CNC MACHINES

Conventional Machine



What is CNC?

- CNC means Computer Numerical Control.
- A form of programmable automation.
- Typical program containing coded alphanumeric data, such as

G01 X120 Y200

The data represent relative positions between a cutting tool and a workpiece



Basic Progression to a CNC M/c



Types of CNC Machines

- CNC Turning Centre
- CNC Milling Machine
- CNC Horizontal Machining Centre (HMC)
- CNC Grinder
- CNC Drilling Machine
- CNC Gear Cutting Machine
- CNC Turret Punch Press

2-Axes Turning Centre



Figure 1.3 : Coordinate System (Turning Operations)

3-Axes Machining Centre (Milling and Drilling Operations)



Figure 1.2 : Coordinate System (Milling and Drilling Operations)

CNC MACHINING CENTRE:

1. Vertical Machining Centre (VMC):

 Vertical spindle configuration comprising of three basic servo axes (X - axis, Y-axis & Z - axis): Two for the table movement and one for the spindle head.



2. Horizontal Machining Centre (HMC):



- It can perform machining on different faces of a cubical or prismatic component.
- Both VMC and HMC uses Auto Tool Changer (ATC) & Automatic Pallet Changer (APC)

Auto Tool Changer (ATC) & Automatic Pallet Changer (APC)

- ATC (Auto Tool Changer) is a device which can automatically change the tool from the tool magazine to the machine spindle as per the CNC programme.
- Tool Magazine is a device which holds number of tools and can automatically index to enable ATC to pick the right tool and to replace the used tool.
- Automatic Pallet Changer (APC) is a device which can automatically change the pallet to/from machine to pallet stand.
- By this Mechanism (**i.e.** APC) the pallet with the finished component and the pallet with a raw component could be exchanged automatically.

ATC & Tool Magazine



Automatic Pallet Changer (APC)

- Pallet is a transferable work table having `T' slots or tapped holes for component/fixture clamping.
- Used to avoid the machine waiting time during loading & unloading of component.
- Pallet is held on the machine table by locating pins and clamping mechanism to ensure repeatability and accuracy.





Contents of mechanical and electronic software and hardware in different manufacturing facilities

CNC SYSTEMS

- **Computer Numerical Control (CNC)** is computer based system to store and process data for control of slide motions and auxiliary motions of machine tools.
- CNC Systems are constructed with NC Unit integrated with HMI, Programmable Logic Controller (PLC) with a 'Feed Back Device'.
- **PLC** controls the **ON/OFF** functions of the machine tool. It sets the output based on the input conditions & corresponding logic.

PLC Functions:

- ✓ Coolant ON/OFF.
- ✓ Spindle ON/OFF.
- $\checkmark \quad \text{Selection of a tool.}$
- ✓ Change of workpiece (Pallet Changing).
- ✓ Workpiece clamping etc.

Components of a CNC Machine

- » CNC System (Controller)
- » Drives.
- » Servo Motors
- » Actuators
- » Sensors/ Feedback devices.

HOW A CNC SYSTEM WORKS?



CLASSIC SERVO LOOP



Analog Servo Loop in CNC System

Special Features of CNC M/c

• Mechanical Features:

- » Ball Lead Screws.
- » Linear Bearings.
- » Improved Guide ways.
- » <u>Timing Belts</u>.
- » Curvic Coupling.

Linear Bearings on guide-ways

- Smooth Linear Motion.
- Low starting friction.
- Wear resistant.

- Toothed Belt, Steel-wires.
- Slip-Proof Drive.

Timing Belt

• Used in Turret Indexing of CNC m/c.

Curvic Coupling

Fanuc Series 0i System

Centralised Lubrication System

Online Machine Diagnosis System

Operating Features

Basic Operating Modes:

JOG Mode

JOG MODE

Manual movement of axes. Manually select the tool. Manually move the axes. Find the tool offset.

MDI MODE

Program phase. Manually feed the program.

AUTO MODE

Create a Program. Store the Program Execute the program

CNC SYSTEMS

MANUFACTURER	COUNTRY	MODEL	
ROCKWELL AUTOMATION	U. S. A	ALLEN BRADLEY 8610, 8650, 9/PC	
CINCINNATI MILACRON	U. S. A	ACRAMATIC 950, 2100	
FAGOR	SPAIN	FAGOR 800, 8025, 8050	
FANUC	JAPAN	FANUC 18i/180i, 21i/210i, 30i/31i/32i, 300i/310i/320i	
FANUC INDIA	INDIA	FANUC 0 , 0i	
HEIDENHAIN	GERMANY	TNC 155, 426, 430	
GSK CNC EQUIPMENT	CHINA	GSK980TDa., GSK983M	
SIEMENS	GERMANY	SINUMERIK 802, 840, 880	
MITSUBISHI ELECTRIC AUTOMATION INC.	JAPAN	70/700 SERIES, C6/C64 SERIES, 60S/E60/E68 SERIES	

Program configuration

Block configuration

		1 block			
N 00000	GOO	x00.0 z000.0	MOO	S 00	T 00 ;
		γ	<u> </u>	<u> </u>	
Sequence number	Preparator function	y Dimension word	Miscel- laneous function	Spindle function	Tool func- tion
;					
					End of block

<u>G - CODES</u>

G-codes are used to move the tool or axes by Program.

- G 00 Rapid travel.
- G 01 Linear interpolation.
- G 02 Circular interpolation clock-wise.
- G 03 Circular interpolation anti-clockwise.
- G 04 Dwell time.
- G 20 Inch data input
- G 21 Metric data input.
- G 22 Stored stroke check on.
- G 23 Stored stroke check off.
- G 27 Reference point return check.

- .G 28 Reference position return.
- G 29 Return from reference point
- G 30 Return to second reference point.
- G 31 Skip function.
- G 32 Thread function.
- G 36 Automatic tool compensation X
- G 37 Automatic tool compensation Z
- G 40 Tool nose radius compensation cancel
- G 90 Absolute dimensioning.
- G 91 Incremental dimensioning.
- G 98 Feed rate in mm/min.
- G 99 Feed rate in mm/rev.

M- CODES (Miscellaneous Codes)

- ON/OFF Codes.
- Controlled by PLC
- M 00 Optional stop.
- M 01 Programmable stop.
- M 02 Main program end.
- M 03 Spindle clock-wise.
- M 04 Spindle counter clock-wise.
- M 05 Spindle stop.
- M 06 Tool change.

- M 07 Coolant b on.
- M 08 Coolant a on.
- M 10 Chuck open.
- M 11 Chuck close.
- M 13 Spindle forward & coolant on.
- M 14 Spindle reverse & coolant on.
- M 16 Special tool call.
- M 17 Sub-program end.
- M 19 Spindle orientation.
- M 30 Main program end & rewind.

Steps to Execute a CNC Program

1.How to start the CNC Machine:

- Main Supply ON
- Stabilizer ON
- Machine Switch ON
- CNC System ON
- Releasing Emergency Button

2.JOGGING – Manual movement of tool in X, Y, and Z-axis directions in off-line mode

3. REFERENCING/HOMING – Sending the tool to Home position with X = 0, Y = 0, & Z = 0 co-ordinates position i.e. MCS position.

4. OFF-SETTING of Tool and Workpiece – WCS & MCS – Shifting of MCS to WCS i.e. selecting a Job '0' position

- 5. TOOL SELECTION & INDEXING With the help of ATC
- 6. SELECTING the Program to be executed

- SIMULATION of the program Do Simulation using the appropriate Button to confirm that you have made the correct CNC program.
- 8. EXECUTION of the Program Perform Execution of the program using Execution Button.
- 9. After Execution, how to make 'OFF' the CNC Machine:
 - Emergency Button off
 - CNC OFF
 - Machine Switch OFF
 - Stabilizer OFF
 - Main Supply OFF

PROGRAM FOR FACING OPERATION

Z-0.2 <	Tool position in Z-direction
Z-0.4 👞	- Tool position in Z-direction
Z-0.6 👞	- Tool position in Z-direction
Z-0.8	
Z-1.0	
Z-1.2	
Z-1.4	
Z-1.6	
Z-1.8	
Z-2.0	
G28	
U0W	Reference position return
0	Spindle Stop
▲ M05	Program stop
M30	

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PROGRAM FOR DRILLING OPERATION

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THANK YOU