
Computer Numerical Control (CNC)

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What are NC & CNC ?

- **Numerical control (NC)** is a method of automatically operating a manufacturing machine based on a code letters, numbers and special characters.
 - The numerical data required to produce a part is provided to a machine in the form of program, called part program or **CNC (computer numerical control)**
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What are NC & CNC ?

- The program is translated into the appropriate electrical signals for input to motors that run the machine.
 - A CNC machine is an numerical control machine with the added feature of an on board computer. The computer is referred to as the **machine control unit (MCU)**
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HISTORY

- In 1775, John Wilkinson- cannon boring machine (lathe).
 - In 1881, Eli Whitney- milling machine.
 - In 1947, Mr. John Parsons began experimenting for using 3-axis curvature data to control the machine tool motion for the production for aircraft components.
 - In 1949, parsons- first NC machine.
 - In 1951, MIT was involved in the project.
 - In 1955, after refinements NC became available in industry
 - Today, modern machinery are CNC milling machines and lathes.
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CNC SYSTEM ELEMENTS

A typical CNC system consists of the following six elements

- Part program
- Program input device
- Machine control unit
- Drive system
- Machine tool
- Feedback system

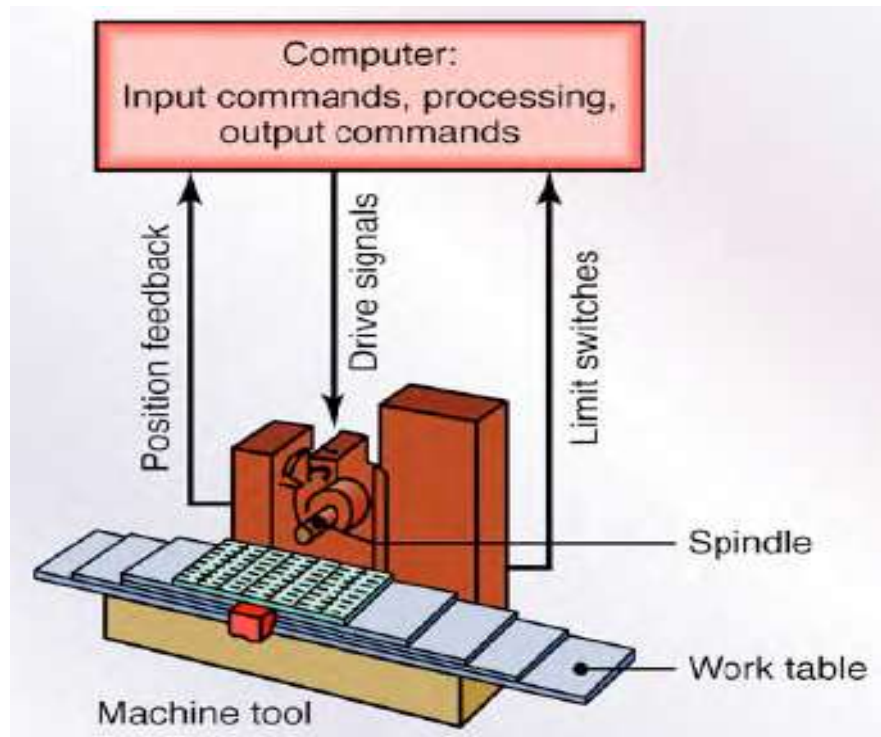
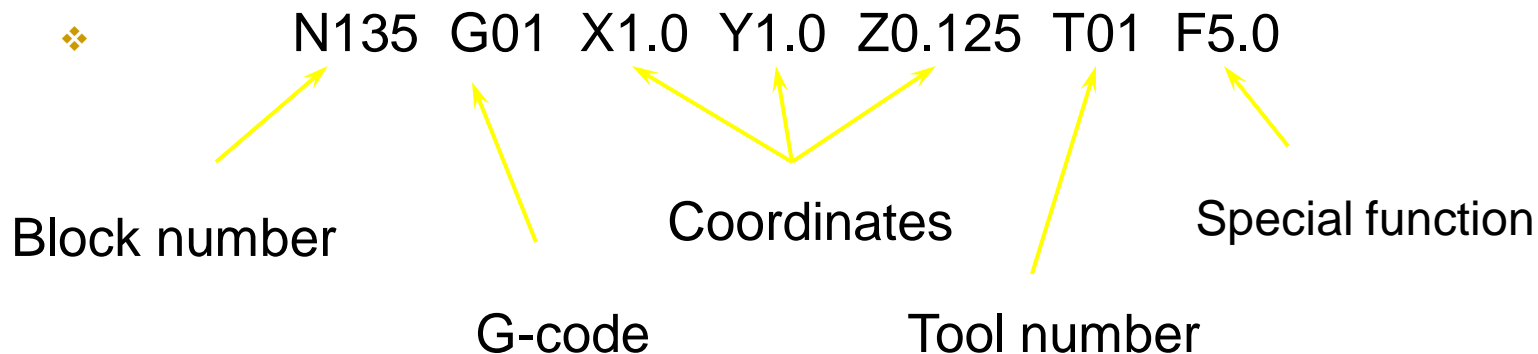


Figure 1 : Schematic illustration of the major components of a numerical control machine tool

Basic Concept of Part Programming

- ❖ Part programming contains geometric data about the part and motion information to move the cutting tool with respect to the work piece.
- ❖ Basically, the machine receives instructions as a sequence of blocks containing commands to set machine parameters; speed, feed and other relevant information.
- ❖ A block is equivalent to a line of codes in a part program.



Programming Methods

- *Automatically Programmed Tools (APT)*
 - A text based system in which a programmer defines a series of lines, arcs, and points which define the overall part geometry locations.
 - These features are then used to generate a cutter location (CL) file.
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Programming Methods

- *Computer Aided Machining (CAM) Systems-
Computer Aided Design (CAD) Systems*
 - CAD/CAM systems allow for rapid development and modifying of designs and documentation.
 - The 3D geometric model produced becomes a common element for engineering analysis (FEA), machining process planning (including CNC part programming, documentation (including engineering drawings), quality control, and so on.
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Drives of CNC machine tool

- Hydraulic actuator
 - high power machine tool
 - Stepping motor
 - small machine due to limited power and torque
 - DC motor
 - excellent speed regulation, high torque, most widely used
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Properties of CNC machines

- ***Based on Motion Type:*** Motion control - the heart of CNC

Point-to-Point or Continuous path

- ***Based on Control Loops:***

Open loop or Closed loop

- ***Based on Power Supply:***

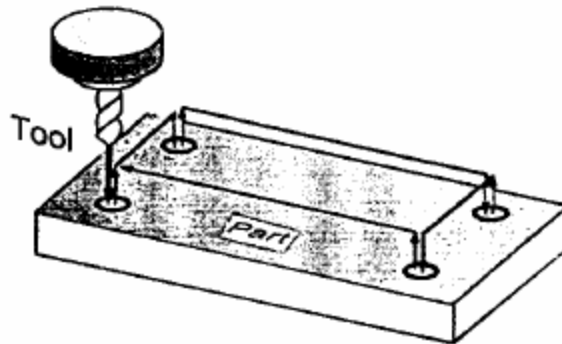
Electric or Hydraulic or Pneumatic

- ***Based on Positioning System***

Incremental or Absolute

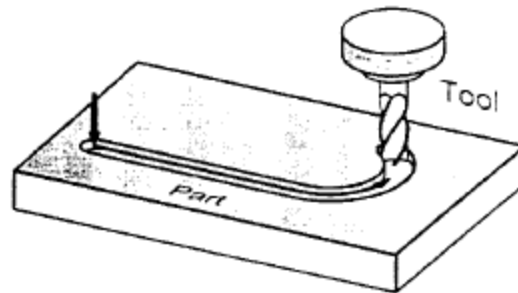
Point-to-Point Tool Movements

- ***Point-to-point control systems*** cause the tool to move to a point on the part and execute an operation at that point only.
- The tool is not in continuous contact with the part while it is moving.
- Examples: drilling, reaming, punching, boring and tapping.

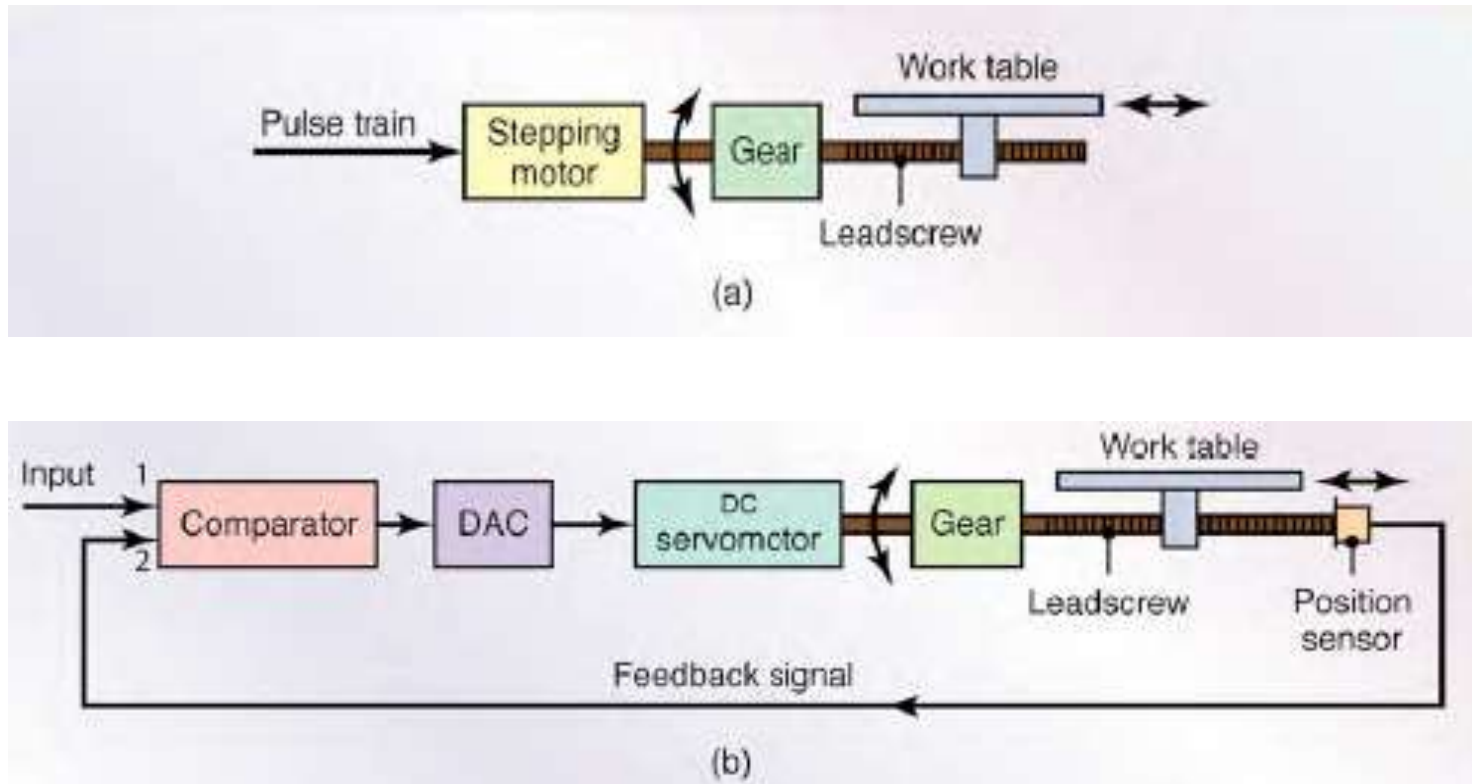


Continuous-Path Tool Movements

- **Continuous-path controllers** cause the tool to maintain continuous contact with the part as the tool cuts a contour shape.
- These operations include milling along any lines at any angle, milling arcs and lathe turning.



Loop Systems for Controlling Tool Movement



Schematic illustration of the components of (a) **an open-loop** and (b) **a closed-loop control system** for a CNC machine.

Types of CNC Machines

- **Lathe Machine**
 - **Milling Machine**
 - **Drilling Machine**
 - The bench drill
 - The pillar drill
 - **Boring Machine**
 - **Grinding Machine**
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Types of CNC Machines

CNC Mills

- These machining centers use computer controls to cut different materials.
- They are able to translate programs consisting of specific number and letters to move the spindle to various locations and depths.
- Used to make 3D prototypes, moulds, cutting dies, printing plates and sights.



Types of CNC Machines

CNC Lathes

- They cut metal that is often turning at fast speeds.
- CNC lathes are able to make fast, precision cuts using indexable tools and drills with complicated programs. Normally, they cannot be cut on manual lathes.
- They often include 12 tool holders and coolant pumps to cut down on tool wear.



Figure 6 : <http://www.automation-drive.com/cnc-lathe-machine>

Types of CNC Machines

Turning Centers are capable of executing many different types of lathe cutting operations simultaneously on a rotating part.

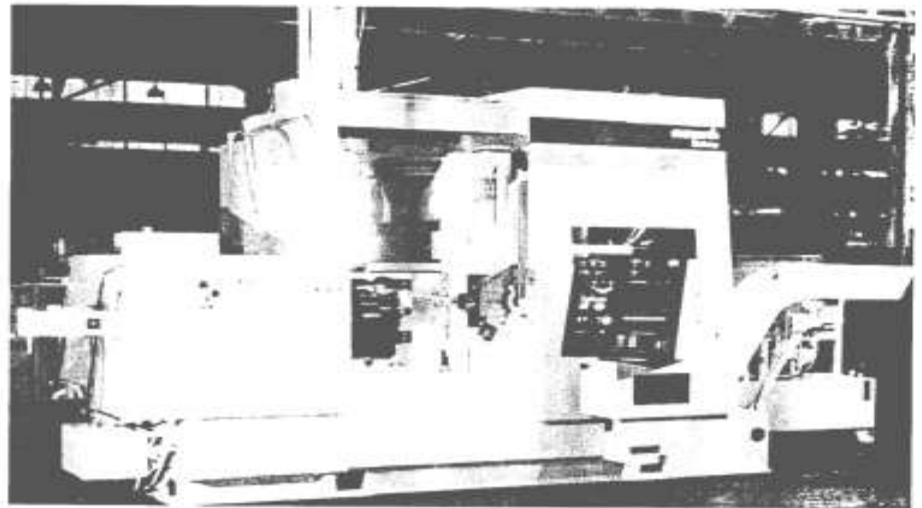


Figure 7 : <http://www.cnc-machining-center-yida.com/cnc-turning-center-bml-420.htm>

Types of CNC Machines

CNC Grinders

- Grinding metal process uses a coated wheel that slowly removes metal to create a part.
- Through the years, grinding was done on a manual machine, but with the advent of CNC technology, the grinding process has advanced



Types of CNC Machines

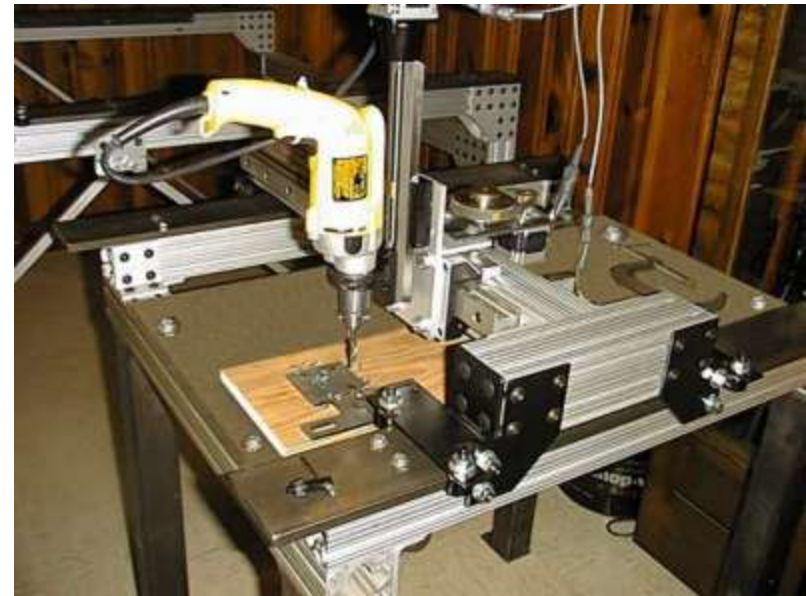
CNC DRILLING

Drilling is commonly used for mass production. The drilling machine (drilling press) is used to create or enlarge holes.

Drilling machine for different jobs;

The bench drill: For drilling holes through raw materials such as wood, plastic and metal

The pillar drill: A larger version that stands upright on the floor. As the bench drill, it can be used to drill larger pieces of materials and produce bigger holes.



Types of CNC Machines

CNC Boring

- Process of enlarging an existing hole or internal cylindrical surface.
- This can be accomplished on a lathe or a machine tool specifically designed for the process, such as a horizontal boring machine.



Types of CNC Machines

Electrical Discharge Machines (EDM)

Wire EDM machines utilize a very thin wire (.0008 to .012 in.) as an electrode. The wire is stretched between diamond guides and carbide that conduct current to the wire and cuts the part like a band saw.

Material is removed by the erosion caused by a spark that moves horizontally with the wire.



Figure 11: <http://news.thomasnet.com/news/machinery-machining-tools/electro-discharge-machines>

Types of CNC Machines

Laser Cutting Machines

- The machine utilizes an intense beam of focused laser light to cut the part.
- Material under the beam experiences a rapid rise in temperature and is vaporized.
- Laser cuts with a minimum of distortion, no mechanical cutting forces.



Specific tools to perform different operations

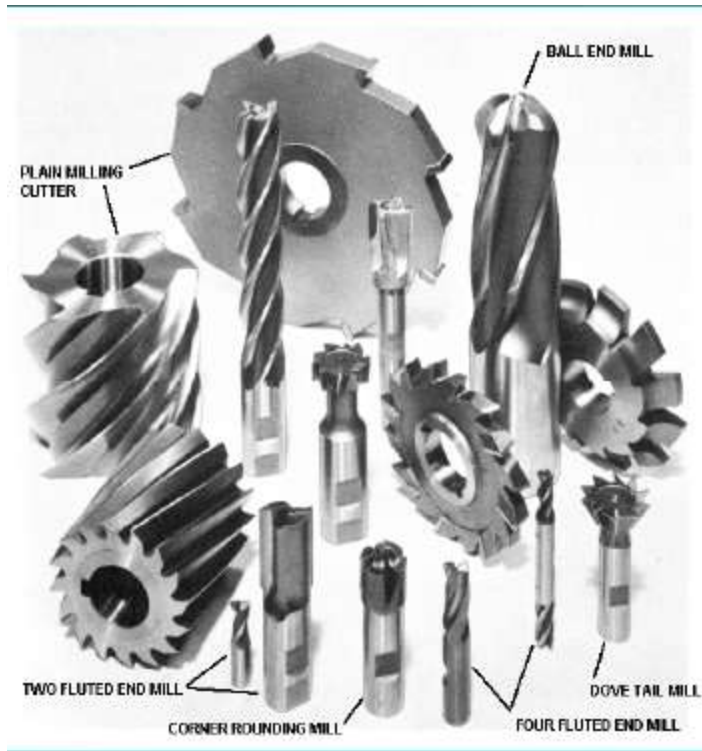
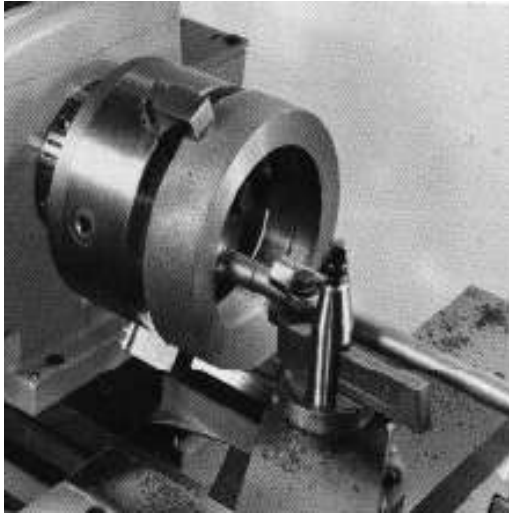


Figure 13: http://users.isr.ist.utl.pt/~pjcro/courses/api0910/API_I_C5.pdf

Specific tools to perform different operations



FACING



ROUGHING



FINISHING



ROUND NOSE



FINISHING



ROUGHING



FACING

LEFT-CUT TOOLS

RIGHT-CUT TOOLS

APPLICATION of CNC MACHINES

- cutting
 - milling
 - boring
 - spinning
 - gluing
 - routing
 - drilling
 - welding
 - bending
 - pinning
 - sewing
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Application of CNC in Some Industries

- Automotive Industry
 - Aerospace Industry
 - Machinery Industry
 - Electrical Industry
 - Instrumentation Industry
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Automotive Industry

Different Products



Figure 15: http://www.efunda.com/eds/company_details.cfm/id2/4846/pv/NO/cp/Zhejiang%20Co

Aerospace Industry

Aircraft Turbine Machined by 5-Axis CNC Milling Machine



Figure 16: <http://boeingcockpit.com/html>

Advantages of CNC Machines

Ease of Use

- CNC machines are easier for beginners
- operation of several CNC machines at same time
- some CNC machines don't need any operator
 - call their operator in case of the emergencies.

High Efficiency

- operate almost continuously 24 hours a day, 365 days a year
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Expanding Options

- Expand the machine's capabilities with Software changes and updates

No Prototyping

- New programmes provide elimination build a prototype, save time and money

Precision

- Parts are identical to each other
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Reduce Waste

- Reduce waste as errors allows minimize wasted material.
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Disadvantage of CNC Machines

Cost

CNC machinery:

- costs quite a lot more than conventional machinery
 - does not eliminate the need for expensive tools
 - expensive to repair
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CONCLUSION

- CNC machines which are applicable any type of processing
 - manufacturing anything is identical in shorter time
 - CNC machines provide many advantages
 - many industries prefer using CNC machines
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Thank you



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