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# CNC Machinery

Module 6: Programming by using  
EMCO CNC machines

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PREPARED BY

**IAT Curriculum Unit**

August 2009

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# Module 6: Programming by using EMCO CNC machines

## Module Objectives:

After the completion of this module, you will be able to:

1. Describe the main parts of the EMCO CNC turning and milling machines.
2. Operate the EMCO CNC turning and milling machines
3. Identify the main reference points on the EMCO CNC turning and milling machines.
4. Identify the main control keys and their functions.
5. Transfer turning and milling NC programs created by MTS simulator and execute them on the EMCO CNC machines.

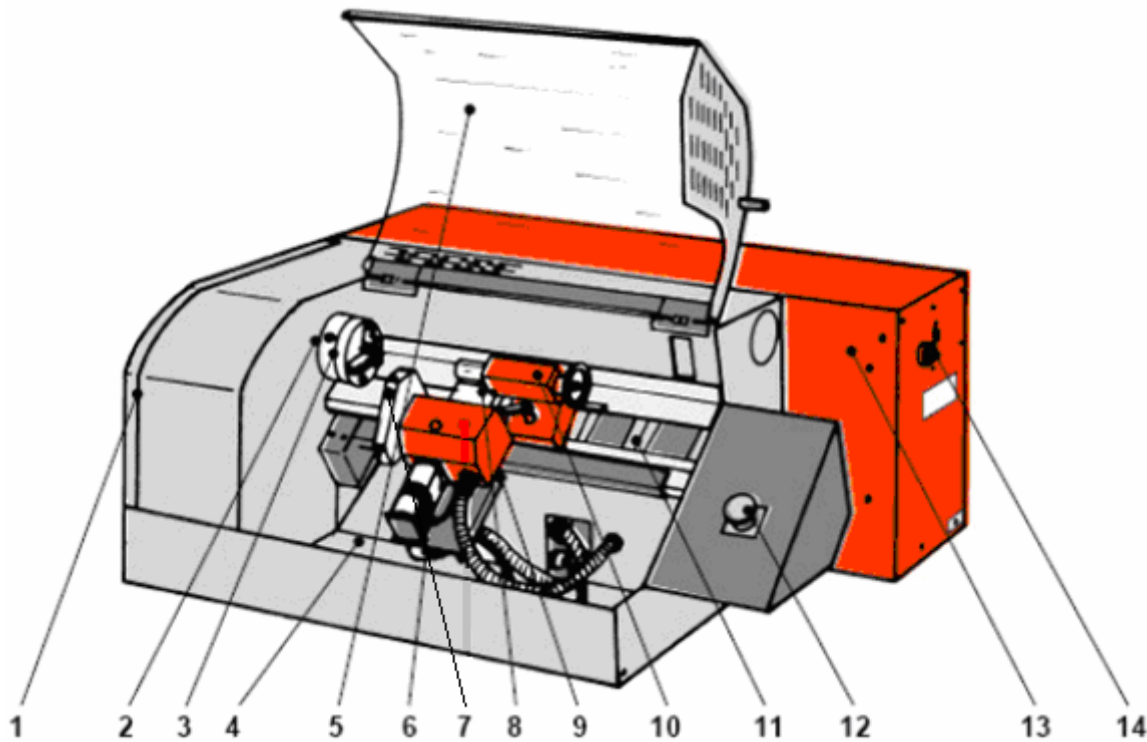
## Module Contents

	Title	Page No.
1	The main Parts and the machine reference points of the EMCO Turn 55.	3
2	The main Parts and the machine reference points of the EMCO Mill 55.	7
3	The main console and Keys of the EMCO CNC machines.	10
4	The procedures to create a simple turning program by using MTS Simulator then transfer and execute it on the EMCO Turn 55.	12
5	The procedures to create a simple milling program by using MTS Simulator then transfer and execute it on the EMCO Mill 55.	25

## 1. The main parts and the machine reference points of the EMCO Turn 55.

### 1.1 The main parts of the machine

The table below shows the main parts of the EMCO Turn 55 CNC machine shown in Fig. 6.1.



**Fig. 6.1:** Parts of the EMCO Turn 55 machine.

1. Wheel Cover	8. Cross slide
2. Headstock	9. Longitudinal slide
3. Three-jaw chuck	10. Tailstock
4. Chip Tray	11. Machine bed
5. Chip Guard	12. Emergency OFF key
6. Step Motor	13. E-cabinet
7. Tool Turret	14. Key switch

### 1. 2 The machine reference points

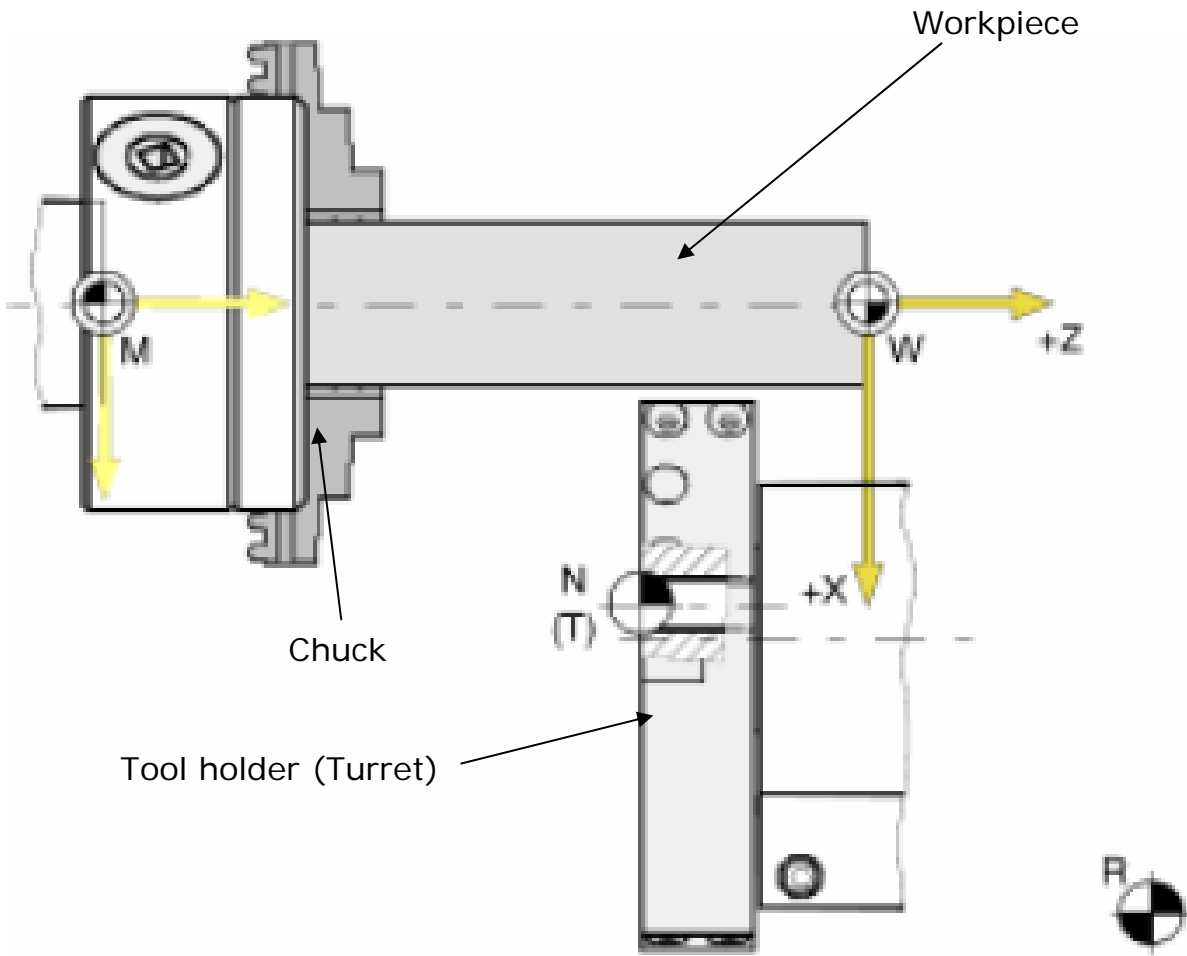


Fig. 6.2: Shows the points at the machine.

#### Machine zero point (M)

The machine zero point is the origin of the coordinate system set by the manufacturer and **cannot** be changed. See Fig. 6.2

The machine zero point is identified by the letter **M** and the symbol shown in Fig.6.3

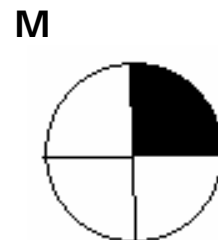


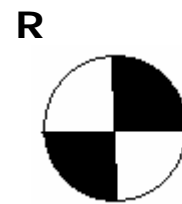
Fig. 6.3: Shows the symbol used to identify the machine zero point

### Reference point (R)

The reference point is a fixed point on the machine. It is used to **calibrate** the measuring system.

The reference point **SHOULD** be approached after switching the machine on or off to communicate the exact distance between the points (**M**) and (**N** (**T**)) to the controller.

The reference point is identified by the letter **R** and the symbol shown in Fig.6.4.



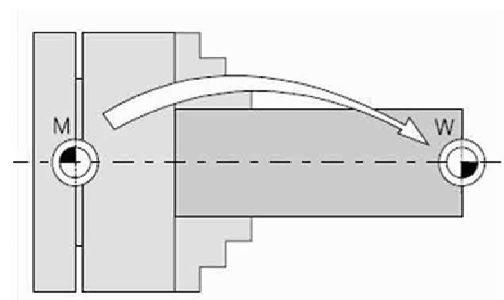
**Fig. 6.4:** Shows the symbol used to identify the reference point

### Workpiece zero point (W)

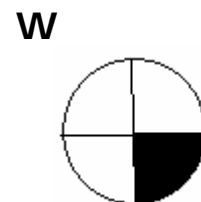
The workpiece zero point can be set by the user.

Once you set a workpiece zero point, the origin of the coordinate system is displaced from **M** to **W** as shown in Fig. 6.5a.

The workpiece zero point is identified by the letter **W** and the symbol shown in Fig.6.5b.



**Fig. 6.5a:** Shows the displacement of the origin of the coordinate system from **M** to **W**



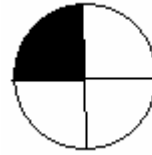
**Fig. 6.5b:** Shows the symbol used to identify the workpiece zero point

**Tool holding fixture (N (T)):**

The tool holding fixture reference point lies on the face of the tool holder (turret) as shown in Fig. 6.2

Tool holding fixture (N (T)) point is identified by the letter (N (T)) and the symbol shown in Fig.6.6.

(N (T))



**Fig. 6.6:** Shows the symbol used to identify the tool holding fixture point

## 2. The main parts and the machine reference points of the EMCO Mill 55.

### 2.1. The main parts of the machine

The table below shows the main parts of the EMCO mill 55 CNC machine shown in Fig. 6.7.

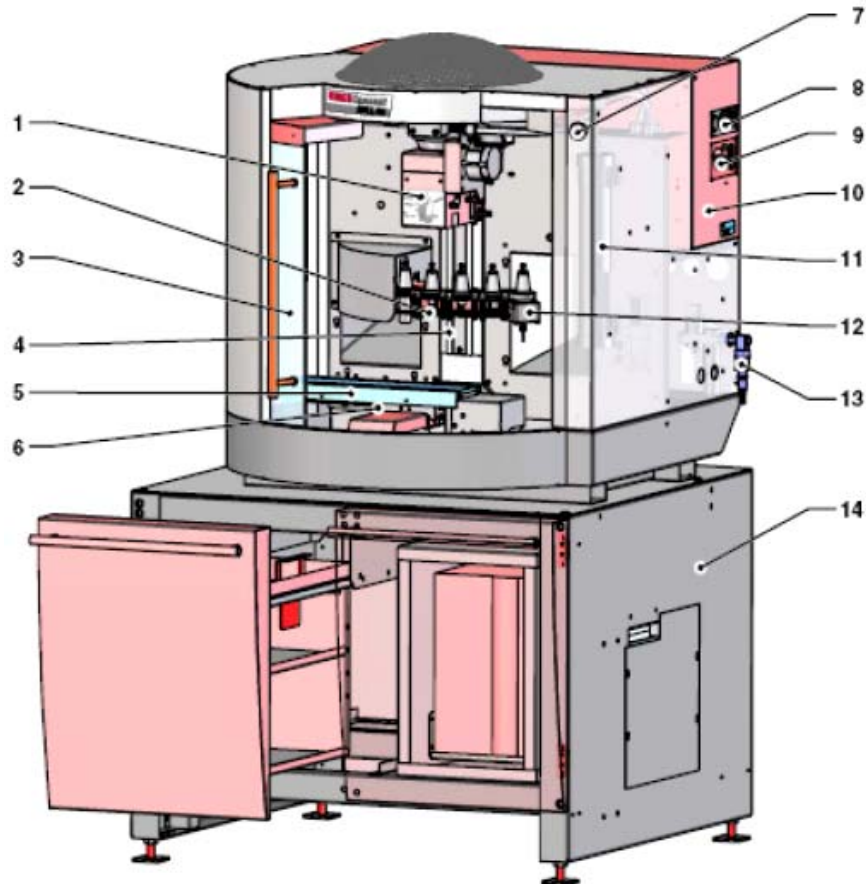


Fig. 6.7: Parts of the EMCO mill 55 CNC machine.

1	Milling head	8	Name plate
2	8 tool changer	9	Key switch
3	Chip guard door	10	E-cabinet
4	Z-slide	11	Machine lamp
4	Milling table with T-slots	12	High spindle speed unit
6	X – Y compound table	13	Pneumatic maintenance unit
7	Emergency OFF key	14	Machine base

## 2.2.The machine reference points:

### 1.Machine Zero point (M)

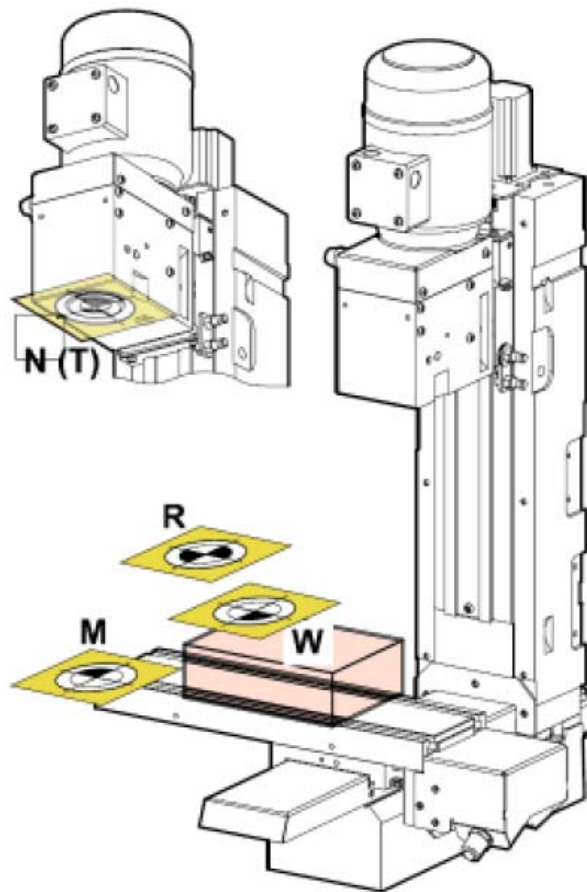
The machine zero point lies on the surface of the milling table on the left front edge. The machine zero point is the origin of the coordinate system set by the manufacturer and **cannot** be changed. See Fig. 6.8

### 2.Reference point (R)

Same function as in turning. The location of **R** is shown in fig.6.8

### 3.Workpiece zero point (W)

Same function as in turning. The location of **W** is shown in fig.6.8

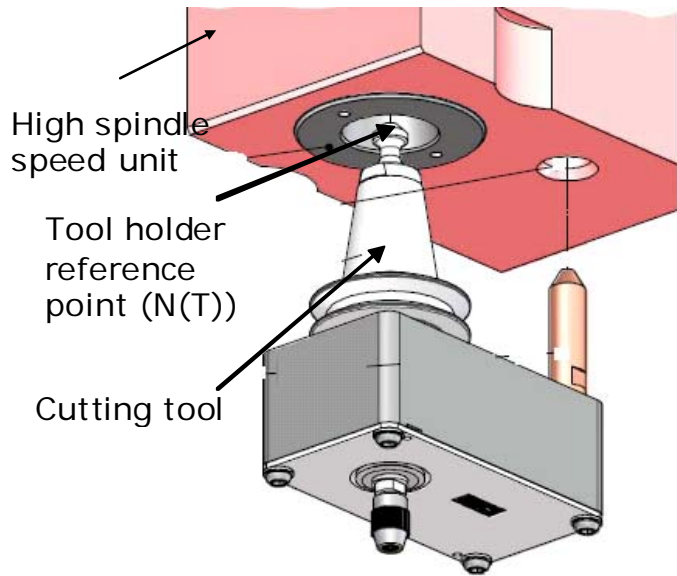


**Fig. 6.8:** Shows the machine points



#### 4.Tool holder reference point (N(T))

The tool holding fixture reference point lies exactly in the rotary axis at the front of milling spindle nose. The tool length is described from this point as shown in Fig. 6.9



**Fig. 6.9:** Shows the position of the tool holder reference point.

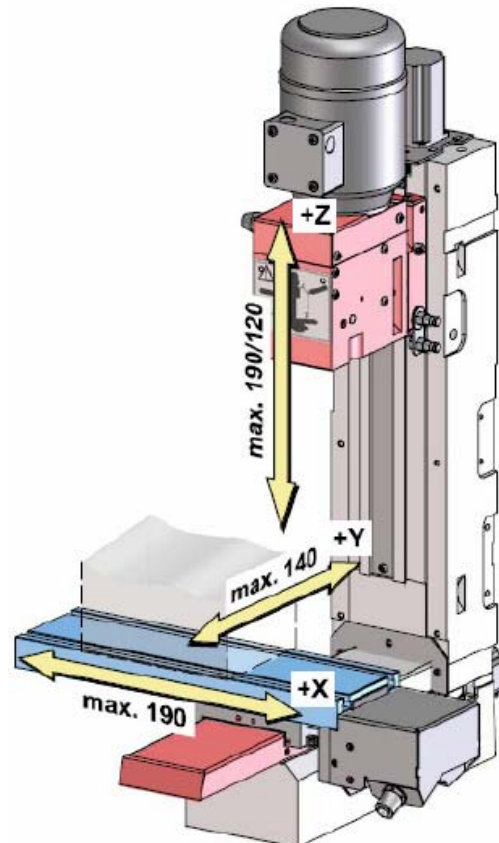
#### 2.3 Coordinate system

The working area is shown in Fig. 6.10 and the coordinates are as follows:

X-axis: max. 190 mm

Y-axis: max. 140mm

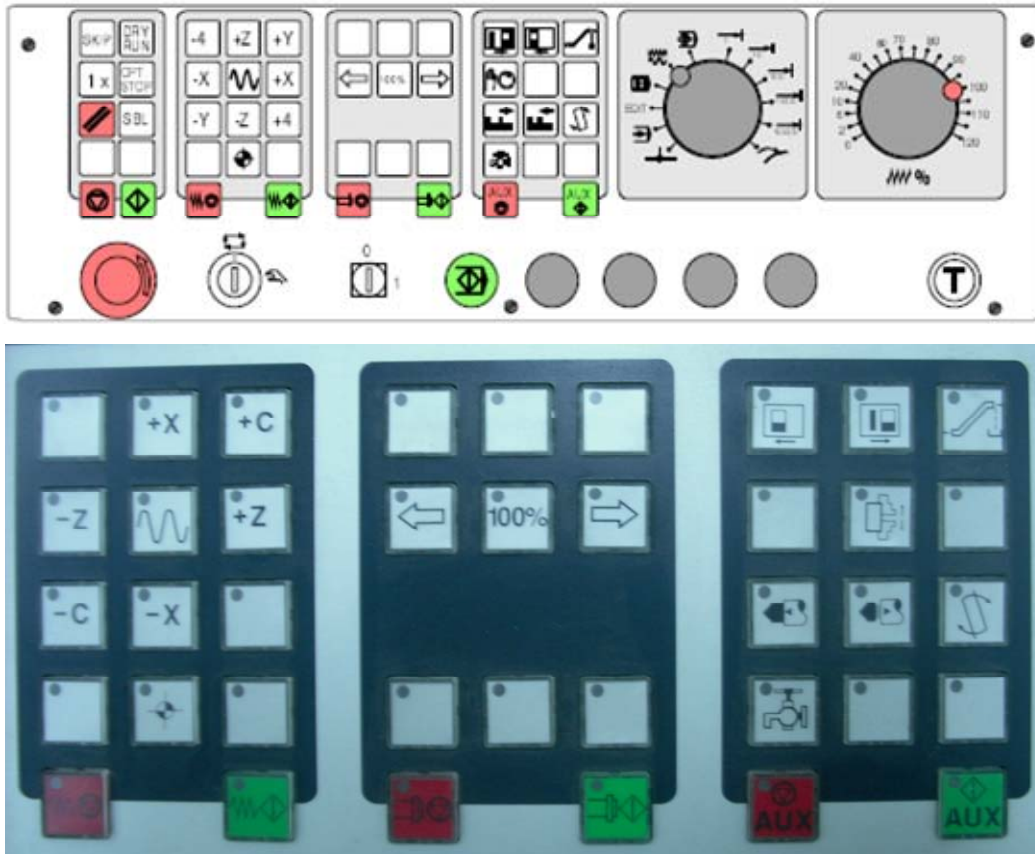
Z-axis: max.190mm for standard machine and a max. of 120mm For the machine with a tool changer)



**Fig. 6.10:** shows the milling working area

### 3. The main console and Keys of the EMCO CNC machines.

#### 3.1. The console of the EMCO CNC machine is shown in Fig. 6.11



**Fig. 6.11:** Shows The control board of the EMCO CNC machine

#### 3.2. The main control keys and their functions.



: Used to **Skip** any block that will not be executed



: Used to **test run** the program before executing it.



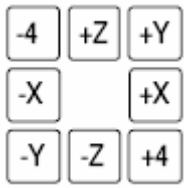
: **Reset** is used to reset the system in case of any fault



: **Program stop** is used to stop the program



: **Program start** is used to start and execute the program



: **Manual axis movement** is used to move the machine manually in all axis



: **Rapid**



: **Approaching the reference point in all axes** is used when automatically referencing the machine



: **Open / Close door** is used to open/close the chip guard



: **Open / Close clamping device** is used to open/close the chuck



: **Swivel tool turret** is used to rotate the tool turret manually



: **Coolant On / Off** is used to activate the coolant



: **Feed/Rapid feed override switch** is recommended to be switched between 40 and 50 percent.



: **Mode selector** is used to select between different modes like reference, automatic, edit, Jog and MDI.

#### 4. The procedure to create a simple turning program by using MTS Simulator then transfer and execute it on the EMCO Turn 55.

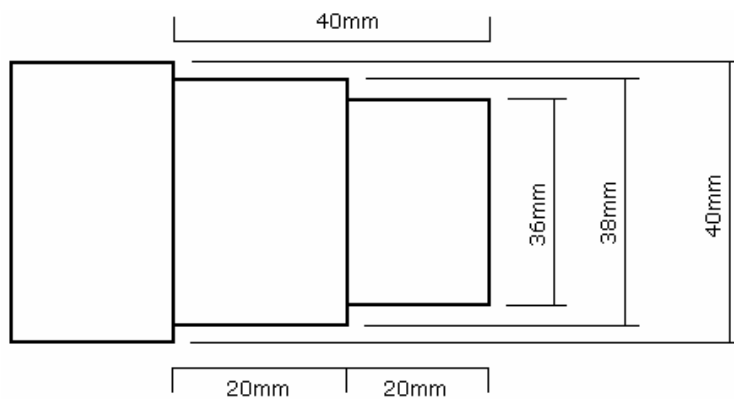
##### 4.1. Create the turning program by using MTS simulator

Using the MTS simulator, create an NC Program to simulate the machining of the workpiece shown in Fig. 6.12.

##### \*Hints:

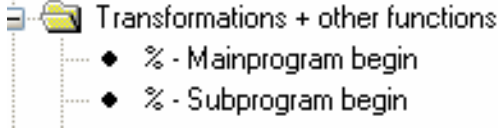
*To create an NC program, use the following procedure:*

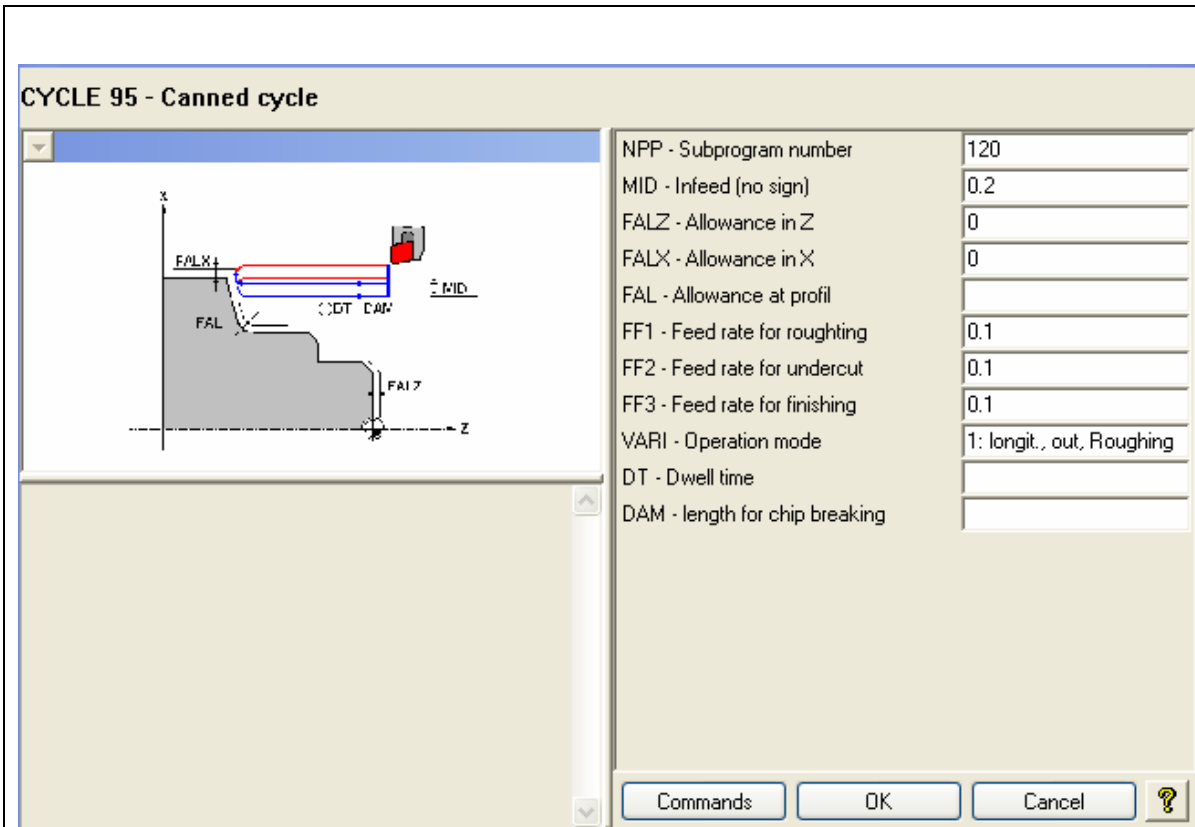
1. Setup sheet using setup dialog; described in module 3.
2. Create the NC program by using the interactive mode.
3. Select the correct tools and parameters (feed, Rotational speed ...etc) according to the work piece dimensions and material used.



**Fig.6.12:** shows the workpiece dimensions

**4.1.1. The main program "Project\_9" is shown in the table below:**

<pre>%_N_9_MPF ;\$PATH=/_N_WKS_DIR/_N_9_WPD</pre>	<p>This two lines indicate that a main program will begin and they are created by using dialog programming and then transformations</p> 
<pre>N300 G54</pre>	<p>Zero point shift</p>
<pre>N305 TRANS 58</pre>	<p>TRANS: is a command used to transfer the workpiece zero point, as the default position of <b>W</b> for the EMCO is on the left workpart side.</p> <p>58: is the distance that <b>W</b> "workpiece zero point" will move which is simply the length of the workpiece.</p>
<pre>N310 S1000 F0.025 M3</pre>	<p>G96 is deleted from that line as the EMCO machine will not recognize it</p>
<pre>N315 T4 D1 M6</pre>	<p>Call Tool No.4 to start the parallel turning operation</p>
<pre>N320 G0 X40 Z5</pre>	<p>Move the cutting tool safely close to the workpiece to start parallel turning.</p>
<pre>N325CYCLE95 ("L120",0.2,0,0,,0.1,0.1,0.1,1,0,0,0)</pre>	<p>The EMCO CNC machine will not recognize the letter in cycle 95 "L" so it should be deleted then the cycle should be recompiled and this will be explained later.</p>



N325CYCLE95 ("120",0.2,0,0,,0.1,0.1,0.1,1,0,0,0)	cycle95 after removing the letter "L"
N330 GO X70 Z70	Move the tool to the tool changing point
N332 FREE	
N335 M30	Program end

#### 4.1.2 The subprogram “L120” is explained in the following table:

<pre>%_N_120_SPF ;\$PATH=/_N_WKS_DIR/_N_9_WPD</pre>	<p>The two lines indicate that a subprogram program will begin. The 1<sup>st</sup> line includes the subprogram no and extension “<b>120_SPF</b>”</p> <p>The 2<sup>nd</sup> line includes the main program no. and extension “<b>9_WPD</b>”</p>
N35 G1 X36 Z1	Starting point outside the workpiece
N40 G1 Z-20	Second point on the contour. See fig. 6.12
N45 G1 X38	Third point on the contour. See fig. 6.12
N50 G1 Z-40	Last point on the contour. See fig. 6.12
N55 G1 X42	2mm Safety distance out of the blank diameter
N60 M17	Subprogram ends

#### 4.2. Switch ON the machine

1. Turn on the air compressor (the pressure reading should be (5 to 6 bars) as shown in Fig. 6.13



**Fig.6.13:** Shows the air compressor

2. Switch on the main switch at the E-cabinet from **0** to **1** as shown in fig 6.13.



**Fig.6.13:** Shows the main switch.

3. Turn on the PC attached to the machine.
4. Launch the Control Software
5. Open the chip guard door and then close it to check that the door safety switch is working properly.

#### **4.3. Reference the machine.**

1. Turn the mode selector on to the "**REF**" mode.
2. Press the -Z or +Z key so; the slide traverses to the reference point in Z.
3. Press the -X or +X key so; the slide traverses to the reference point in X.

#### **Note:**

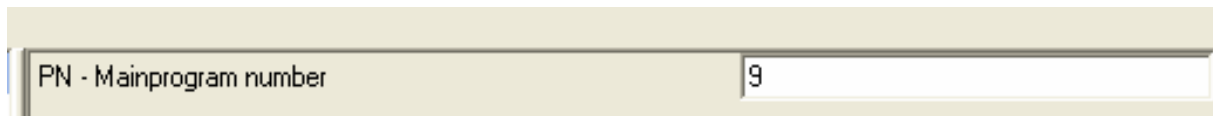
*In manual referencing, only axes are referenced; tool changer cannot be referenced in this mode.*

#### **4.4. Transfer the MTS program as follows:-**

1. Select the program "**Project\_9**".
2. Open the editor
3. Click on "**Dialog program**"
4. Click on "**Main program begin**"
5. Click on "**Parameter**"

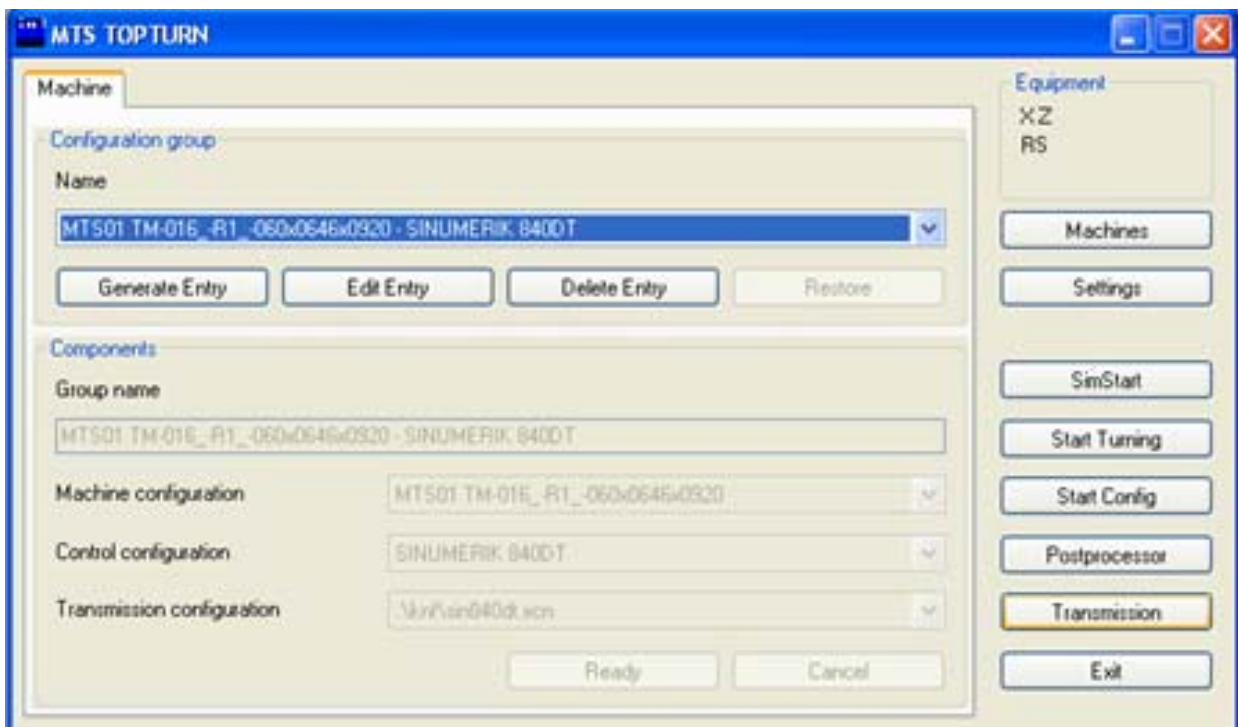


6. Insert the no "9" in the PN-Main program number as shown in Fig.6.14



**Fig.6.14:** Shows the transformation of the main program.

7. Click "Ok"
8. Save the program and close the window.
9. Click on "Transmission" as shown in Fig. 6.15



**Fig.6.15:** Shows the transmission button.

10. Click on "File".
11. Click on "Trans main program"
12. Select the program "project\_9"
13. Save the program on your storage device.
14. Insert the storage device in the machine's PC
15. Create a new folder in the C drive; e.g. "MTS TRANSFERS"
16. Copy your file to the new created folder
17. Launch the machine's software
18. Right click to activate the options.

19. Click on **"Services"** as shown in fig.6.16

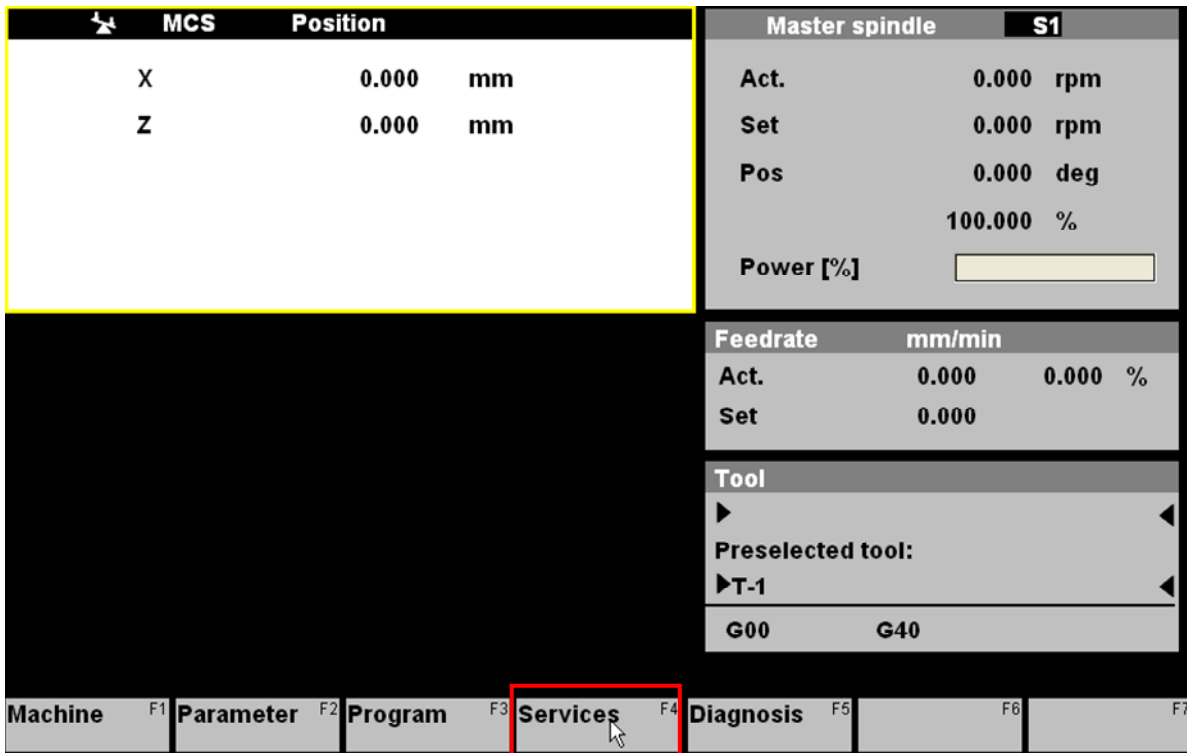


Fig.6.16: Shows the service button.

20. Click on **"Drive"** as shown in fig. 6.17

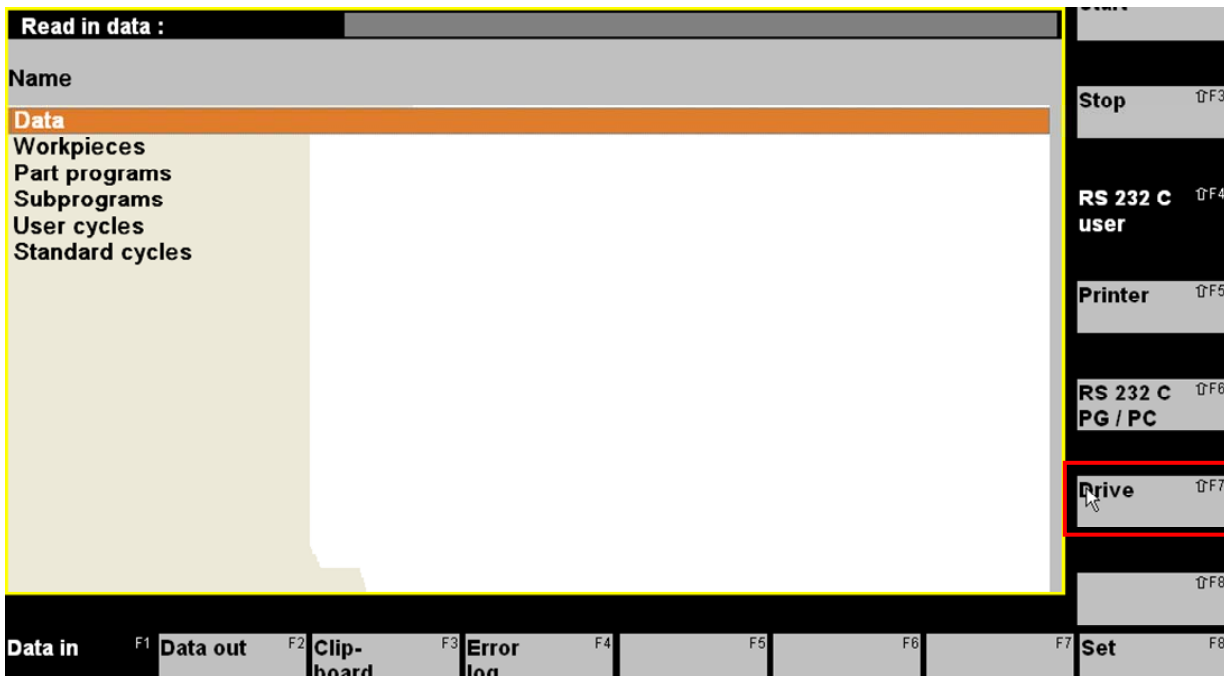


Fig.6.17: Shows the "read in data" screen.

21. Click on **"Set"**

22. Write the path "C:\MTS TRANSFERS" as shown in Fig.6.18

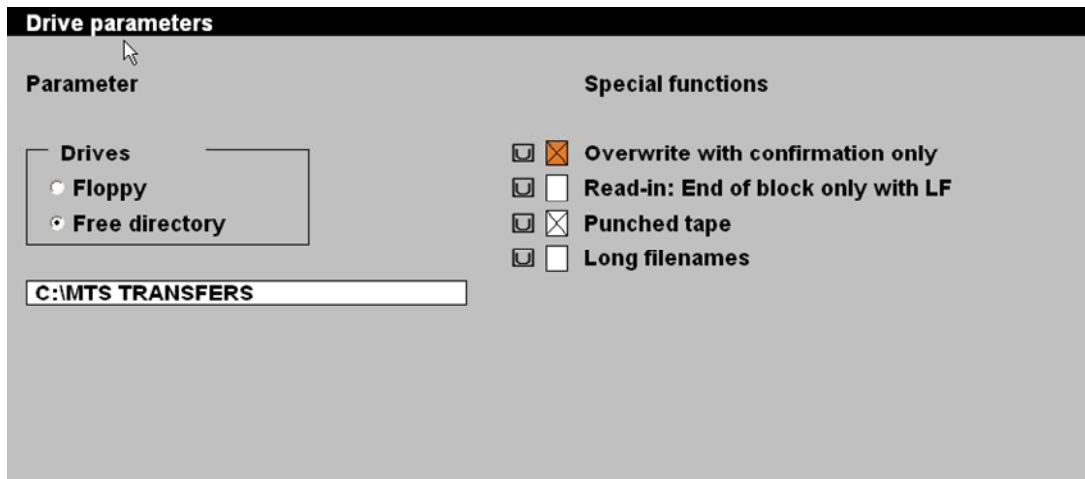


Fig.6.18: Shows the drive parameters.

23. Click on "Save settings"

24. Select the program "Project\_9"

25. Click on "Start"

26. Click on "Ok"

27. Turn the mode selector to "Edit" mode

28. Right click to activate the options

29. Click on "program"

30. Select "9" from the "workpiece overview" as shown in Fig.6.19

Workpiece overview				
Name	Type	Date	Enable	
1	WPD	24.03.08	X	
16	WPD	15.12.08	X	
2	WPD	06.03.08	X	
3	WPD	28.08.07	X	
656	WPD	18.03.08	X	
66	WPD	05.03.08	X	
77	WPD	05.03.08	X	
9	WPD	04.05.09	X	

Press INPUT key to edit program!

Fig.6.19: Shows the workpiece overview screen.

31. click on "9" to open the "program overview" as shown in Fig. 6.20

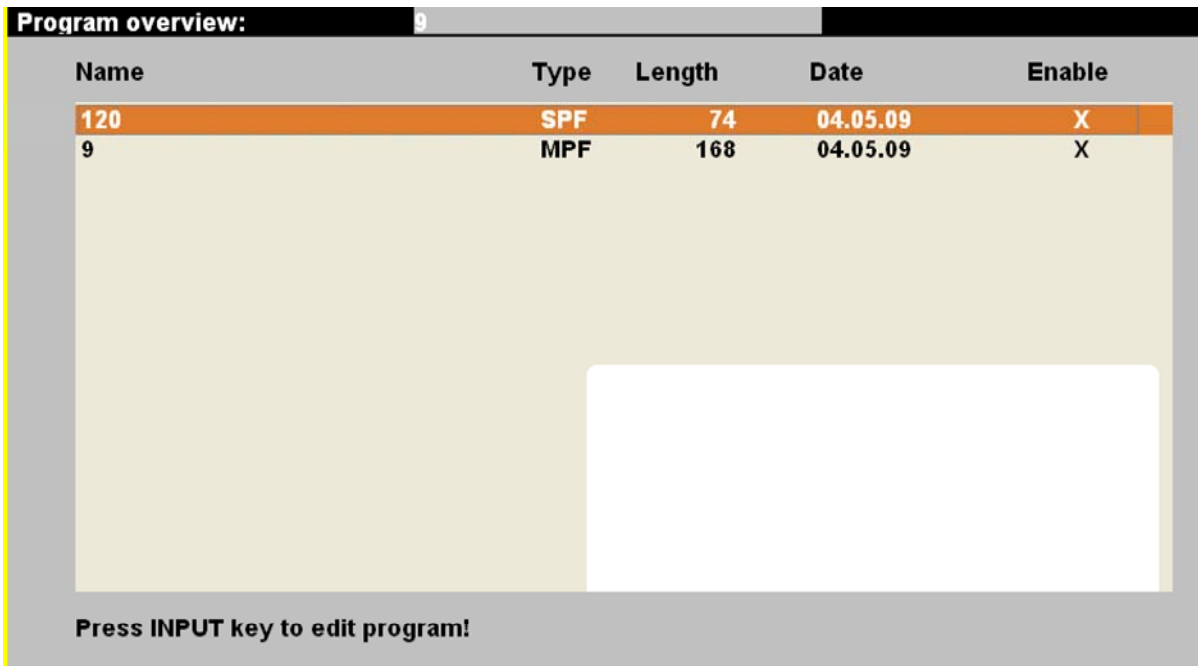


Fig.6.20: Shows the program overview.

32. Click on "9" the main program file to open it in the "program editor" (see Fig.6.21) to recompile cycle 95 as has been discussed earlier.

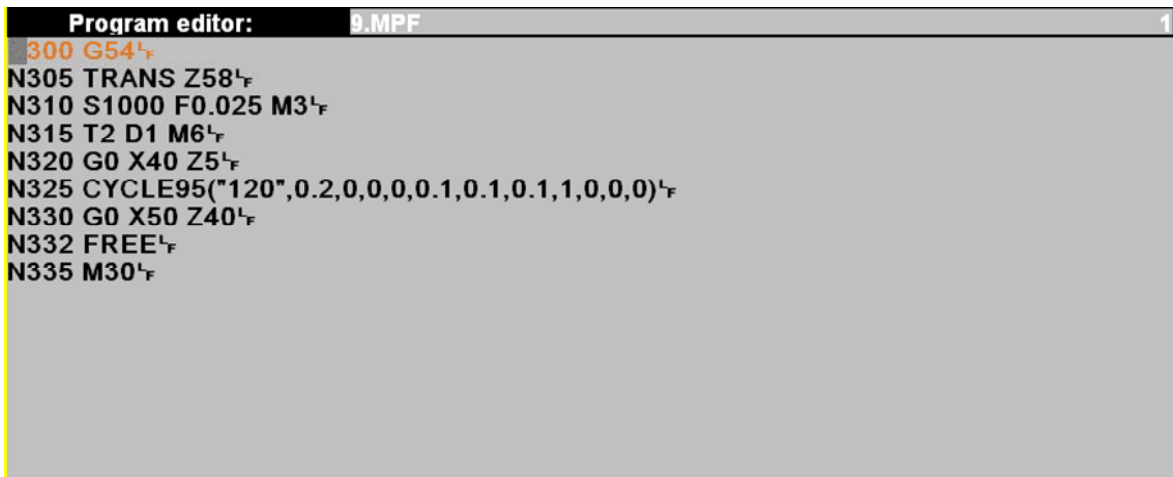


Fig.6.21: Shows the program editor.

33. Click on “**support**” to recompile cycle 95 as shown in Fig. 6.22

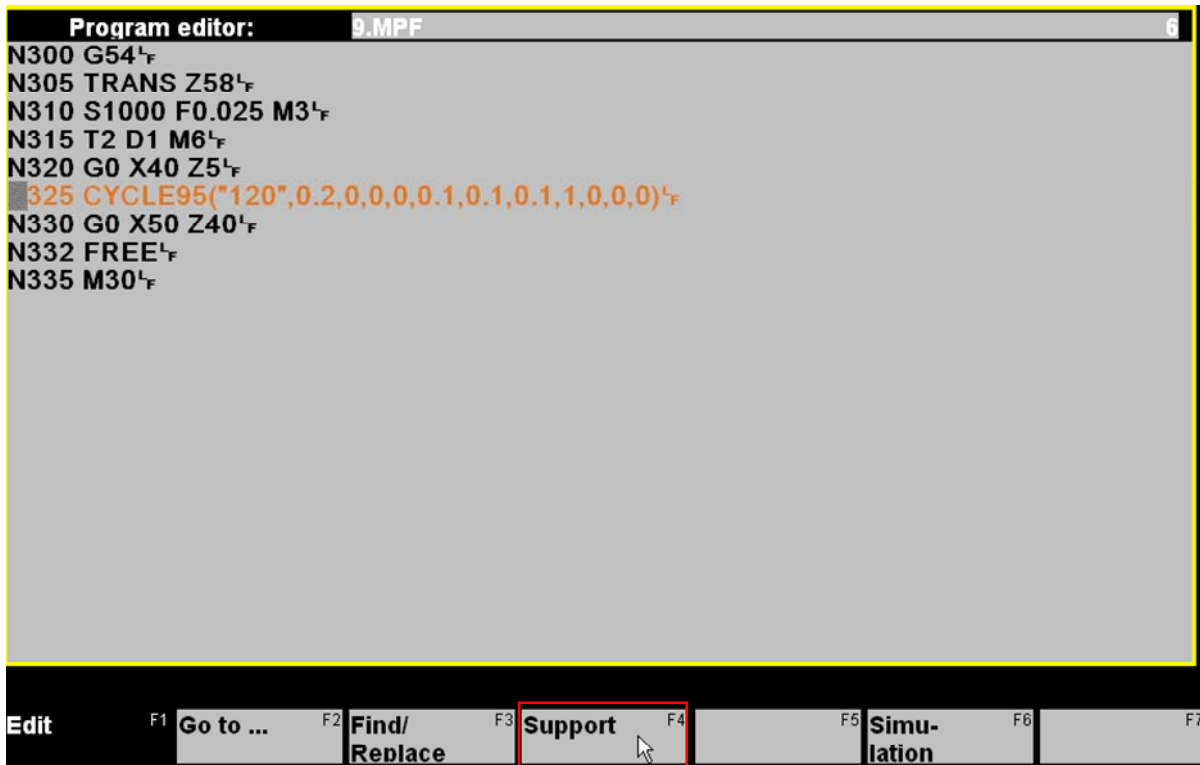


Fig.6.22: Shows the support button in the program editor.

34. Click on “**Recompile**” as shown in Fig. 6.23

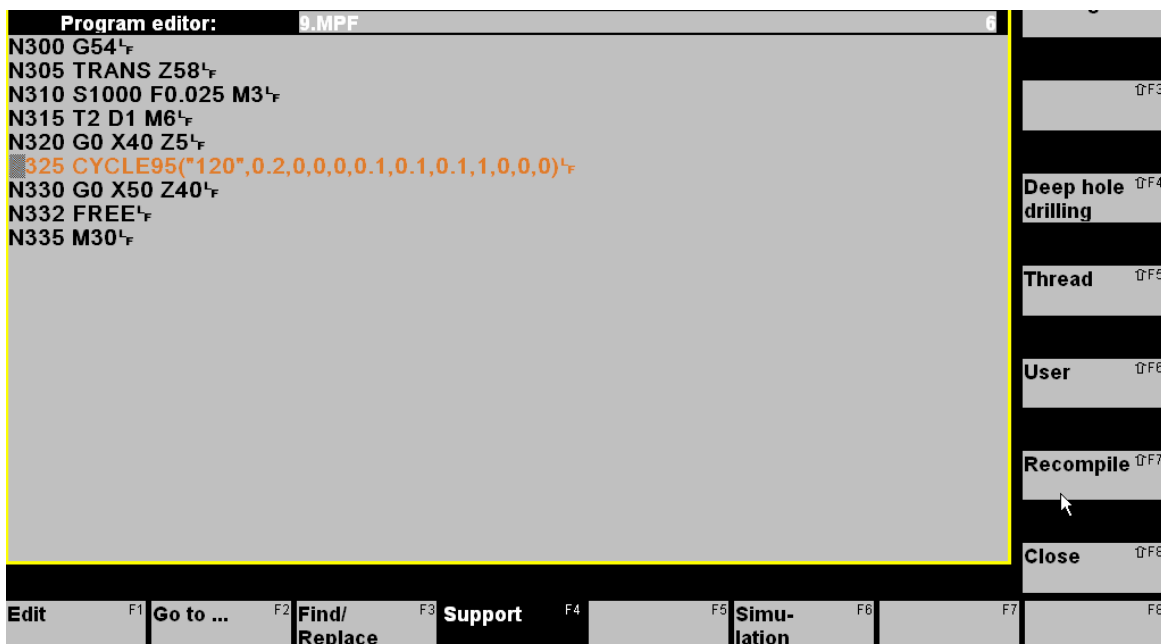


Fig.6.23: Shows the Recompile button in the program editor.

35. Add the missing "O" for the "Retract path" which is missing in the MTS software cycle as shown in Fig.6.24

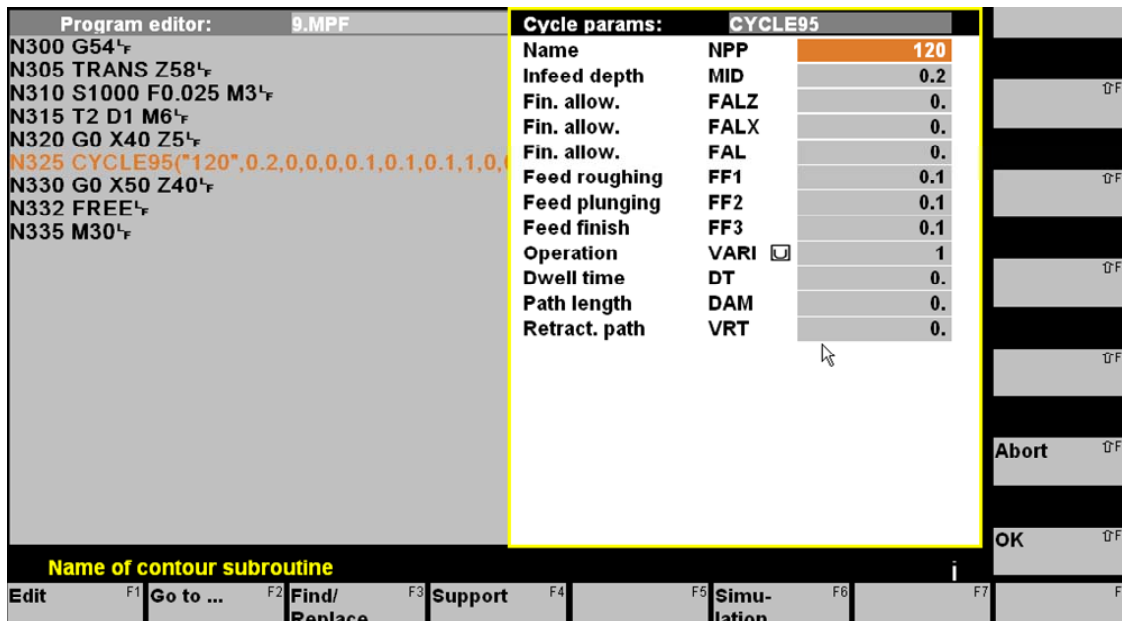


Fig.6.24: Shows the Cycle 95 in the EMCO software

36. Click "OK"
37. Change your tool number according to the tool number on your machine
38. Change all M4 to M3 to suit the machine tool
39. Delete all G92, G94, G95, G96; as they are not recognized by EMCO machines
40. Set the speed "S" between 1000 and 2000 and the feed "F" shouldn't be more than 0.05
41. Click on "Close"
42. Click on "Back"
43. Click on "Machine"
44. Turn the mode selector to "AUTO"

45. Select the override speed using the override switch between (40 - 50%) and make sure that the program's name is in the "Actual block" box as shown in Fig. 6.25

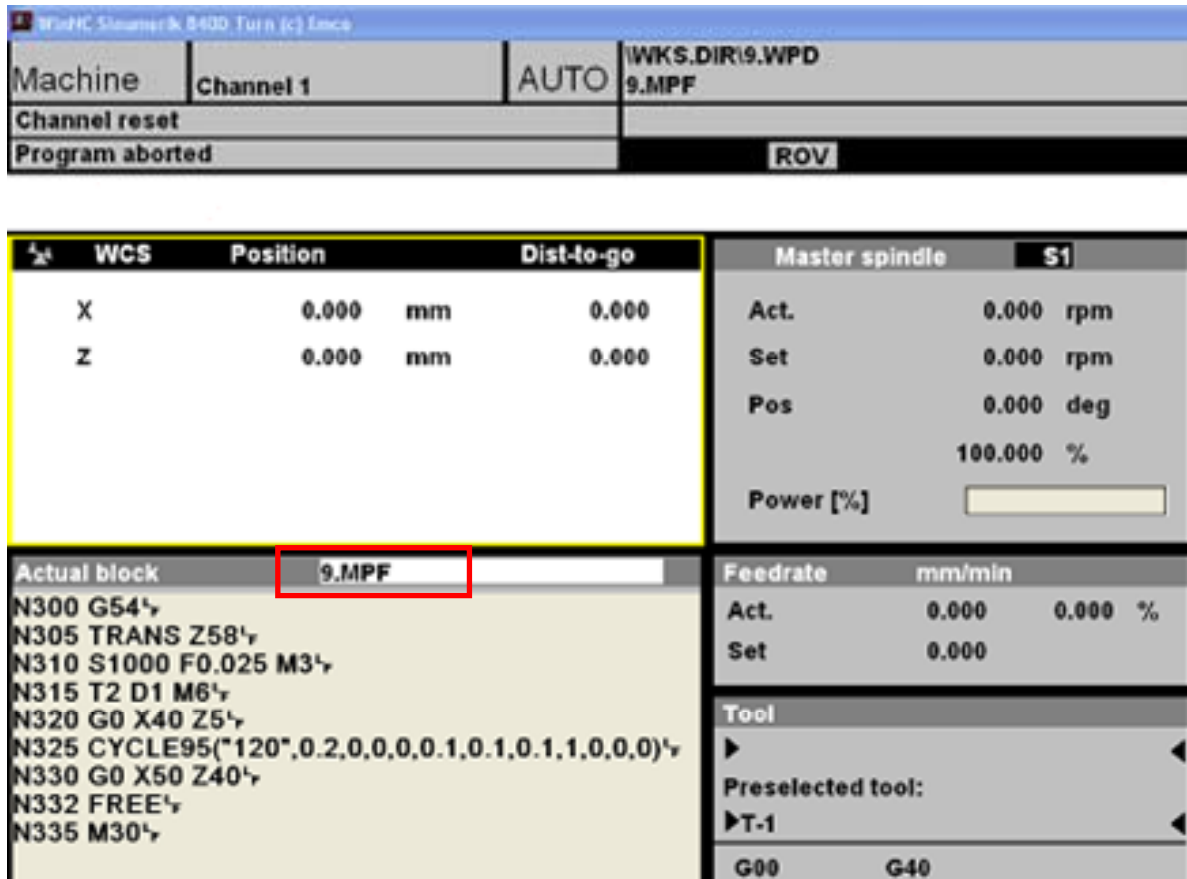


Fig.6.25: Shows the program in the actual block

#### 4.5. Run and execute the program

1. Put the workpiece in the clamping device

*\*It is better first to try without a work part*

2. Close the clamping device using the main console.
3. Close the chip guard door using the main console.
4. Turn the mode selector to "Auto" mode
5. Right click on the screen to activate the options
6. Click on "program" at the bottom menu
7. Click on "part programs"

8. Select the program "9"

*\*the program to run should be enabled (X)*

9. Click on "program selection" on the left menu

10. Click on "machine" on the bottom menu

11. Click on "start" on the main console to start executing the program and get the finished part as shown in Fig. 6.26

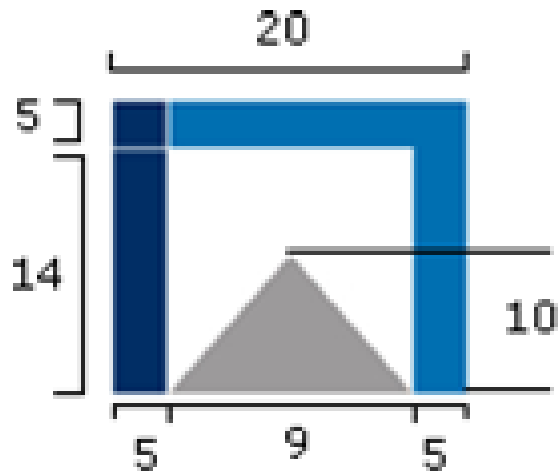


**Fig.6.26:** Shows the finished work part.



**5. The steps followed to create a simple milling program by using MTS Simulator then transfer and execute it on the EMCO Mill 55.**

Using the MTS Simulator, create an NC Program to simulate the machining of the **IAT Logo** as shown in Fig. 6.27.



**Fig.6.27:** Shows the finished work part

**Hints:**

- \* All dimensions are in mm.
- \* The gap between the "I" and the dot is 1mm
- \* The gap on both sides of the triangle is 0.5mm
- \* Right-angled corners will not be obtained due to the shape of tool mounted on the machine.

**5.1.The Procedures are the same as turning and the final program should be as follows:-**

```
G54
TRANS Z58
T2 D1 M6
S1000 F50 M3
G0 X0 Y0 Z10
G1 X-7.5 Y-7.5 Z3
G1 Z-1
```

F150  
G1 Y1.5  
G0 Z3  
G1 Y7.5  
F50  
G1 Z-1  
G0 Z3  
F150  
G1 X-1.5  
F50  
G1 Z-1  
F150  
G1 X7.5  
G1 Y-7.5  
G0 Z3  
G1 X2  
F50  
G1 Z-1  
F150  
G1 X0 Y-2.5  
G1 X-2 Y-7.5  
G1 X2  
G0 Z3  
G0 X-7.5 Y-7.5 Z3  
F50  
G1 Z-2  
F150  
G1 Y1.5  
G0 Z3  
G1 Y7.5  
F50

G1 Z-2  
F150  
G0 Z3  
G1 X-1.5  
F50  
G1 Z-2  
F150  
G1 X7.5  
G1 Y-7.5  
G0 Z3  
G1 X2  
F50  
G1 Z-2  
F150  
G1 X0 Y-2.5  
G1 X-2 Y-7.5  
G1 X2  
G0 Z3 M71  
FREE  
M72  
M30

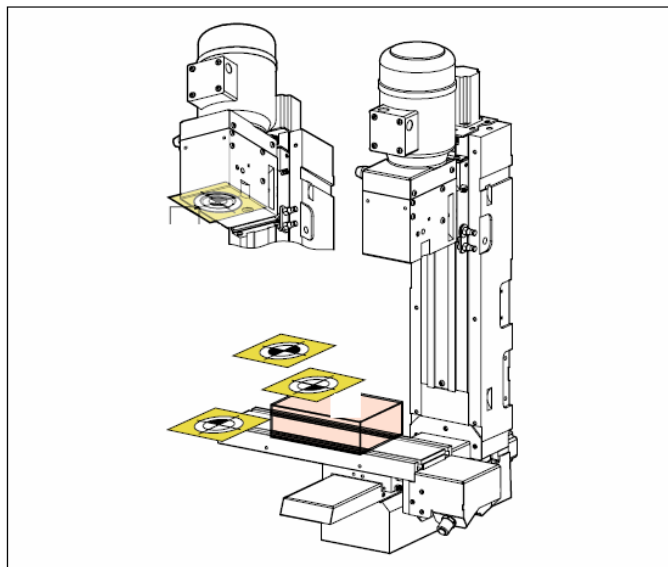




## Work Sheet

1. Write the correct name of the machine points by selecting from the following list:


Tool reference point	Work piece zero point	Machine zero point	Reference point
----------------------	-----------------------	--------------------	-----------------



1. \_\_\_\_\_ 

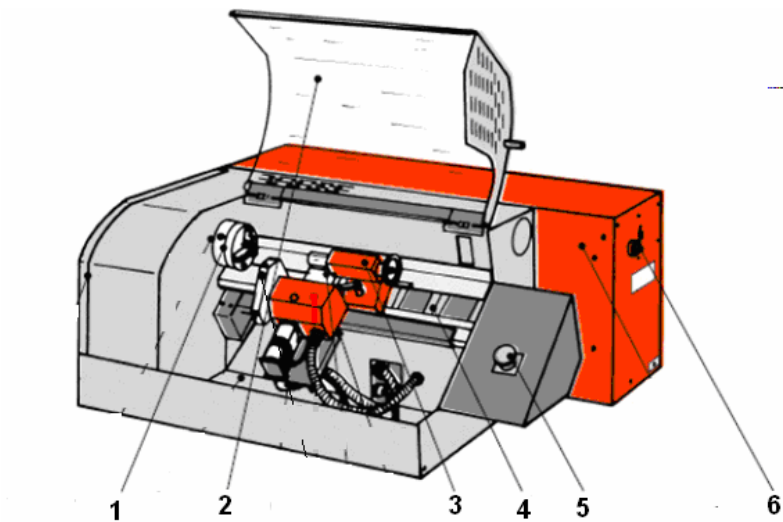
2. \_\_\_\_\_ 

3. \_\_\_\_\_ 

4. \_\_\_\_\_ 

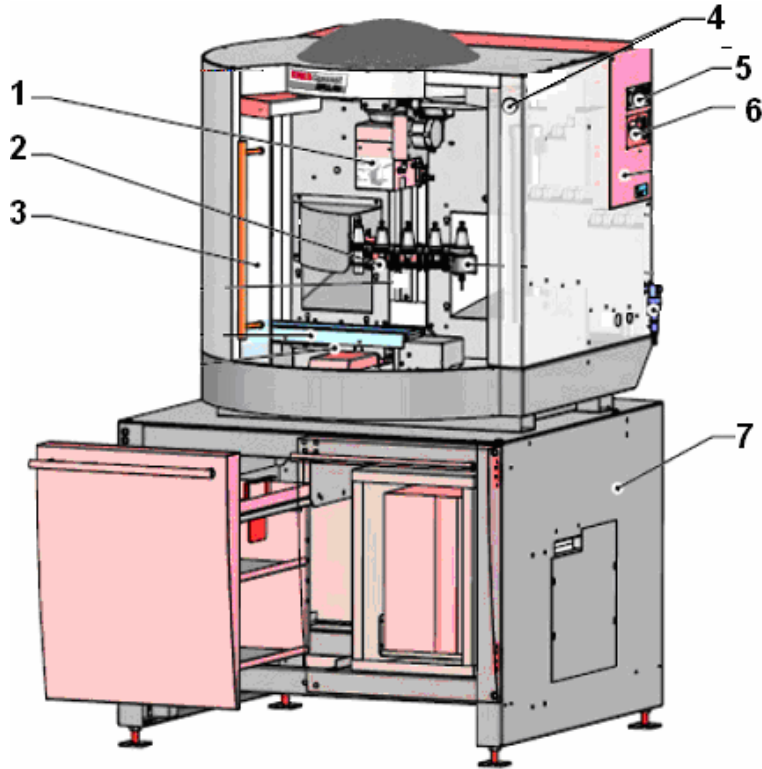
2. Name the parts of the turning machine shown below by selecting from the following list:

- a- Tail stock
- b- Three-jaws chuck
- c- Wheel cover
- d- X-, Y-compound table
- e- EMERGENCY OFF key
- f- Key switch
- g- Chip guard
- h- Machine bed



No.	1	2	3	4	5	6
Letter						

3. Using the list below, label the parts of the milling machine shown in the picture:








- a- 8 position tool changer
- b- Pneumatic maintenance unit
- c- Chip guard door
- d- Milling table
- e- X-, Y-compound table
- f- EMERGENCY OFF key
- g- Milling head
- h- Key switch
- i- Machine base
- j- Name Plate

Put your answers in the table below:

No.	1	2	3	4	5	6	7
Letter							



4. Write the correct name for the keys shown below:

Key name	Key symbol
	
	
	
	
	

**References:**

- 
1. Emco machines – Turn55 – Manual
  2. Emco machines – Mill55 – Manual
-