

NUMERICAL CONTROL

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INTRODUCTION

- ✦ Today industries demands faster production in harder and tougher material to unprecedented tolerances. Conventional machine tool (Manual or Automatic) can not meet this demands.
- ✦ The solution to this problem is Numerical control as it supports 85% of the market demand.
- ✦ These machines are highly flexible and are most economical for producing a single or large number of parts in batches
- ✦ Numerical control is nothing, but relatively new process of organization the information required for a process resulting in automations.

AUTOMATION IN PRODUCTION PROCESS MAY BE ACHIVED BY ONE OF THE FOLLOWING STRATEGIES

- ✦ **IPC** (Industrial Process Control)
- ✦ **CADP** (Computer Aided Data Processing)
- ✦ **SPMM** (Special Purpose Mfg. Machines)
- ✦ **NC** (Numerical Control)

IPC (INDUSTRIAL PROCESS CONTROL)

- Sense physical quantity like temperature, Pressure by Sensor.
- Controlling a process by actuators.

Example: Boiler
 Control of Oil refinery
 Air Conditioning

CADP (COMPUTER AIDED DATA PROCESSING)

- Computer lessens the burden of excessive data, to be processed in no time.
- Data processing may range from computer aided process planning (CAPP)
- Material requirement planning (MRP) Which can be directly converted to tape for input to NC machine.

SPMM (SPECIAL PURPOSE MANUFACTURING MACHINES)

- Close tolerance and least wastage.
- Fixed automation and is feasible only for long mass production.

Example: Automobile
 Home Appliances
 News Papers

NC (NUMERICAL CONTROL)

- Digital control of Machining process.
- Flexible method of automation which can change it self according to the product design changes.
- Combination of Machine tool and Control System

DIFFERENCE BETWEEN SPM AND NC MACHINE

SPM

NC

Fixed sequence of operation with little or no variation to a machine part

Sequence of operation can be changed to machine a new part

Suitable for mass production having identical parts.

Can be applied to short/batch production run or even a single part

Requires more time for setting up.

Complex setting up procedures are almost by passed.

Program or sequences of operation built in a hardware.

Program is stored as a software.

Less scope of variation as it is to costly

Large scope of variation of different product with out involvement of high costs.

FUNCTION OF NC MACHINE TOOL

- Starting and stopping of machine tool spindle
- Controlling the spindle speed
- Positioning the tool tip
- Automatic control of motion of slide
- Controlling the feed rate
- Changing of tool in the spindle

OBJECTIVE NC MACHINE TOOL

- To increase production
- To reduce labour cost
- To make production more economical
- To do job that would be impossible or impractical without NC
- To increase the accuracy of duplicate part

ADVANTAGES OF NC MACHINE TOOL

- Increased productivity
- Reduce tool / fixture storage cost
- Faster set-up time
- Reduce parts inventory
- Flexibility that speeds changes in design
- Better accuracy of parts
- Reduction in part handling
- Better uniformity of parts
- Better quality control
- Improvement in manufacturing control



DISADVANTAGES OF NC MACHINE TOOL

- Increase in electrical maintenances
- High initial investment
- Operating cost per hour is higher than traditional machine tool
- Retraining of existing personnel

NC MACHINE TOOLS ARE SUITABLE IN FOLLOWING SITUATIONS

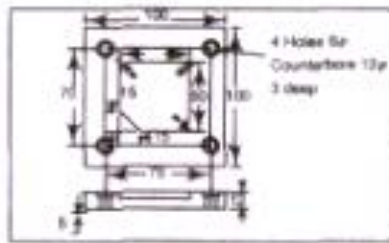
- The components have complex shapes
- The part to be made are in small batches
- The set up are numerous or costly
- A repetition of close tolerances / accuracy (i.e. precisions) is desired
- All parts are subject to design changes
- The inspection cost is a significant portion of the total cost

NC MACHINES

➤ DEFINITION:

EIA(Electronic Industries Association) "A system in which actions are controlled by direct insertion of Numerical Data at some point. The system must automatically interpret latest some portion of this data"

- The control of a machine tool by means of recorded information on punched tape or card is known as Numerical Control
- Numerical control is defined as a form of software controlled automation, in which the process is controlled by alphanumeric characters or symbols.



Part Drawing

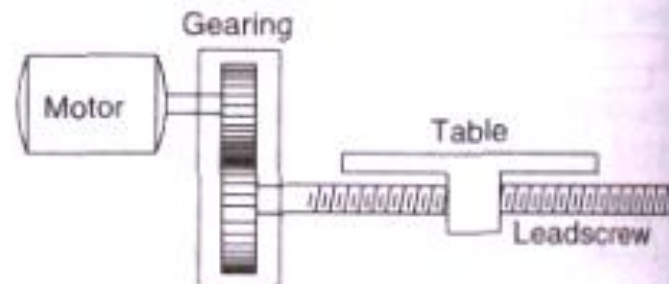
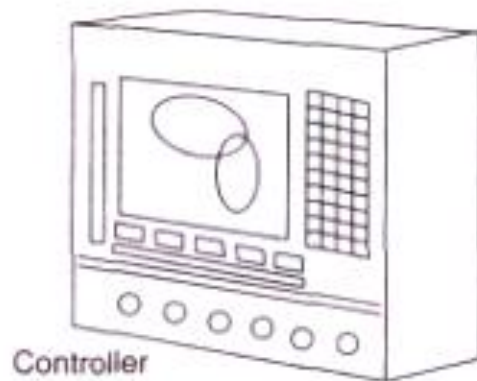
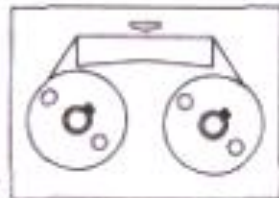


```
-----  
N030 G00 X34.43 Y12.5  
N035 Z2.0  
N040 G01 X105.0 Y35.5  
N045 X55.0 Y65.0  
N050 G00 Z50  
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```

Part Program



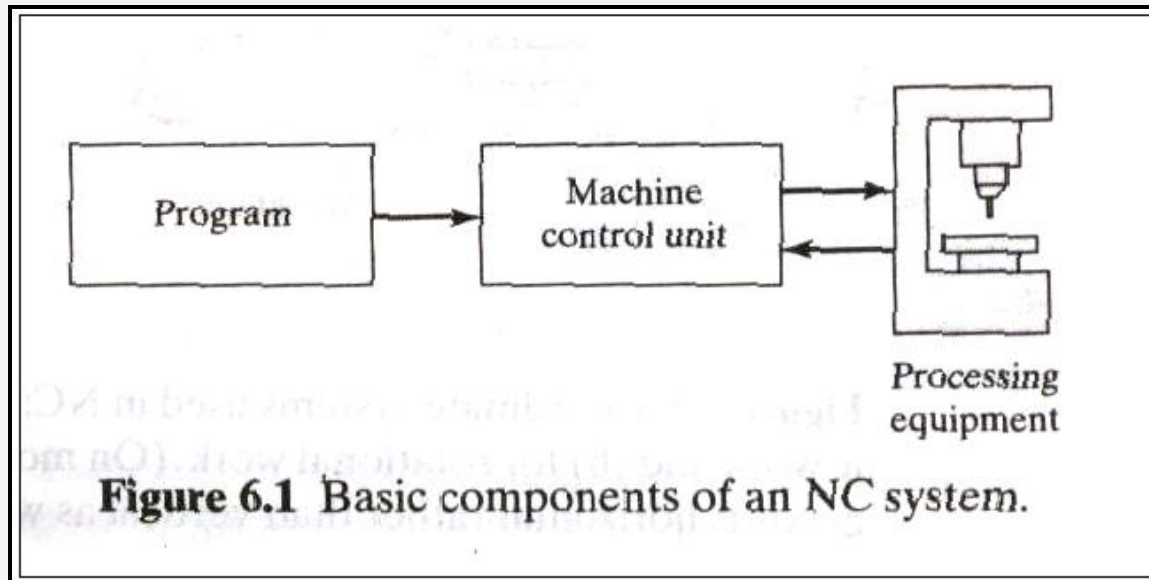
Paper
Tape Reader



Constructional Details of NC Machine

➤ We need the following basic elements / components:

- Software
- Machine Control Unit (MCU)
- Machine Tools (MT)



SOFTWARE

➤ *“The programs or set of instructions, languages, punch cards, magnetic tape, punched paper tape and other such information processing items are referred to as ‘Software’ ”*

- ✓ *Binary Coding for NC*
- ✓ *Radix Conversion*
- ✓ *BCD Codes*
- ✓ *EIA Codes*
- ✓ *ISO / ASCII Code*
- ✓ *Punch Cards*
- ✓ *Punched Paper Tape*
- ✓ *Magnetic Tape*
- ✓ *Floppy Disk*

EIA Code							Character or Interpretation							ISO Code (ASCII)						
7	6	5	4	3	2	1							8	7	6	5	4	3	2	1
			*												0	0	*			
			*												1	0	*			
			*												2	0	*			
			*												3	0	*			
			*												4	0	*			
			*												5	0	*			
			*												6	0	*			
			*												7	0	*			
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			*												X	0	*			
			*												Y	0	*			
			*												Z	0	*			
			*												Tab		*			
			*												End-of-Block		*			
			*												Space		*			
			*												Positive sign (+)		*			
			*												Negative sign (-)		*			
			*												Period (decimal point) (.)		*			
			*												Comma (,)		*			

Column numbers identify columns on the punched tape; 0's represent holes in the tape.



TABLE 6.8 Five Block Formats Used in NC Programming

<i>Block Format (Tape Format)</i>	<i>Example for Figure 6.12</i>
<i>Fixed sequential format.</i> This format was used on many of the first commercially available NC machines. Each instruction block contains five words specified in only numerical data and in a very fixed order.	00100070000300003 00200070000600003
<i>Fixed sequential format with TAB ignored.</i> This is the same as the fixed sequential format except that TAB codes are used to separate the words for easier reading by humans.	001 00 07000 03000 03 002 00 07000 06000 03
<i>Tab sequential format.</i> This is the same as the preceding format except that words with the same value as in the preceding block can be omitted in the sequence.	001 00 07000 03000 03 002 00 06000
<i>Word address-format.</i> This format uses a letter prefix to identify the type of word. See Table 6.9 for definition of prefixes. Repeated words can be omitted. The words run together, which makes the code difficult to read (for humans).	N001G00X07000Y03000M03 N002Y06000
<i>Word address format with TAB separation and variable word order.</i> This is the same format as the previous, except that words are separated by TABs, and the words in the block can be listed in any order. See Table 6.9 for definition of letter prefixes.	N001 G00 X07000 Y03000 M03 N002 Y06000

MCU (MACHINE CONTROL UNIT)

➤ *Every NC machine tool has a main unit, which is known as MCU, consist of some electronic circuitry (Hardware) that reads the NC program, interprets it and conversely translates it for mechanical actions of the machine tool.*

- ✓ *Housed MCU*
- ✓ *Swing around MCU*
- ✓ *Stand alone MCU*

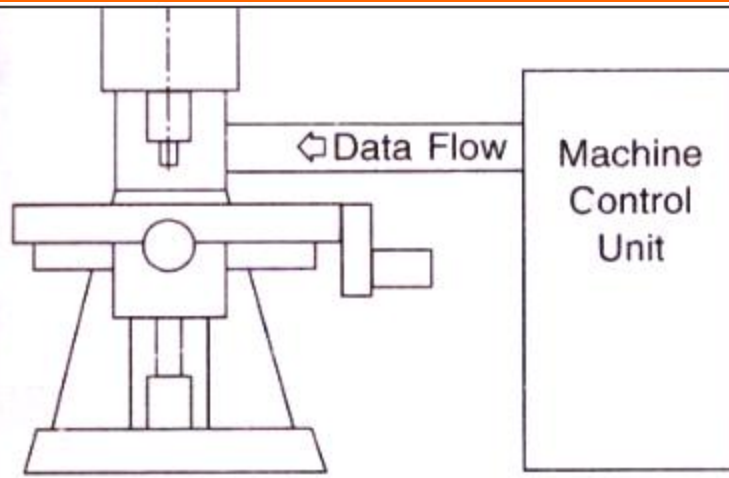


Fig. 9.1 *Principle of Operation of a NC Machine Tool!*

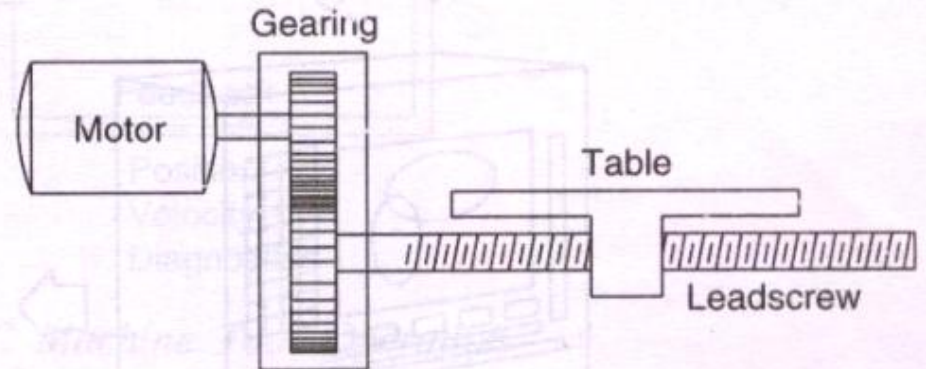


Fig. 9.2 *Principle of Operation of the Control of Axis Motion in a NC Machine Tool*

Control System In NC System.

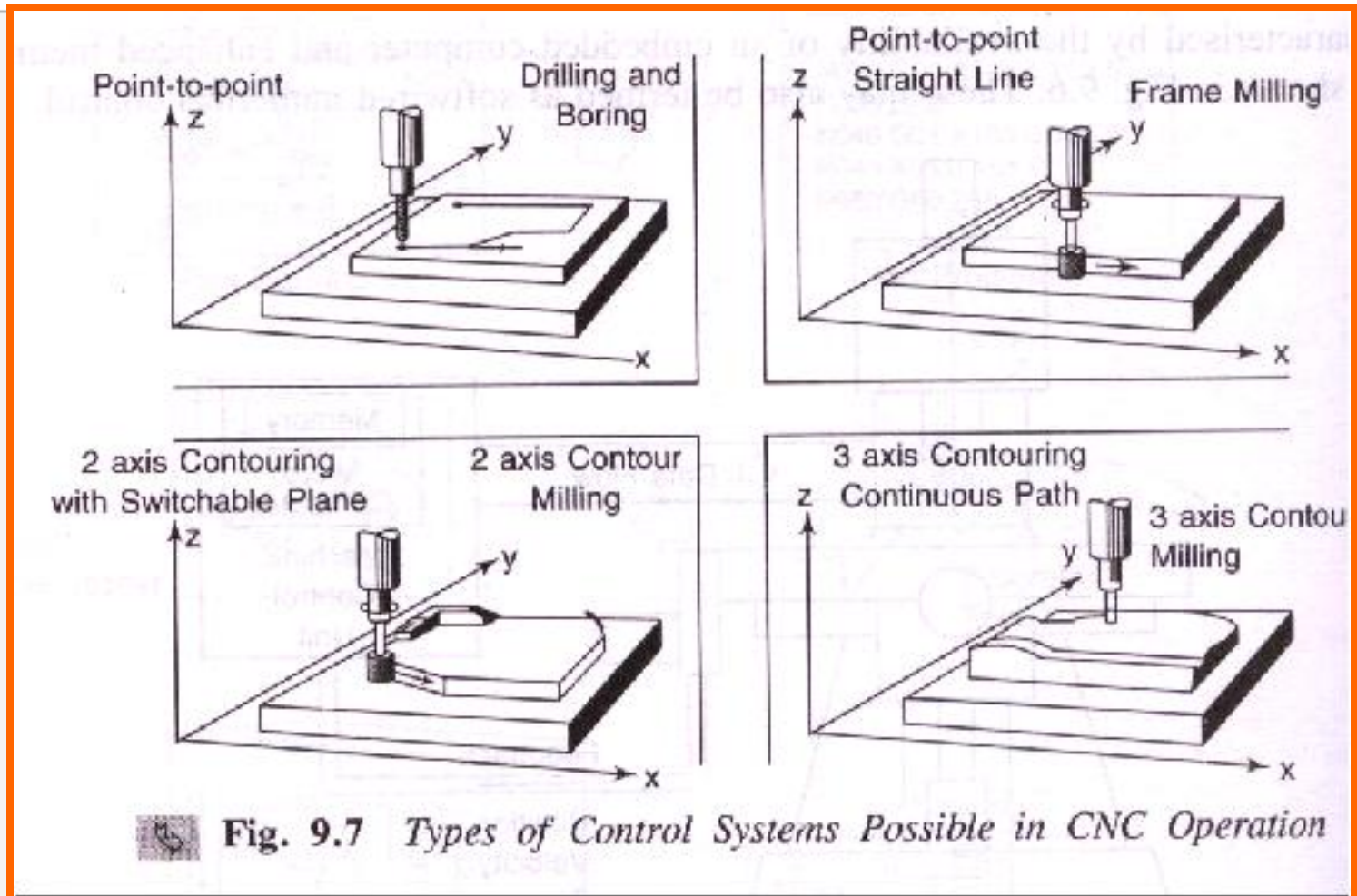


Fig. 9.7 Types of Control Systems Possible in CNC Operation