¶
N270 G0 Z100¶
N280 End of group
```



The swivel is programmed in the "**3_SWIVEL**" block.



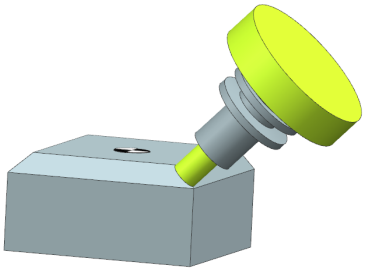
PL	G17 (XY)
TC	TABLE
Retract	Z
Swivel	Yes
Swivel plane	New
X0	-40.000
Y0	0.000
Z0	0.000
Swivel mode	Project. angle
Projection pos.	Xα Yα Zβ
Xα	0.000 °
Yα	-45.000 °
Zβ	180.000 °
X1	0.000
Y1	0.000
Z1	0.000
Select	+



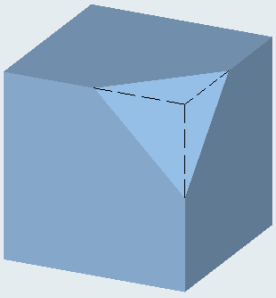
The third chamfer is programmed in the "**3_CHAMFER**" block.

```
N330 G0 X8 Y-65 Z100
N340 G0 Z5
N350 G1 Z0
N360 G1 Y65
N370 G0 Z100
```

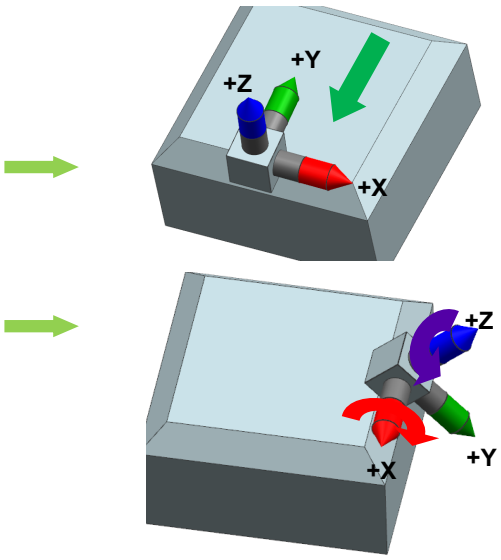
```
N320 3_CHAMFER
N330 G0 X8 Y-65 Z100¶
N340 G0 Z5¶
N350 G1 Z0¶
N360 G1 Y65¶
N370 G0 Z100¶
N380 End of group
```



The swivel is programmed in the "**4_SWIVEL**" block.



PL	G17 (XY)
TC	TABLE
Retract	Z
Swivel	Yes
Swivel plane	New
X0	0.000
Y0	-40.000
Z0	0.000
Swivel mode	Project. angle
Projection pos.	Xα Yα Zβ
Xα	45.000 °
Yα	0.000 °
Zβ	270.000 °
X1	0.000
Y1	0.000
Z1	0.000
Select	+

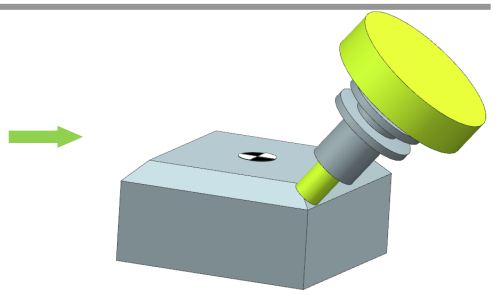


Notes:

The fourth chamfer is programmed in the "**4_CHAMFER**" block.

```
N430 G0 X8 Y-65 Z100
N440 G0 Z5
N450 G1 Z0
N460 G1 Y65
N470 G0 Z100
```

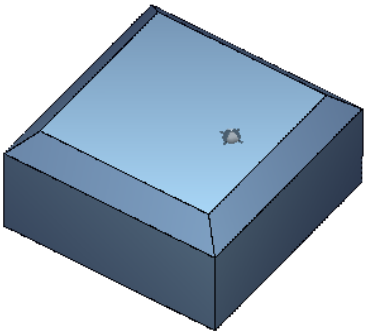
```
N420 4_CHAMFER
N430 G0 X8 Y-65 Z100¶
N440 G0 Z5¶
N450 G1 Z0¶
N460 G1 Y65¶
N470 G0 Z100¶
N480 End of group
```



In the "**END**" block, "**CYCLE800**" travels to the initial setting and the Tool Carrier is deselected.

The program is now fully created.

```
N490 END
N500 CYCLE800(2, "TABLE", 200000, 57, 0, 0, 0, 0, 0, 0, 0, 0, 1, 100, 1)¶
N510 CYCLE800(1, "0", 200000, 57, 0, 0, 0, 0, 0, 0, 0, 0, 1, 100, 1)¶
N520 M30¶
```



6th example, swivelling directly

Example for the projection angle.

Another example for projection angle is listed and described step-by-step.

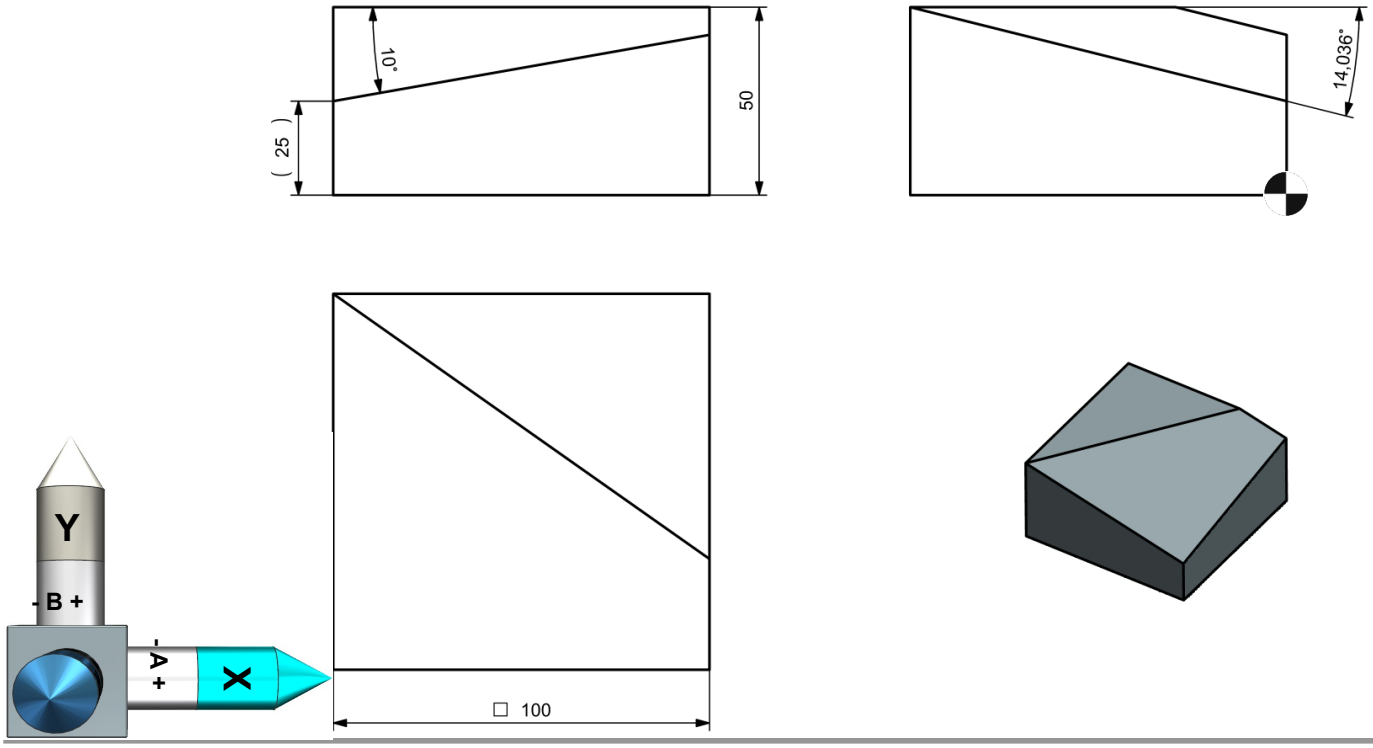
This example cannot be programmed axis-by-axis with these dimensions, because the second axis rotation already refers to a rotated coordinate system.
This is not the case with projection angles. The rotations refer to the projected component edge.

The blank for the program example has the dimensions 100x100x50 mm

⇒ Programming in ShopMill
⇒ The surface is programmed on the basis of projection angles

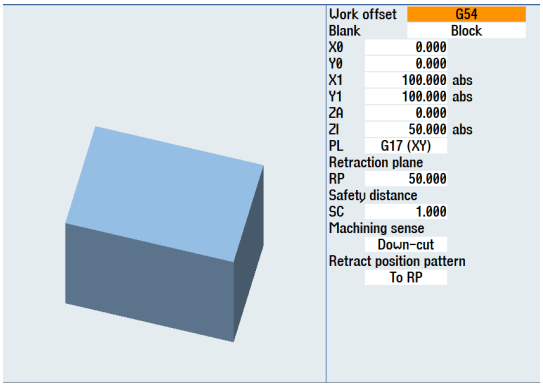
Notes:

Drawing:



After creating a new ShopMill program

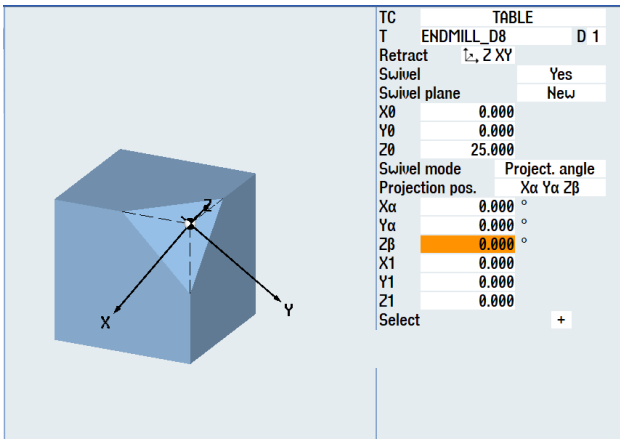
and programming the program header,

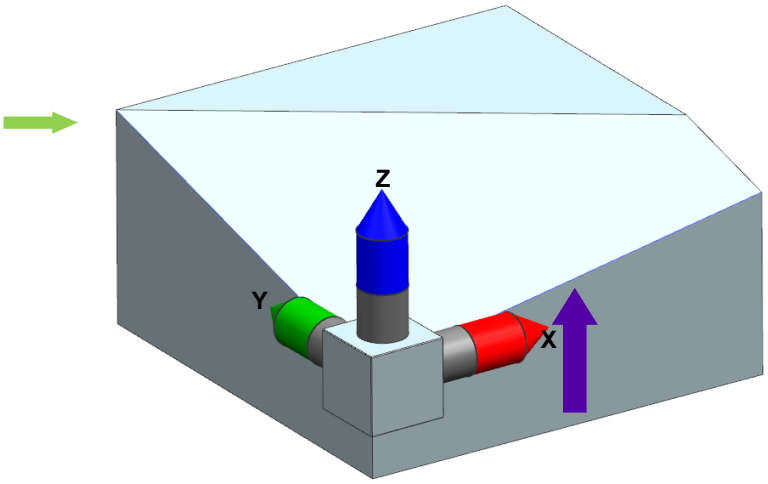


Notes:

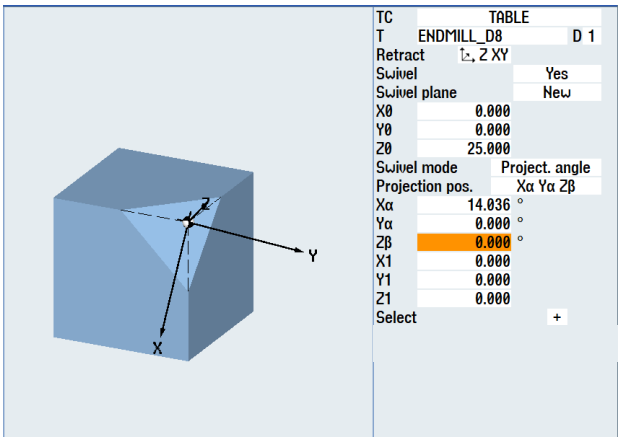
the swivel is programmed via "CYCLE800".
To improve clarity, the coordinate system on the completed component is shown.

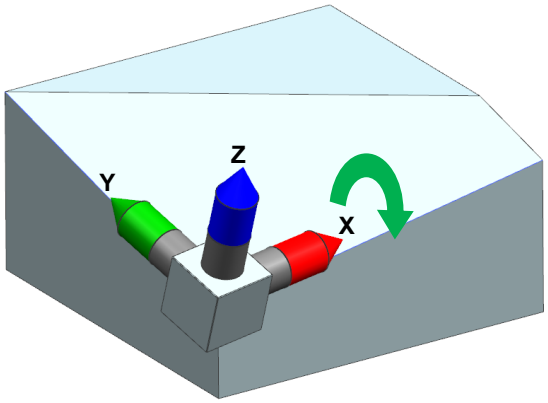
In the first step, the coordinate system is moved by 25 mm in the "Z direction".





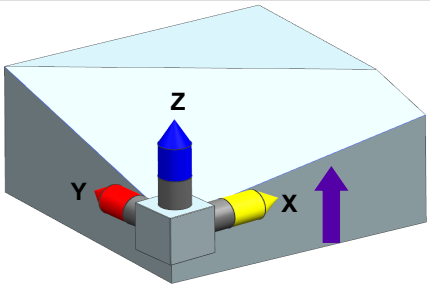
"**Xα**" is the angle by which the X axis must be rotated so that the component edge results in the Y/Z plane.



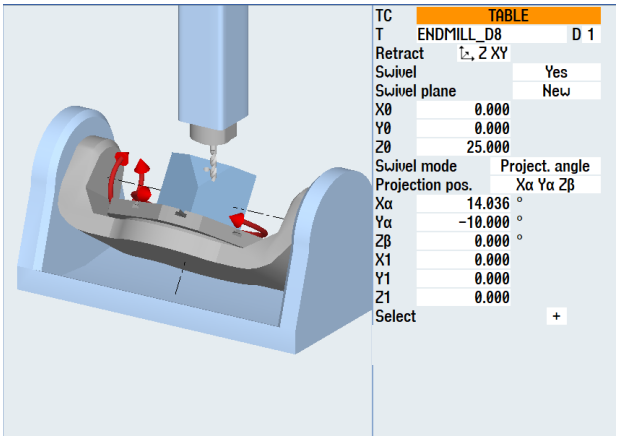


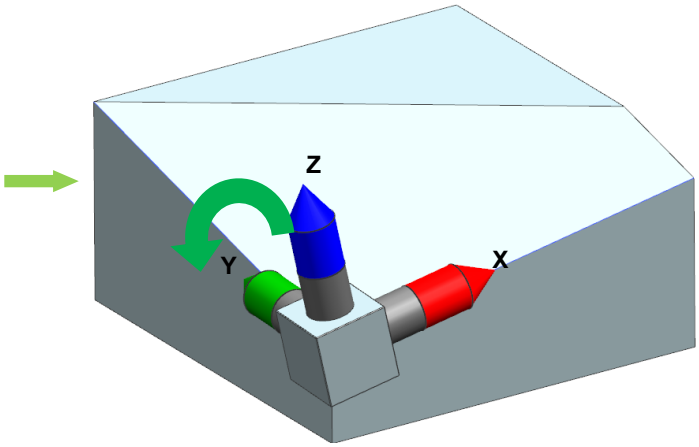
Notes:

Again, starting from the implicit, non-rotated coordinate cross,

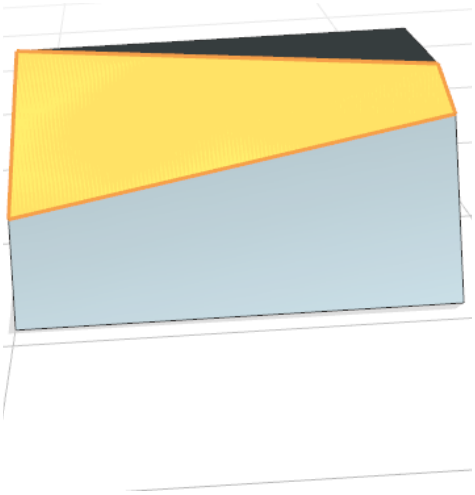


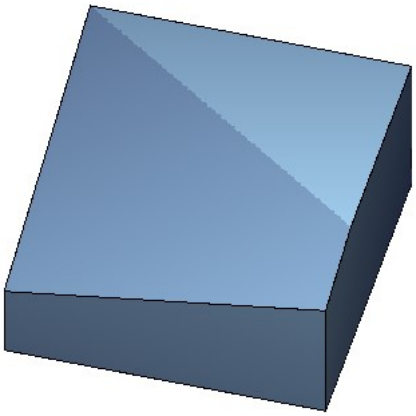
the second projection angle "**Yα**" is programmed. This is the angle by which the Y axis must be rotated so that the shown component edge results.





The surface can be programmed only via projection angles, but not via axis angles.





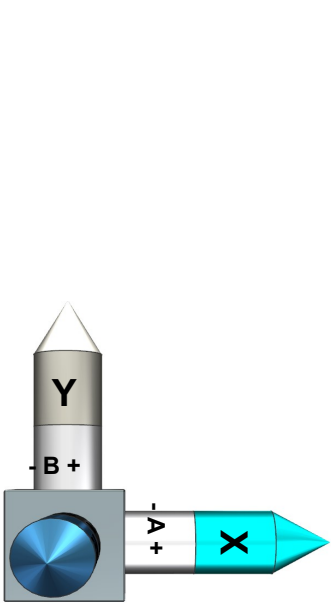
Notes:

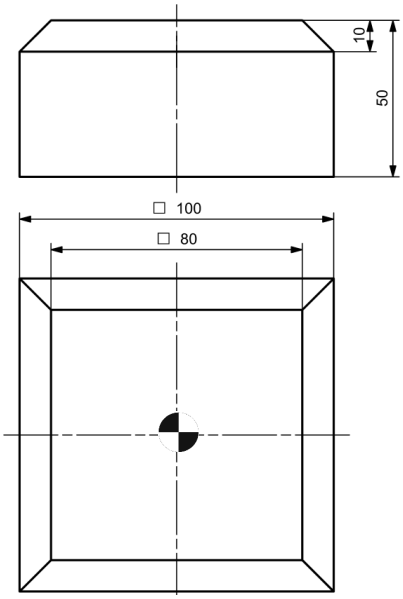
6th example, direct swivel

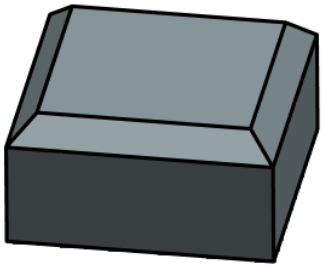
Task:

The blank for the program example has the dimensions 100x100x50 mm
⇒ Programming in programGUIDE
⇒ The program is programmed "directly" with "A-C" kinematics

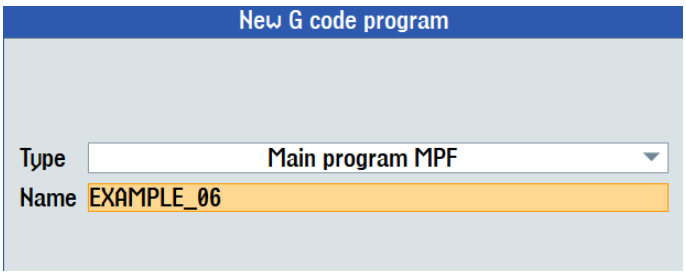
Drawing:





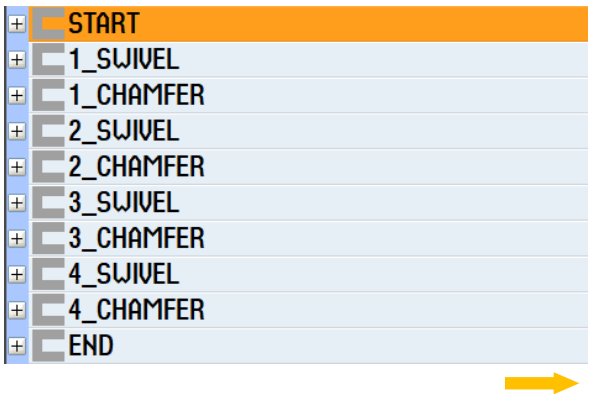


After creating a new G-code program,



describe a block structure for this G-code program.

Function	Block name
Start commands	START
1st swivel	1_SWIVEL
1st operation	1_CHAMFER
2nd swivel	2_SWIVEL
2nd operation	2_CHAMFER
3rd swivel	3_SWIVEL
3rd operation	3_CHAMFER
4th swivel	4_SWIVEL
4th operation	4_CHAMFER
End commands	END



Notes:

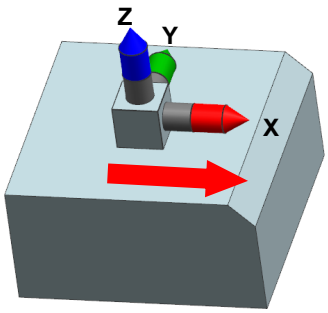
The "**START**" block is programmed.

```
N20 G54 G17 G40 G90
N30 CYCLE800(2,"TABLE",200000,57,0,0,0,0,0,0,0,0,1,100,1)
N40 WORKPIECE(,"C",,"RECTANGLE",0,0,-50,-80,100,100)
N50 T="CUTTER 16"
N60 M6
N70 S2000 F1000 M3
```

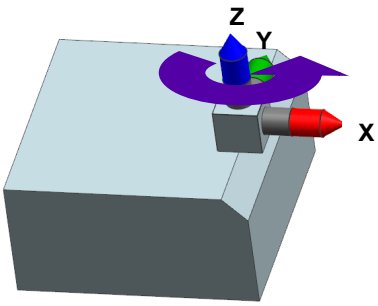
```
N10  START
N20 G54 G17 G40 G90¶
N30 CYCLE800(2, "TABLE", 200000, 57, 0, 0, 0, 0, 0, 0, 0, 0, 1, 100, 1)¶
N40 UORKPIECE(, "C", , "RECTANGLE", 0, 0, -50, -80, 100, 100)¶
N50 T="CUTTER 16"¶
N60 M6¶
N70 S2000 F1000 M3¶
```

1st step: Move the coordinate system from the center to the point where the edge should result.
2nd step: Always rotate at the center point.
3rd step: Swivel by 45°.

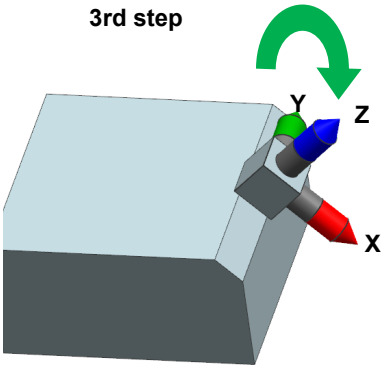
1st step



2nd step

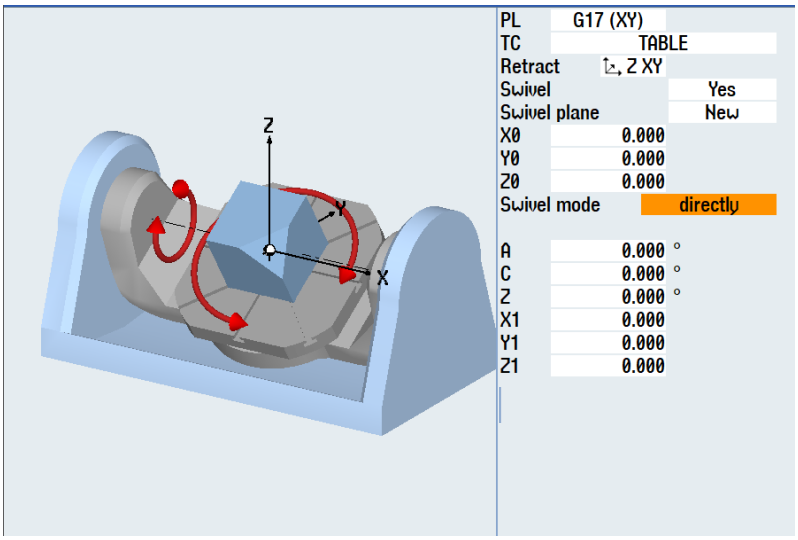


3rd step



0°, 90°, 180°, 270°

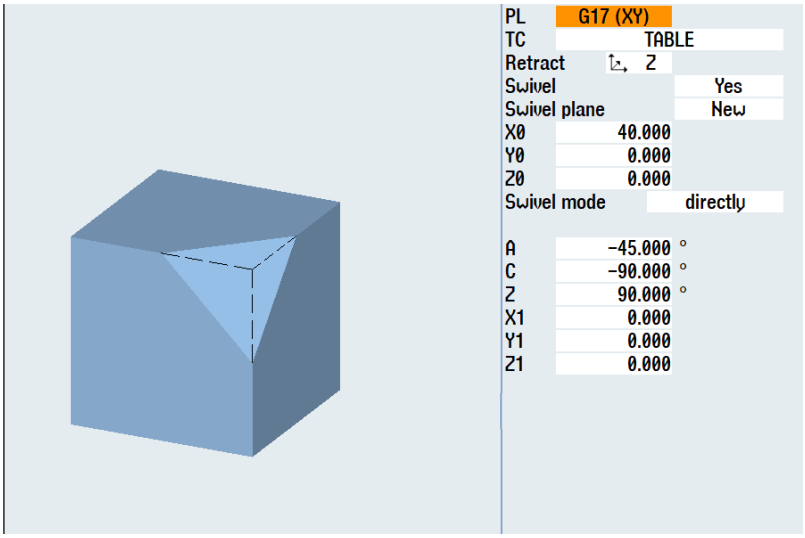
The projection angle is selected in "**CYCLE800**".



These machine kinematics are now programmed directly.
The program is dependent on the machine kinematics.

Notes:

The tool axes are rotated so that the first chamfer can then be produced.



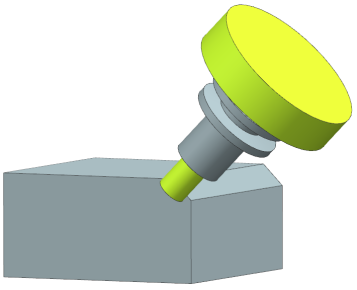
Pressing  accepts the values in the "**1_SWIVEL**" block.


```
1_SWIVEL
CYCLE800(1, "TABLE", 200000, 192, 40, 0, 0, -45, -90, 90, 0, 0, 0, 1, 100, 1)¶
```

The first chamfer is programmed in the "**1_CHAMFER**" block.

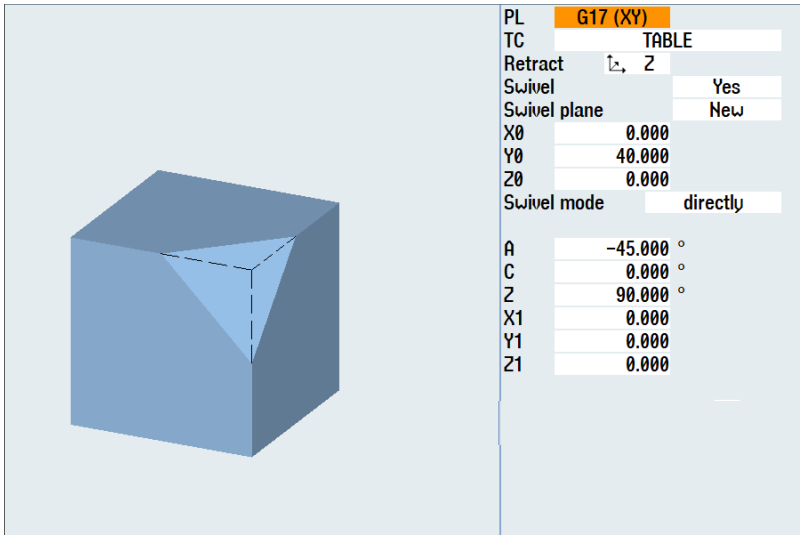
```
G0 X7 Y-60 Z100
G0 Z5
G1 Z0
G1 Y60
G0 Z100
```

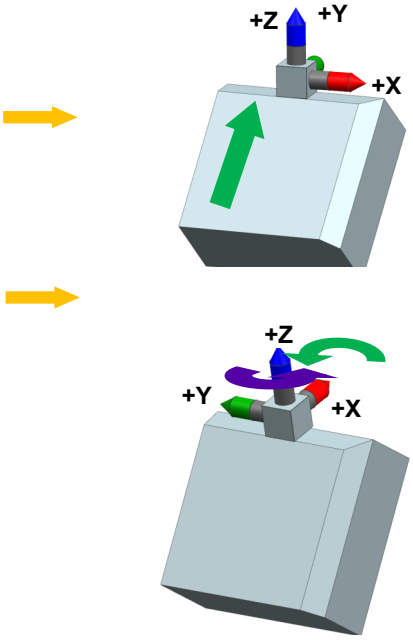
```
1_CHAMFER
G0 X7 Y-60 Z100¶
G0 Z5¶
G1 Z0¶
G1 Y60¶
G0 Z100¶
End of group
```



Notes:

The second swivel is programmed in the "**2_SWIVEL**" block.

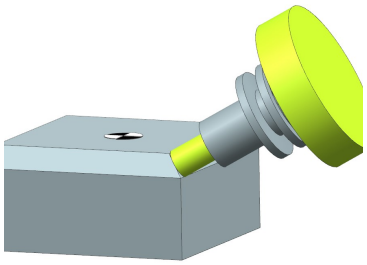




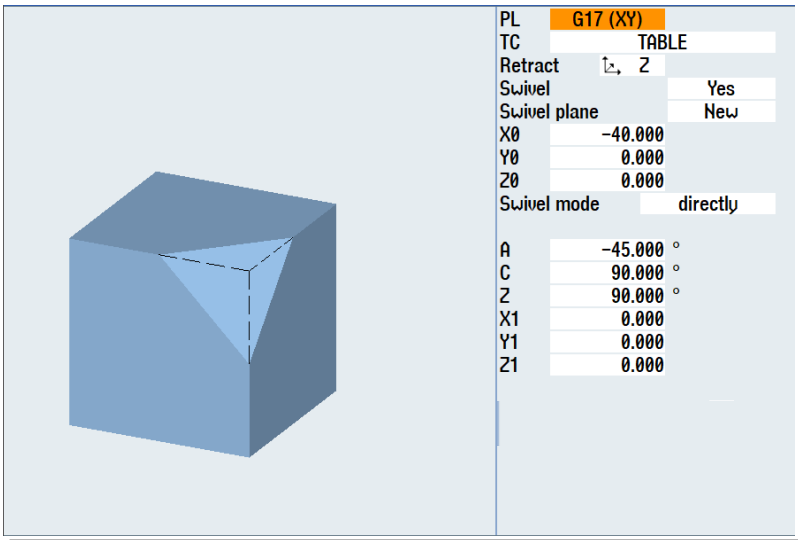
The second chamfer is programmed in the "**2_CHAMFER**" block. It corresponds exactly to the first programming for "1_CHAMFER".

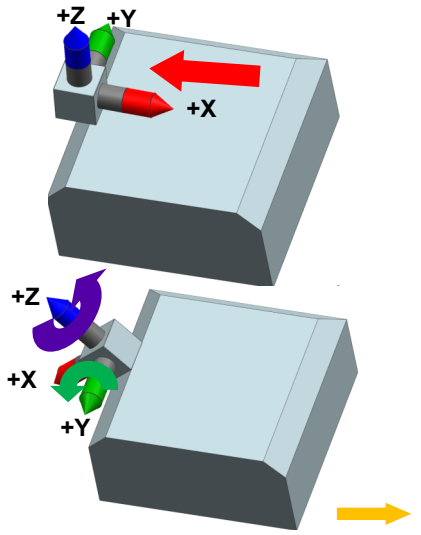
```
G0 X7 Y-60 Z100
G0 Z5
G1 Z0
G1 Y60
G0 Z100
```

```
2_CHAMFER
G0 X7 Y-60 Z100¶
G0 Z5¶
G1 Z0¶
G1 Y60¶
G0 Z100¶
```



The swivel is programmed in the "**3_SWIVEL**" block.



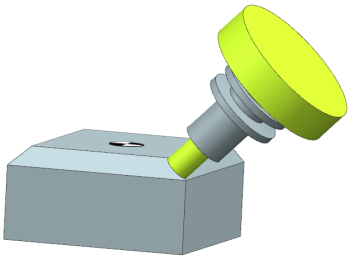


Notes:

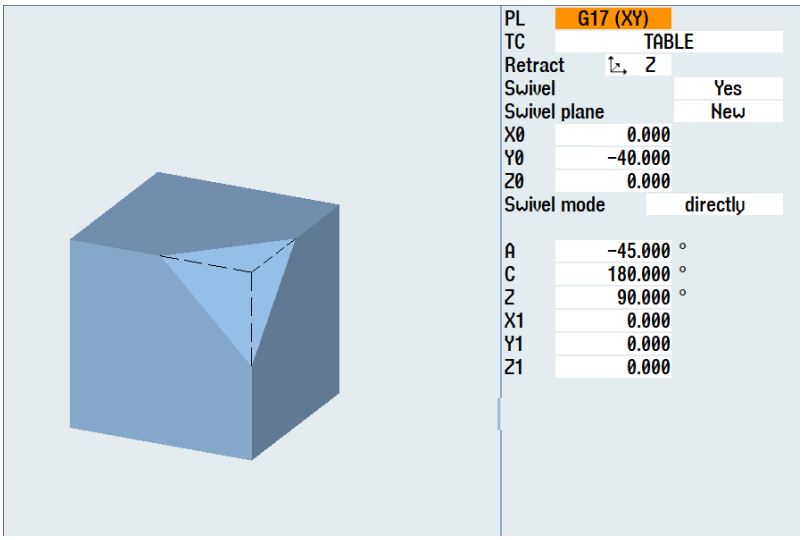
The third chamfer is programmed in the "**3_CHAMFER**" block.

```
G0 X7 Y-60 Z100
G0 Z5
G1 Z0
G1 Y60
G0 Z100
```

```
3_CHAMFER
G0 X7 Y-60 Z100¶
G0 Z5¶
G1 Z0¶
G1 Y60¶
G0 Z100¶
End of group
```



The swivel is programmed in the "**4_SWIVEL**" block.

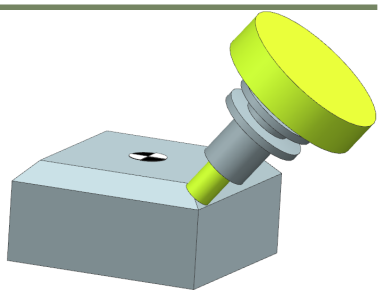


PL	G17 (XY)
TC	TABLE
Retract	Z
Swivel	Yes
Swivel plane	New
X0	0.000
Y0	-40.000
Z0	0.000
Swivel mode	directly
A	-45.000 °
C	180.000 °
Z	90.000 °
X1	0.000
Y1	0.000
Z1	0.000

The fourth chamfer is programmed in the "**4_CHAMFER**" block.

```
G0 X7 Y-60 Z100
G0 Z5
G1 Z0
G1 Y60
G0 Z100
```

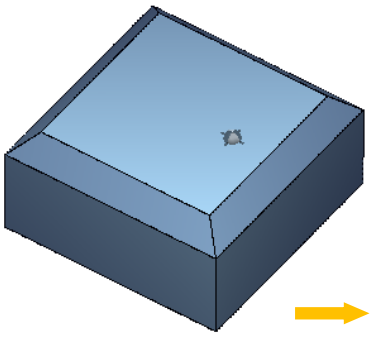
```
4_CHAMFER
G0 X7 Y-60 Z100¶
G0 Z5¶
G1 Z0¶
G1 Y60¶
G0 Z100¶
End of group
```



In the "**END**" block, "**CYCLE800**" travels to the initial setting and the Tool Carrier is deselected.

The program is now fully created.

```
END
CYCLE800(1, "TABLE", 200000, 57, 0, 0, 0, 0, 0, 0, 0, 0, 1, 100, 1)¶
CYCLE800(1, "0", 200000, 192, 0, -40, 0, -45, 180, 90, 0, 0, 0, 1, 100, 1)¶
M30¶
```



Notes:

7th example, complex with ShopMill

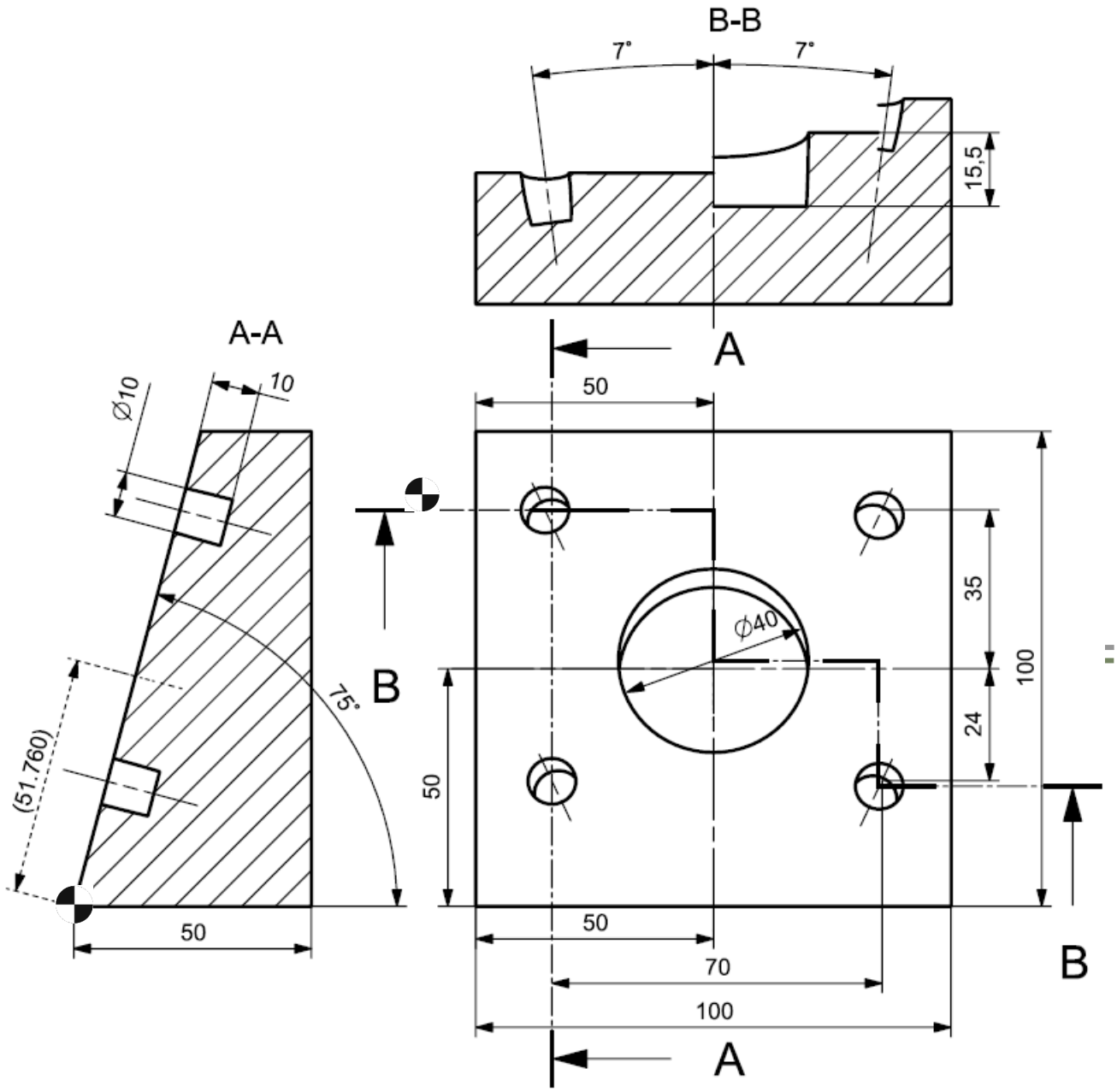
Task:

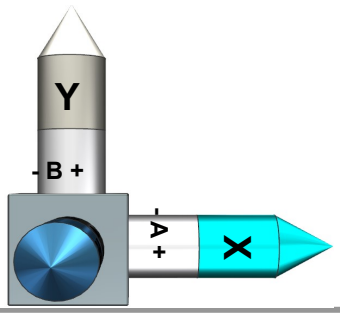
The blank for the program example has the dimensions 100x100x52 mm

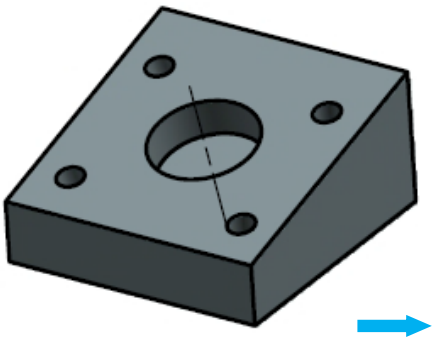
⇒ Programming in ShopMill
⇒ Face milling in the initial setting
⇒ Milling oblique surface 15°
⇒ Milling centered circular pocket (roughing, finishing)
⇒ Milling "1st corner" (roughing, finishing)
⇒ Milling "2nd corner" (roughing, finishing)
⇒ Circular pockets (-7°) (roughing)
⇒ Circular pockets (7°) (roughing)
⇒ 1st circular pocket on oblique surface (roughing, finishing)
⇒ 2nd circular pocket on oblique surface (roughing, finishing)

Notes:

Drawing, 1st view

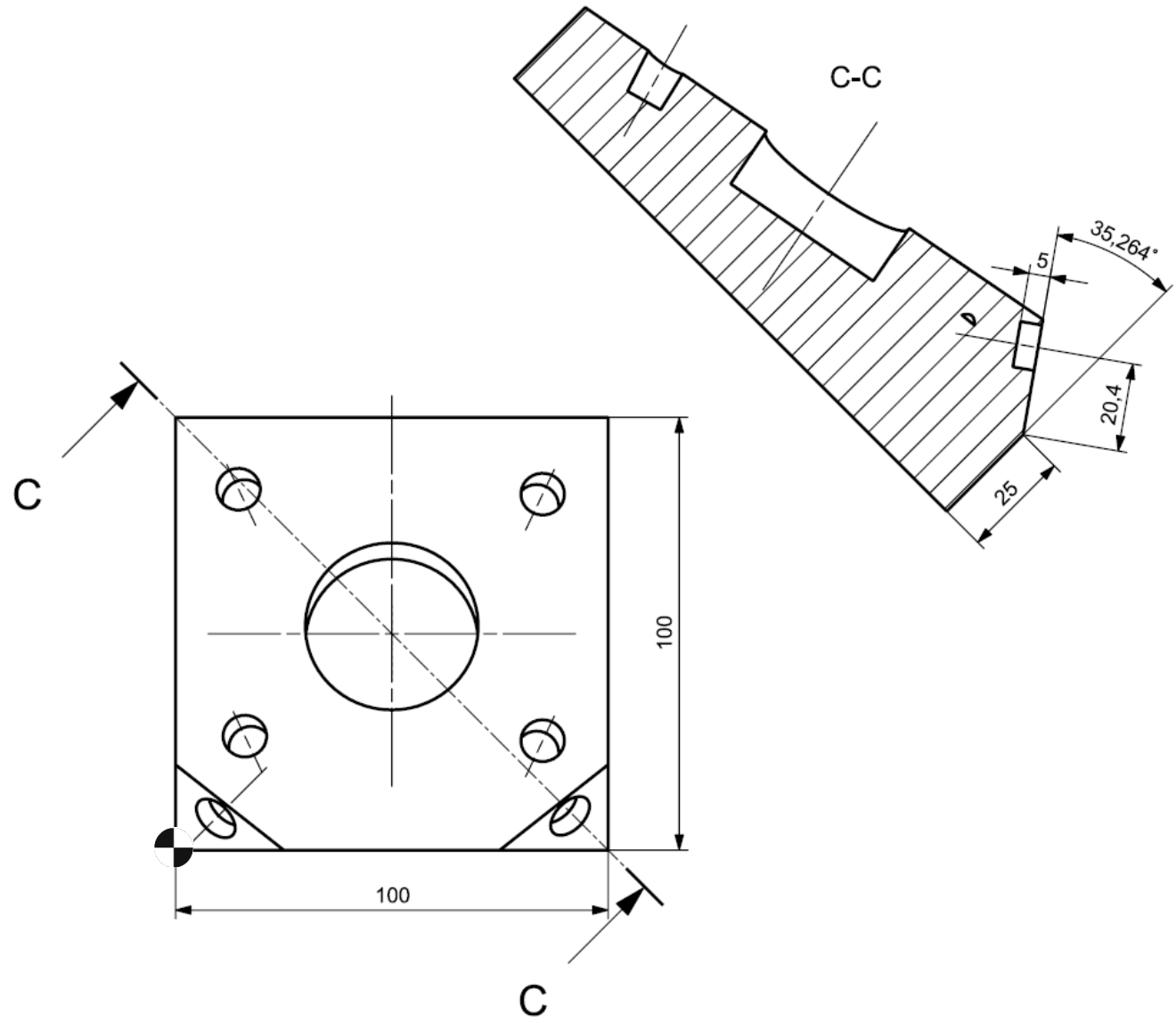


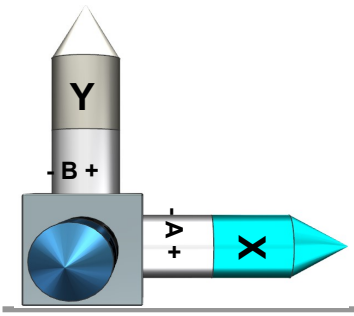


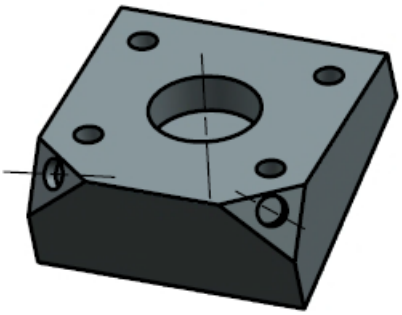


Notes:

Drawing, 2nd view

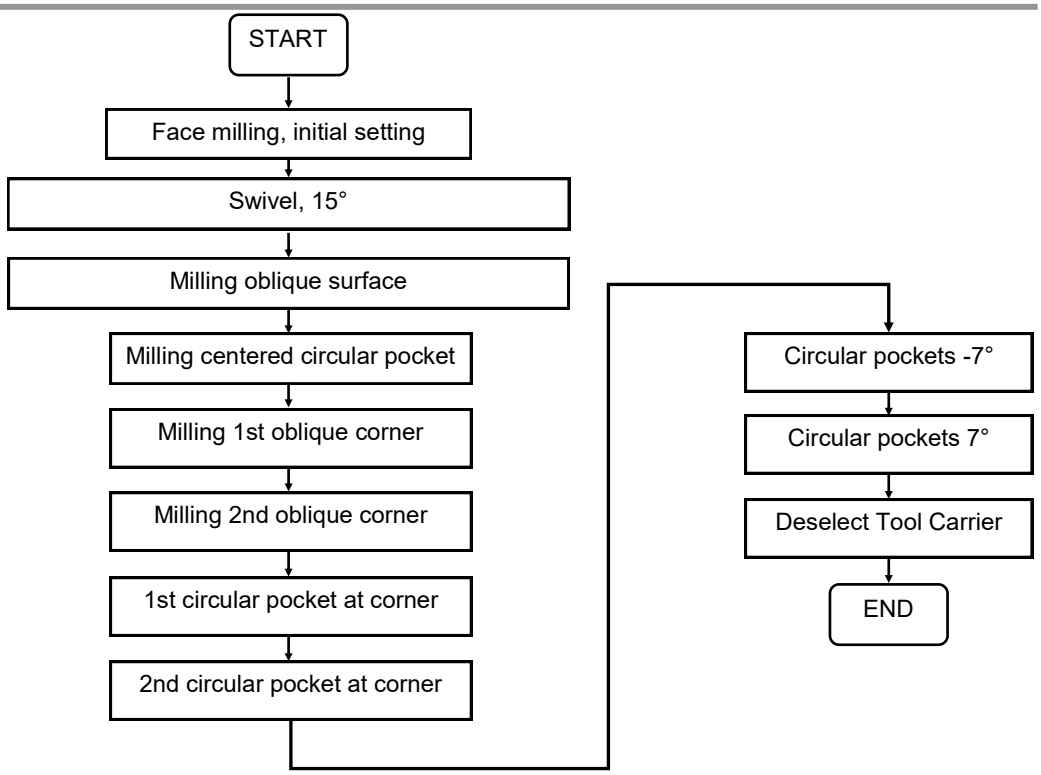




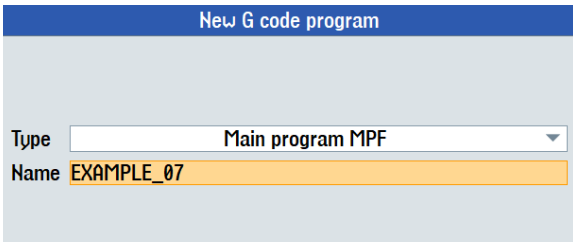


Notes:

Flow diagram:



A new program is created.



Machine manufacturers can program a different behavior for "CYCLE800".

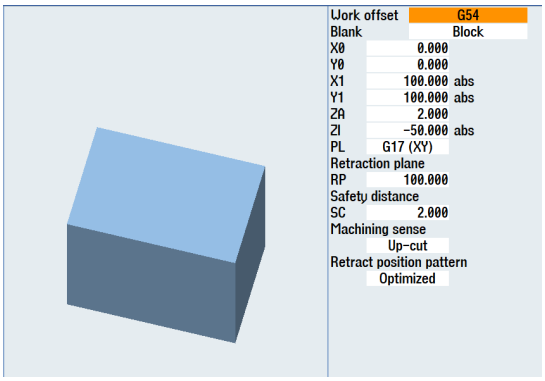
- **New:**
  Before each tool change, "CYCLE800" must travel to the initial setting.
  The swivel plane must then be reprogrammed.
  Example: Centering, drilling, reaming.
  If no "CYCLE800" is programmed in the initial setting, the tool is switched to the swivel plane.

- **Chaining:**
  After machining in a swivel plane, another cycle in which a tool change is programmed can be called directly.
  For the tool change, ShopMill travels automatically to the initial setting, changes the tool and swivels in the most-recently programmed plane and continues the program.
  (Example: roughing circular pocket, finishing circular pocket with two different tools).

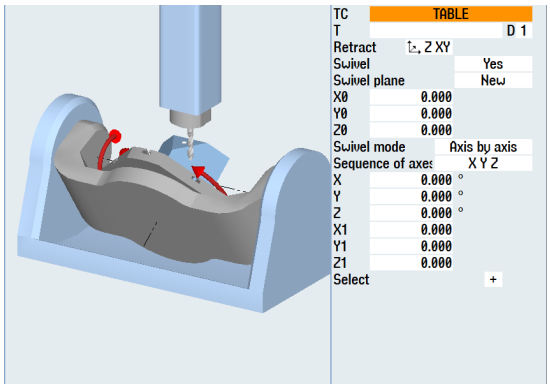
Die Umsetzung ist alleine Sache des Maschinenherstellers.

Notes:

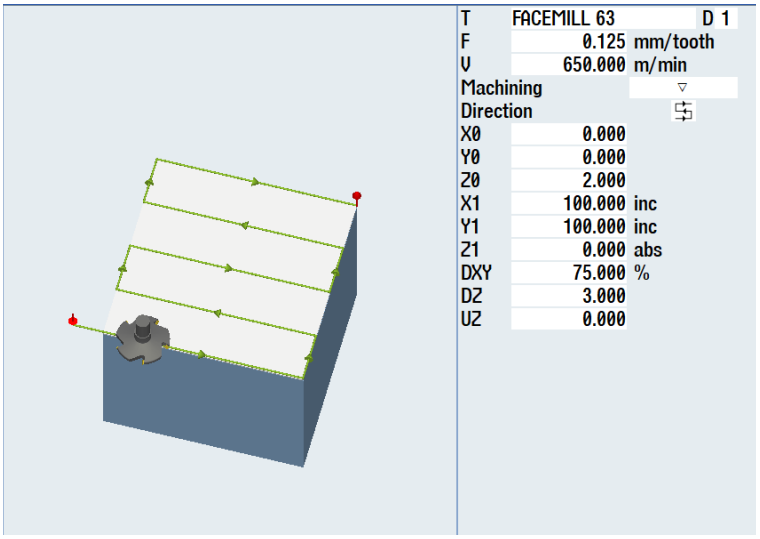
After entering the program header,

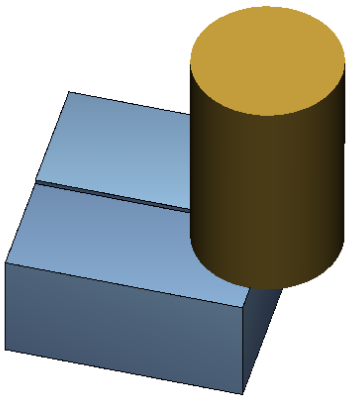


travel is made to the initial setting in the next step.



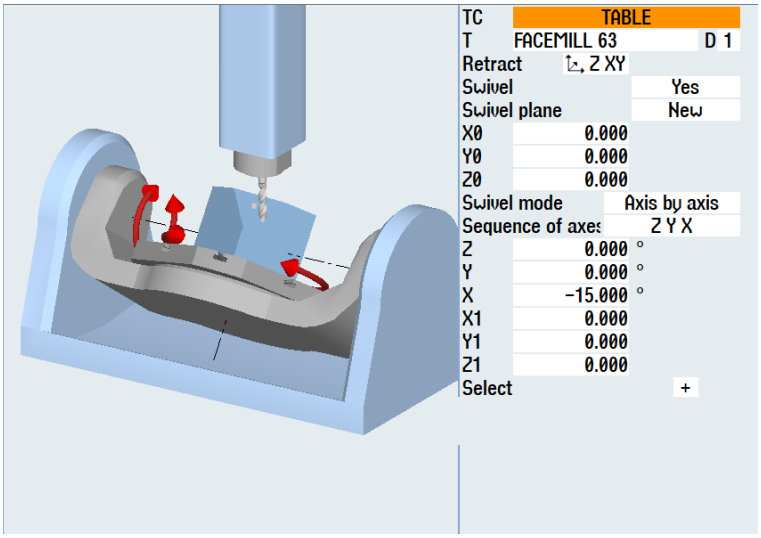
The face cutting in the non-swiveled state follows.

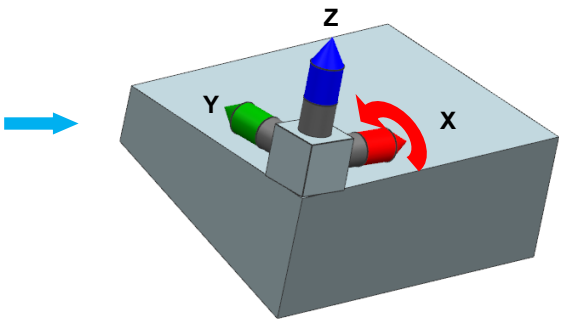




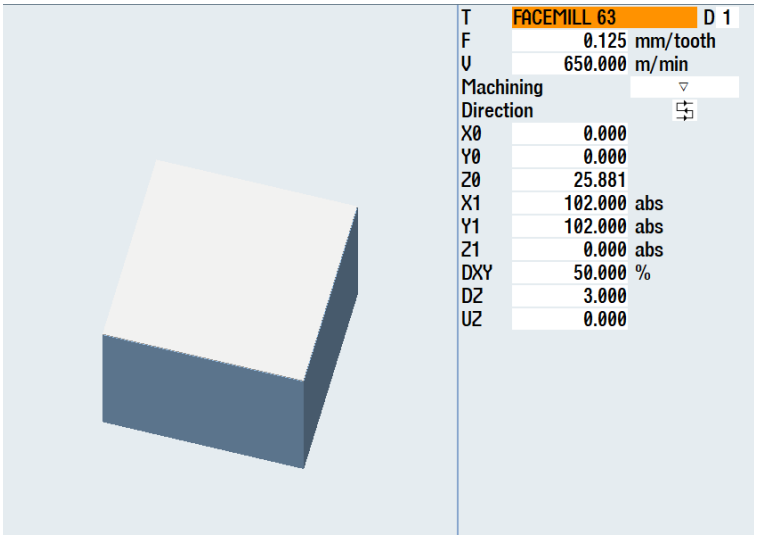
Notes:

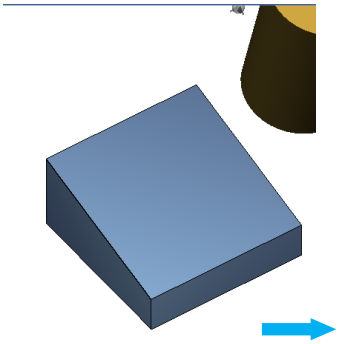
A swivel is made on the machining plane of -15°.





The face cutting in the swivel plane follows. A protrusion >100 mm is programmed in "**X1**" and "**Y1**" so that no edge remains.

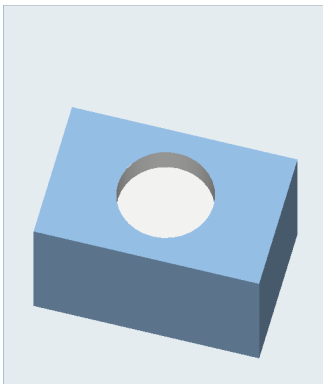




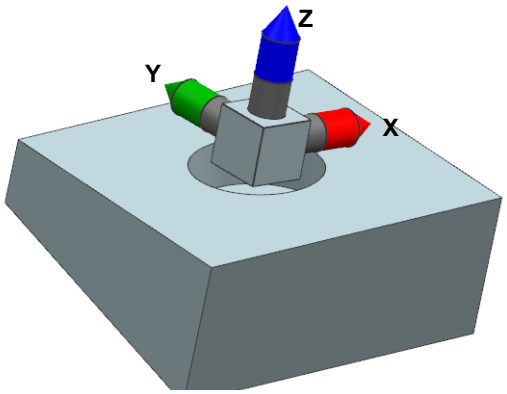
P	Program header	G54 Block
	Swivel plane	X=0 Y=0 Z=0 Z XY
	Face milling	T=FACEMILL 63 F=0.125/t V=650m X0=0 Y0=0 Z0=2 Z1=0
	Swivel plane	Z=0 Y=0 X=-15 T=FACEMILL 63 Z XY
	Face milling	T=FACEMILL 63 F=0.125/t V=650m X0=0 Y0=0 Z0=25.881

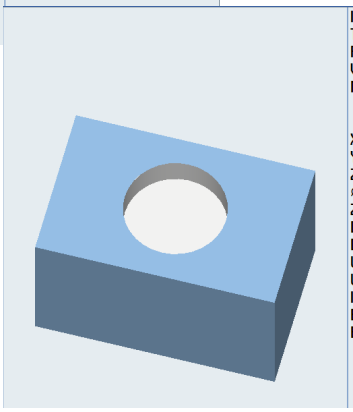
Notes:

A circular pocket is produced.

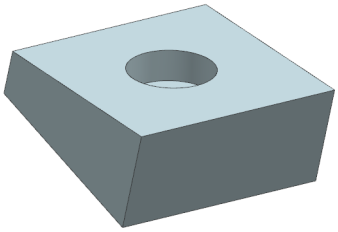


Input		Complete
T	ENDMILL_D16	D 1
F	0.205	mm/tooth
V	350.000	m/min
Machining		
	Centric	
	Single position	
X0	50.000	
Y0	51.760	
Z0	0.000	
⌀	40.000	
Z1	-15.500	abs
DXY	65.000	%
DZ	6.000	
UXY	0.200	
UZ	0.200	
Insertion		Helical
EP	1.500	mm/rev
ER	6.000	
Removing		Comp. machining

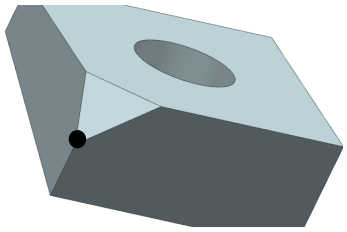


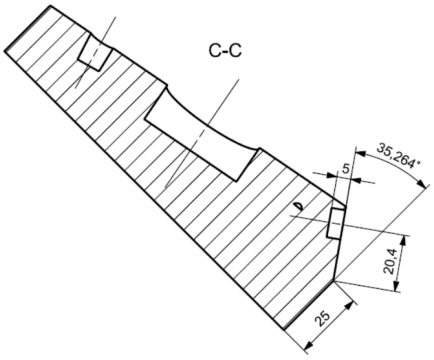


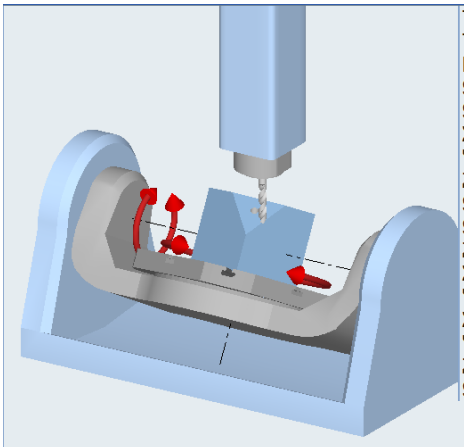
Input		Complete
T	ENDMILL_D16	D 1
F	0.205	mm/tooth
V	350.000	m/min
Machining		
	Centric	
	Single position	
X0	50.000	
Y0	51.760	
Z0	0.000	
⌀	40.000	
Z1	-15.500	abs
DXY	50.000	%
DZ	15.500	
UXY	0.200	
UZ	0.200	
Insertion		Helical
EP	1.500	mm/rev
ER	6.000	



The oblique surface is programmed in the next step.
To do this, a swivel is made to a new machining plane.



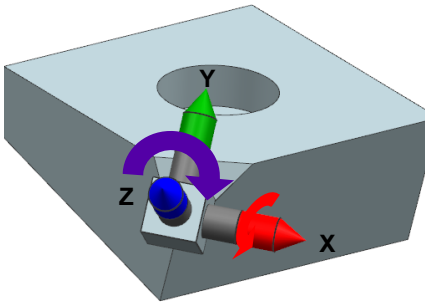




TC	TABLE	
T	ENDMILL_D16	D 1
Retract	⌞, Z XY	
Swivel		Yes
Swivel plane		New
X0	0.000	
Y0	0.000	
Z0	-25.000	
Swivel mode		Axis by axis
Sequence of axes		Z X Y
Z	-45.000	°
X	54.736	°
Y	0.000	°
X1	0.000	
Y1	0.000	
Z1	0.000	
Select		+

The value for "**X**" is calculated as follows.

(90°-35.264°= 54.736)



Notes:

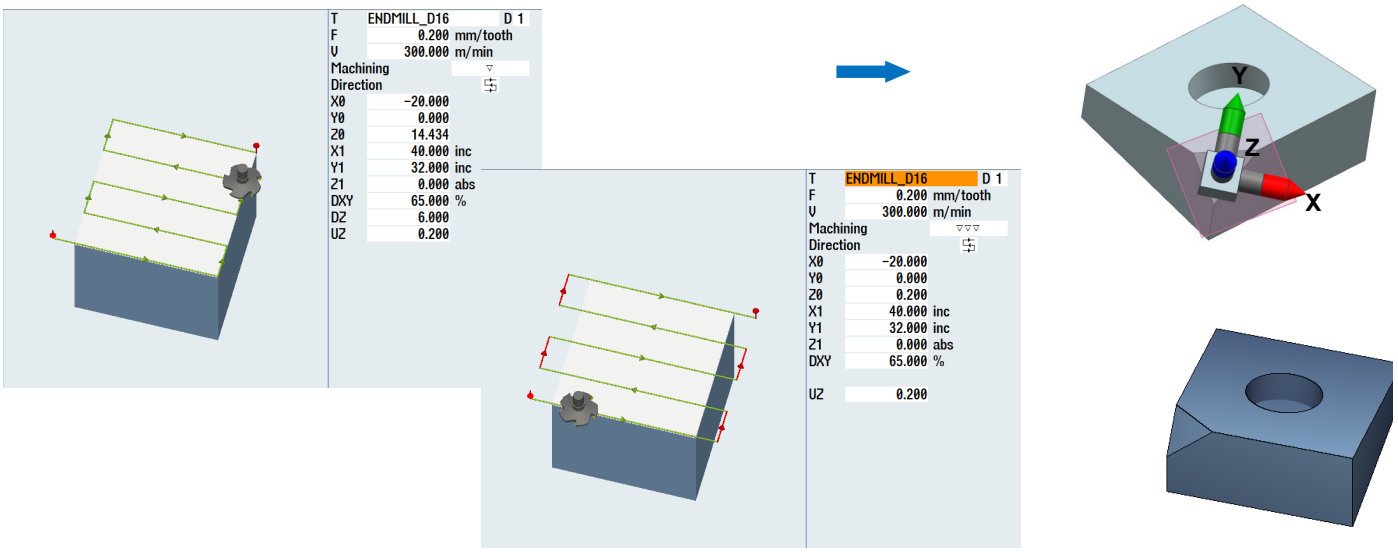
The inputs for face milling the surface are then made.
Parameter "**Z0**" must be calculated.

Note: (Calculation of the "**Z0**" parameter)

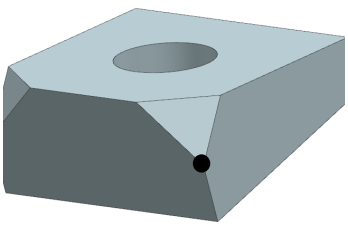
sin α = GK / HP

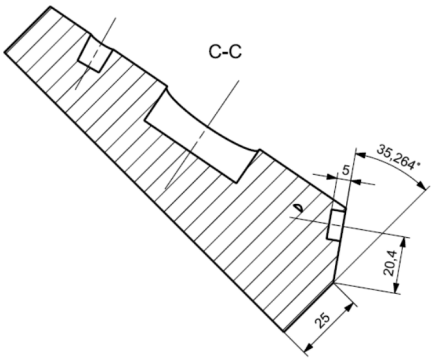
GK = sin 35.264 * 25

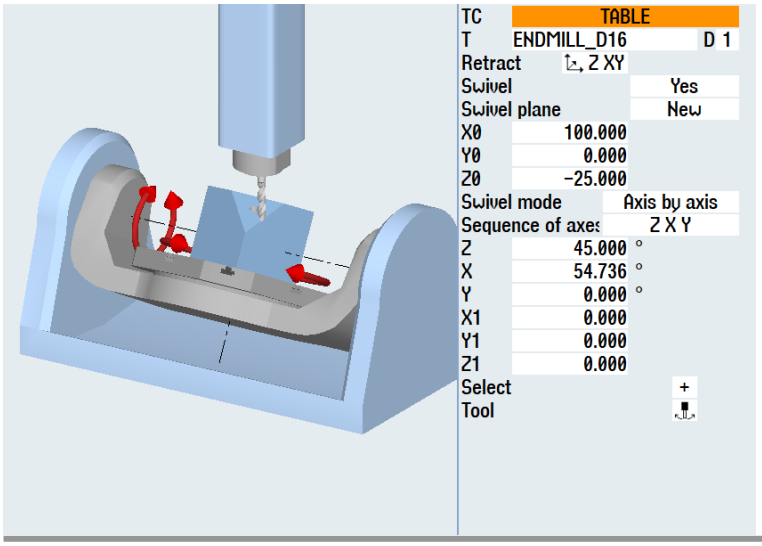
The values "X0", "X1", "Y0" and "Y1" specify the dimensions of the milling plane.

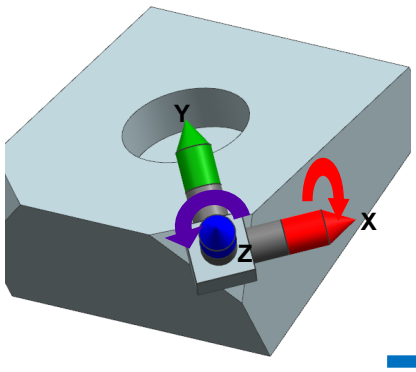


The second oblique surface is programmed in the next step.
To do this, a swivel is made to a new machining plane.
The value for "**X**" is calculated as follows. (90°-35.264°= 54.736)









Notes:

The inputs for face milling the surface are then made.

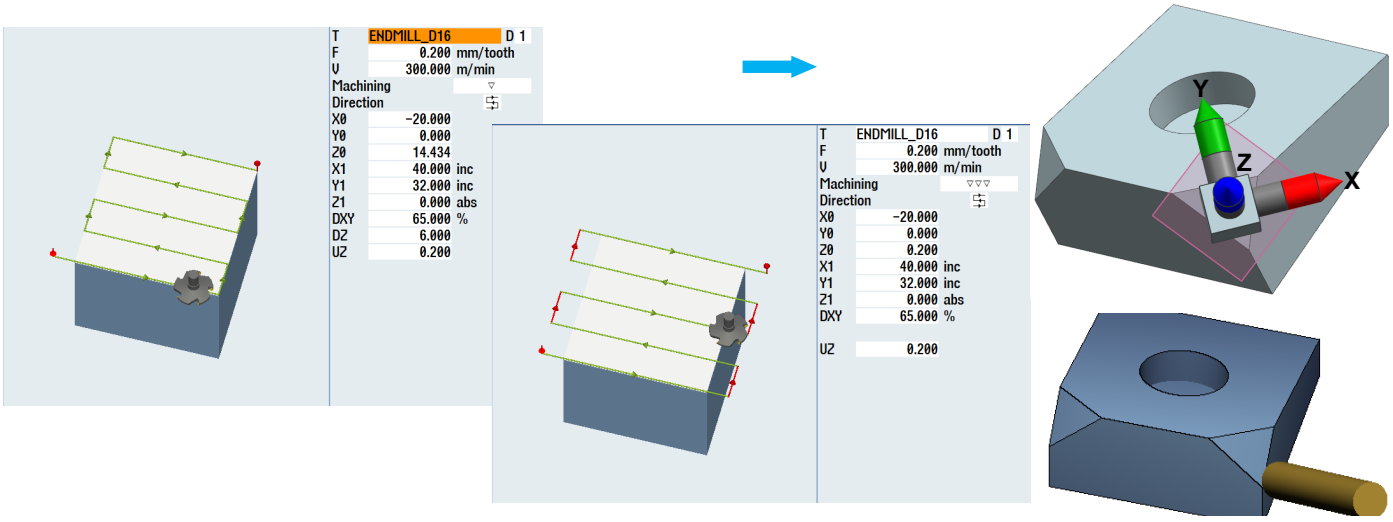
Parameter "**Z0**" must be calculated.

Note: (Calculation of the "**Z0**" parameter)

sin α = GK / HP

GK = sin 35.264 * 25

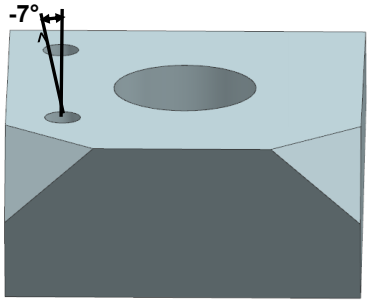
⇒ GK = **14.4336**



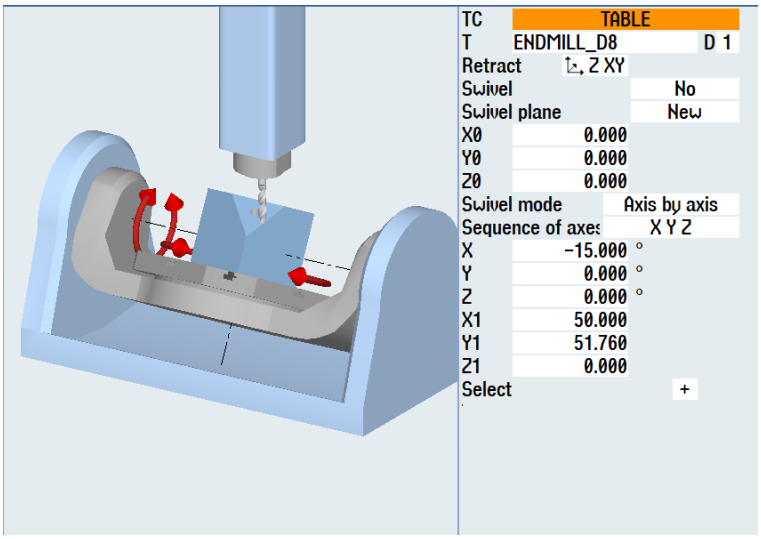
The circular pockets below (-7°) are produced in the next step.

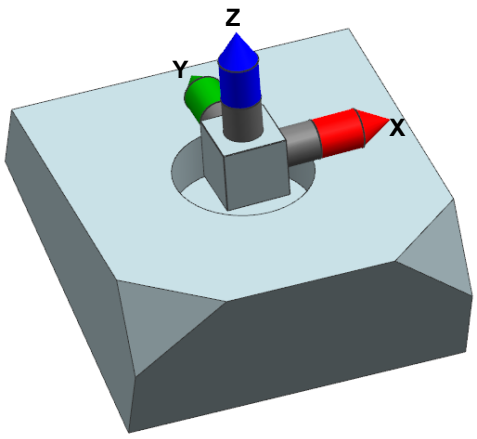
A selection can be made in "CYCLE800".

Swivel	No
Swivel plane	No
	Yes



No swiveling is performed for "**Swivel No**". This swivels to a "theoretical plane" used as basis for the next swiveling.





Swiveling is first made to the center in this example.

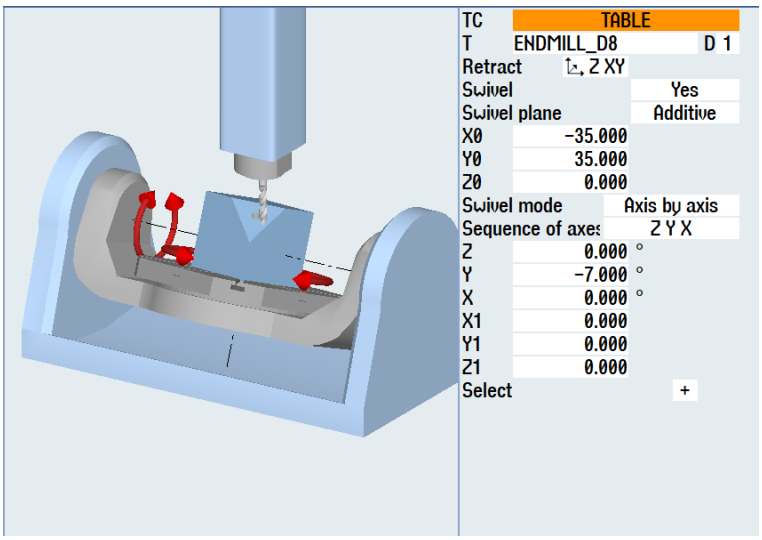
Notes:

"**CYCLE800**" is called again.

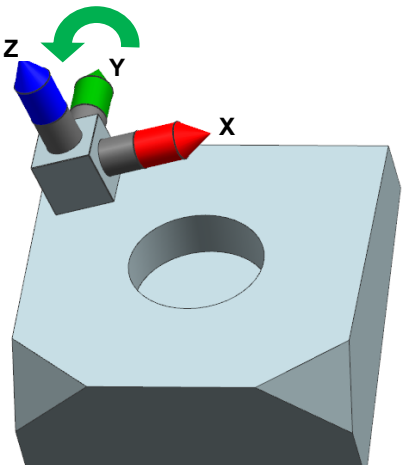
A further swivel plane is now programmed additive on the previous theoretical swiveling.

Swivel plane	Additive
	New
	Additive

The degree **(-7)** and the position of the first circular pocket are programmed.

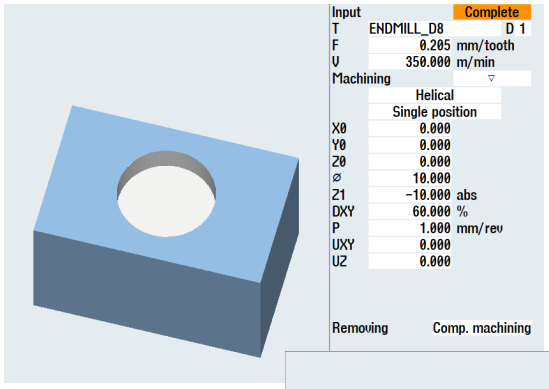


TC	TABLE
T	ENDMILL_D8 D 1
Retract	Z XY
Swivel	Yes
Swivel plane	Additive
X0	-35.000
Y0	35.000
Z0	0.000
Swivel mode	Axis by axis
Sequence of axes	Z Y X
Z	0.000 °
Y	-7.000 °
X	0.000 °
X1	0.000
Y1	0.000
Z1	0.000
Select	+

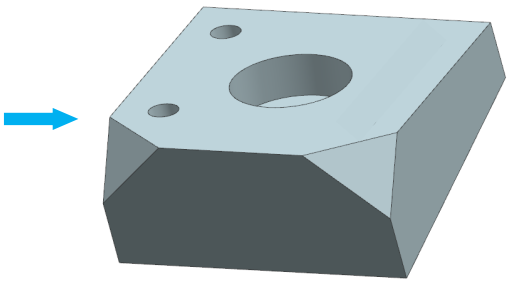


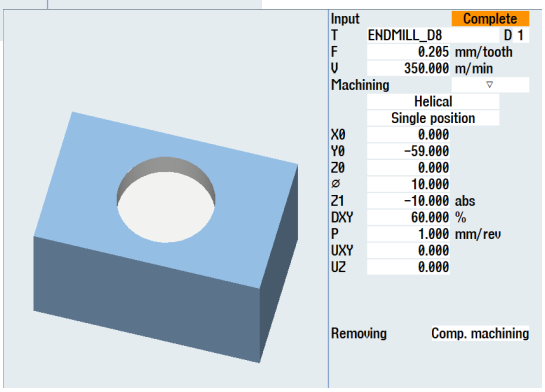
Swivel plane	X=-15 Y=0 Z=0 T=ENDMILL_D8 Z XY
Swivel plane	Additive Z=0 Y=-7 X=0 T=ENDMILL_D8 Z XY

The two circular pockets are programmed.

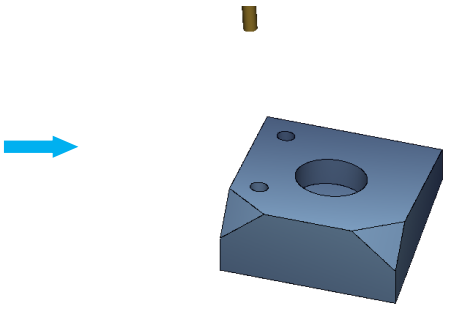


Input	Complete
T	ENDMILL_D8 D 1
F	0.205 mm/tooth
V	350.000 m/min
Machining	
	Helical
	Single position
X0	0.000
Y0	0.000
Z0	0.000
⌀	10.000
Z1	-10.000 abs
DXY	60.000 %
P	1.000 mm/rev
UXY	0.000
UZ	0.000
Removing	Comp. machining





Input	Complete
T	ENDMILL_D8 D 1
F	0.205 mm/tooth
V	350.000 m/min
Machining	
	Helical
	Single position
X0	0.000
Y0	-59.000
Z0	0.000
⌀	10.000
Z1	-10.000 abs
DXY	60.000 %
P	1.000 mm/rev
UXY	0.000
UZ	0.000
Removing	Comp. machining

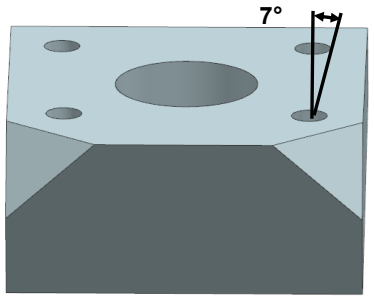


Die Position der zweiten Kreistasche wird direkt im Zyklus porgrammiert.

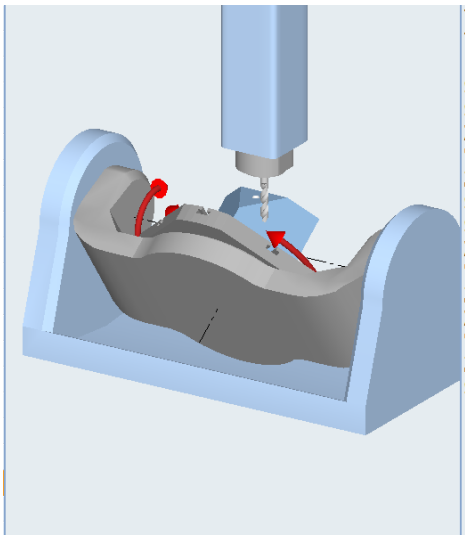
Notes:

The circular pockets below (**7°**) are programmed.

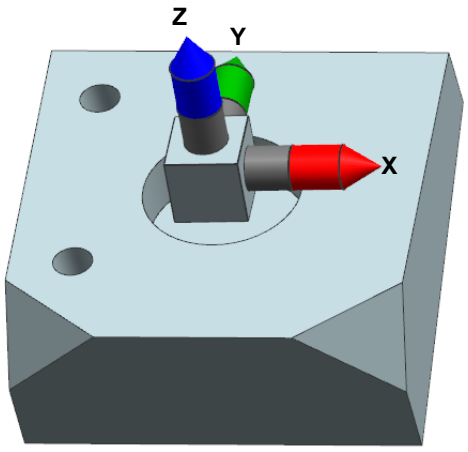
Swivel	No
Swivel plane	No / Yes



A swivel is made to the workpiece center.



TC	TABLE	
T	ENDMILL_D8	D 1
Retract	↳, Z XY	
Swivel		No
Swivel plane		New
X0	0.000	
Y0	0.000	
Z0	0.000	
Swivel mode		Axis by axis
Sequence of axes		X Y Z
X	-15.000	°
Y	0.000	°
Z	0.000	°
X1	50.000	
Y1	51.760	
Z1	0.000	
Select		+

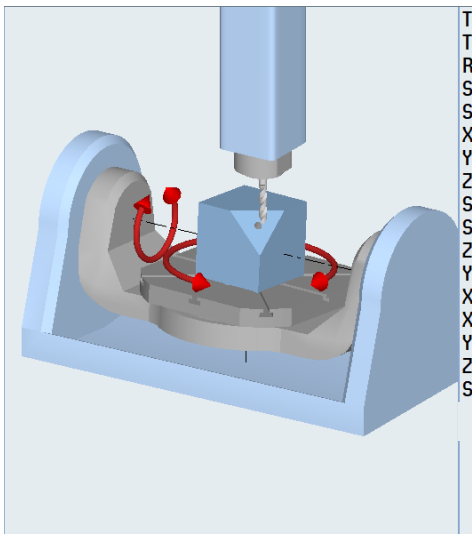


"**CYCLE800**" is called again.

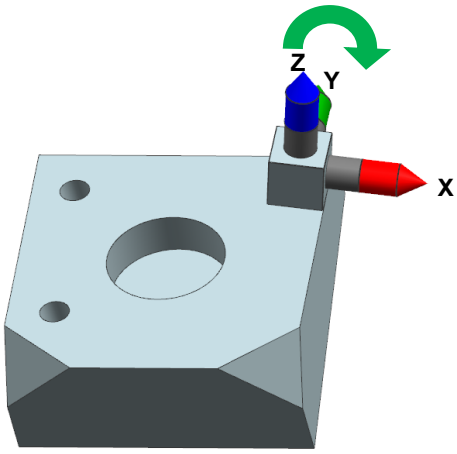
A swivel is made "**additive**" to **(7°)**.

Swivel plane	Additive / New / Additive

.



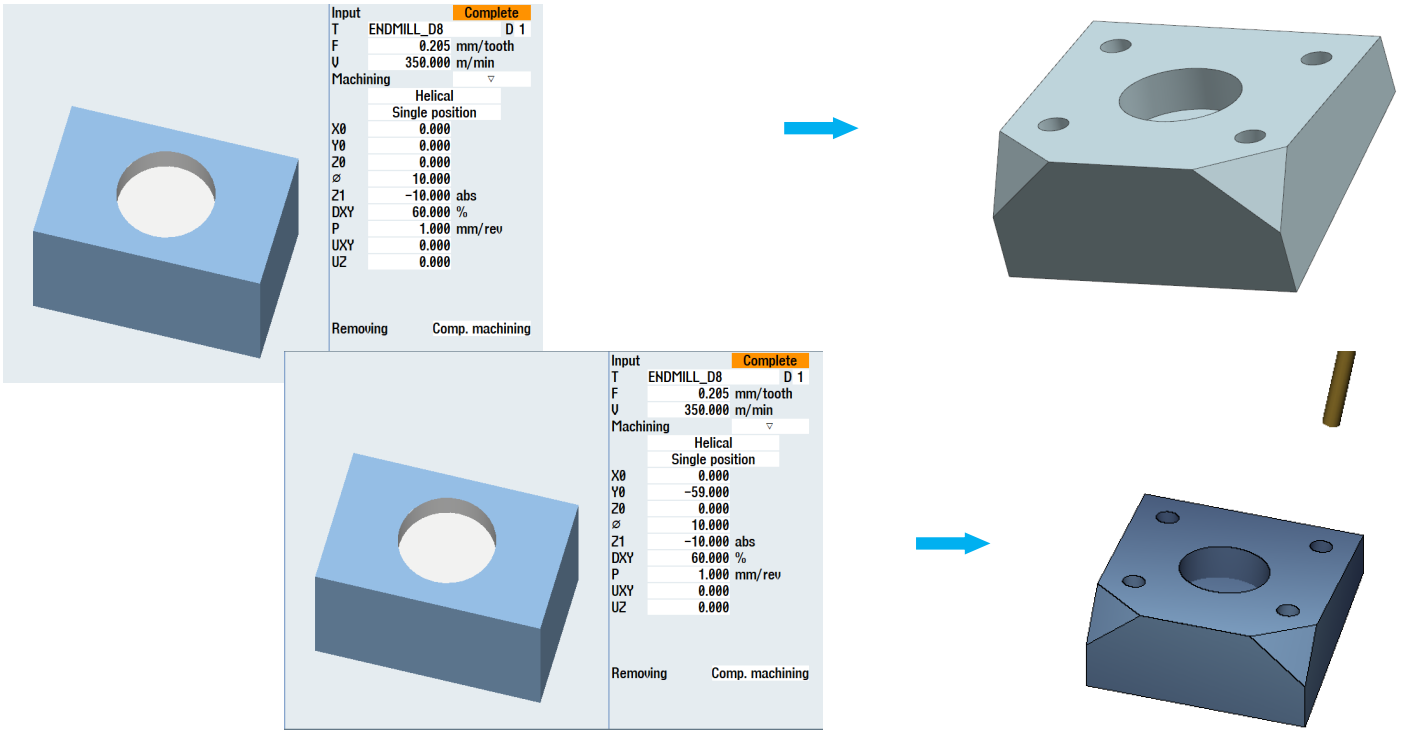
TC	TABLE	
T	ENDMILL_D8	D 1
Retract	↳, Z XY	
Swivel		Yes
Swivel plane		Additive
X0	35.000	
Y0	35.000	
Z0	0.000	
Swivel mode		Axis by axis
Sequence of axes		Z Y X
Z	0.000	°
Y	7.000	°
X	0.000	°
X1	0.000	
Y1	0.000	
Z1	0.000	
Select		+



Swivel plane	X=-15 Y=0 Z=0 T=ENDMILL_D8 Z XY
Swivel plane	Additive Z=0 Y=7 X=0 T=ENDMILL_D8 Z XY

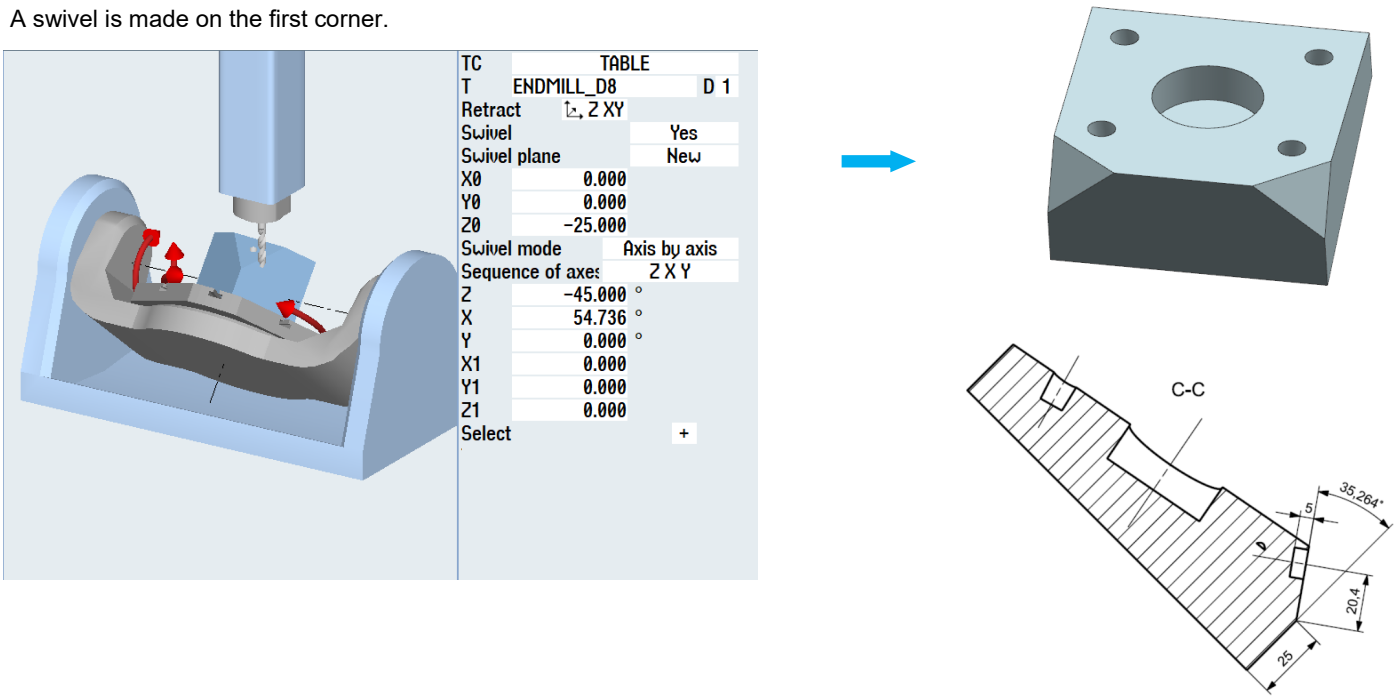
Notes:

The two circular pockets are programmed.



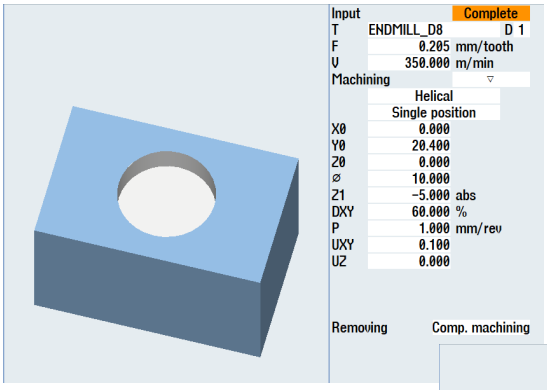
Die Position der zweiten Kreistasche wird direkt im Zyklus programmiert.

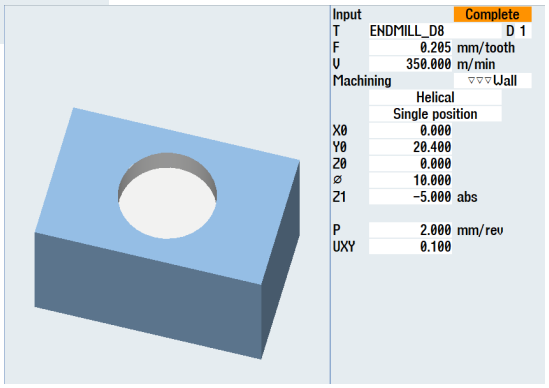
A swivel is made on the first corner.

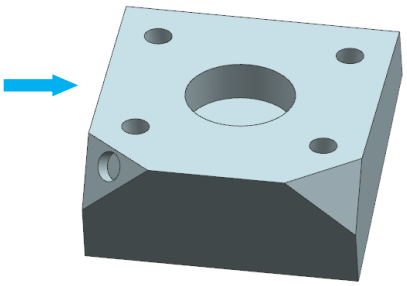


Notes:

The circular pocket is programmed in the next step.

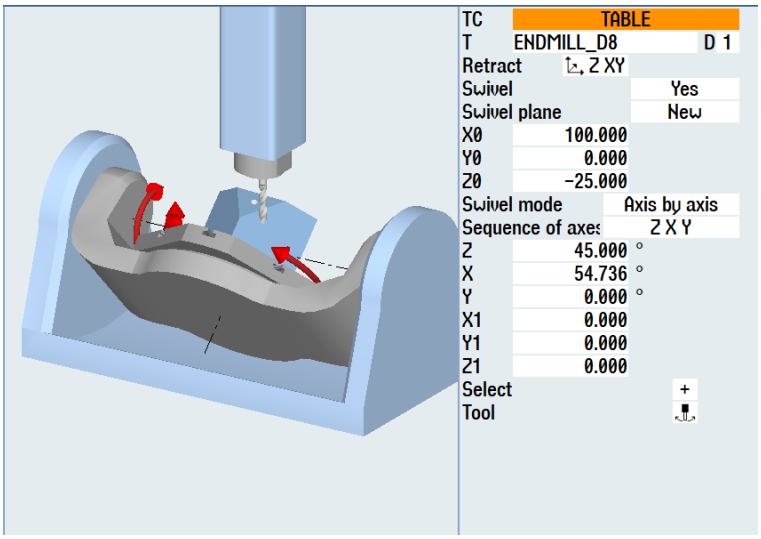


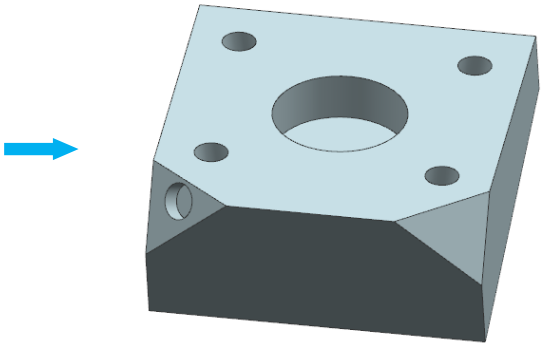


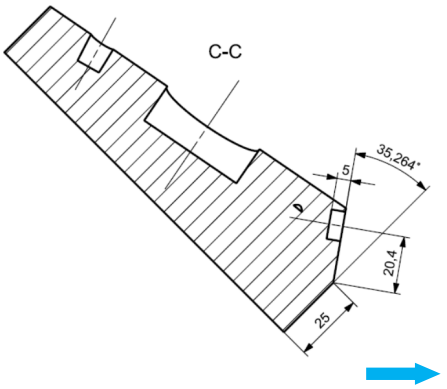


Die Position der Tasche wird im Zyklus programmiert.

A swivel is made to the first corner to produce the circular pocket.

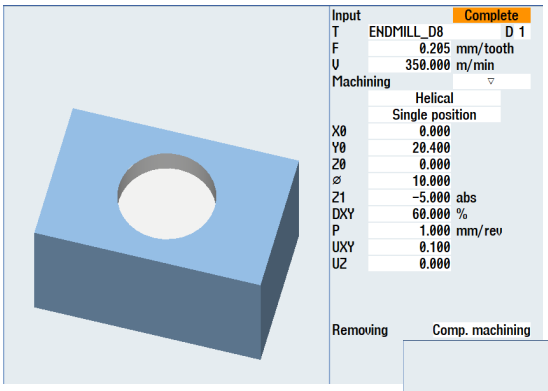




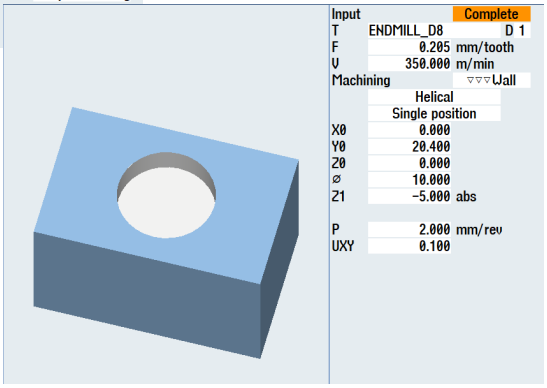


Notes:

The circular pocket is programmed in the next step.



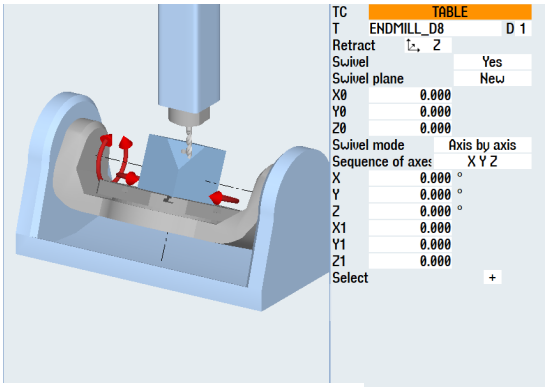
Input		Complete
T	ENDMILL_D8	D 1
F	0.205	mm/tooth
V	350.000	m/min
Machining		
	Helical	
	Single position	
X0	0.000	
Y0	20.400	
Z0	0.000	
⌀	10.000	
Z1	-5.000	abs
DXY	60.000	%
P	1.000	mm/rev
UXY	0.100	
UZ	0.000	
Removing		Comp. machining



Input		Complete
T	ENDMILL_D8	D 1
F	0.205	mm/tooth
V	350.000	m/min
Machining		Wall
	Helical	
	Single position	
X0	0.000	
Y0	20.400	
Z0	0.000	
⌀	10.000	
Z1	-5.000	abs
P	2.000	mm/rev
UXY	0.100	

Die Position der Tasche wird im Zyklus programmiert.

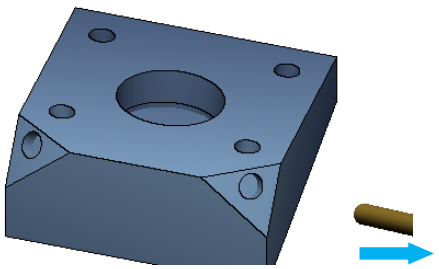
A swivel is made to the initial setting.



TC	TABLE	
T	ENDMILL_D8	D 1
Retract	Z	
Swivel		Yes
Swivel plane		New
X0	0.000	
Y0	0.000	
Z0	0.000	
Swivel mode		Axis by axis
Sequence of axes		X Y Z
X	0.000	°
Y	0.000	°
Z	0.000	°
X1	0.000	
Y1	0.000	
Z1	0.000	
Select		+

TC	0
Retract	Z XY

The "**Tool Carrier**" is deselected.



Das Programm ist fertig erstellt.

Notes:

8th example, complex with programGUIDE

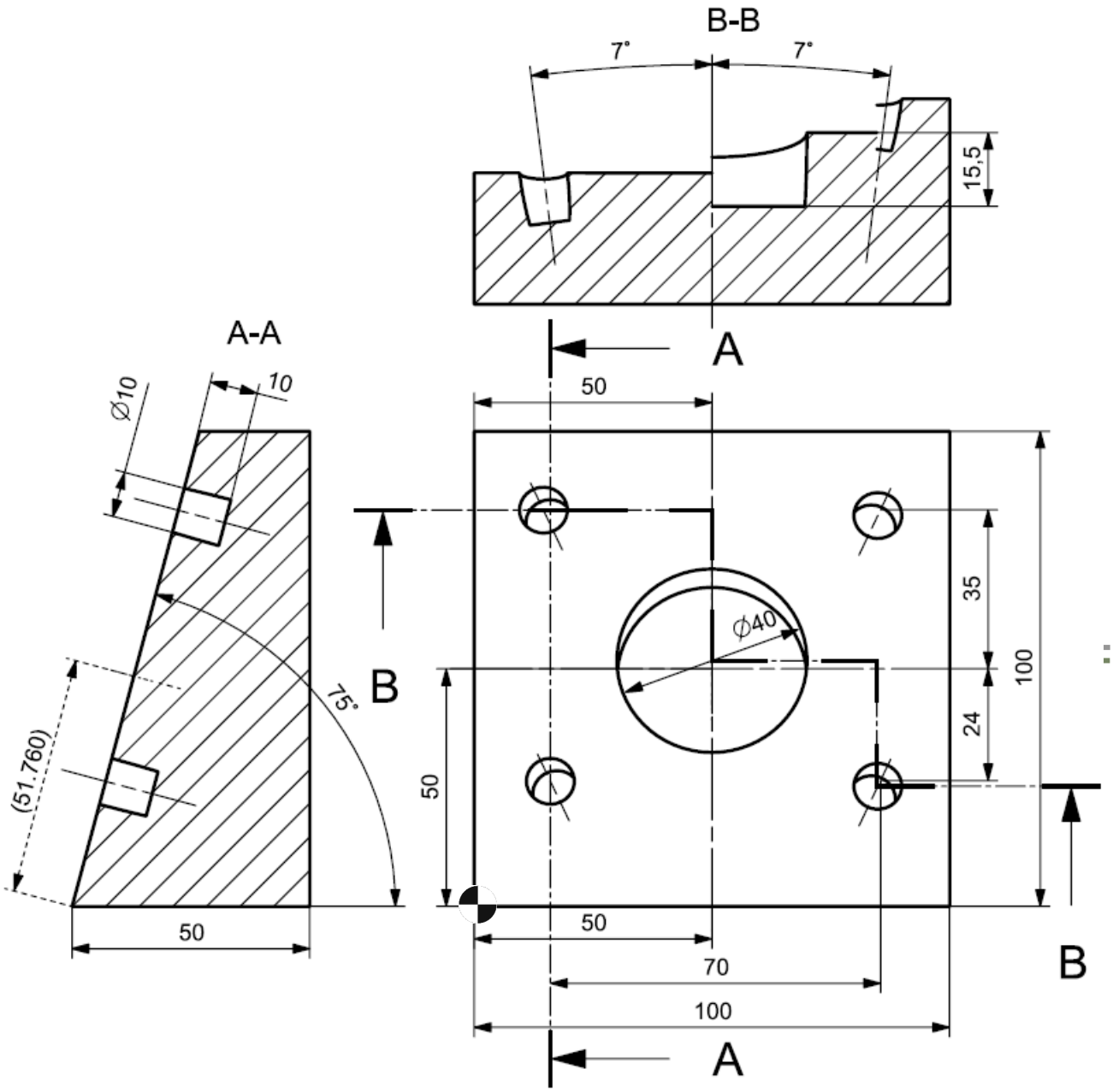
Task:

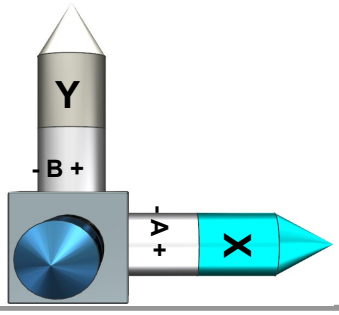
The blank for the program example has the dimensions 100x100x52 mm

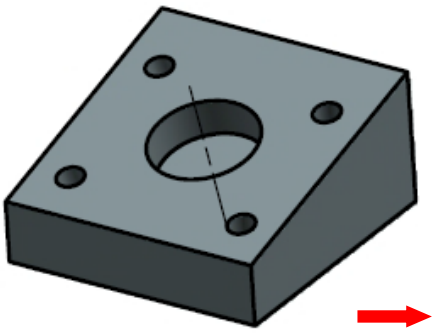
⇒ Programming in programGUIDE
⇒ Face milling in the initial setting
⇒ Milling oblique surface 15°
⇒ Milling centered circular pocket (roughing, finishing)
⇒ Milling "1st corner" (roughing, finishing)
⇒ Milling "2nd corner" (roughing, finishing)
⇒ Circular pockets (-7°) (roughing)
⇒ Circular pockets (7°) (roughing)
⇒ 1st circular pocket on oblique surface (roughing, finishing)
⇒ 2nd circular pocket on oblique surface (roughing, finishing)

Notes:

Drawing, 1st view

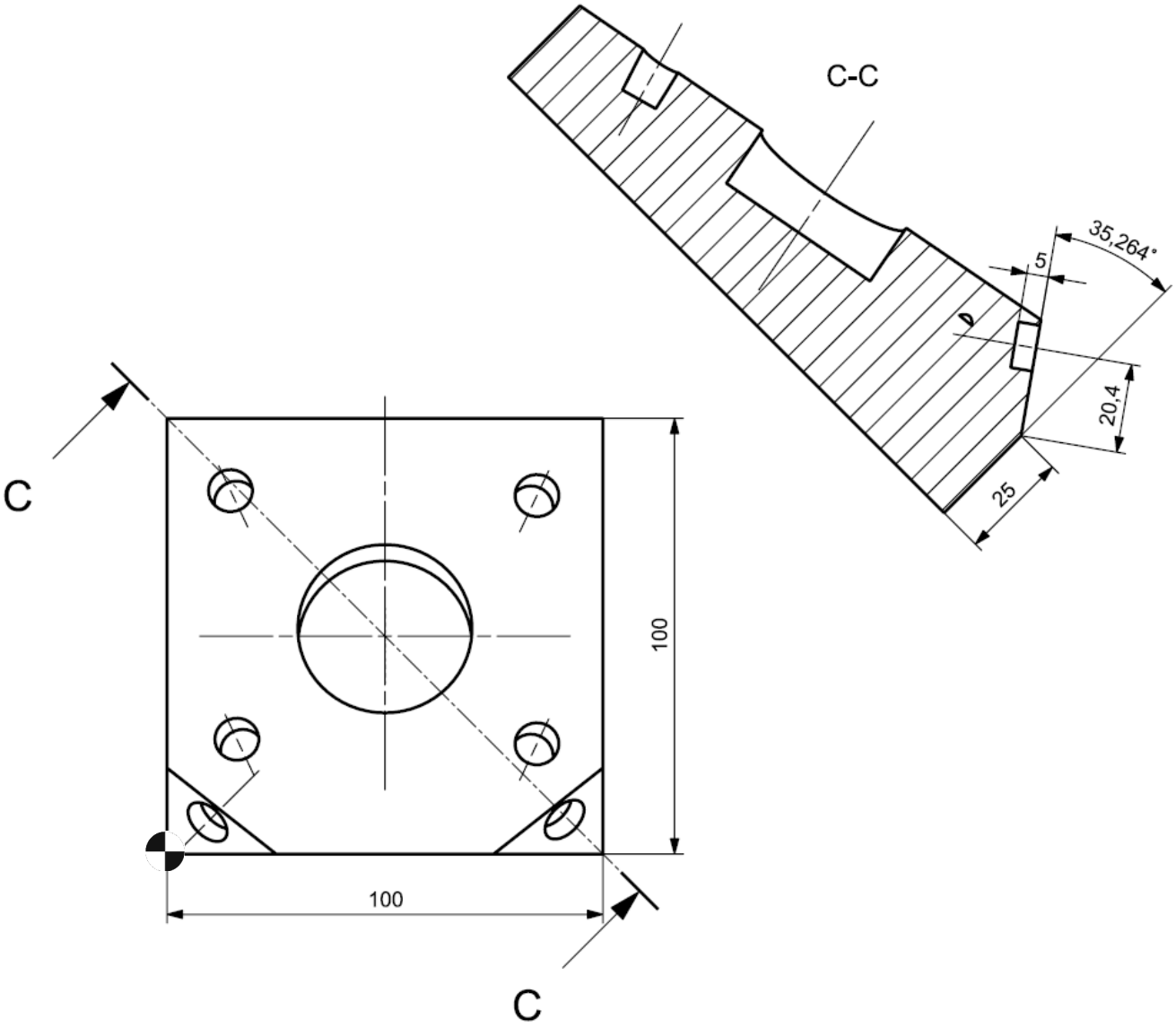


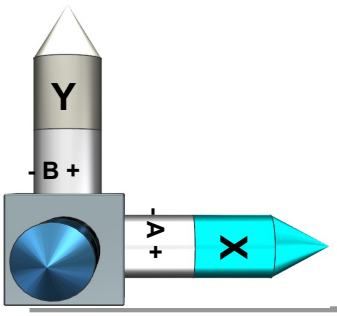


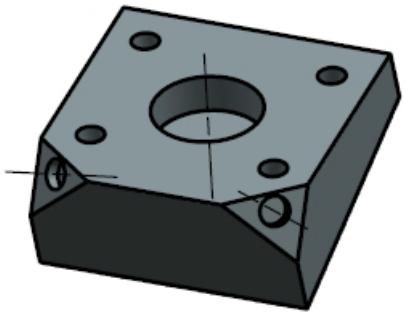


Notes:

Drawing, 2nd view

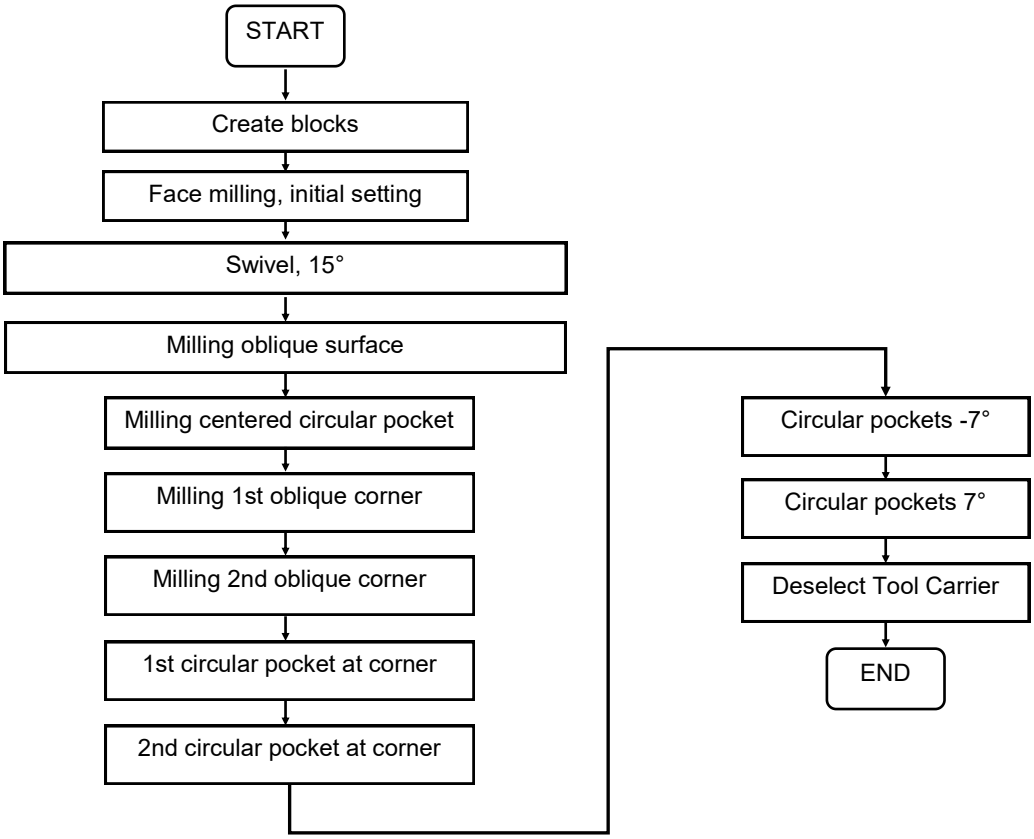






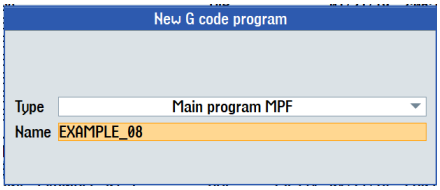
Notes:

Flow diagram:



Function	Block name
Start commands	START
Face milling	FACE_MILLING_INITIAL_SETTING
Swivel by 15°	SWIVEL_PLANE
Mill oblique by 15°	MILLING_OBLIQUE
Swivel by 15°	SWIVEL_PLANE
Milling centered circ. pocket	MILLING_CIRCULAR_POCKET_CENTERED
Swivel plane 1st corner	SWIVEL_PLANE
Mill the 1st corner	MILLING_FIRST_CORNER
Swivel plane 2nd corner	SWIVEL_PLANE
Mill the 2nd corner	MILLING_SECOND_CORNER
Swivel plane -7°	SWIVEL_PLANE
Circular pockets -7°	CIRCULAR_POCKETS_-7
Swivel plane 7°	SWIVEL_PLANE
Circular pocket on 7°	CIRCULAR_POCKETS_7
Swivel plane 1st corner	SWIVEL_PLANE
Circular pocket on 1st corner	MILLING_CIRCULAR_POCKET_FIRST_CORNER
Swivel plane 2nd corner	SWIVEL_PLANE
Circ. pocket on 2nd corner	MILLING_CIRCULAR_POCKET_SECOND_CORNER
End commands	END

After creating a new program, the blocks

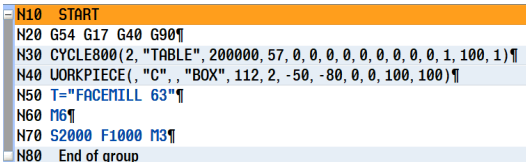


are programmed.

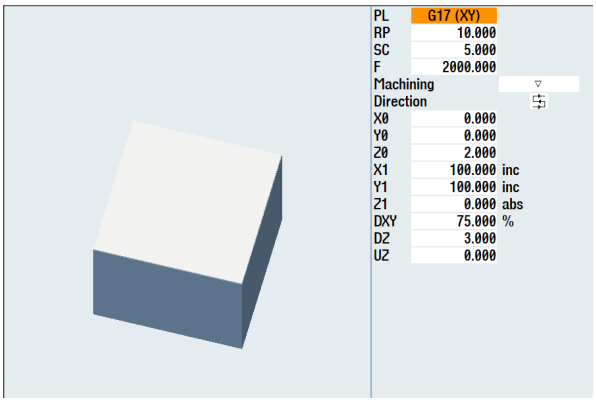
Notes:

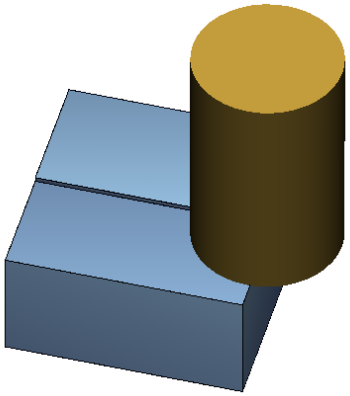
The program header in the "**START**" block is programmed.

```
N20 G54 G17 G40 G90
N30 CYCLE800(2,"TABLE",200000,57,0,0,0,0,0,0,0,0,1,100,1)
N40 WORKPIECE(,"C",,"BOX",112,2,-50,-80,0,0,100,100)
N50 T="FACEMILL 63"
N60 M6
N70 S2000 F1000 M3
```

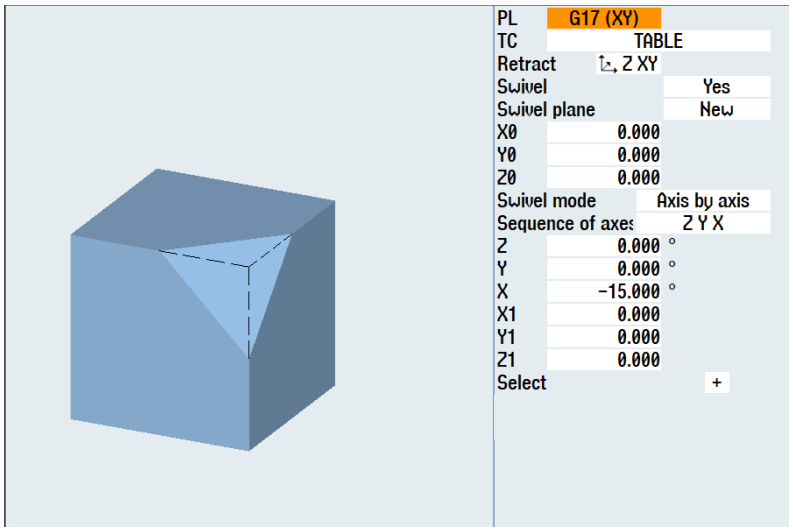


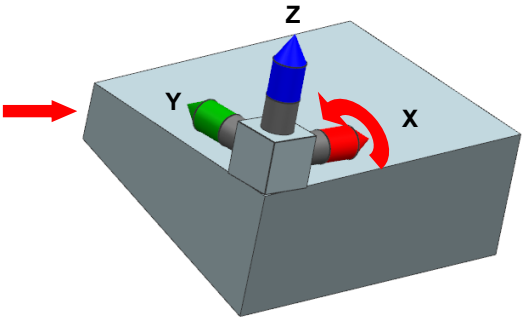
Face milling in the "**FACE_MILLING_INITIAL_SETTING**" block is programmed.





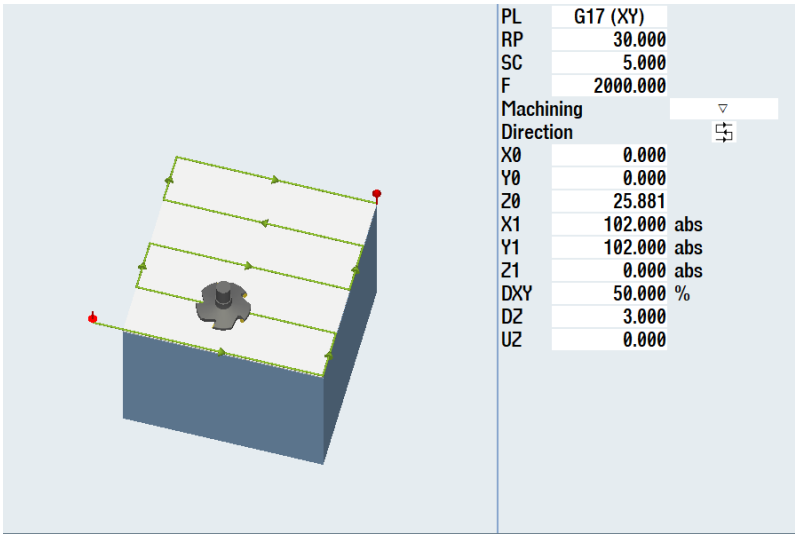
Swivel the plane to 15° in the "**SWIVEL_PLANE**" block.

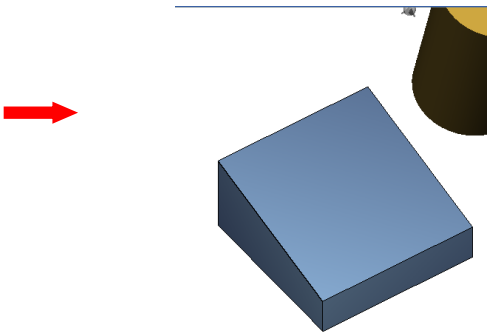




Notes:

The face cutting in the swivel plane follows. A protrusion >100 mm is programmed in "**X1**" and "**X2**" so that no edge remains.

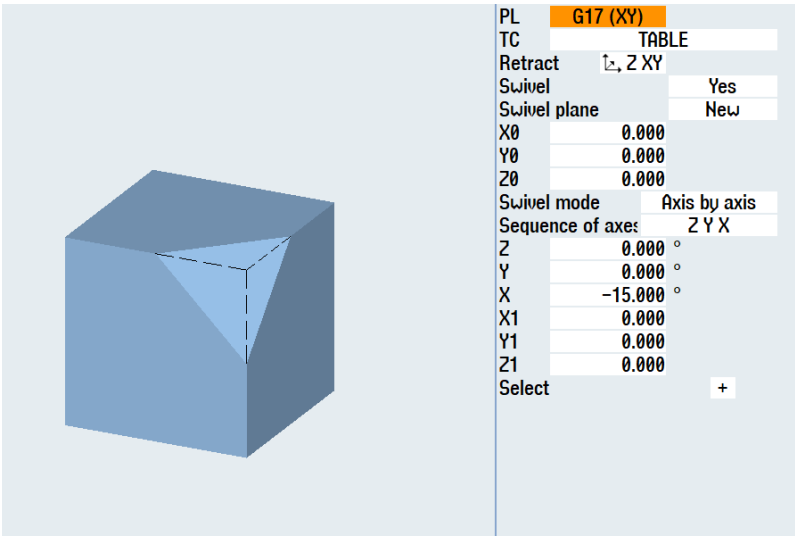


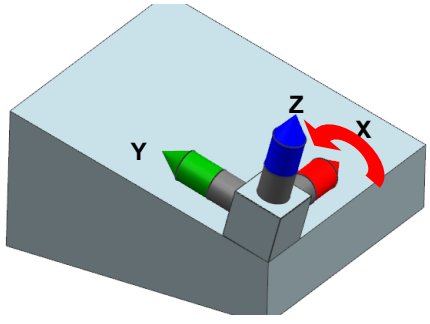


```
N120 SWIVEL
N130 CYCLE800(2, "TABLE", 200000, 27, 0, 0, 0, 0, 0, -15, 0, 0, 0, 1, 100, 1)¶
N140 End of group
N150 MILLING_OBLIQUE
N160 CYCLE61(30, 25.881, 5, 0, 0, 0, 102, 102, 3, 50, 0, 2000, 31, 0, 1, 11010)¶
N170 End of group
```

Swivel to 15° in the "**SWIVEL_PLANE**" block. A tool call is performed beforehand.

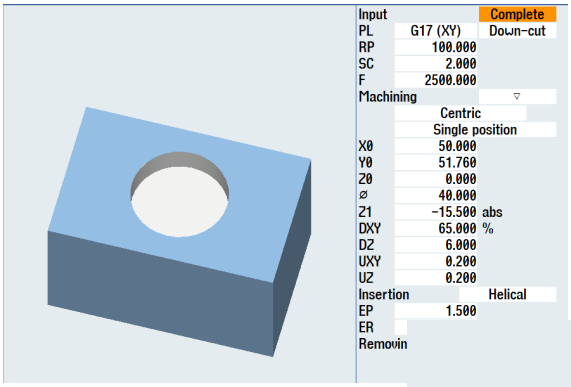
```
N190 T="ENDMILL_D16"
N200 M6
N210 D1
N220 S4000 F1800 M3
N230 CYCLE800(2,"TABLE",200000,27,0,0,0,0,0,-15,0,0,0,1,100,1)
```



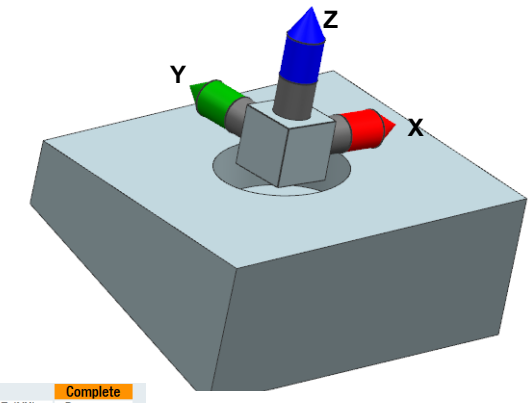


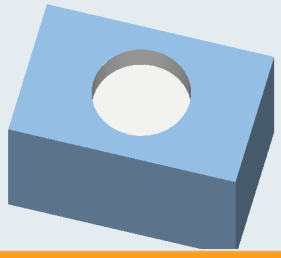
Notes:

The centered circular pocket is programmed in the "**MILLING_CIRCULAR_POCKET_CENTERED**" block.

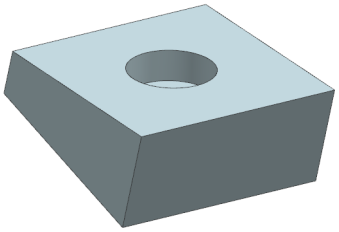


Input		Complete
PL	G17 (XY)	Down-cut
RP	100.000	
SC	2.000	
F	2500.000	
Machining		
	Centric	
	Single position	
X0	50.000	
Y0	51.760	
Z0	0.000	
⌀	40.000	
Z1	-15.500	abs
DXY	65.000	%
DZ	6.000	
UXY	0.200	
UZ	0.200	
Insertion		Helical
EP	1.500	
ER		
Removin		



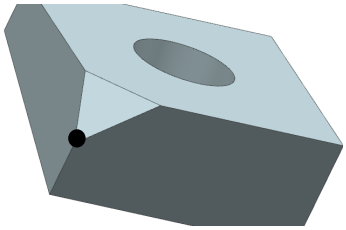


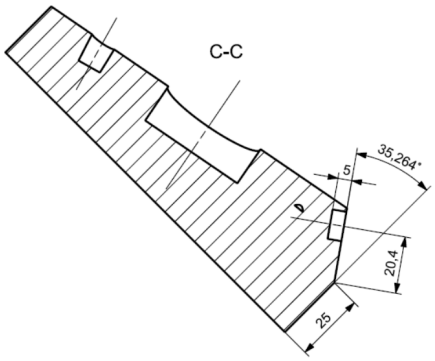
Input		Complete
PL	G17 (XY)	Down-cut
RP	100.000	
SC	2.000	
F	2500.000	
Machining		
	Centric	
	Single position	
X0	50.000	
Y0	51.760	
Z0	0.000	
⌀	40.000	
Z1	-15.500	abs
DXY	65.000	%
DZ	15.500	
UXY	0.200	
UZ	0.200	
Insertion		Helical
EP	1.500	
ER	6.000	

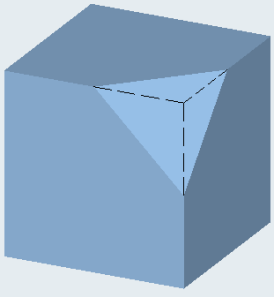


```
N250 MILLING_CIRULAR_POCKET
N260 POCKET4(100,0,2,-15.5,40,50,51.76,6,0.2,0.2,2500,1000,0,21,65,0,,6
N270 POCKET4(100,0,2,-15.5,40,50,51.76,15.5,0.2,0.2,2500,1000,0,22,65,0
N280 End of group
```

The oblique surface is programmed in the next step.
To do this, a swivel is made to a new machining plane.

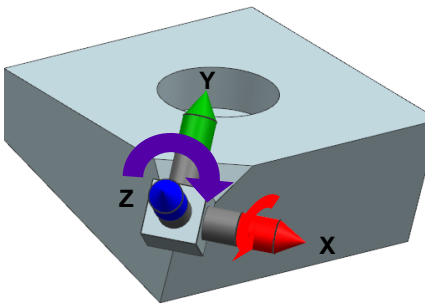






PL	G17 (XY)	
TC	TABLE	
Retract	Z XY	
Swivel		Yes
Swivel plane		New
X0	0.000	
Y0	0.000	
Z0	-25.000	
Swivel mode		Axis by axis
Sequence of axes		Z X Y
Z	-45.000	°
X	54.736	°
Y	0.000	°
X1	0.000	
Y1	0.000	
Z1	0.000	
Select		+

The degree value for "**X**" must be calculated.
(90°-35.264°= 54.736)



Notes:

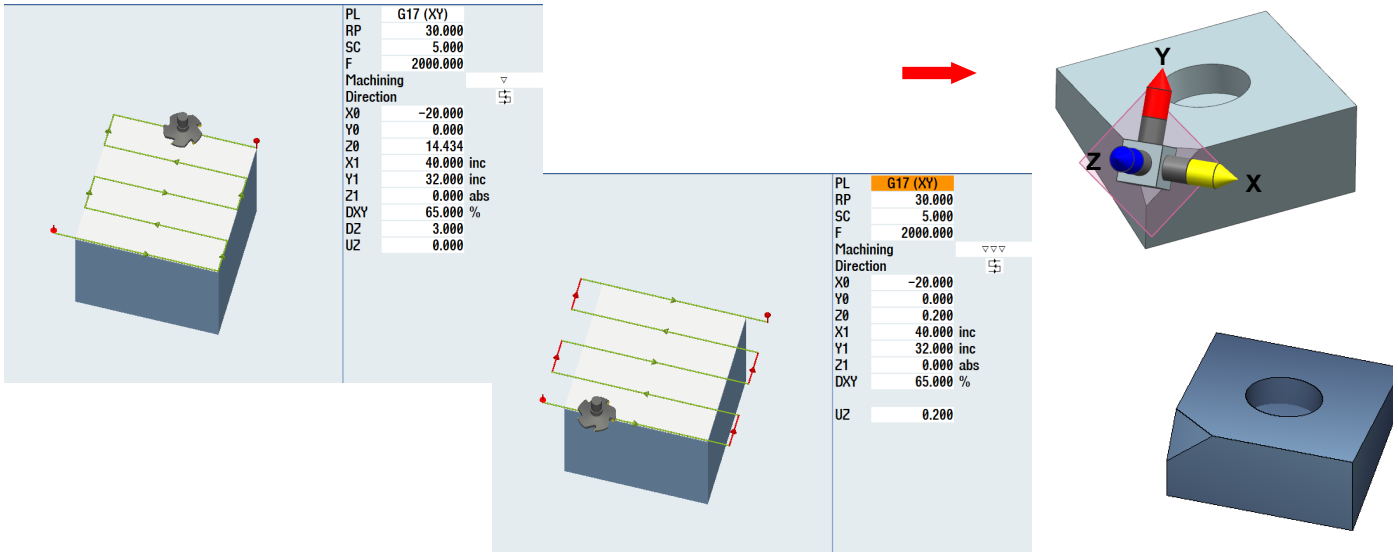
The first corner is programmed with the face milling cycles in the "MILLING_FIRST_CORNER" block.
Parameter "**Z0**" must be calculated.

Note: (Calculation of the "**Z0**" parameter)

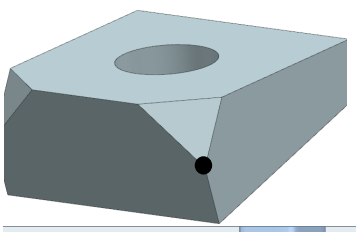
sin α = GK / HP

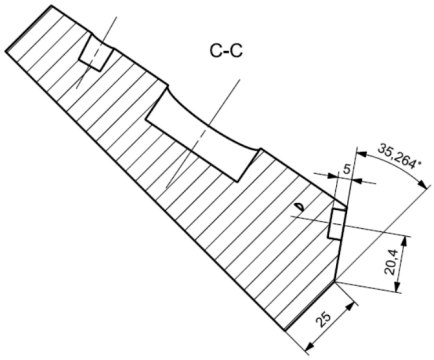
GK = sin 35.264 * 25
⇒ GK = **14.4336**

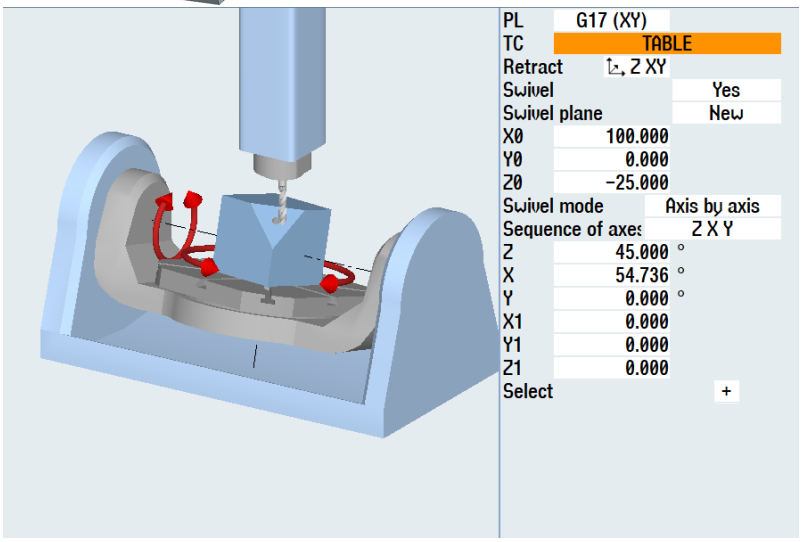
The values "X0", "X1", "Y0" and "Y1" specify the dimensions of the milling plane.

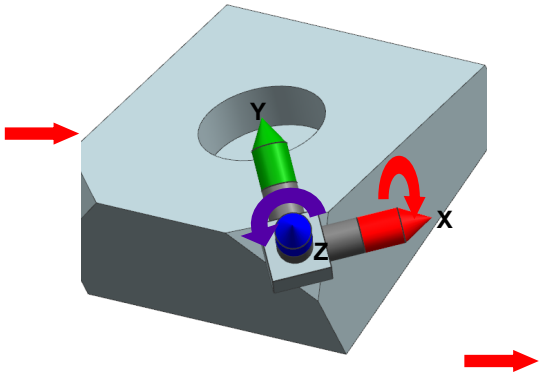


This is programmed in the "MILLING_SECOND_CORNER" block.
The coordinate system is programmed accordingly starting at this point.
The degree value for "X" must be calculated. (90°-35.264°= 54.736)







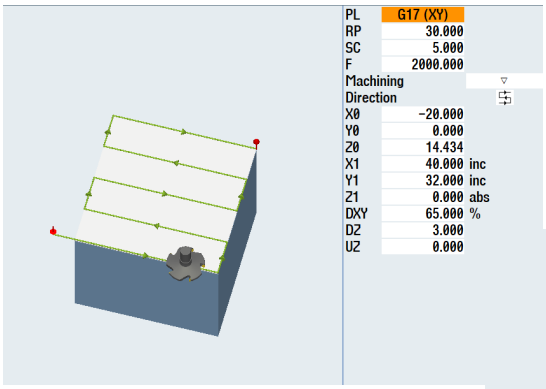


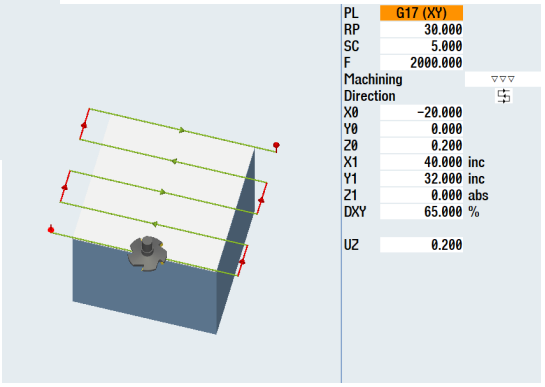
Notes:

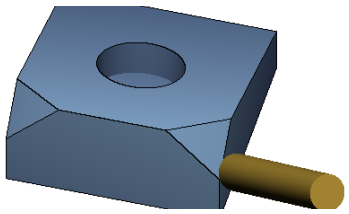
The inputs for the face milling are then made.
Parameter "**Z0**" must be calculated.

Note: (Calculation of the "**Z0**" parameter)

sin α = GK / HP
GK = sin 35.264 * 25 GK = **14.4336**

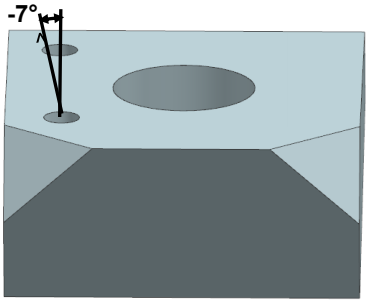




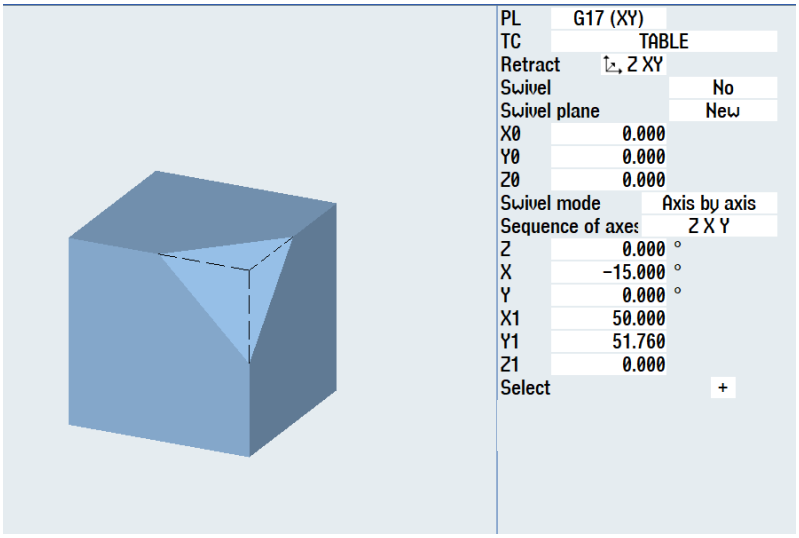


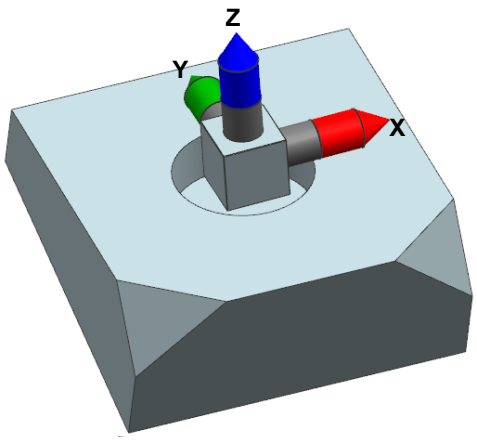
The circular pockets below (-7°) are programmed in the "**SWIVEL_PLANE**" block in the next step.

The selection is made in "**CYCLE800**".



No physical swiveling is performed for "**Swivel No**".
This swivel serves to swivel to a "theoretical plane".
The next swivel builds on this.





Es wird zuerst auf die Mitte des Werkstücks geschwenkt.

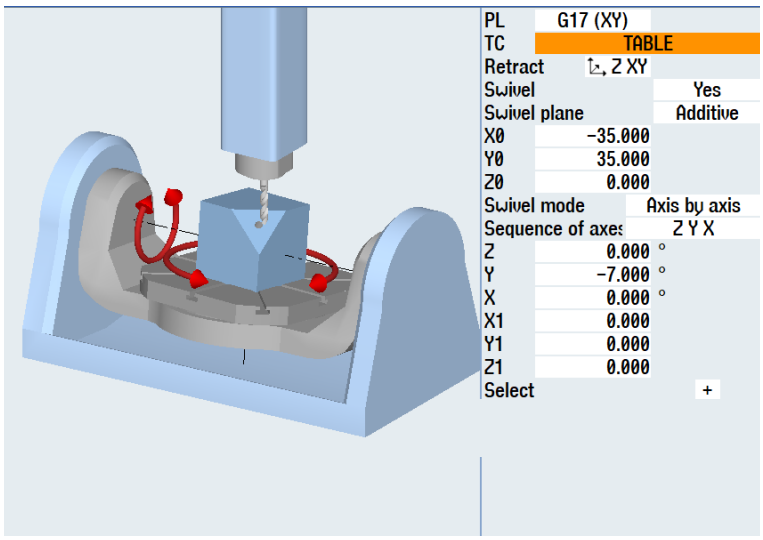
Notes:

"CYCLE800" is called again.

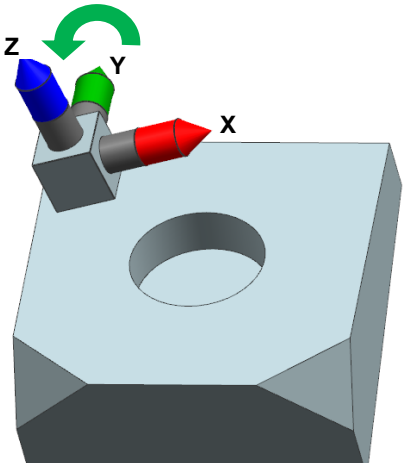
Schwenkebene	additiv
	neu
	additiv

A further one is now programmed additive on the previous theoretical swivel.

The degree (-7) and the position of the first circular pocket are programmed.



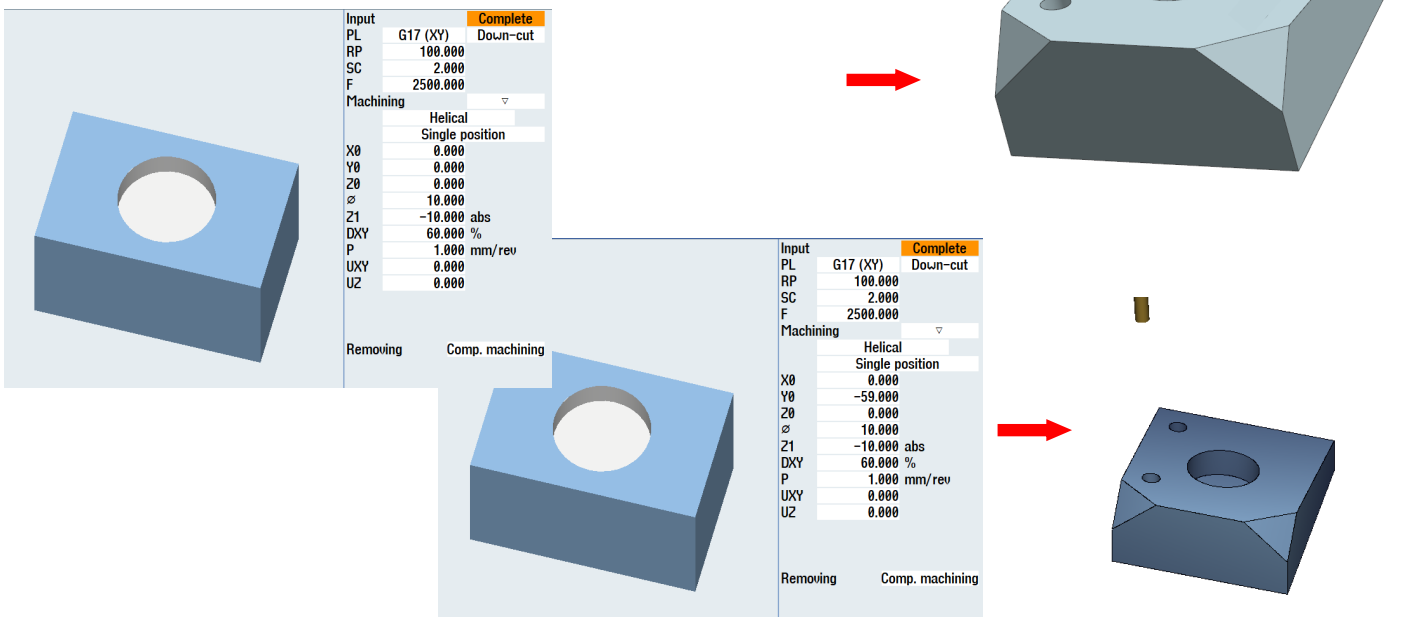
PL	G17 (XY)
TC	TABLE
Retract	Z XY
Swivel	Yes
Swivel plane	Additive
X0	-35.000
Y0	35.000
Z0	0.000
Swivel mode	Axis by axis
Sequence of axes	Z Y X
Z	0.000 °
Y	-7.000 °
X	0.000 °
X1	0.000
Y1	0.000
Z1	0.000
Select	+




```
N430 SWIVEL
N440 CYCLE800(2, "TABLE", 220000, 39, 0, 0, 0, 0, -15, 0, 50, 51.76, 0, 0, 100, 1)¶
N450 CYCLE800(2, "TABLE", 200001, 27, -35, 35, 0, 0, -7, 0, 0, 0, 0, 1, 100, 1)¶
N460 End of group
```

The two circular pockets are programmed with a new tool in the "CIRCULAR_POCKETS_-7°" block.

```
N10 T="ENDMILL_D8"
N20 M6
N30 D1
N220 S4000 F1800 M3
```



Input	Complete
PL	G17 (XY) Down-cut
RP	100.000
SC	2.000
F	2500.000
Machining	
	Helical
	Single position
X0	0.000
Y0	0.000
Z0	0.000
⌀	10.000
Z1	-10.000 abs
DXY	60.000 %
P	1.000 mm/rev
UXY	0.000
UZ	0.000
Removing	Comp. machining

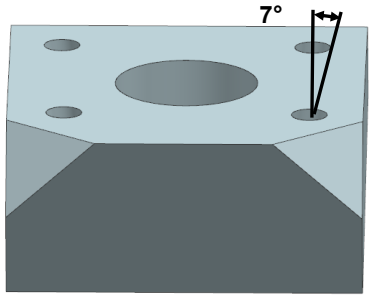
Input	Complete
PL	G17 (XY) Down-cut
RP	100.000
SC	2.000
F	2500.000
Machining	
	Helical
	Single position
X0	0.000
Y0	-59.000
Z0	0.000
⌀	10.000
Z1	-10.000 abs
DXY	60.000 %
P	1.000 mm/rev
UXY	0.000
UZ	0.000
Removing	Comp. machining

Die Position der zweiten Kreistasche wird direkt im Zyklus programmiert.

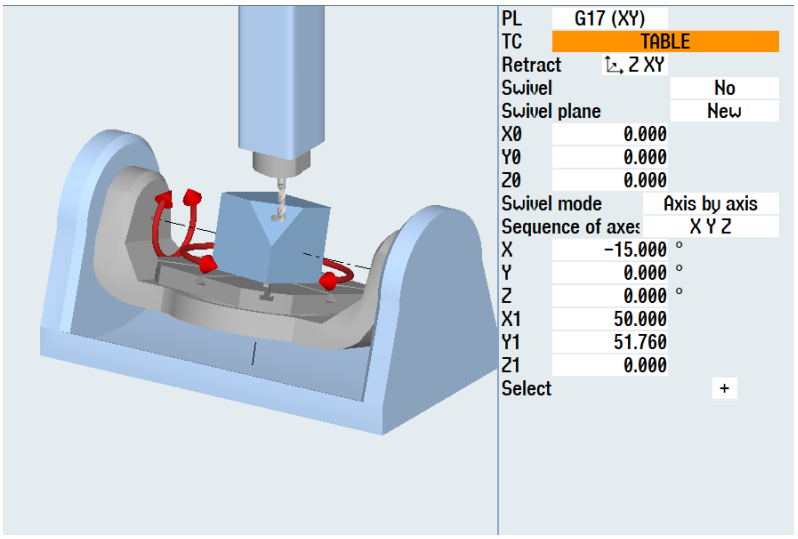
Notes:

The circular pockets below (**7°**) are programmed.

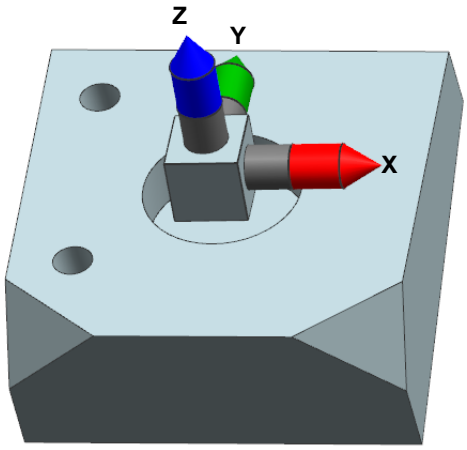
Swivel	No
Swivel plane	No / Yes



A swivel is made to the workpiece center.



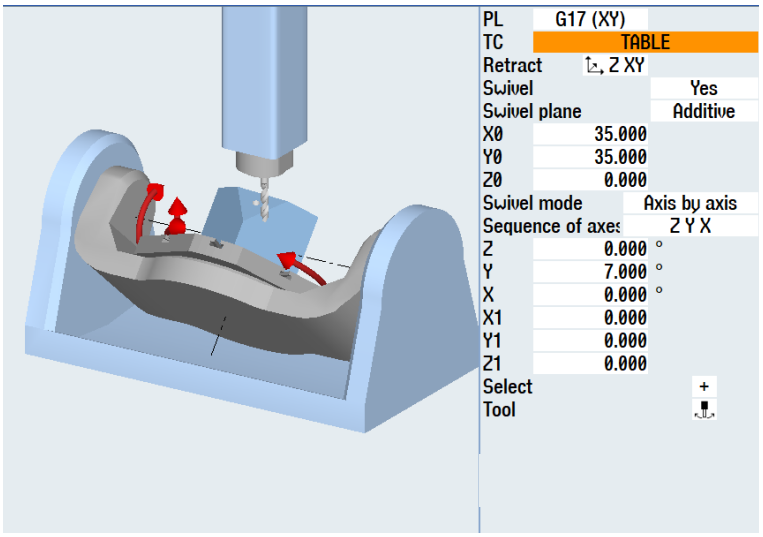
PL	G17 (XY)
TC	TABLE
Retract	Z XY
Swivel	No
Swivel plane	New
X0	0.000
Y0	0.000
Z0	0.000
Swivel mode	Axis by axis
Sequence of axes	X Y Z
X	−15.000 °
Y	0.000 °
Z	0.000 °
X1	50.000
Y1	51.760
Z1	0.000
Select	+



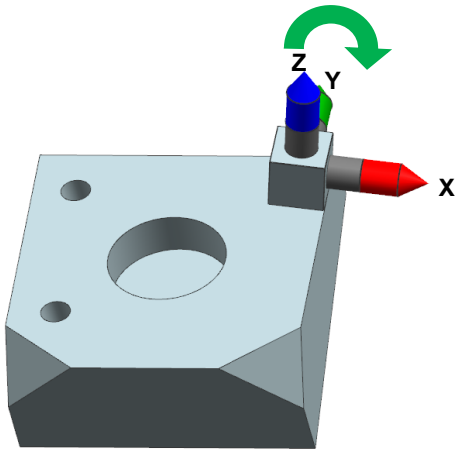
"CYCLE800" is called again.

A swivel is made "**additive**" to **(7°)**.

Swivel	Yes
Swivel plane	Additive



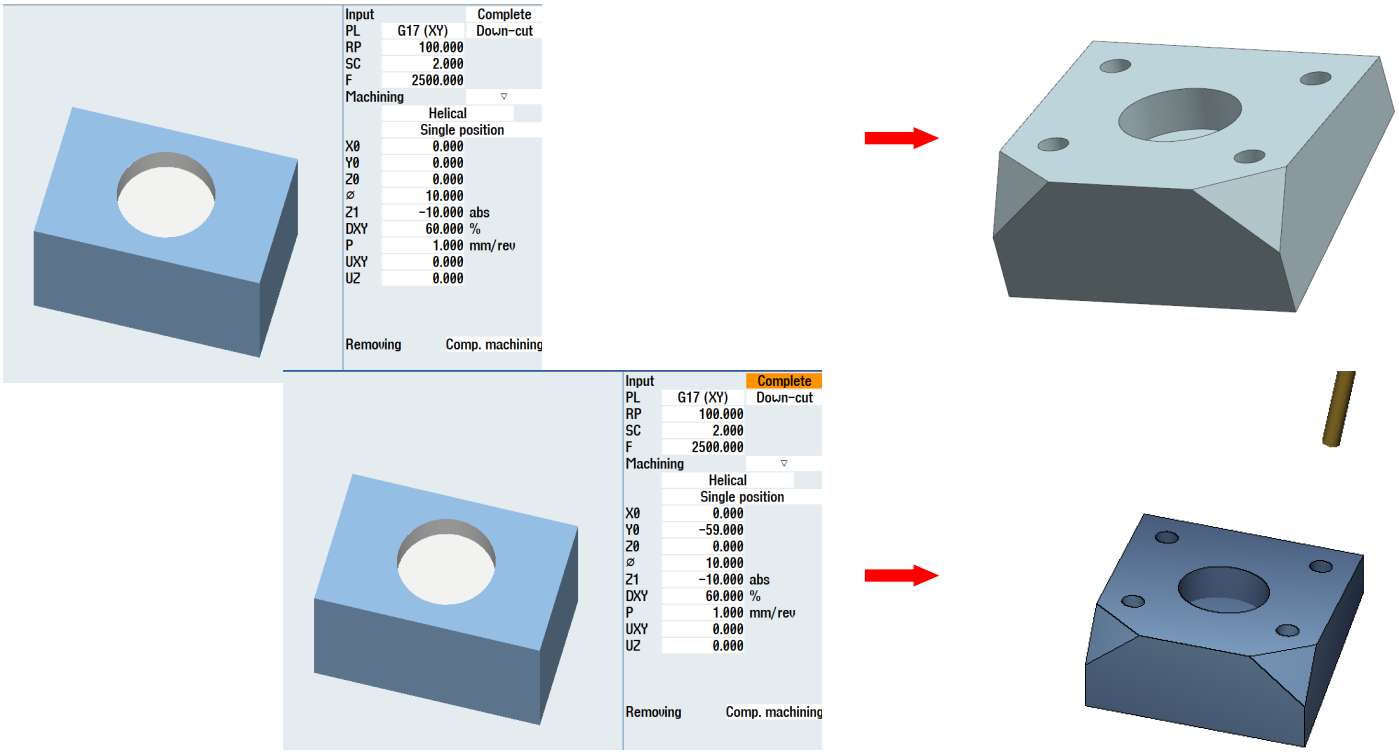
PL	G17 (XY)
TC	TABLE
Retract	Z XY
Swivel	Yes
Swivel plane	Additive
X0	35.000
Y0	35.000
Z0	0.000
Swivel mode	Axis by axis
Sequence of axes	Z Y X
Z	0.000 °
Y	7.000 °
X	0.000 °
X1	0.000
Y1	0.000
Z1	0.000
Select	+
Tool	




```
N520 SWIVEL
CYCLE800(2, "TABLE", 220000, 57, 0, 0, 0, -15, 0, 0, 50, 51.76, 0, 0, 100, 1)¶
CYCLE800(2, "TABLE", 200001, 27, 35, 35, 0, 0, 7, 0, 0, 0, 0, 1, 100, 1)¶
N530 Ende Block
```

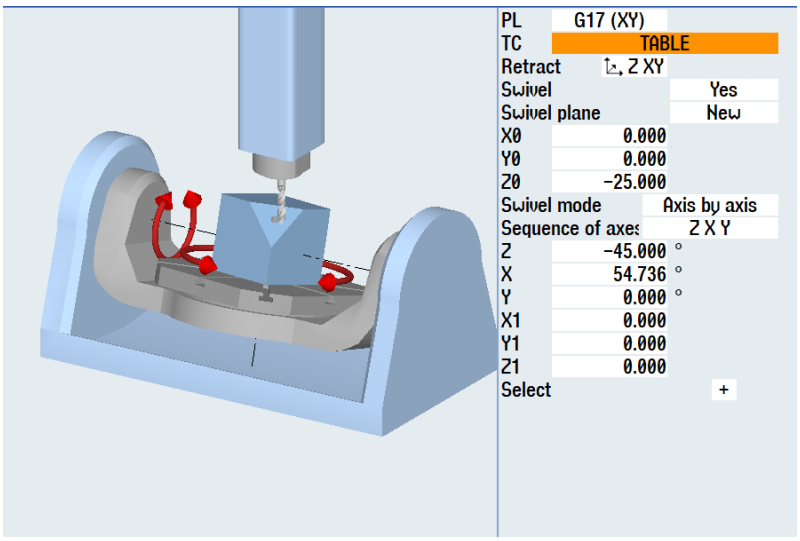
Notes:

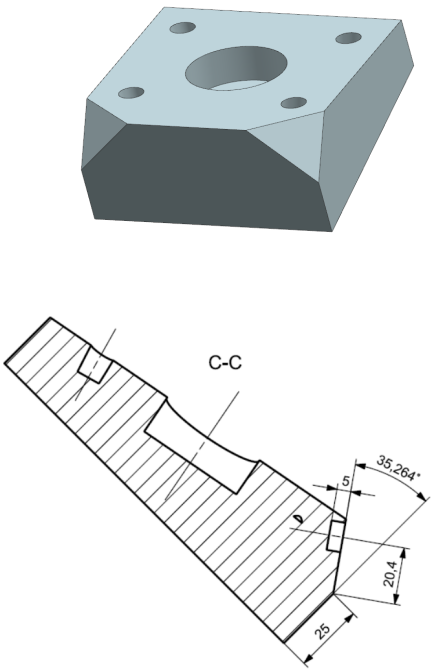
The two circular pockets are programmed.



Die Position der zweiten Kreistasche wird direkt im Zyklus porgrammiert.

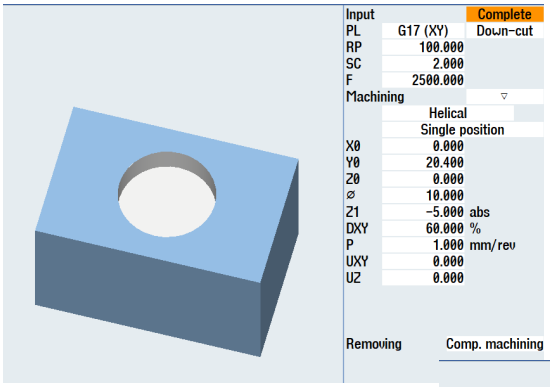
A swivel is made to the first corner to produce the circular pocket.

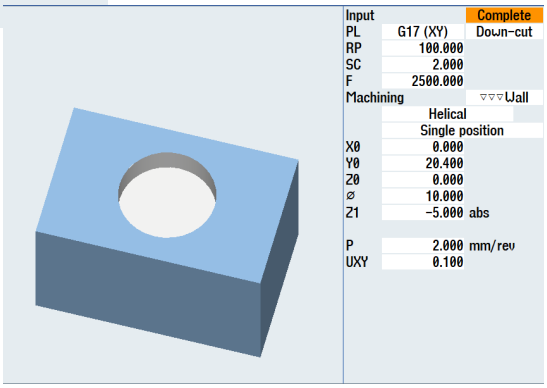


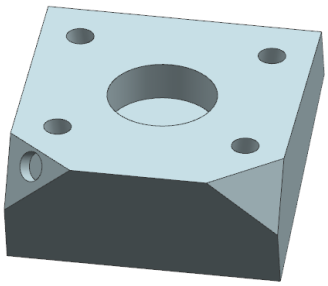


Notes:

The circular pocket is programmed in the next step.

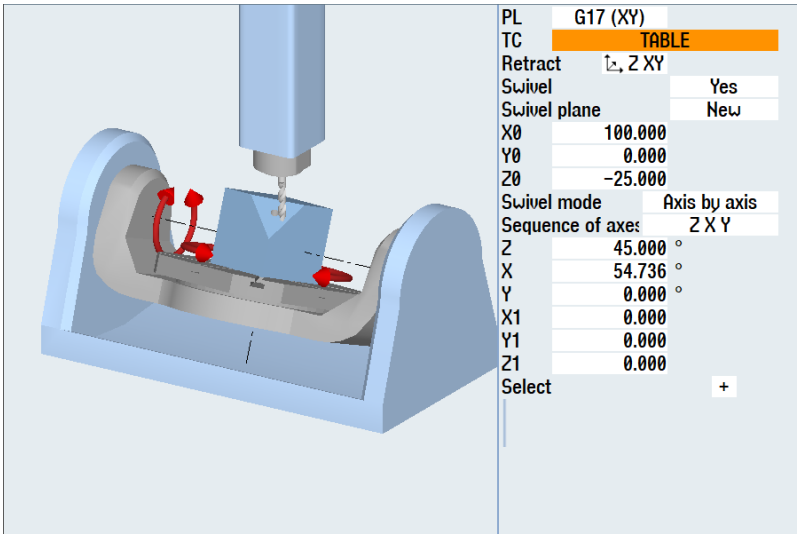


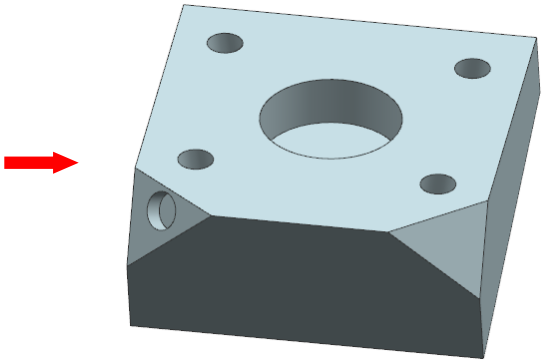


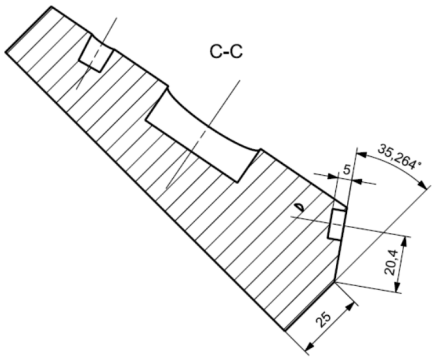


Die Position der Tasche wird im Zyklus programmiert.

A swivel is made to the first corner to produce the circular pocket.

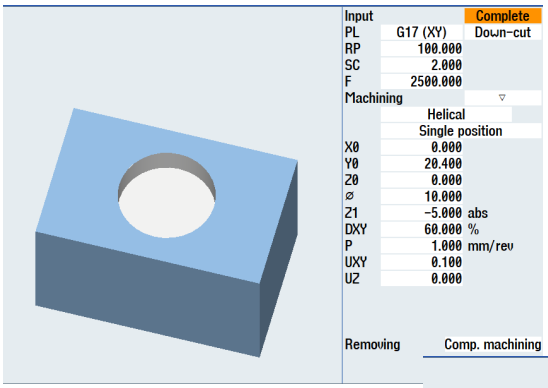


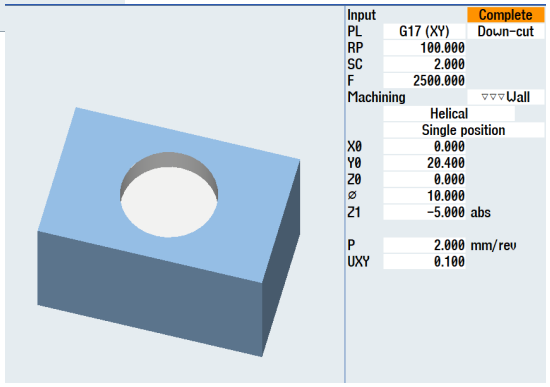




Notes:

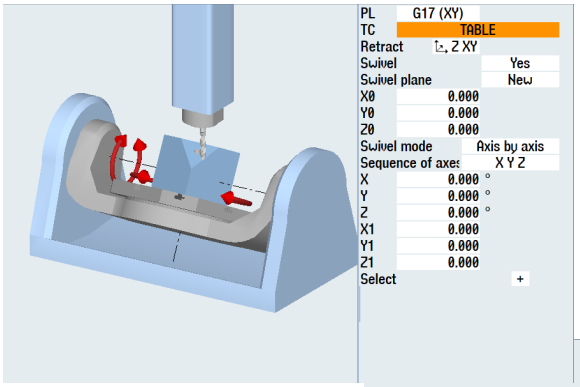
The circular pocket is programmed in the next step.

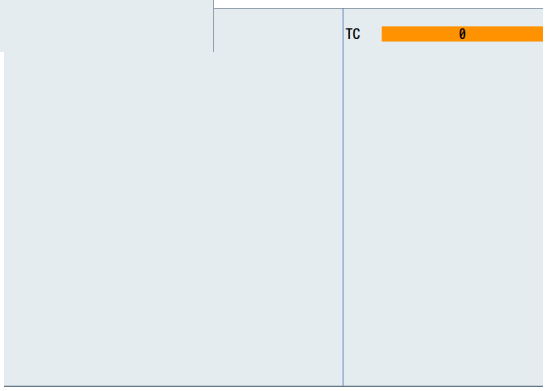




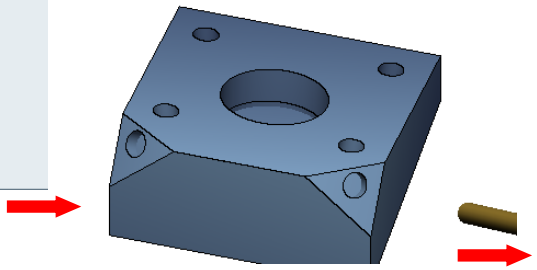
Die Position der Tasche wird im Zyklus programmiert.

A swivel is made to the initial setting in the "**END**" block.





The "**Tool Carrier**" is deselected.



Das Programm ist fertig erstellt.

Notes:

9th example, cylinder

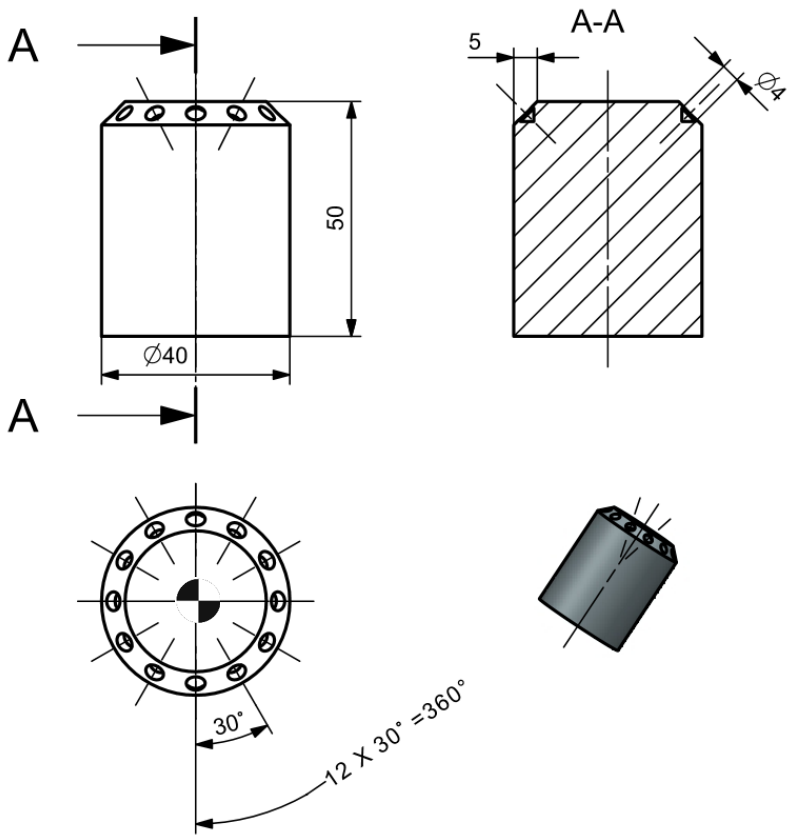
-

Task:

The blank for the program example has the dimensions Ø40x50 mm

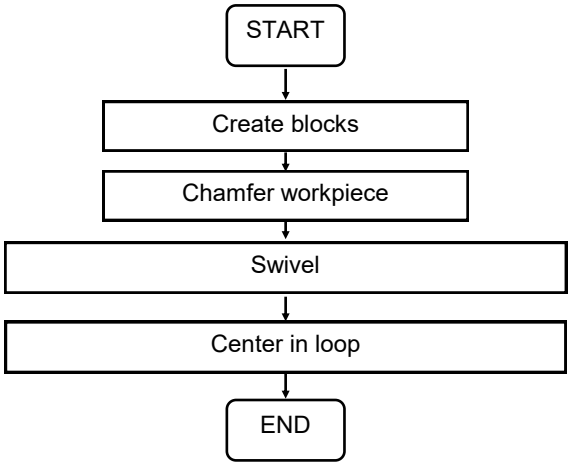
⇒ Programming in programGUIDE
⇒ Chamfering with centering drill 90°
⇒ 12 centerings on chamfer

Drawing:

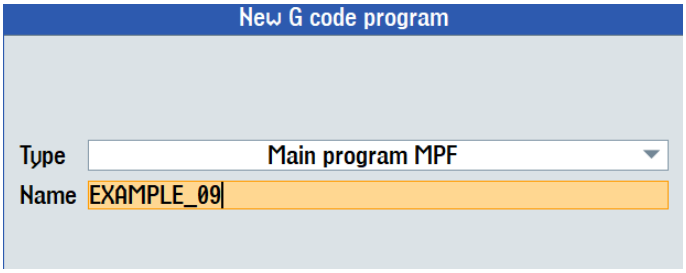


Notes:

Flow diagram:



After creating a new G-code program,



Describe a block structure for this G-code program.

Function	Block name
Start commands	START
1st chamfering, cylinder	CHAMFER
Centerings on chamfer	LOOP_CENTERING
End	END

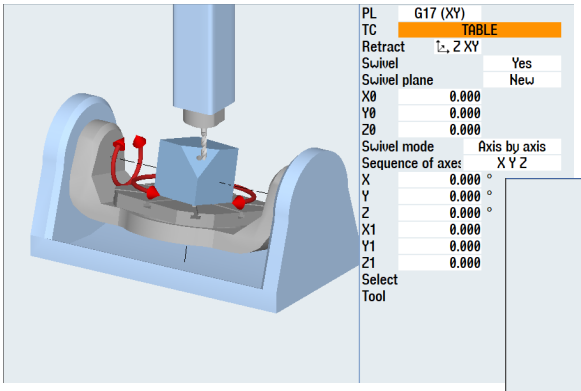
Notes:

The program header in the "**START**" block is programmed in the first step.

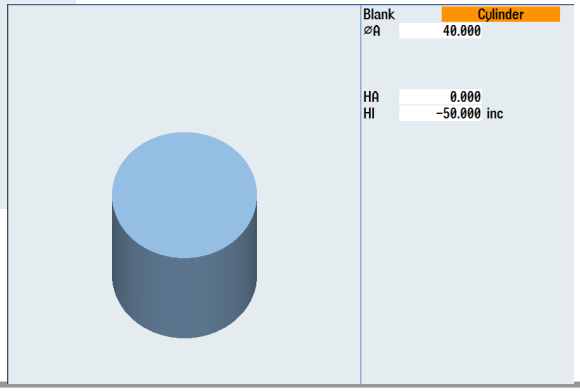
```
G54 G90 G17 G40
T="CENTERDRILL 12"
M6
S5000 F1000 M3
CYCLE800
(2,"TABLE",200000,57,0,0,0,0,0,0,0,0,1,100,1)
WORKPIECE(,"C",,"CYLINDER",0,0,-50,-80,40)
```

```
START
G54 G90 G17 G40¶
T="CENTERDRILL 12"¶
M6¶
S5000 F1000 M3¶
CYCLE800(2, "TABLE", 200000, 57, 0, 0, 0, 0, 0, 0, 0, 0, 1, 100, 1)
WORKPIECE(, "C", , "CYLINDER", 0, 0, -50, -80, 40)¶
```

Travel to initial setting.



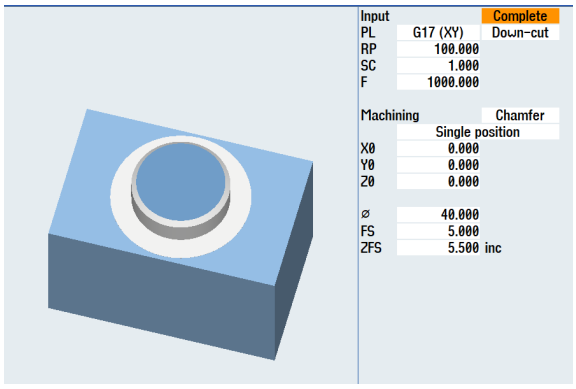
Blank description as

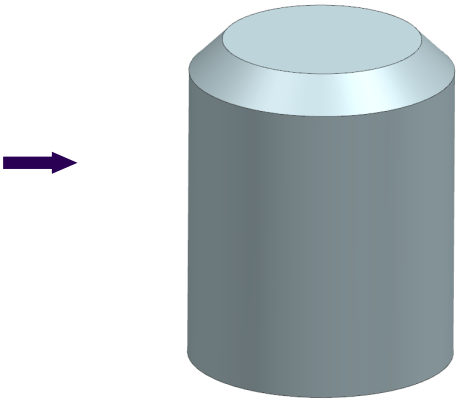


cylinder.

The chamfer is programmed with the "**Spigot**" cycle.

```
G0 X0 Y0
CYCLE77(100,0,1,,5,40,0,0,0.5,0.1,0.1,1000,1000,0,5,6,5,5.5,100,1,101)
```





```
CHAMFER
G0 X0 Y0¶
CYCLE77(100, 0, 1, , 5, 40, 0, 0, 0.5, 0.1, 0.1, 1000, 1000, 0, 5, 6, 5, 5.5, 100, 1, 101)¶
End of group
```

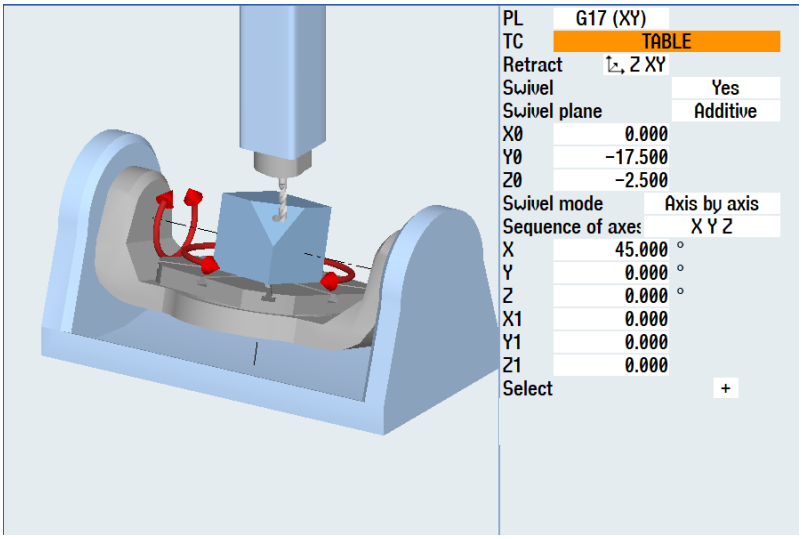
Notes:

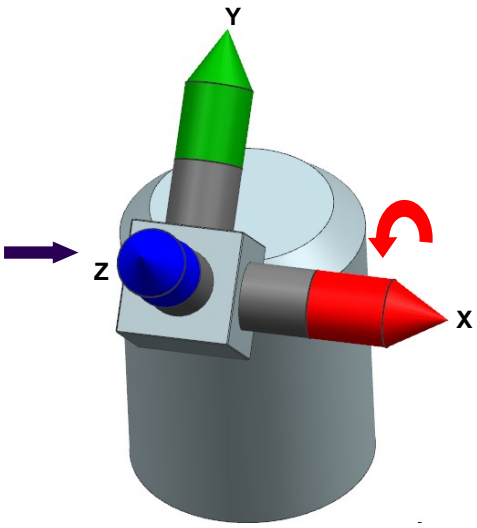
A mark is programmed first in the "**LOOP_CENTERING**" block.

```
MARK1:
```

In the loop, "**CYCLE800**" is called with

The position should switch by 30° after each loop pass.

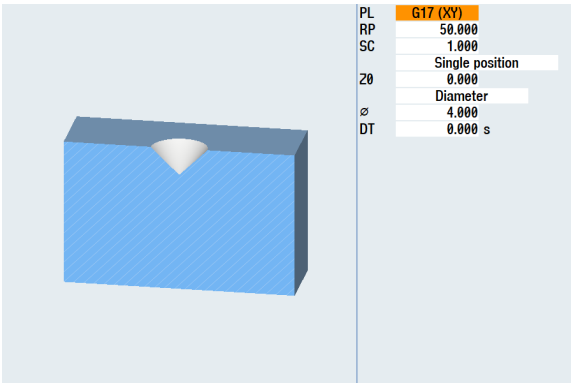




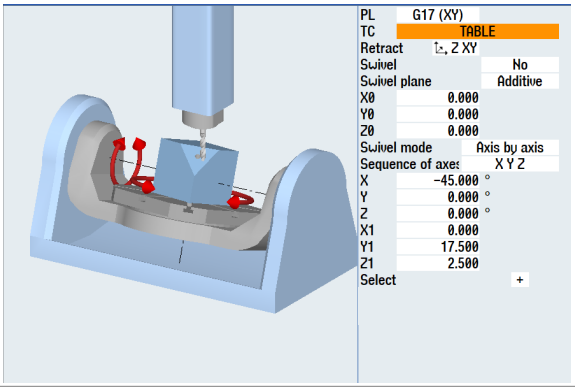
Geschwenkt wird auf Mitte der Fase um 45°Grad.

The hole centering

```
G0 X0 Y0 Z50
CYCLE81(50,0,1,4,,0,10,1,11)
```



and the new call of "**CYCLE800**" with positioning of the axes follow.

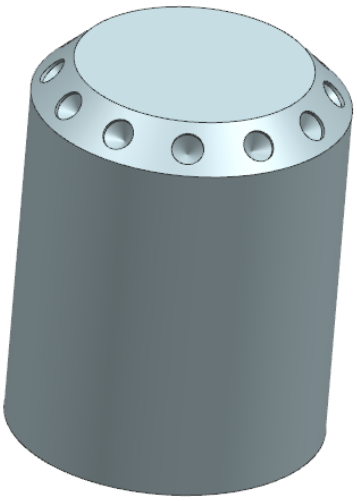


Notes:

The additive offset by 30° and the call how often this rotation within the marks should occur follow.

```
AROT Z30
MARK2:
REPEAT MARK1 MARK2 P11.
```

```
CYCLE800(2,"TABLE",200000,57,0,0,0,0,0,0,0,0,1,100,1)
CYCLE800(2,"0",200000,57,0,0,0,0,0,0,0,0,1,,1)
M30
```



In the "END" block, "CYCLE800" is programmed again in the initial setting and the "Tool Carrier" is deselected.

```
END
CYCLE800(2, "TABLE", 200000, 57, 0, 0, 0, 0, 0, 0, 0, 0, 1, 100, 1)¶
CYCLE800(2, "0", 200000, 57, 0, 0, 0, 0, 0, 0, 0, 0, 1, , 1)¶
M30¶
```

Das Programm ist fertig erstellt.

10th example, turning on the tool

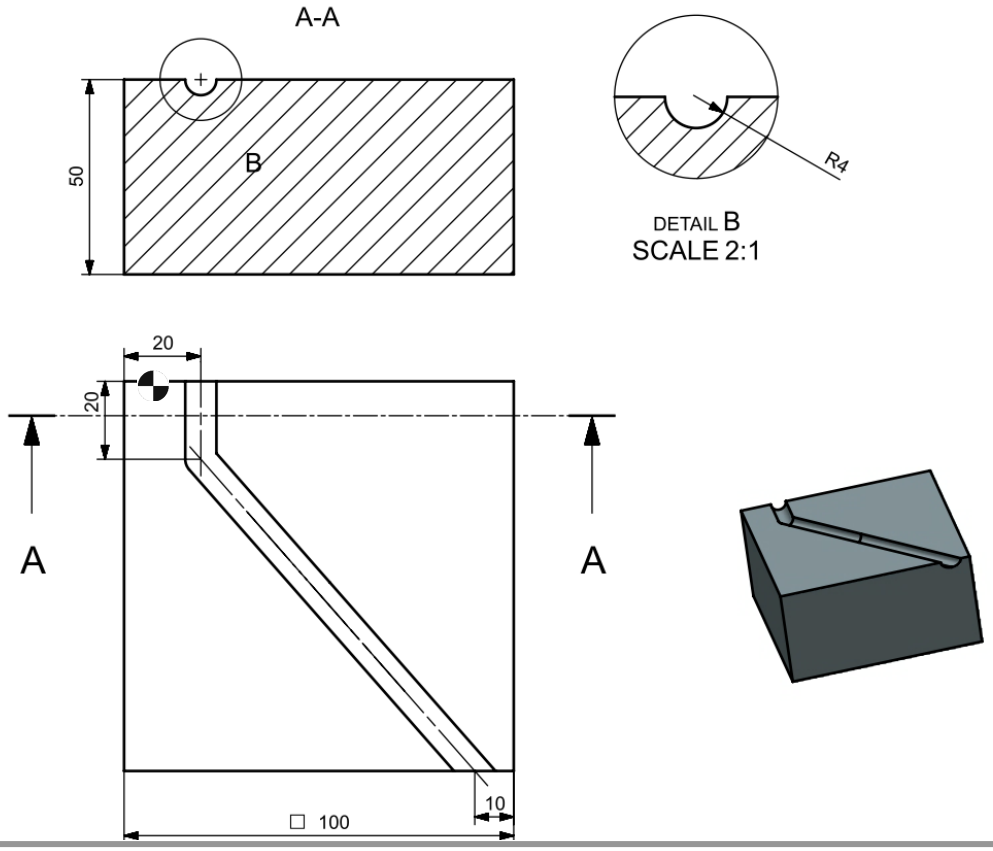
Task:

The blank for the program example has the dimensions 100x100x20 mm

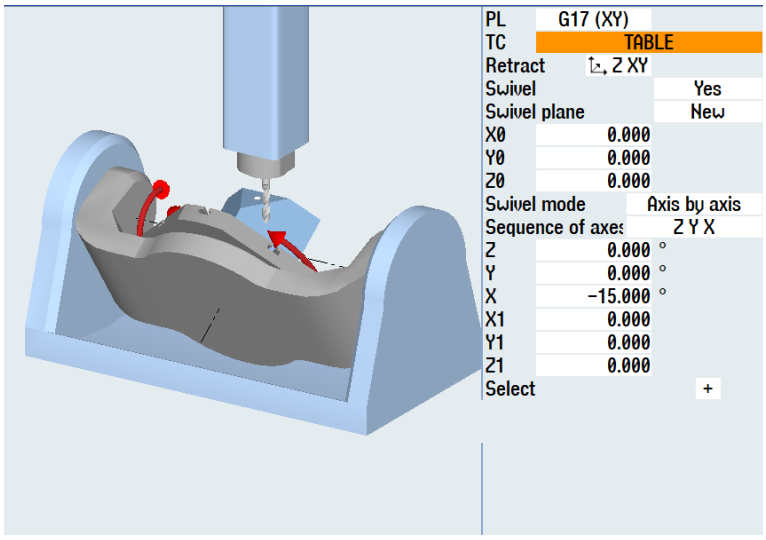
⇒ A groove is to be produced with ball mill diameter 8
⇒ The program is to be programmed in G-code
⇒ Set the tool in X and Y each by 20°, and retain this position during the subsequent milling
⇒ Subsequent initial setting

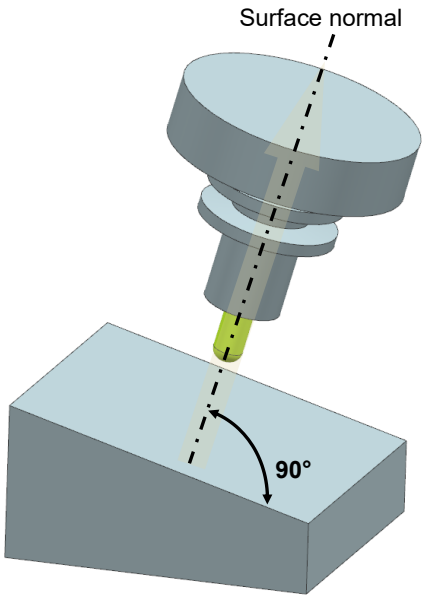
Notes:

Drawing:



The tool orientation is always perpendicular to the machining plane after swiveling with "**CYCLE800**".

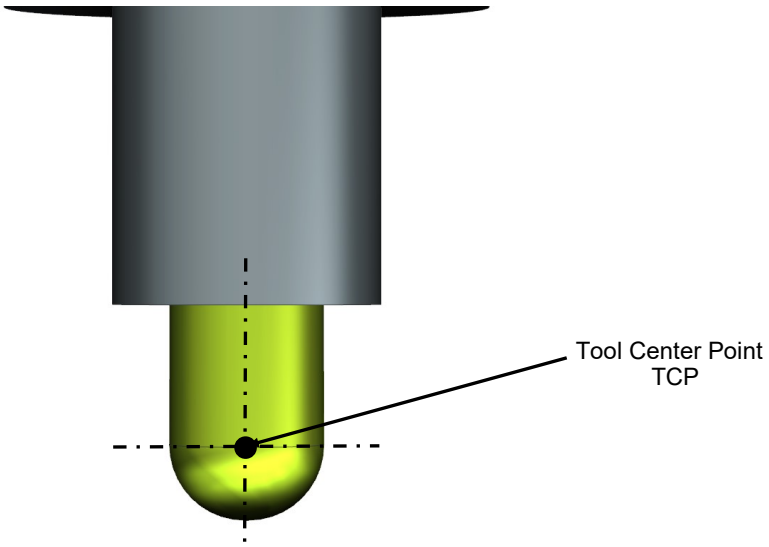




Notes:

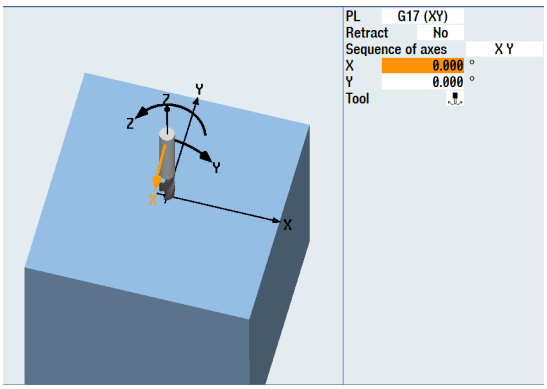
When machining with a ball mill, it is important that the tool is not perpendicular to the machining plane, because the ball mill does not then cut theoretically, because the speed is zero at the contact point.

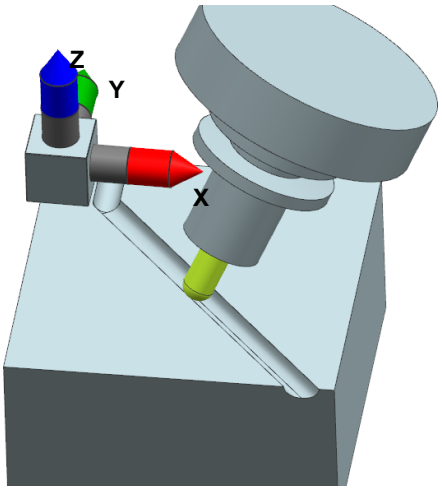
The measured point for a ball mill, the so-called "**T**OOL-**C**ENTER-**P**OINT" (TCP), should always be measured at the ball center point.



Once the ball mill has been measured in this way, it can be swiveled arbitrary at the point or "set".
In the simulation, only the external diameter of the tool is represented as cutter.

After pressing 





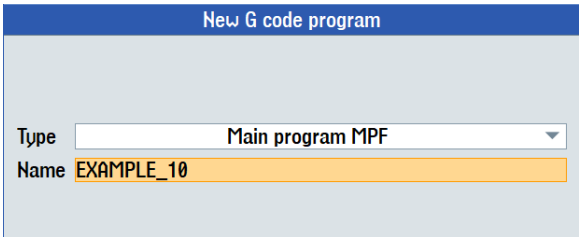
the tool can be set at the "**X**" and "**Y**" axes.

Important:
"CYCLE800" must be called before calling the "Turn-On Tool" cycle.
The coordinate system is **not swiveled** during "Turn-On Tool".

Es verändert sich nur die Orientierung des Werkzeugs bezogen zur Werkstückoberfläche.

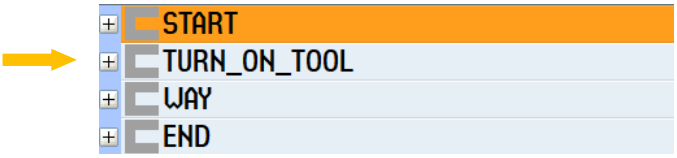
Notes:

After creating a new program,



the blocks are programmed.

Function	Block name
Start commands	START
Turn-on tool	TURN_ON_TOOL
Way commands	WAY
End commands	END

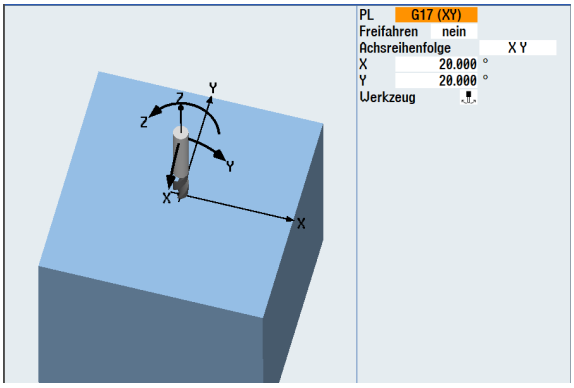


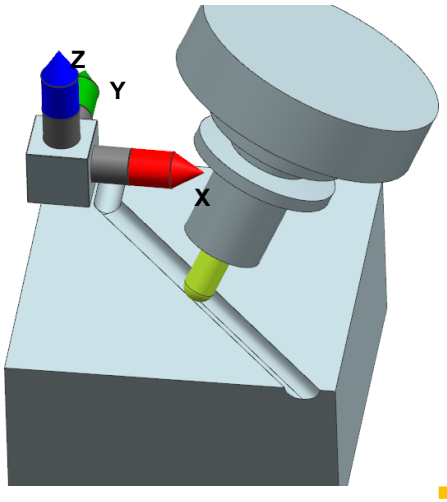
The program header is programmed in the "START" block.

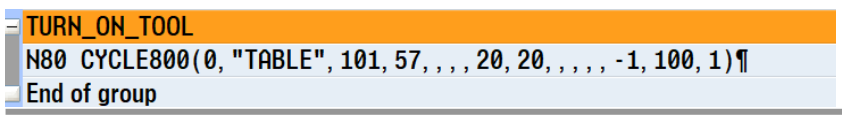
```
N10 G17 G64 G94 G90
N20 T="BALL_END_CYL_D8"
N30 M6
N40 G90 S8000 F1000 M3 M8
N50 CYCLE800(4,"TABLE",200000,57,0,0,0,0,0,0,0,0,1,,1)
G54
N70 WORKPIECE(,"",,"BOX",112,0,-20,-80,100,100,0,0)
```

The tool is then turned on in the "TURN_ON" block

```
N80 CYCLE800(0,"TABLE",101,57,,,,20,20,,,,,-1,100,1)
```



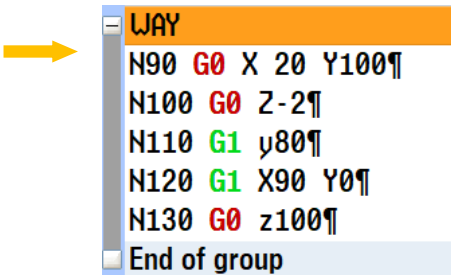




Notes:

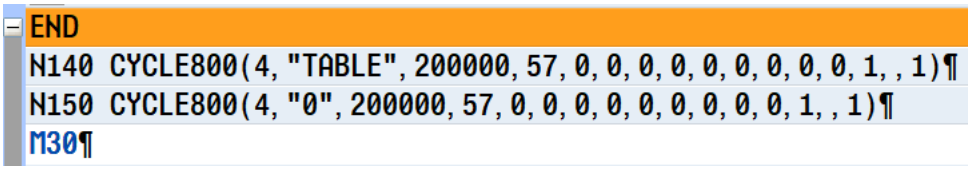
and the positions programmed in the "**WAY**" block.

```
N90 G0 X 20 Y100
N100 G0 Z-2
N110 G1 y80
N120 G1 X90 Y0
N130 G0 z100
```

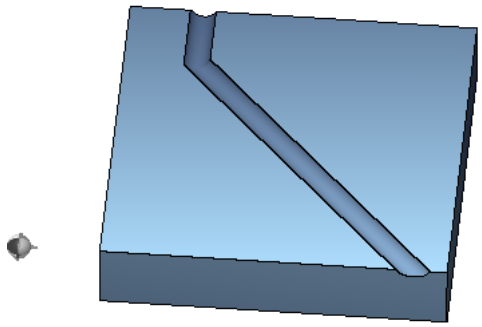


The program end is programmed in the "**END**" block.

```
N140 CYCLE800(4,"TABLE",200000,57,0,0,0,0,0,0,0,0,1,,1)
N150 CYCLE800(4,"0",200000,57,0,0,0,0,0,0,0,0,1,,1)
M30
```



The program is now fully created.



Notes:

M102: END

Notes: