ch-01 { :- Non-Conventional Machining Process :-

Process :-

Process is the sequence of independent and linked procedures which at every stage, consume one or more resources (employee, time, energy, machine, money) to convert inputs (data, material, parts etc.) into outputs.

Manufacturing :-

The process of converting raw material, component or parts into finished goods that meet a customer's expectations or specifications.

Machining :-

Machining is a term used to describe a variety of material removal process in which a cutting tool removes unwanted material from a workpiece to produce the desired shape.

Ex :- Turning, Milling, Drilling, Shaping, Sawing etc.

Need of Non-Conventional Machining Methods :-

→ Economic considerations.

→ Replacement of existing manufacturing methods by more efficient and quicker ones.

→ Achivement of higher accuracies and quality of surface finish.

→ Adopting of cheaper materials in place of costlier ones.

→ Developing methods of maching such materials which cannot be easily machined through the conventional methods.

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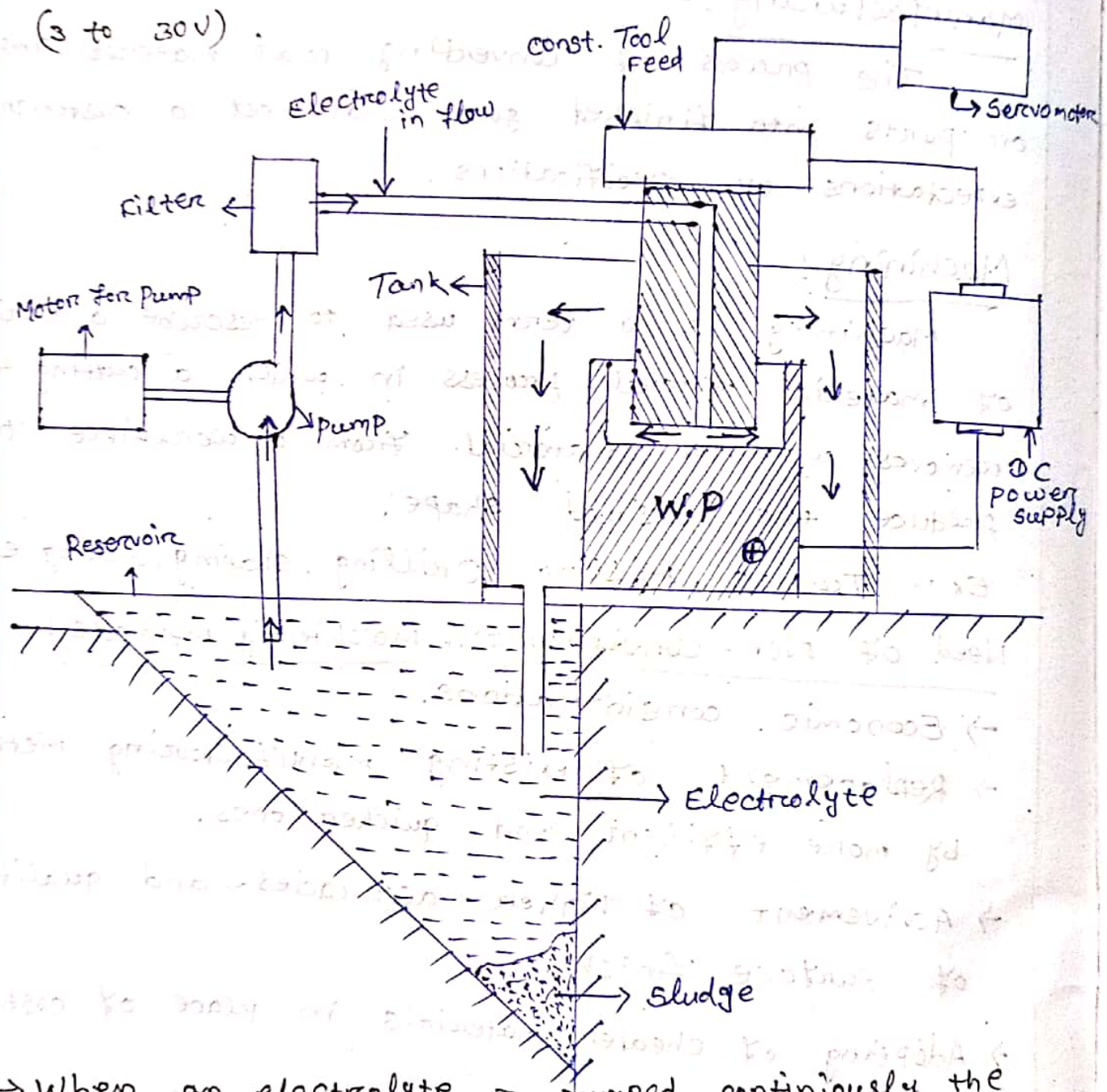
Electro-Chemical Machining Process (ECM) :-

→ The principle is based on Faraday's Laws of Electrolysis.

→ Workpiece acts as anode while the tools acts as cathode.

→ The tool and the workpiece are held close to each other (0.5 mm) & a mild DC voltage is applied (3 to 30 V).



→ When an electrolyte is pumped continiously the positively charged ion are attracted towards the tool (cathode), resulting in removal of material from the work piece in the form of sludge.

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→ This sludge is taken away from the gap by the following electrolyte along with it.

→ The area where the tool and workpiece are closer experience flow of higher current due to low resistance leading to higher and faster metal removal.

→ This enables the reproduction of the tool shape on the workpiece.

→ Workpiece is stationary during the process while the tool is fed at a constant speed in a linear direction.

→ The common electrolytes are Sodium Nitrate and Sodium Chloride.

→ Stainless steel, Brass, Copper, Titanium etc. are used as tool materials.

Advantages :-

→ Intricate and complex shapes can be machined easily.

→ High metal removal rate.

→ Insignificant tool wear.

→ No cutting forces are involved, so work surface is free of stresses.

→ High surfaces finish of the order of 0.1 to 2.0 microns.

Dis-advantages :-

→ Non-conductors of electricity cannot be machined.

→ Very high power consumption.

→ Corrosion and rusting of workpiece, machine tool, fixtures.

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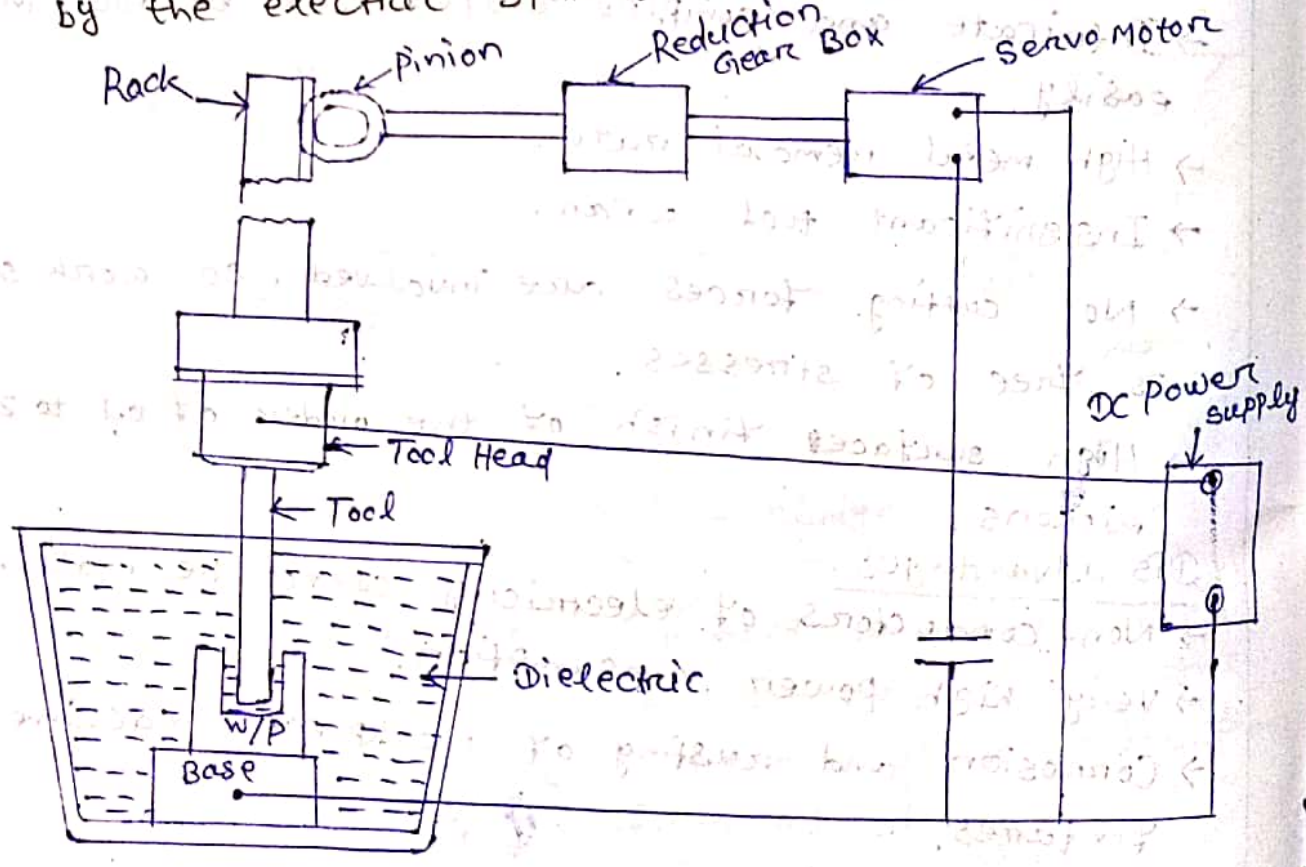
→ Hig initial investment.
→ Difficulty in designing & fabrications of tools.
→ Larger floor space is required.

Applications :-

→ Machining of hard to machine & heat resistant materials.
→ Machining of blind holes & pockets.
→ Machining of complicated profiles such as jet engine blades, turbine blades, wheels.
→ Drilling small deep holes in nozzles.
→ Deburring of parts.

Electrical Discharge Machining Process (EDM) :-

→ It is also know as spark-over-initiated discharge machining.
→ Metal removal takes place due to erosion caused by the electric spark.



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→ Workpiece and electrode is separated by a gap, called spark gap (0.005 mm to 0.5 mm).

→ The workpiece is connected to the positive terminal (anode) and the tool to the negative terminal (cathode) of the power source.

→ This gap is filled by a dielectric which breaks down when a proper voltage is applied ~~to the~~ between these two.

→ When a circuit voltage of 50V to 450V is applied, electron start flowing from the cathode, due to electrostatic field, and the gap is ionised.

→ The electric spark so caused directly impinges on the workpiece with considerable force and velocity, resulting in the development of very high temperature (10,000°C) on the spot.

→ This forces the metal to melt and a portion of it may be vaporised even.

→ These vaporised or melted particles of the metal are thrown into the gap by the electrostatic and electromagnetic forces from where they are driven away by the flowing liquid dielectric.

→ The rate of material removal depends upon the discharge current, duration of pulse and the rate of pulse repetation.

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→ Machining speed is in cm^3/min.

→ The gap control is through a servo system which may be electrical or hydraulic.

Advantages :-

→ Enables high accuracy.

→ Even highly delicate sections and weak materials can be machined.

→ Irrespective of its hardness and strength, any material which is electrically conductive can be machined.

→ Any shape that can be imparted to the tool can be reproduced on the work.

→ It is a quicker process.

Dis-advantages :-

→ Capacity to machine small workpiece only.

→ Unsuitable for machining non-conductive materials.

→ Thermal distortion in the workpiece.

→ Inability to produce sharp corners.

Applications :-

→ Useful in tool manufacturing.

→ Re-sharpening of cutting tool and broaches.

→ Trepanning of holes with straigh and curved axes.

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→ Machining of cavities for dies.

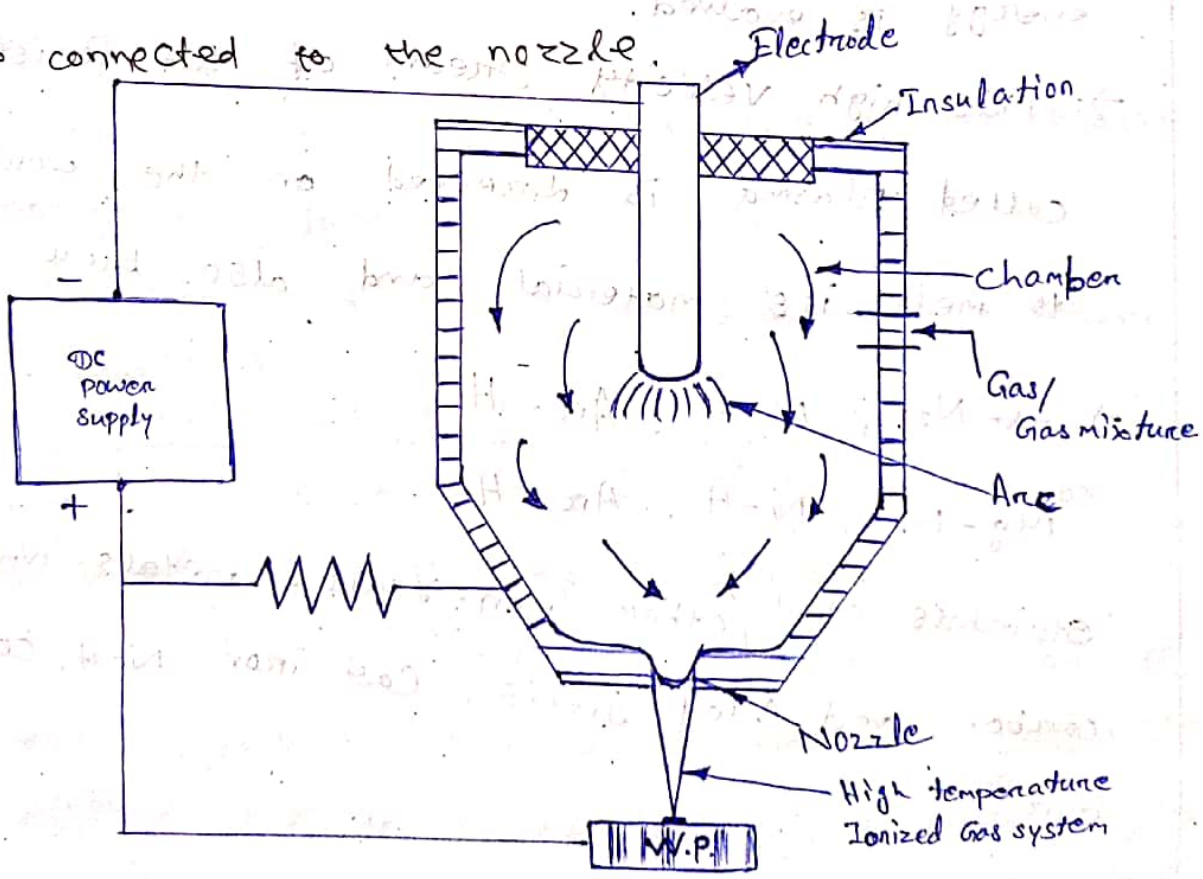
Plasma Arc Machining Process (PAM) :-

→ When gases are heated to temperature above 5500°C, they are partially ionized and exists in the form of mixture of free electrons, positively charges ions and neutral atoms, this mixture is termed as plasma.

→ The temperature of the central part is between 11000°C to 28000°C.

→ Plasma-arc torch carries a tungsten electrode.

→ It is connected to the negative terminal of a DC power supply source and the other terminal (positive) is connected to the nozzle.



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→ Passage for supply of gas into the chamber is provided in the torch.

→ To keep the electrode and nozzle water cooled, there is also a provision of water circulation around the torch.

→ A strong arc is struck between the electrode and the nozzle and the gas forced into the chamber.

→ As the gas molecules collide with the high velocity electrons of the arc the former gets ionised and a very large amount of heat energy is evolved.

→ This high velocity stream of hot ionised gas called plasma is directed on the workpiece to melt its material and also blow it away.

→ Al - N_2 , N - H , Ar - H

Mg - N_2 , N - H , Ar - H

Stainless steel / other non-ferrous metals - N-H, Ar-H

carbon and Alloy Steels, Cast iron - N-H, compressed air.

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Advantages :-

→ Faster process.

→ Excessively high temperature.

→ Can be used to cut any material.

Dis- advantages :-

→ High - initial cost of equipment.

→ Adequate safety precaution needed for the operations.

→ Work surface may undergo metallurgical changes.

Applications :-

→ Cutting of stainless steel and non-ferrous metals.

→ Used in shipyards due to the under water feasibility.

→ Other industries like nuclear power plants, chemical industries, etc.

→ Turning and milling of hard to machine materials.

Laser Beam Maching process (LBM) :-

→ LASER stands for - Light Amplification by Stimulated Emission of radiation.

→ The optical energy (light) is thrown by the flash lamp on the laser tube (Ruby rod) which excites the atoms of the inside media, which absorbs the radiation of incoming light energy.

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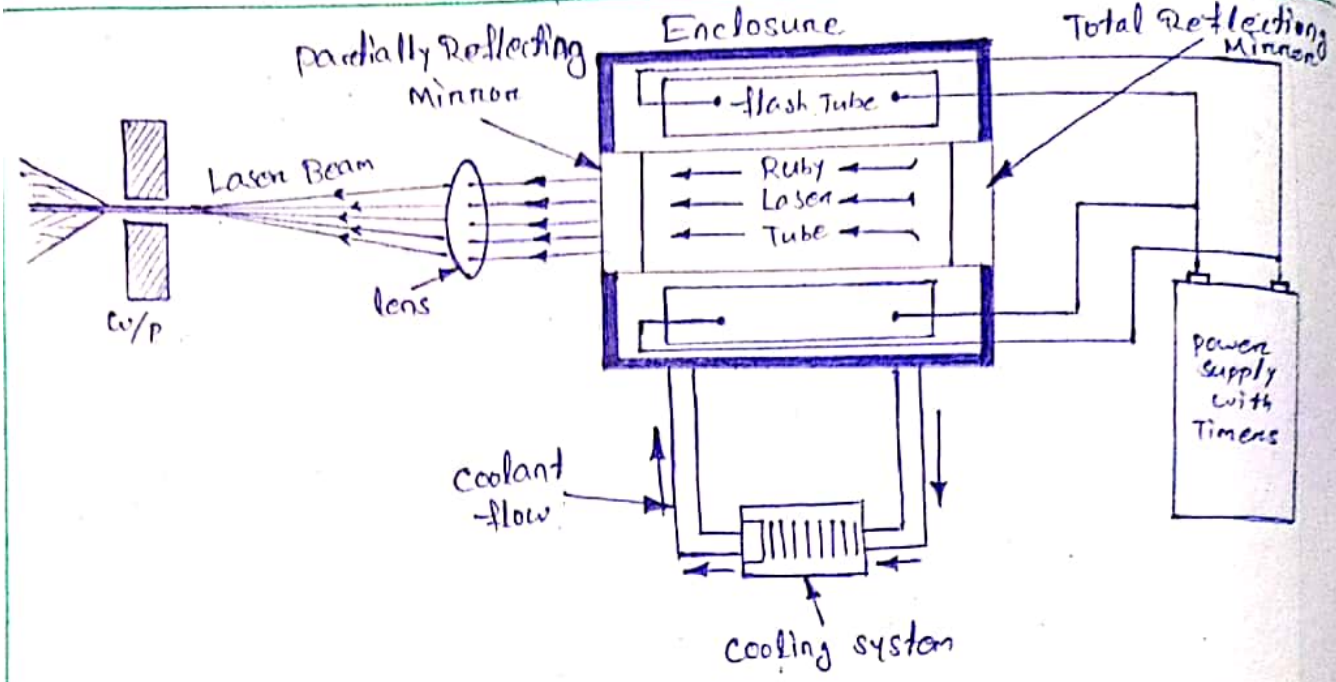

→ This results in the to and fro travel of light between the two reflecting mirrors, but the partial reflecting mirror doesn't reflect the total light back and a part of it goes out in the form of a coherent stream of monochromatic light.

→ This highly amplified beam (stream of light) is focused through a lens, which converges it to a chosen point on the workpiece.

→ This high intensity converged laser beam, when falls on the workpiece, melts the workpiece material, vaporizes it almost instantaneously and penetrates into it.

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Advantages :-

→ Any material can be machined irrespective of its structure and physical and mechanical properties.

→ Non-existant tool wear.

→ Can be used for joining dis-similar metals as well.

→ Very small holes can be made with fairly high degree of accuracy.

~~Abrasive~~

Dis-advantages :-

→ High capital investment.

→ High operating cost.

→ Highly skilled operator needed.

→ Lower production rate.

→ Limited to thin section.

→ Not effective to machine highly heat conductive and reflective materials.

Applications :-

→ Drilling small holes in hard materials like tungsten and ceramics.

→ Cutting complex profiles on thin and hard materials.

→ Cutting or engraving patterns on thin films.

→ Trimming of sheet metal & plastic parts.

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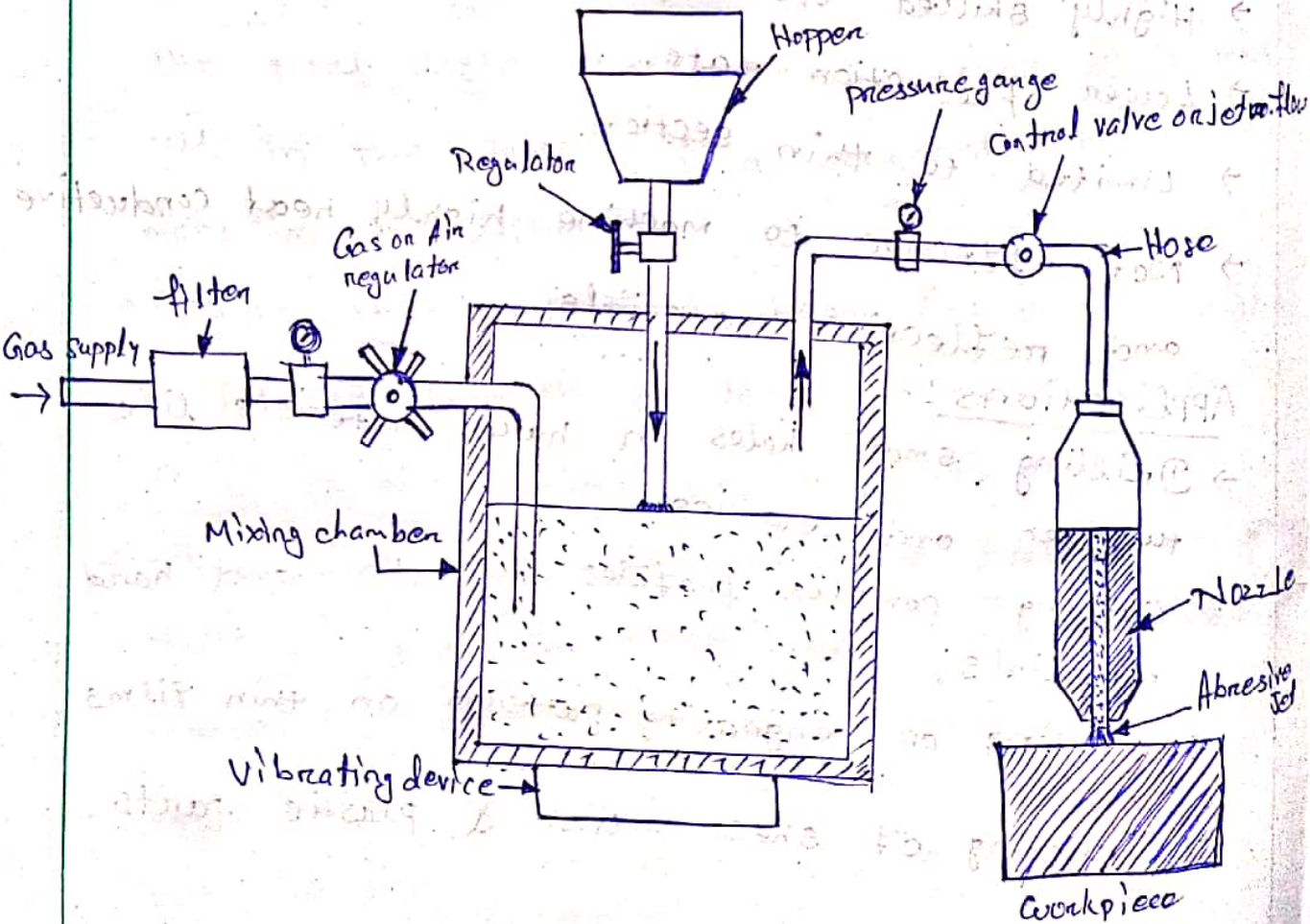
Abrasive Jet Machining Process (AJM) :-

→ The process consists of directing a stream of fine abrasive grains, mixed with compressed air or some other gas at high pressure, through a nozzle onto a surface of the workpiece to be machined.

→ The abrasive particles are contained in a suitable holding device like a hopper, and fed into the mixing chamber.

→ A regulator is incorporated in the line to control the flow of abrasive particles.



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→ Compressed air or high pressure gas is supplied to the mixing chamber through a pipe line which carries a pressure gauge and a regulator to control the gas flow and it's pressure.

→ The mixing chamber carrying the abrasive particles is vibrated and the amplitude of these vibrations controls the flow of abrasive particles.

→ These particles mix in the gas stream, travel further through a hose and finally through the nozzle at a considerable high speed.

→ This outgoing high speed stream of the mixture of gas and abrasive particles is known as abrasive jet.

→ The carrier gas used should be non-toxic, easily available, cheap and the one that dries quickly (Air, Nitrogen and CO_2)

→ The abrasive commonly used are

Aluminium Oxide - Machining, grooving, cutting

Silicon Carbide - Faster machining of hard material

Sodium Bi-carbonate - For finishing work

Dolomite - Etching, light cleaning

Glass beads - Fine deburring & light polishing

→ The nozzles used are made of Tungsten carbide or synthetic Sapphire.

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Advantages :-

→ Machining of intricate cavities and holes

→ Machining of brittle material with thin sections.

→ Low capital investment.

→ No direct contact between tool and workpiece.

→ Negligible amount of heat generation.

Dis-advantages :-

→ Not suitable for machining ductile materials.

→ Slow metal removal rate.

→ Poor machining accuracy.

→ Abrasive particles cannot be reused.

→ Cleaning of embeded abrasive particles required.

Applications :-

→ Fine drilling and micro welding.

→ Machining of semiconductors.

→ Machining of intricate profiles on hard and fragile materials.

→ Apeture drilling for electronic microscopes.

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Electron Beam Machining Process (EBM) :-

→ It is a process of machining materials with the use of high velocity electrons.

→ The complete set up is enclosed in a vacuum chamber (10^{-5} mm of Hg).

→ Carries a door through which the workpiece is placed over the table and then closed and sealed.

→ The electron gun consists of three parts, tungesten filament, the grid cup and anode.

→ The filament wire is heated to a temperature of about 2500°C in the vacuum as a result of which a cloud of electrons is emitted by the filament, which is directed by the grid cup to travel downwards.

→ As the electrons are attracted by the anode, they pass through its aperture in the form of a controlled beam without colliding with it.

→ A potential difference of 50 to 150 kV is maintained between the filament and the anode, as such the electrons passing through the anode are accelerated to achive as high a velocity as around two third of of light.

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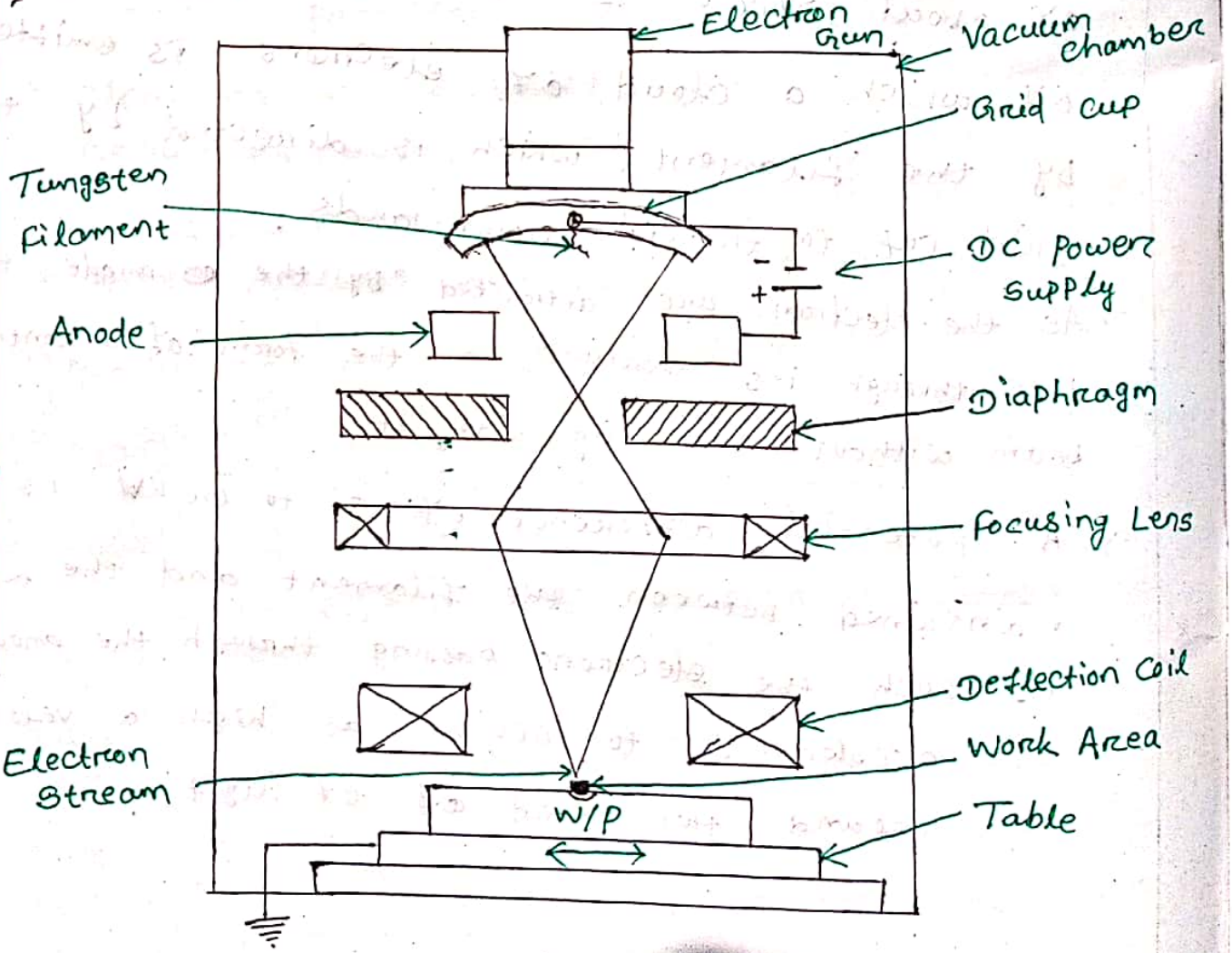
→ This high velocity of electron stream, after leaving the anode passes through the tungsten diaphragm and then through the electromagnetic focusing coils.

→ The stream is quite aligned and the focusing lens manages to focus it precisely onto the desired spot of the workpiece,

→ The electromagnetic deflector coil then deflects this aligned stream onto the workpiece, through which the path of cut can be controlled.

→ The high velocity beam of electrons impinges on the workpiece, where its kinetic energy is released and gets converted into heat energy.



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→ This heat melts and vaporises the work material at the spot of beam impingment.

→ Adequate vacuum is required to be maintained inside the chamber so that the electrons can travel from cathode to anode without any hindrance.

→ There is no arc discharge between the electrodes, no loss of heat from cathode and no contamination of cathode.

Advantages :-

→ Any material can be machined.

→ Workpiece is not subjected to any physical or metallurgical damage.

→ Negligible tool wear.

→ Heat can be concentrated on a particular spot.

→ An excellent technique for micro-machining.

→ No contact between work and tool.

Dis-advantages :-

→ High initial investment.

→ Highly skilled operator needed.

→ Not suitable to produce perfectly cylindrical deep holes.

→ For small and fine cuts only.

→ Limited workpiece size due to vacuum.

→ Lower material removal rate.

→ High power consumption.

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Ch-02 : Automation :-

Introduction :-

→ It has been and continues to be the tendency of industry to increase productivity, improve quality of the finished products and thus enhance the production efficiency.

→ These objectives have led to an ever growing tendency to transfer more and more human activities into power operated or mechanisms operated activities.

→ It implies that the tendency has been to use power for performing more and more of those functions which were performed by human beings or replace more and more human operations by power operated operations.

Mechanization :-

Mechanization of a particular process means that the same will be carried out or performed with the use of power or energy, such as mechanical, electrical, pneumatic, hydraulic, etc. instead of being performed by a human being.

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Automation :-

It represents a higher degree of mechanization, through which most or all of the operations or activity involved in the manufacturing of a product are performed through automatic means i.e, without direct participation of a human being, except in some aspects like retooling of machine when there is a change of product, readjustments for corrections etc.

Types of Automation :-

(i) Partial automation :-

It means replacement of human activities or involvement by automatic means only partially

(ii) Full automation :-

In this type of automation the human involvement is totally elimated and the process is entirely carried out and controlled through automatic means along with a proper feedback system.

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Levels of Automation :-

According to 'Amber and Amber's Yard stick for Automation', all types of automation are divided into 10 levels, from A(0) to A(9), each representing a different level of human attribute replaced by machine in an ascending order.

A(0) :- Levels stands for no mechanization i.e, no human attribute is replaced by machine, implying that all the activities and operations are performed by human beings only and this includes only hand tools and manually operated machines.

A(1) :- Indicates a higher level of automation, i.e, the one which the energy of human muscles.

A(2) :- Replacement of dexterity (skill in performing tasks, especially with the hands).

A(3) :- Diligence (careful and persistent work or effort).

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A(4):- Judgement (the ability to make considered decisions from sensible opinions).

A(5):- Evaluation (to form an idea of the amount, number or value of anythings).

A(6):- Learning (knowledge or skills acquired through experience or study or by being taught).

A(7):- Reasoning (the power of the mind to think, understand and form judgements logically).

A(8):- Creativeness (relating to or involving the use of imagination or original ideas in order to create something).

A(9):- Dorminance (Power and influence over others).

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Needs of Automation :-

→ Where the environment is highly injurious to human beings i.e., handling the radioactive substances.

→ Where economic feasibility permits it.

→ Where the Process is extremely rapid and complex, such that human participation may lead to errors.

→ Where their adoption will facilitate the use of a larger number of standardized parts and sub-assemblies.

→ Where their adoption will lead to large scale savings in labor cost, tooling cost, Processing cost and other associates cost.

→ Where their adoption will enable the use of groups technology in parts manufacture.

→ Where their adoption will make the Process control simpler and more effective.

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→ Where their adoption will enable maximum utilization of machine, advanced production methods and tooling in order to maximize production rate and enhance quality standards of the products.

→ When they can be easily adopted without any major alteration in the existing process layout.

Advantages:-

→ Overall production cost is reduced.
→ Ensured human safety.
→ Increased Productivity.
→ Better working conditions for workers.
→ Tidy and safe workspace.
→ Minimized human fatigue.
→ After initial setting, there is minimal involvement of the operator in the actual process.
→ Less floor area required.
→ Minimized inventory requirement.

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→ Improved quality and ~~reliability~~ reliability of the Products.

→ Components produced are uniform.

→ Minimized maintenance requirements.

→ Overall profits of the manufacturing concerns are increased.

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Ch-03 } :- Numeric Control :-

~~→ Control can be de~~

Numeric Control :-

→ Control can be defined as the situation of being under the regulation, domination, or command of another.

→ Numerical control means control by numbers.

→ These numbers are arranged in the form of blocks or series, which carry specific instruction known as prepared programme.

→ The instructions contained in the programme are read and interpreted by the NC system to regulate the different slides of the machine tool, select suitable cutting speeds and feeds and control tool movements, so that the component is machined to the required size and shape.

→ As per Electronics Industries Association (EIA) NC system is "A system in which actions are controlled by the direct insertion of numerical data at some point. The system must automatically interpret at least some portion of this data".

→ NC system has made it possible to automate these conventional machine tools too, used in small lot production, and thus overcome the difficulty, especially in respect of large set up time.

→ In a NC system, the operating instruction are in coded form, such as numbers, letters, symbols etc. are stored on punched tapes or cards.

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→ The numerical data, containing these instruction, is arranged on the tape in the form of a series of several blocks; each block containing information needed to machine one portion of the component.

→ When the machining of one portion of the component is over, the tape moves forward, by a distance equal to the next block, so that the next portion of the component is machined.

Numerical Control of Machine Tool :-

→ Tool is any physical item that can be used to achieve a goal, especially if the item is not consumed in the process.

→ A machine is a tool containing one or more parts that uses energy to perform an intended action.

→ A machine tool is a machine for shaping or machining metal or other forms of deformation.

→ All machine tools have some means of constraining the workpiece and provide a guided movement of the parts of the machine.

→ So numerical control of machine tools is a programmable automation where in the operating functions of the machine tool are controlled by coded numbers and letters.

Manufacturing Through NC :-

→ The manufacturing through NC starts with Engineering Drawing of the part to be produced.

→ It is first received by the process planning department where it is analysed and interpreted in terms of the process of manufacturing and their sequence to be used for producing that part.

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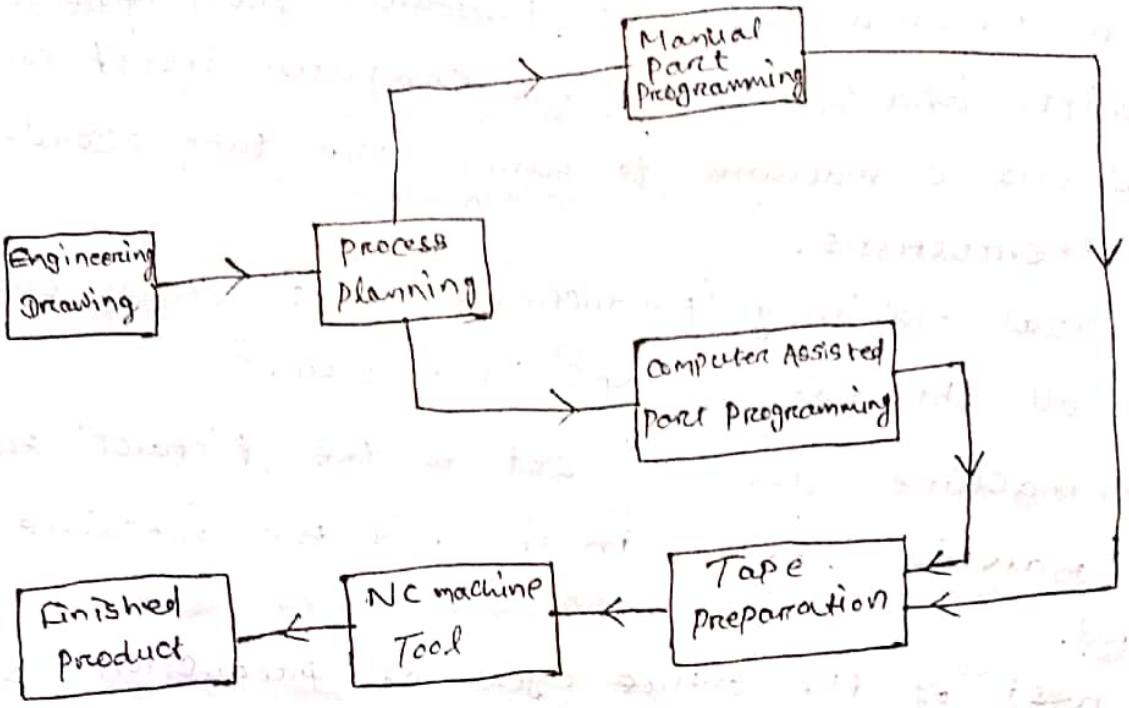

The process sheet is used for:

i) Tool designing
ii) Fixture designing
iii) Deciding tool details
iv) Preset tooling
v) Part programming

→ The part of programming need to be done which involves planning of the machining sequence, relative positions of cutting tool and workpiece at each step of the operation and necessary instruction for machining.

→ This programming can be done manually (MPP- the machining instructions are recorded in a special format, called manuscript) and with the use of computer as computer assisted part programming (CPP - the process sheet is handeled by the computer to interpret the contained instructions, prepare necessary commands for machining and prepare the tape for the NC machine tool).

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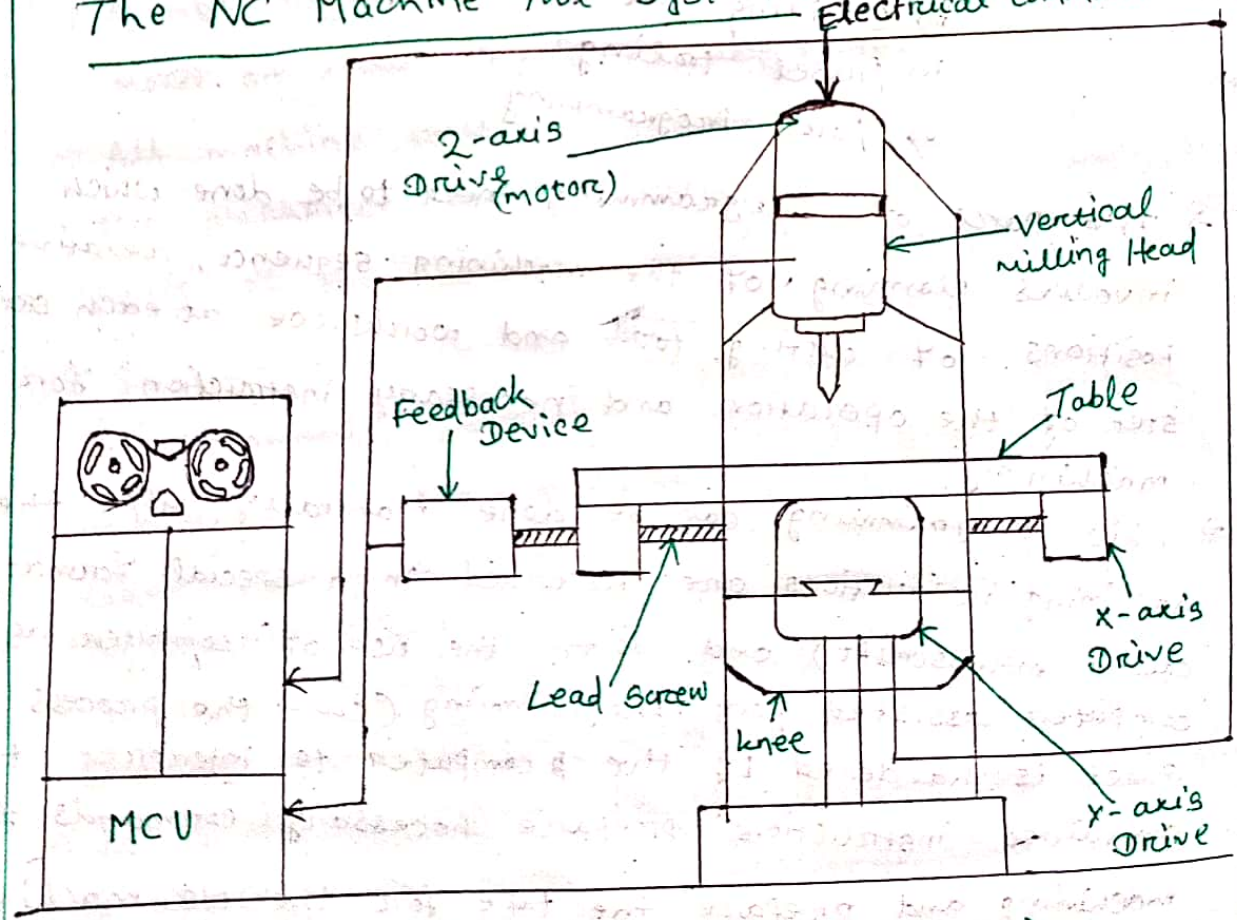
→ The next step is preparation of the tape, for MPP, a punched tape is prepared from the manuscript and for CPP, the computer itself controls and directs a machine to punch the tape according to its instructions.

→ The actual machining (production) works starts only after all the above steps are over.

→ The machine tool is set to the 'start' position, raw material loaded in it and the machine started.

→ The rest of the entire cycle of production is taken care of by Numerical Control i.e., through the commands and instructions given by the punched tapes.

The NC Machine Tool System :-



(NC Machine Tool System)

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A complete NC machine tool system consists of the following main elements or units:

a) A machine control unit (MCU)
b) The machine tool
c) The drive units and servo control
d) Feedback devices

a) Machine Control Unit (MCU):-

→ The first subunit of MCU is a Tape reader which receives the coded data from the punched tape, reads it and passes on the information to the buffer storage or data buffer via the decoding circuits.

→ Buffer storage stores the received information, till it is needed, and transfers it fast to the required area, when needed. to ensure that machine tool operates continuously.

→ This unit is called Data Processing Unit (DPU) which passes on the decoded information to the control unit.

→ The control unit directs and controls the operations of different drive units of the machine tool through signal output channels which convey the instructions from the control unit to the machine tool.

→ The control unit also receives the feedback, through feedback drives to make sure that the instructions given by it are properly carried out by the machine tool.

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b) The Machine Tool :-

→ It is the principal manufacturing arm of the NC system.

→ It receives the raw material and performs different machining operations over it, in accordance with the instructions conveyed by the MCU, to shape the material into the desired shape and size of finished article.

c) The Drive Units and Servo Control :-

→ The drive units mainly consists of stepping motors, DC motors or hydraulic motors, gear trains and transducers etc. and all these units as a group known as servo controls or servomechanism.

→ The original commands from MCU are received by the servo controls in the form of electrical signals or precisely electrical pulses and converted into controlled mechanical movements of various slides and other parts of the machine tool.

Commonly there are two types of servo control systems.

i) Open-Loop Systems
ii) Closed-Loop Systems

i) Open-Loop Systems :-

→ It is simpler and cheaper.

→ In this system there is no provision to ensure that the slides has actually moved through the desired distance only and that it has actually acquired the desired position as a result of this distance.

→ It involves feeding of tape, interpreting the information by the tape reader, storing the information in the buffer storage, converting the information into electrical signals and sending the signals into the control unit.

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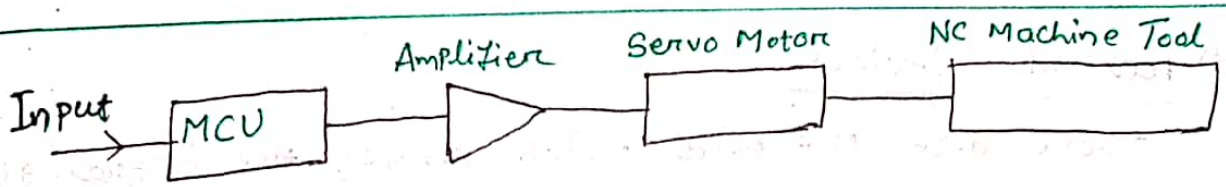
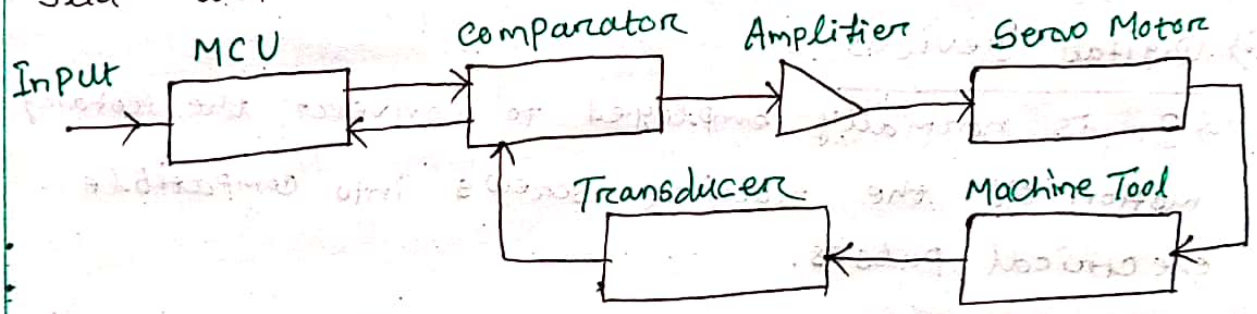


→ The control unit energizes the servo controls (driving units) by sending command signals to them, resulting in the driving units to perform certain motion to move the slides through a desired distance.

ii) Closed - Loop System :-

→ It carries an additional feature in that a feed back system (is a transducer accompanied by a comparator) is incorporated in its electrical circuit.

→ The command signals are sent to the servo motor by the control unit while the transducer feedback the slide displacement corresponding to these command signals.



→ The comparator compares the actually achived slide positions with the command signals and the error, if any is fed back to the control unit, via an amplifier.

→ The control unit sends corrective commands to the servomotor and this cycle continues unless the signal from feedback unit and that from the control unit both become equal i.e. zero error.

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d) Feedback Devices :-

These are the units which convey the actual slide positions to the MCU, so that these can be compared there with the programmed positions and errors (if any) noted and corrected.

i) Analog Transducers :-

→ It is a feedback device which produces a variable electrical voltage.

→ This voltage varies in proportion to the rotational speed of the input shaft and can be easily measured and converted into linear distances to indicate corresponding positions of machine table.

Ex - Potentiometer

ii) Digital Devices :-

→ It is normally employed to convert the rotary motion of the machine screws into compatible electrical pulses.

→ The number of these pulses indicates the linear distance moved by the table of the machine corresponding to the rotation of the lead screw.

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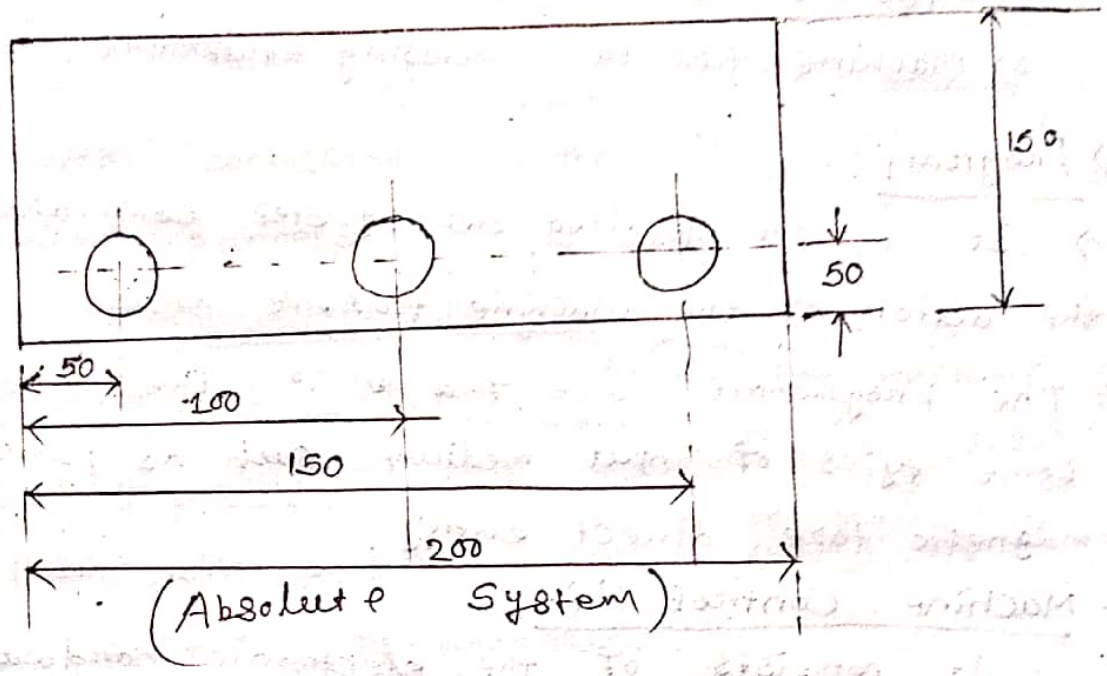
Tool Positioning System :-

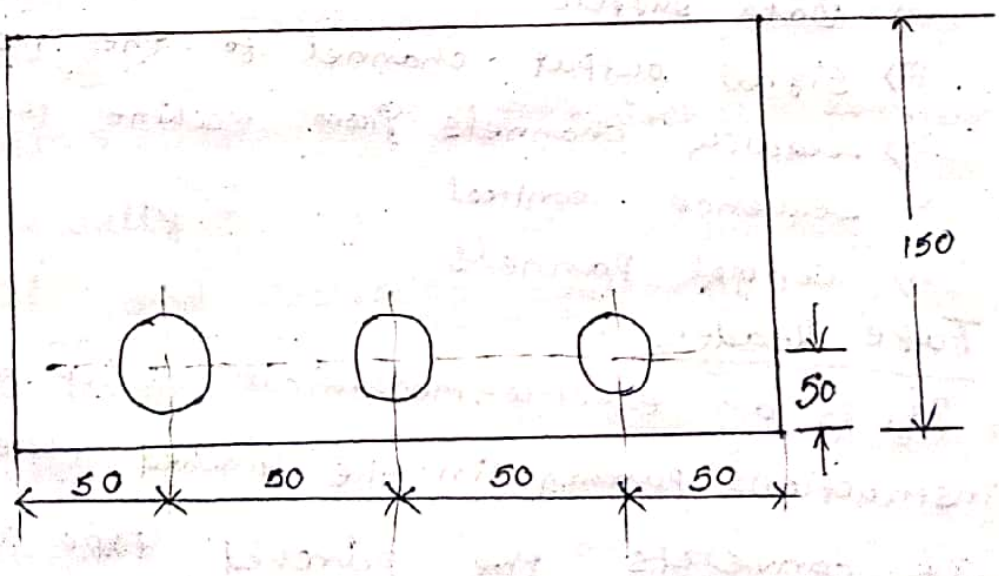
a) Absolute System :-

In this system, the positions are indicated from a fixed zero at reference point.



b) Incremental System :-

In this system, the tool positions or locations are indicated with reference to a previously known location.



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Numerical Control Technology :-

→ Controlling a machine tool by means of a prepair program is called Numerical control technology.

→ Basic components of NC system :-

1) Program
2) Machine control unit
3) Machine tool or processing equipment.

1) Program :-

→ It is the detailed step by step commands that directs the action of the machine tool.

→ The programme are fed to the machine through some types of input medium such as punched tape, magnetic tape, direct entry.

2) Machine Control Unit :-

→ It consists of the electronic hardware systems that reads and interpretates the programme and converts it into mechanical action of the machine tool.

→ MCU includes :-

i) Tape reader
ii) Data buffer
iii) Signal output channel to the machine tool
iv) Feedback channels from machine tool.
v) Sequence control
vi) Control pannels

i) Tape Reader :-

→ It is an electro-mechanical device used to read the instructions punched in the punched tape.

→ It converts the punched tape instructions into the machine code instructions and stored in data buffer.

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ii) Data Buffer :-

→ It is used to store the input instructions in the logical blocks of information.

→ Each block of information represents one complete step in the sequence of processing elements.

iii) Signal Output Channels to the Machine Tool :-

They are connected to the servo motors to do the machining process.

iv) Feedback Channels from Machine Tool :-

They send the feedback from the machine tool about the new positions of machine tool slides, compare them with original control output signal and correct the positions if necessary.

v) Sequence Control :-

It co-ordinates all activities of the machine control units elements like reading from the tape and sending signal to the machining tools.

vi) Control Pannel :-

It contains dials and switches to run the machine manually.

3) Machine Tool and Processing Equipment :-

The machine tool performs the useful work, it consists of the work table, slides and spindles with separate individual servo motor and it controls to drive them independently.

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→ The linear movement of the slides and spindles are specified with respect to the co-ordinate axis x, y & z.

→ It is capable of performing verity of machining operations like drilling, reaming, tapping.

→ It has automatic tool changing capacity by using automatic tool changer automatic work positioning.

NC Procedure :-

a) Process planning

b) Part programming

c) Tape preparation

d) Production

a) Process Planning :-

→ From the drawing of work part, the manufacturing process are determined and a root seat is prepare.

→ A root seat is a list containing the sequence of operations.

b) Part Programming :-

→ The sequence of machining steps to be performed by numerical control (program instructions are converted into output signals which in turn control machine operations such as spindle speeds, tool selections and tool movement.

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c) Tape Preparation :-

The punched tape is checked by running it through a computer which plots vertical or various tool movements on backwards.

d) Production :-

Finally the production can be started after successful verification and checking of the tape.

Advantages of NC Machine :-

→ Greater accuracy.
→ Increased productivity.
→ Improved product quality.
→ Greater manufacturing flexibility.
→ Reduced part inventory.
→ Reduced floore space requirement.
→ Improved machine utilisation.

CNC :-

→ In CNC machine in dedicated computer is used to perform the most of basic NC basic functions.

→ CNC machine is a NC machine which uses a dedicated computer as the machine control unit.

→ The entire programme is entre and stored in computer memory.

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→ The machining cycle for each component is controlled by the programme, contained in the computer memory.

Components of CNC Machine Tool System :-

i) Input / output console.

ii) micro processor based controlled unit.

iii) Memory

iv) feedback unit

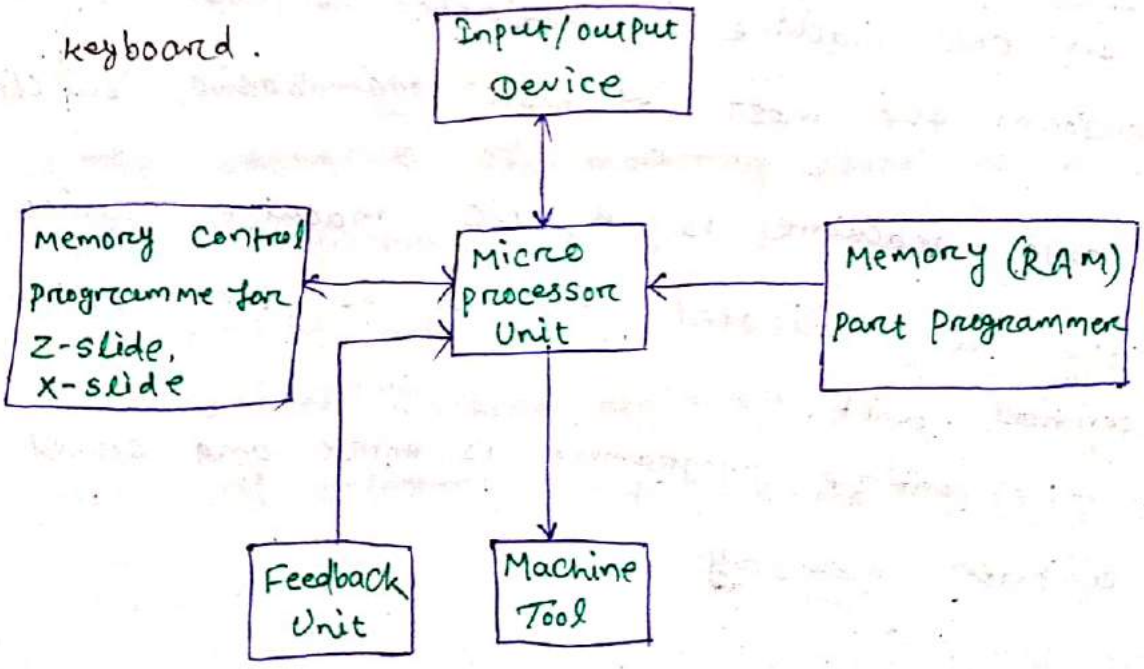
v) Machine Tool

vi) Interfaces

i) Input / output console :-

→ It is the unit through which part programm is fed to the CNC machine tool system and required output is taken out.

→ It is basically consists of monitor and keyboard.



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ii) Micro Processor :-

The controller takes input from input device to feedback ~~unit~~ from feedback unit and actuate the ~~device~~ drives as well as the machine tool.

iii) Memory :-

→ It consists of RAM and ROM.

→ The RAM stores part programme, while ROM stores the programmes for machine control.

iv) Feedback Unit :-

The feedback units takes input from machine tool and transfers it to control unit for necessary correction.

v) Machine Tool :-

The machine tool is operated by control unit.

vi) Interfaces :-

They are the connections between the different components of the CNC machine tool system.

Classifications Based on Type of Feedback system:-

1) Open loop type CNC machine
2) Closed loop type CNC machine.

1. Open loop type CNC machine :-

→ It does not have any feedback mechanism.

→ It only has motion control unit but don't have any provision for feedback, which is needed to be compared with input for better control & correction of drive system.

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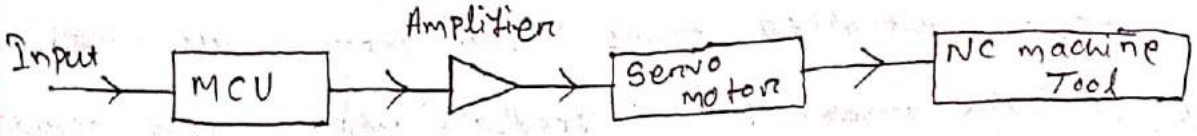
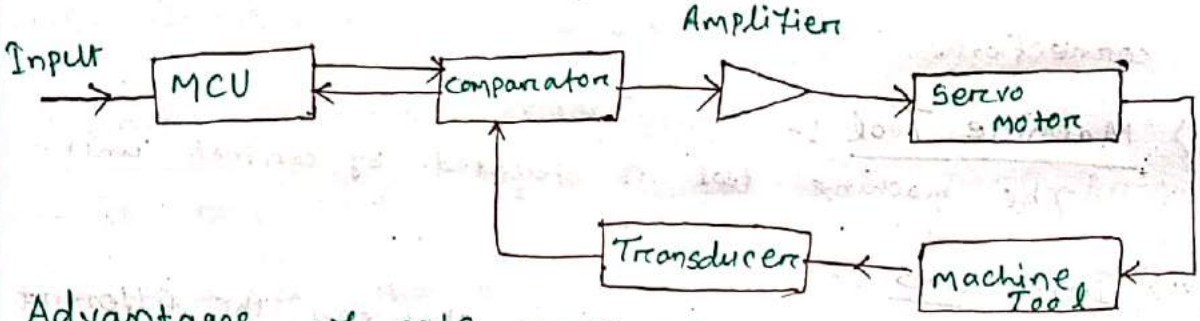


2. Closed loop type CNC machine :-

→ It has a feedback mechanism.

→ It has the motion control with a provision of feedback, which can be used for accurately controlling the drive system by comparing it with the input information until the required or desired position is achieved.



Advantages of CNC Machine :-

→ Each of programme input.

→ Multiple programme storage.

→ Online part programming & editing.

→ Use of advanced interpolation.

→ Automatic tool condensation.

Limitations :-

→ Higher investment cost.

→ Higher maintenance cost.

→ Required specialized operator.

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Motion Control System (Positioning Control System) :-

→ It means a system of movement through which there will be a relative motion between the tool and the workpiece to enable proper positioning of the tool and machining of workpiece.

→ In all positioning control systems, a sensor is employed to record the slide positions and feedback this information to the control unit, which compares it with the input data and rectifies the errors, if any.

a) Point to Point System

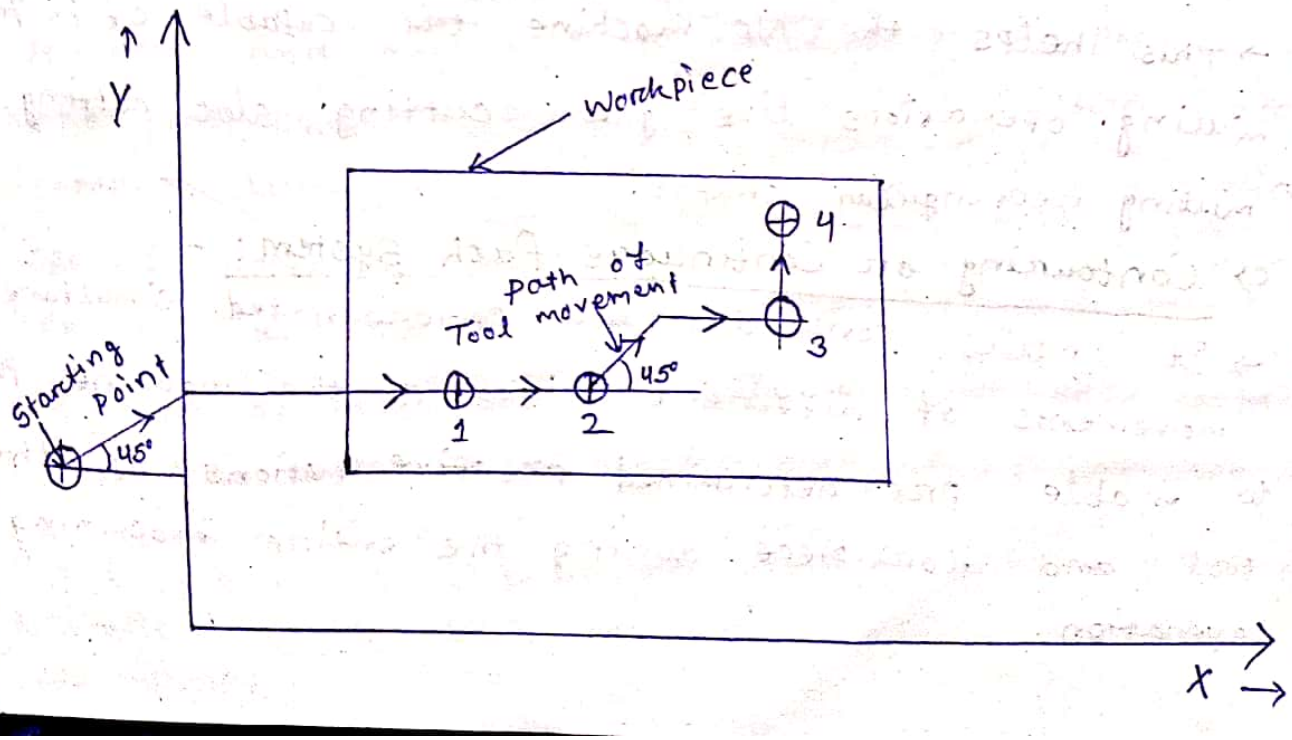
b) Straight Line or Straight Cut System

c) Contouring or Continious Path System

a) Point to Point System :-

→ It is commonly used in operations like drilling, boring, tapping, reaming etc.

→ Where the primary requirement is of accurately locating the tool or the workpiece at some specified location to perform the desired operation.



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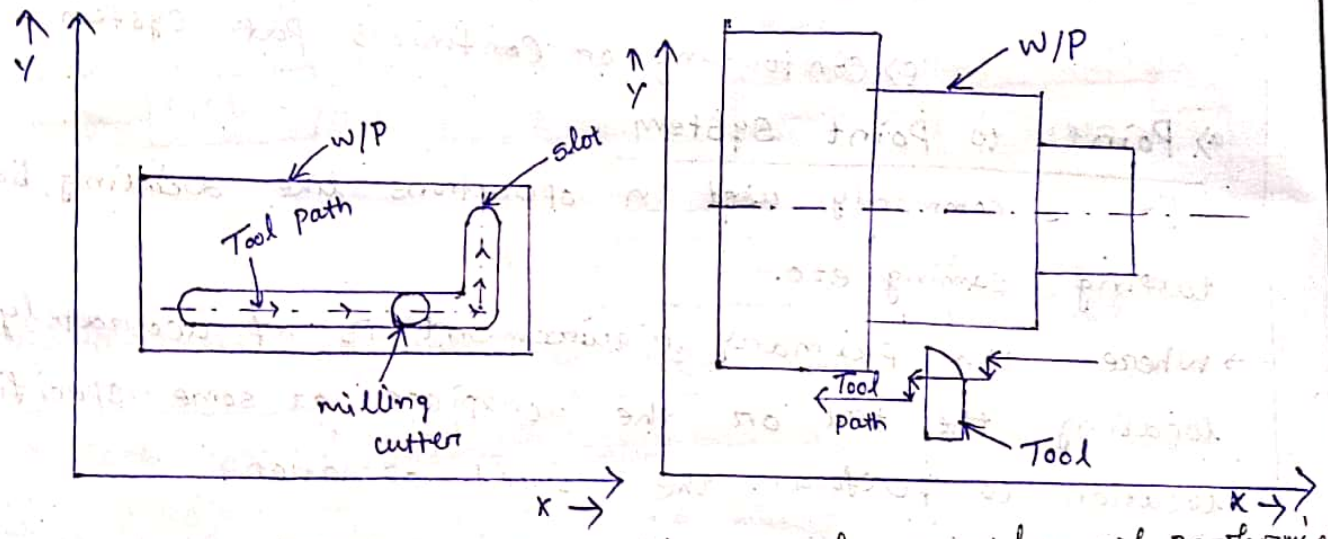
→ This involves positioning of tool or workpiece from one co-ordinate location to another.

→ The movement from one location to another is very fast and no control is required over this relative motion between the tool and workpiece because no cutting takes place between the two locations.

b) Straight Line or Straight Cut System :-

→ In this system the cutting tool can move along straight lines only which is parallel to principal axes of motion i.e., X-, Y- & Z-axis.



→ This helps the NC machine tool capable of performing milling operations like groove cutting, slot cutting, milling rectangular shapes.

c) Contouring or Continuous Path System :-

→ It implies controlled and co-ordinated simultaneous movements of different slides of the machine tool to enable pre-determined relative motions of the tool and work-piece during the entire machining operation.

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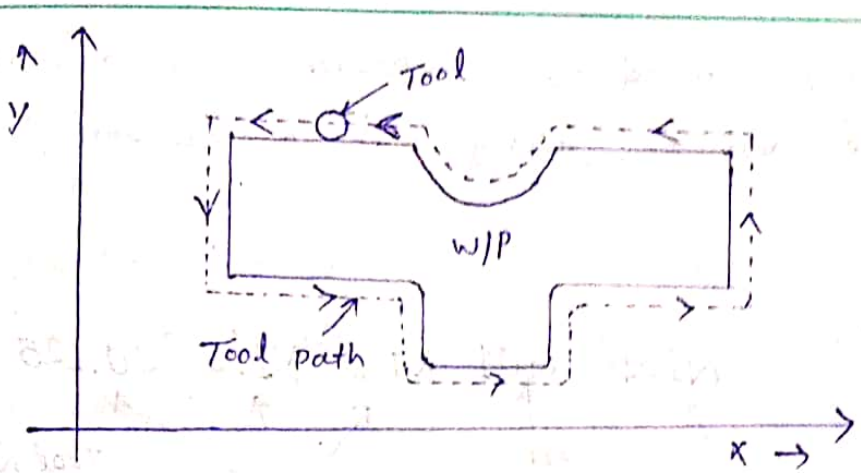

→ The motion of tool and workpiece are controlled along many axes simultaneously in this system and this result in machining of different types of curved surfaces and particles, contours and combinations of straight and curved profiles.

NC Part Programming :-

→ A part program is a list of coded instructions which describes how the designed component or part will be manufactured.

→ These coded instructions are called data - a series of letters and numbers.

→ The part program includes all the geometrical and technological data to perform the required machine functions and movements to manufacture the part.

→ The part program can be further broken down in to separate lines of data, each line describing a particular set of machining operations. These lines, which run in sequence are called blocks.

→ A block of data contains words, sometimes called codeds. Each word refers to a specific cutting/movement command or machine function.

→ The programming language recognized by the CNC, the machine controller, is an I.S.O. code, which includes the G and M code groups.

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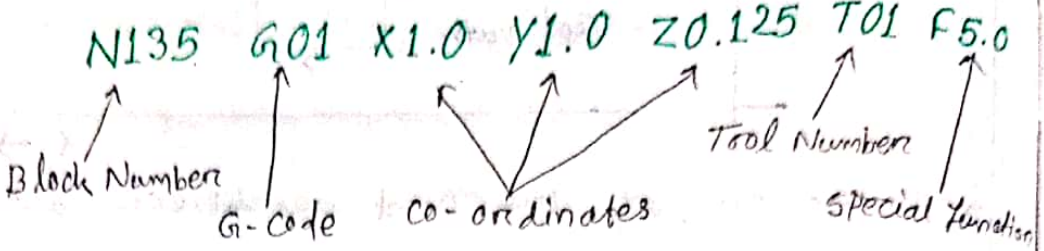
→ Each program word is composed from a letter, called the address, along with a number.



Block Example – N080 G01 Z0.5 F40.

↓

Word Example - G01

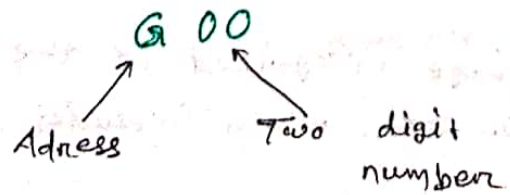
↓

Address Example - G

Types of NC Codes :-

→ The term "preparatory" in NC means that it "prepares" the control system to be ready for implementing the information that follows in the next block of instructions.

→ A preparatory function is ~~designat~~ designated in a program by the word adress 'G' followed by two digits.



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Miscellaneous Codes :-

→ Miscellaneous functions use the adress letter M followed by two digits.

→ They perform a group of instructions such as coolant on/off, spindle on/off, tool change, program stop, or program end.

→ They are often referred to as machine functions or M-functions.

Important G Codes :-

G00	Rapid Transverse
G01	Linear Interpolation
G02	Circular Interpolation, CW
G03	circular Interpolation, CCW
G17	XY plane
G18	XZ plane
G19	YZ plane
G20/G70	Inch Units
G21/G71	Metric Units
G40	Cutter compensation cancel
G41	Cutter compensation Left
G42	Cutter compensation Right
G43	Tool length compensation (plus)
G44	Tool length compensation (minus)
G49	Tool length compensation canced
G80	cancel canned cycles
G81	Drilling cycle
G82	Counter boring cycle
G83	Deep hole drilling cycle
G90	Absolute positioning
G91	Incremental positioning

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Important M codes :-

M00 ——— Program stop
M01 ——— Optional program stop
M02 ——— Program end
M03 ——— Spindle on clock wise
M04 ——— spindle on counter-clockwise
M05 ——— Spindle stop
M06 ——— Tool change
M08 ——— coolant on
M09 ——— coolant off
M10 ——— clamps on
M11 ——— clamps off
M30 ——— program stop, reset to start

Programming Procedure :-

Step 1 : Select reference point, program zero.

Step 2 : Determine co-ordinates (Absolute or chain dimensions, zero offset)

Step 3 : Prepare working plan - determine step by step.

- tool motions
- feed rates
- spindle speeds
- tools used
- coolant supply

Step 4 : Write program - translate operating steps into programming language.

Step 5 : key in program

Step 6 : Test and edit program

step 7 : Start auto cycle

Step 8 : Archive proved program

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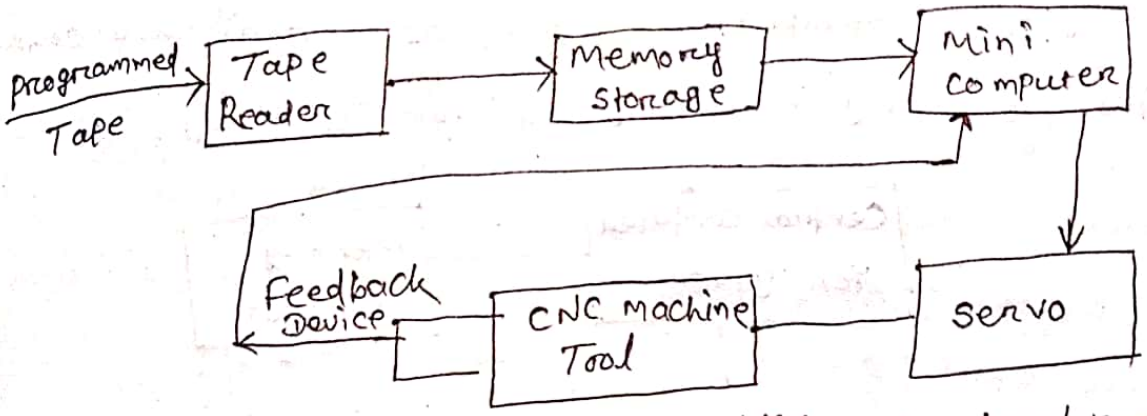
Computer Numerical Control (CNC):-

→ It is a software based system, in which the computer replaces the control unit of the conventional NC.



→ The main objective is to simplify the hardwared logic systems and all their functions for controlling the machine tool and replace it with the software programme to the maximum possible extent.

→ The program is entered into the computer through a tape or keyboard and stored in its memory, which can be called whenever a part is to be machined.

→ It is ~~easily~~ easy to edit and modify a program if required which results in considerable saving in time and cost increased reliability.

→ An added feature in this system is the diagnostic software, which enables easy trouble shooting if the CNC system fails to operate.

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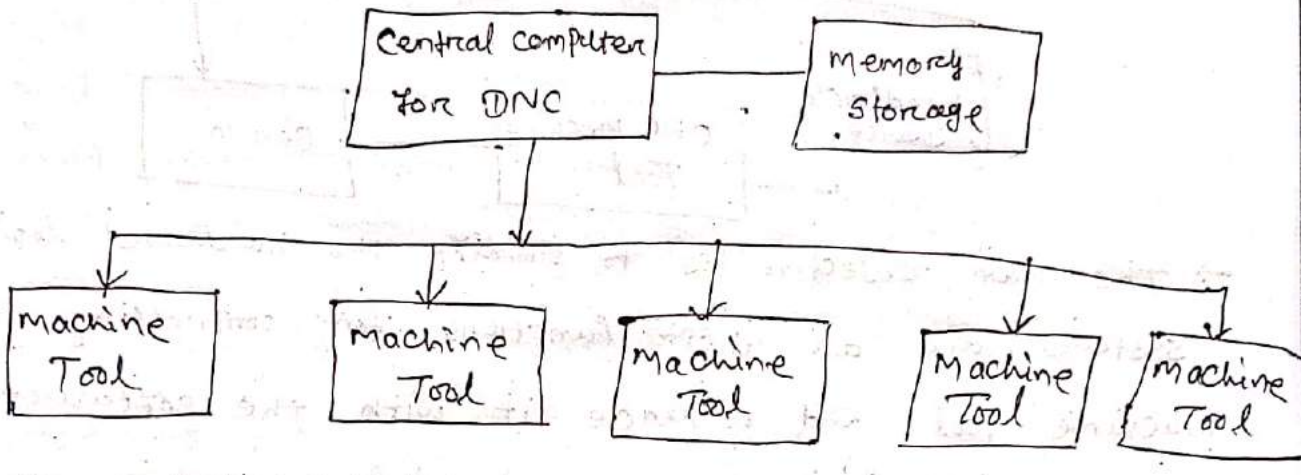
Direct Numerical Control (DNC) :-

→ It employs a separately located central computer and directly controls several machine tools simultaneously.

→ The central computer (known as mainframe computer) carries a large memory storage facility.



→ In this the machine programmes of all the machine tools, connected to the central computer are stored in a device like magnetic disk or drum.

→ A single mainframe computer controls a large number of different machine tools simultaneously, providing necessary programming instructions from its memory storage instantly to each individual machine tool linked to it.

→ The computer also performs the functions of processing and post processing of the part programmes, enabling an easy and quick correction of these programmes.

→ The initial installation investment is high and the downtime may also cost a lot in case of breakdown of central computer.

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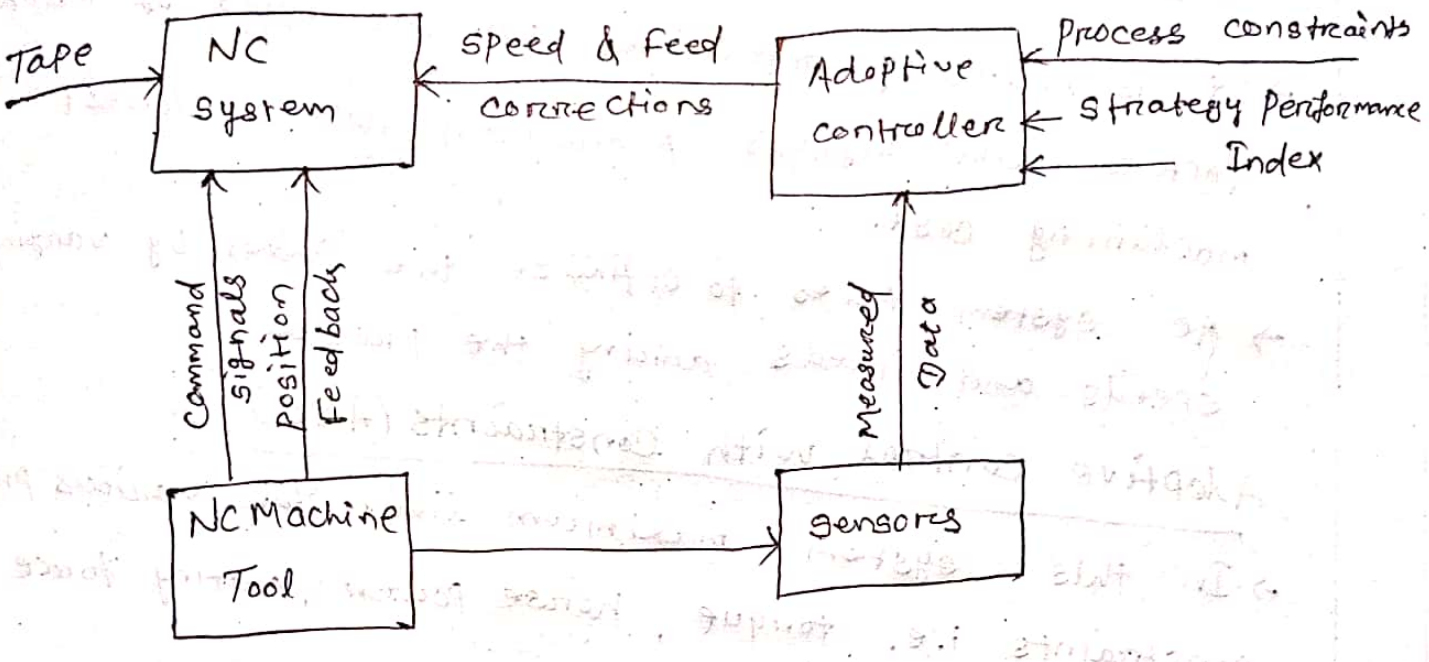
Adoptive Control (AC) :-

→ The AC system automatically determines the process variables, such as cutting speed and ~~feed~~ feed, during the process.



→ So it makes the speed and feed vary automatically according to the needs of actual cutting conditions present while the machining process is in progress.

The operational methods of the system are as follows :-

→ Measure the output process variables.

→ Determine the machining constraints or performance level.

→ Decide a proper strategy for improving the performance level.

→ Vary the cutting speed and feed under this strategy to improve the process efficiency.

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Adoptive Control with Optimization (ACO) :-

→ In this system a performance index/merit figure is to be specified, which is indicative of the overall performance of the process.

→ It is normally determined on the basis of economic factors like highest production rate or lowest machining cost.

→ AC system tries to optimize the index by varying speeds and feeds during the process.

Adoptive control with Constraints (ACC) :-

→ In this system, maximum limit for various process constraints i.e. torque, horse power, cutting force etc. are specified.

→ When the process is in progress, the ACC system maximizes the cutting parameters, like speeds and feeds, to such an extent that the resulting actual values of constraints (torque, power etc.) remain within their prescribed limits.

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Chapter-04 :- ROBOT TECHNOLOGY :-

Robot :-

→ The word 'Robot' is derived from a Czech word 'Robota' which means a 'slave labourer' or 'forced labourer'.

→ It can be conceived as such an automated machine which can be programmed and carries many humanistic characteristics in respect of its different movements

→ Once programmed it can repeat the same sequence of motions any number of times.

→ It can also be programmed to perform a different sequence of motions to suit different types of requirements.

→ According to RIA (Robotic Industries Association) "A robot is a programmable, multifunctional manipulator designed to move material, parts, tools or special devices through variable programmed motion for the performance of a variety of tasks".

Main Components of Robot :-

i) Base : which may be fixed or mobile.

ii) Manipulator Arm :- With a number of degrees of freedom of movement.

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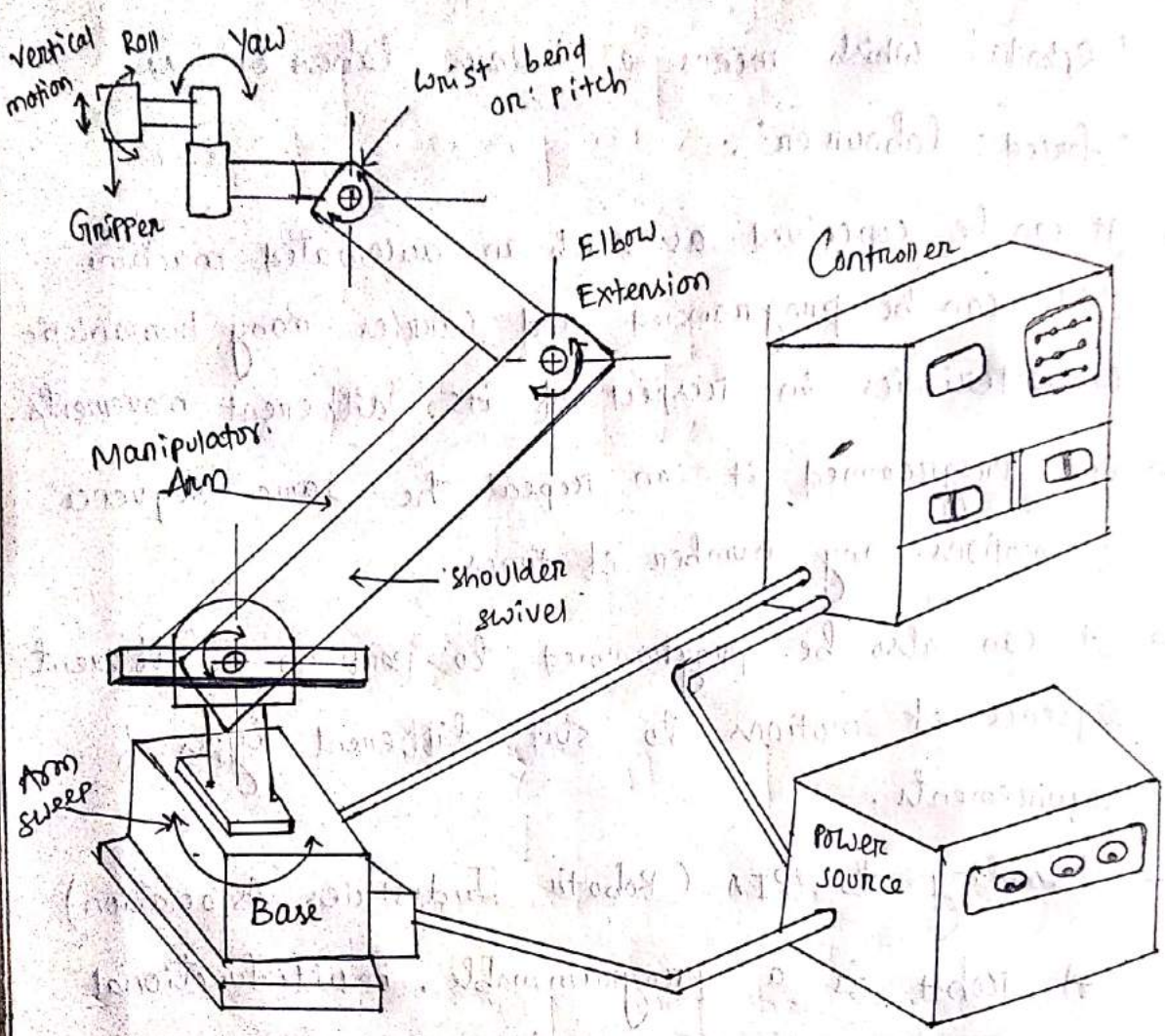
(iii) Gripper or End Effector :-

For holding a piece or a tool, depending upon the application of Robot.



(Main Components of Robot)

(iv) Drives : known as actuators, which moves the manipulator arm and effector to the required position in space.

(v) Controller : delivers commands to the actuators with the help of hardware and software support.

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(vi) Sensors:- to act as feedback devices to direct further actions of the manipulator arm and the end effector and to interact the Robot's working environments

Six Basic Motions or Degrees of Freedom:-

(i) Vertical Motion:- the entire manipulator arm can be moved up and down vertically either by means of shoulder swivel i.e. turning it about a horizontal axis, or by sliding it in a vertical slide.

(ii) Radial Motion:- in and out movement to the manipulator arm Provided by elbow extension by extending it and drawing back.

(iii) Rotational Motion:- Clockwise or anticlockwise rotation about the vertical axis to the manipulator arm provided Through arm sweep.

(iv) Pitch Motion: enable up and down movement of the wrist and involves rotational movement as well, known as wrist bend.

(v) Roll Motion:- enable rotation of the wrist, known as wrist swivel.

(vi) Yaw:- also called wrist yaw which facilitates rightward or leftward swiveling movement of the wrist.

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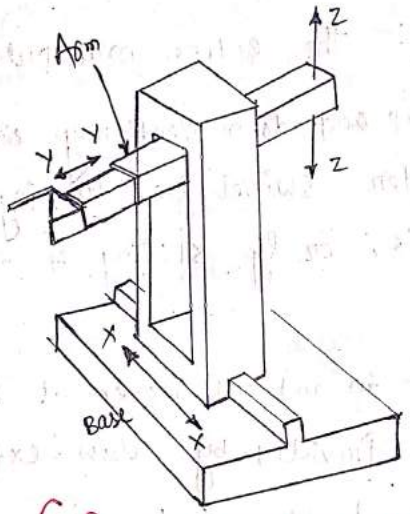
Basic Co-ordinate Systems or Configurations:

(i) Cartesian co-ordinate system:

The robot with this type of configuration has sliding motions along the three standard orthogonal axes, x, y and z.



(Cartesian co-ordinate system)

→ The slide moving along the x-axis ambles a right and left motion, that along the Y-axis a forward and backward motion and the one along the Z-axis an up and down motion.

→ So with proper movements of the slides along these three co-ordinate axes the robot arm can reach any point in its cubic volume in space.

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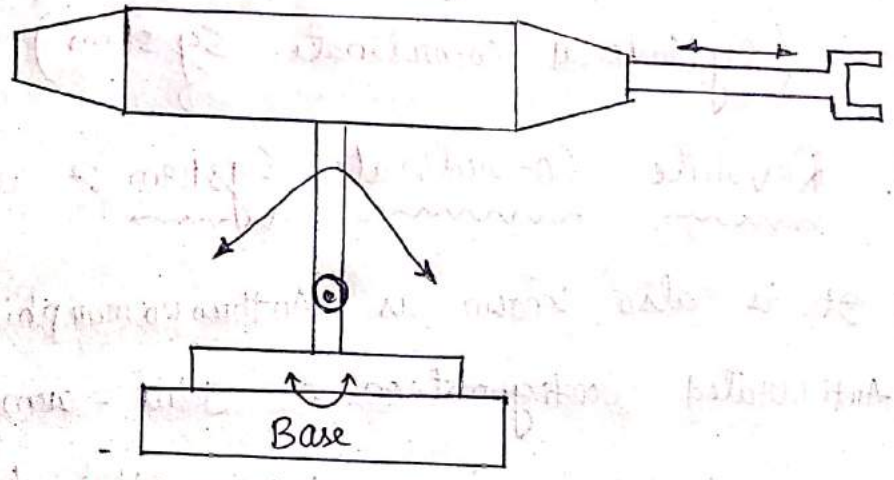
(ii) Polar co-ordinate systems :-

→ It is also known as spherical co-ordinate system and the robot with this type of configuration carries two angular (rotary) motions and one radial (linear) motion.

→ This type of robot carries a rotary base which rotates about a vertical axis providing one angular motion, the second angular motion is provided by the rotation of the arm about an axis that intersects the vertical axis of the base.

→ The linear motion is provided by the in and out motion of the telescopic arm and workpiece or work envelope is hemisphere.



(Polar co-ordinate system)

(iii) Cylindrical co-ordinate system :-

→ The robot carries two linear motions and one rotary motion.

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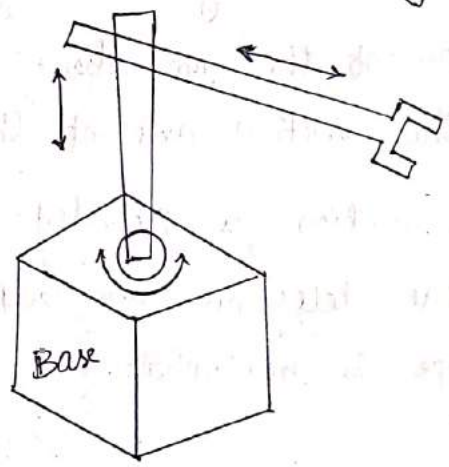
→ The body of the robot is a vertical column which can rotate about a vertical axis to provide the rotary motion.

→ The arm can slide up and down to provide one linear motion in the vertical direction.

→ Also it can be slide in and out to provide the second linear motion.

→ workspace or work envelope is cylindrical in shape.



(cylindrical co-ordinate system)

(iv) Revolute Co-ordinate System :-

→ It is also known as Anthropomorphic Configuration, Articulated Configuration or Joint - arm configuration.

→ The whole arm is mounted on the base which can be rotated about a vertical axis (Z-axis) and also can rotate about a horizontal axis provided by the shoulder joint.

→ The arm link can also rotate about another horizontal axis provided by the elbow joint which enables the arm to extend or retract.

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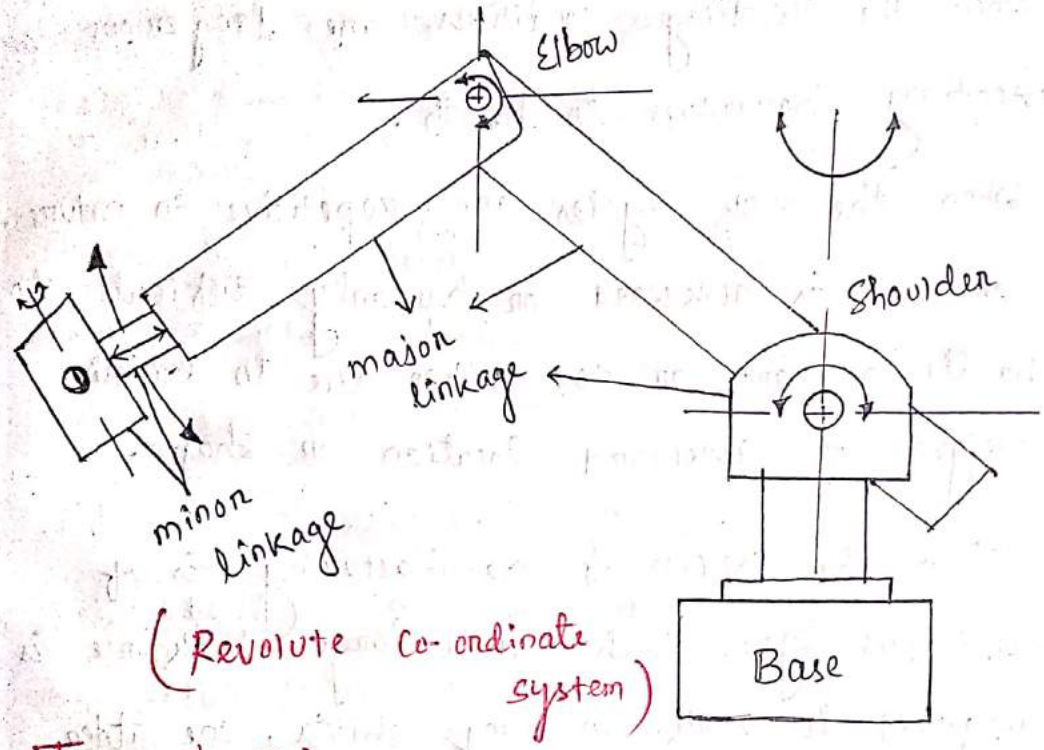
→ The last link of the arm (wrist) can rotate about a horizontal axis provided by the wrist joint.

→ workspace or work envelope is quasi-spherical.



(Revolute Co-ordinate system)

Types of Robots :-

(a) General purpose robots :- are those which carry standard designs and parts and are readily available.

(b) Special purpose robots :- are tailor made to specific job requirements.

Motion system of Robots :-

It is of following types :-

(a) point to point system.

(b) continuous path system.

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Application of Robots :-

The use of Robot for industrial applications is useful under following conditions :-

→ When the working conditions are dangerous and potentially hazardous to health.

→ When the work cycles are repetitive in nature.

→ When it is awkward or humanly difficult to handle a part or tool either due to excessive weight or awkward location or shape.

→ When the process of manufacturing is of continuous type, such that a large workforce is required to work in many shifts, one after other.

Areas of Application :-

Welding :- Mostly spot welding and arc welding in automobile industries.

Spray painting :- Robots are used for spray painting of automobile bodies and bodies of home appliances.

machine loading and unloading :- used for loading stock parts and unloading of finished parts on CNC machine tool, Die casting machines, forging presses and hammers, stamping and punch press etc.

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Material handling and transfer :- Used for shifting an object from one location to the other.

Assembly operations :-

Screwing of studs and screws in threaded holes, insertion of shafts in holes, screwing and unscrewing of nuts, insertion of electronic components in electronic assemblies, assemblies of small electronic motors, plugs, switches etc.

Sorting of parts :-

Inspection of finished workpieces or sub assemblies especially of electronic components and devices.

Future Applications :-

→ Medical Science - Surgery, diagnosis.
→ Nuclear and fossil fuel power plants and reactors.
→ Mining - Exploration, tunneling, rescue work.
→ under water Application - Exploration of minerals and oils, salvaging of sunken ships, underwater repairing of vehicles.
→ Army - Surveillance, guarding, loading of bombs.
→ Aerospace researches.
→ Harvesting and agricultural activities.
→ Domestic services.
→ Utility services like under water sewer line servicing, delivery services.

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Ch-05

:- FLEXIBLE MANUFACTURING SYSTEM (FMS):-

Introduction:-

→ Flexibility can have different interpretations; but it generally refers to the system's responsiveness to changing demand patterns, so that the mix of part styles in the system and the production volume that can be adjusted rapidly to meet changing requirements.

→ So FMS is the production with machine systems capable of making a different product without retooling or similar changeover.

Need for FMS:-

(i) To Improve Operational Control Through:-

→ Reduction in number of uncontrollable variables.

→ Providing tools to recognize and react quickly to deviations in the manufacturing plan.

→ Reducing the dependence of human communication.

(ii) To Reduce Direct Labour:-

→ Removing operators from the machining site by which their responsibility activities can be improved / broadened.

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→ Eliminating dependence on highly skilled machine operators.

(iii) To improve short Run Responsiveness consisting of :-

→ Engineering changes.
→ Processing changes.
→ Machining down time.
→ Cutting tool failure.
→ Late material delivery.

(iv) To Improve long Run Accommodations Through Quicker and Easier Assimilation of :-

→ Changing Production Volumes.
→ New production additions and introductions.
→ Increase machine utilization by :-
  - Eliminating machine setup.
  - Utilizing automated features to replace manual intervention.
  - Providing quick transfer devices to keep machines in cutting cycle.
→ Reduce inventory by :-
  - Reducing lot sizes.
  - Improving inventory turnover.
  - providing the planning tools for JIT (Just In time) manufacturing.

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Components of FMS:-

(i) Work stations / Processing stations:-

The Work stations are typically CNC machine tools that perform machining operations on families of parts.

- The various work stations are :-

(i) machining centre :- are usually CNC machine tools with appropriate automatic tool changing and tool storage features to facilitates quick physical changeover as necessary.

(ii) Load and unload stations :- is the physical interface between the FMS and the rest of the factory where raw parts enter the system and completely processed parts exit the system.

(iii) Assembly work stations :- consists of a number of work stations with industrial robots that sequentially assemble components of the base parts to create the overall assembly.

(iv) Inspection stations :- the parts manufactured are inspected here for quality purpose.

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(v) Others:- Sheet metal fabrication which has station for press working operations, such as punching, shearing, forging stations.

(vi) Supporting: may include inspections stations where CAM, special inspection probes and machine vision may be used, other stations may include part washing stations and temporary storage stations.

(b) Material Handling and Storage Systems:-

→ The Primary material handling system establishes the FMS layout and is responsible for moving parts between stations in the system.

→ The Secondary handling system consists of transfer devices, automatic pallet changers and other mechanisms to transfer parts from the primary material handling system to the work head of the processing station or to a supporting station.

→ It is also responsible for the accurate positioning of the part of the workstation, so that the machining process may be performed upon the part in the correct manner.

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- Other purposes include re-orientation of the part if necessary to present the surface that is to be processed and to act as buffer storage as the workstation.

The function of the material handling and storage system in FMS are:-

- Allow random and independent movement of the work parts between stations so as to allow for various routing alteration for the different parts in the system.
- Enables handling of a variety of works part configurations by means of pallet fixtures for prismatic parts and industrial robots for rotational parts.
- Provides temporary storage.
- Provides convenient access for loading and unloading work parts at load and unload stations.
- Creates compatibility with computer control so that the computer system can direct it to the various workstations load / unload stations and storage areas.

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(c) Computer Control System :-

→ FMS uses a distributed computer system that interfaces with all work stations in the system, as well as with the material handling system and other hardware components.

→ It consists of a central computer and series of micro-computers that control individual machines in FMS.

→ The central computer co-ordinates the activities of the components to achieve smooth operational control of the system.

The various functions are :-

Control of each workstation: often in the form of a CNC control.

Distribution of control instructions: to workstations by means of a central computer to handle the processing occuring at different work stations.

Production control: Management of the mix and rate at which various parts are launched into the system is important.

Traffic control :- So that parts arrive at right location at the right time and right condition.

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Shuttle Control :- to ensure the correct delivery of the work part to the station's work head.

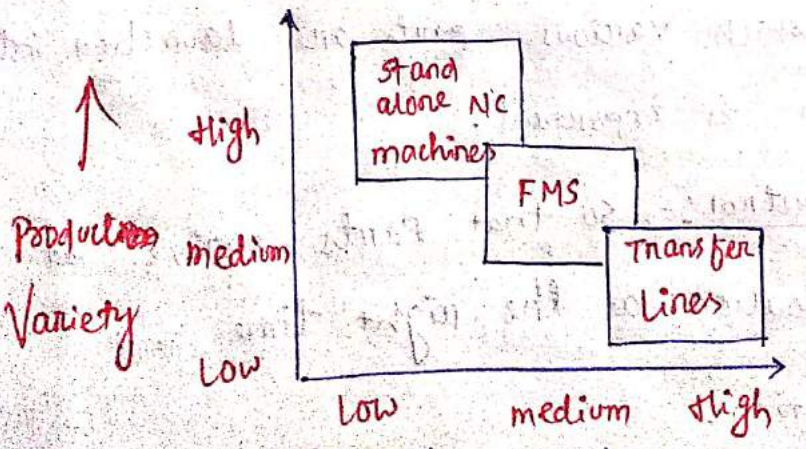
Workpiece monitoring :- to ensure that we know the location of every element in the system.

Tool Control :- is connected with managing tool location and tool life.

Performance monitoring and reporting :- the computer must collect the data on the various operations ongoing in the FMS and present performance findings based on this.

Diagnostics :- the computer must be able to diagnose, to a high degree of accuracy, where a problem may be occurring in the FMS.

The FMS is most suited for the mid variety, mid value production range.



(Flexible Manufacturing system).

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∴ CAD/CAM and CIM :- Ch-06

CAD :-

→ The use of a computer to interact with a designer in developing and testing product ideas without actualy building prototypes.

→ The application of digital computers in engineering design and production.

→ The evolution of a design typically involves the creation of geometric models of the product, which can be manipulated, analyzed and refined.

→ In CAD, computer graphics replace the sketches and engineering drawings traditionally used to visualize products and communicate design information.

CAD Software :-

→ It describes the main functions of a CAD program such as drawing, editing, data output, system control, data storage, management and other special features.

→ falls in two broad catagories, 2-D and 3-d based on number of dimensions.

→ 3D software permits the parts to be viewed with the 3-D planes, height, width and depth visible.

→ Such representation approximates the actual shape and appearance of the object to be produced, therefore they are easier to read and understand.

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CAD Hardware :-

→ It describes the physical components of a CAD system such as system unit, memory and hard disk.

→ It consists of one or more design workstations, digital computers, plotters and other output devices.

→ Would have a communication interface to permit transmission of data to and from other computer systems, thus enabling some of the benifits of computer integration.

→ Input devices are generally used to transfer information from a human or storage medium to computer where "CAD functions" are carried out.

→ The main hardware components of CAD are System unit, Central processing unit, memory, monitor, printers and plotters, keyboard, mouse etc.

Benefits of CAD :-

→ Reduces conceptional times for new designs.

→ Products can be created more quickly.

→ Costly mistakes in design and production can be avoided.

→ Reduced manufacturing time.

→ Documentation can be printed in various forms for multiple users.

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→ Ease of documents reproduction and cloning.
→ visualization of complex technical elements.
→ The quality of designs.
→ Clarity of documentation.
→ Easier to apply new ideas.

Application of CAD :-

→ Solid Modelling.
→ Drafting and detailing.
→ Surface modelling.
→ Assembly.
→ Reverse engineering.

CAM :-

→ It is defined as the use of computer system to plan, manage and control the operations of a manufacturing plant through either direct or indirect computer interface with the plants product resources.

→ The ~~genet~~ geometric model developed during the CAD process forms the basic of CAM activities.

→ In case of process planning, features that are utilized in manufacturing (i.e, holes, slots etc.) must be recognized to enable efficient planning of manufacturing.

→ NC programmes, along with ordering tools and fixtures result from processing planning.

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→ Once parts are produced, CAD Software can be used to inspect them.

→ After passing inspection, CAM Software can be utilized to instruct to robot systems to assemble the parts to produce the final product.

Benefits of CAM :-

→ In large scale production, the results are consistent.

→ Enables very high accuracy levels in large scale production.

→ Usually speeds up production of low volume products.

→ Can maximize utilisation of a full range of production equipment, including high speed, 5-axis multi-function and turning machines, EDM, CMM etc.

→ Can aid in Creating, Verifying and optimizing NC programmes for optimum ~~machining~~ machining productivity as well as automate the creation of shop documentation.

→ Advanced CAM systems with PLM (Product Lifecycle management) integration can provide manufacturing planning and production personnel with data and process management to ensure use of correct data and standard resources.

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Application of CAM :-

→ plotter / cutter
→ Turning
→ Laser cutting.
→ 3-D printing
→ 3-D milling.

Difference Between CAD / CAM :-

CAD	CAM
→ Stands for Computer Aided Design.	→ Stands for Computer Aided manufacturing.
→ Help of a computer to design some object.	→ Help of a computer to manufacture an object.
→ A CAD user will typically be an engineer with training in CAD software.	→ A CAM user will be a special trained machinist.
→ Enables engineers and architects to design models of products.	→ Is used to control the machine tools and related machinery in the manufacturing process of the products.
→ CAD software offers better visualization of the design, improves accuracy and eliminates errors during the manufacturing process.	→ Optimizes production process by reducing waste of raw materials and manufacturing errors.

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CIM:-

→ Complete integration of CAD, CAM and FMS.

→ Are being used for high volume, highly standardized production where mass production technology has traditionally been employed.

→ Represents the union of hardware, software database management and communications to plan and control production activities from planning and design to manufacturing and distribution.

Challenges Before the ~~Management~~ Manufacturing Engineers:-

Manufacturing engineers are required to achieve the following objectives to be competitive in a global context.

→ Reduction in Inventory.

→ Lower the cost of the product.

→ Reduce Waste.

→ Improve quality.

→ Increase flexibility in manufacturing to achieve immediate and rapid response to:

→ ~~Product~~ changes

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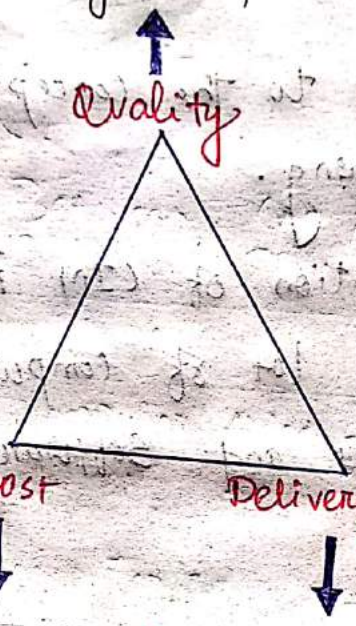
→ Product changes:

- Production changes
- Process change
- Equipment change
- Change of personnel.



(Challenges before the Manufacturing Engineers)

Evolution of CIM :-

→ Computer Integrated Manufacturing (CIM) is considered a natural evolution of the technology of CAD / CAM. which by itself evolved by the integration of CAD and CAM.

→ Manufacturing engineers also started using computers for such tasks like inventory control, demand forecasting, production planning and control etc. CAE technology was adopted in the development of co-ordinate measuring machines (CMMs) which automated inspection.

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→ Yet the full potential of computerization could not be obtained unless all the segments of manufacturing are integrated, permitting the transfer of data across various functional modules.

→ This realization led to the concept of computer integrated manufacturing.

→ Thus the implementation of CIM required the development of whole lot of computer technologies related to hardware and software.

CIM HardWare :-

CIM Hardware comprises the following :-

→ Manufacturing equipment such as CNC machines or computerized work centers, robotic work cells, DNC / FMS systems, work handling and tool handling devices, storage devices, sensors, shop floor data collection devices, inspection machines etc.

→ Computers, controllers, CAD / CAM systems, work station terminals, data entry terminals, bar code reader, RFID tags, printers, plotters and other peripheral devices, modems, cables, connectors etc.

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CIM Software :-

CIM Software comprises computer programmes to carry out the following functions :

- Management Information System
- Sales
- Marketing
- Finance
- Database Management
- Modeling and Design
- Analysis
- Simulation
- Communications
- Monitoring
- Production Control
- Manufacturing Area Control
- Job Tracking
- Inventory Control.
- Shop floor Data collection
- order Entry
- Materials Handling
- Device Drivers
- Process planning
- Manufacturing facilities Planning
- Work flow Automation.
- Business Process Engineering
- Network Management.
- Quality management.

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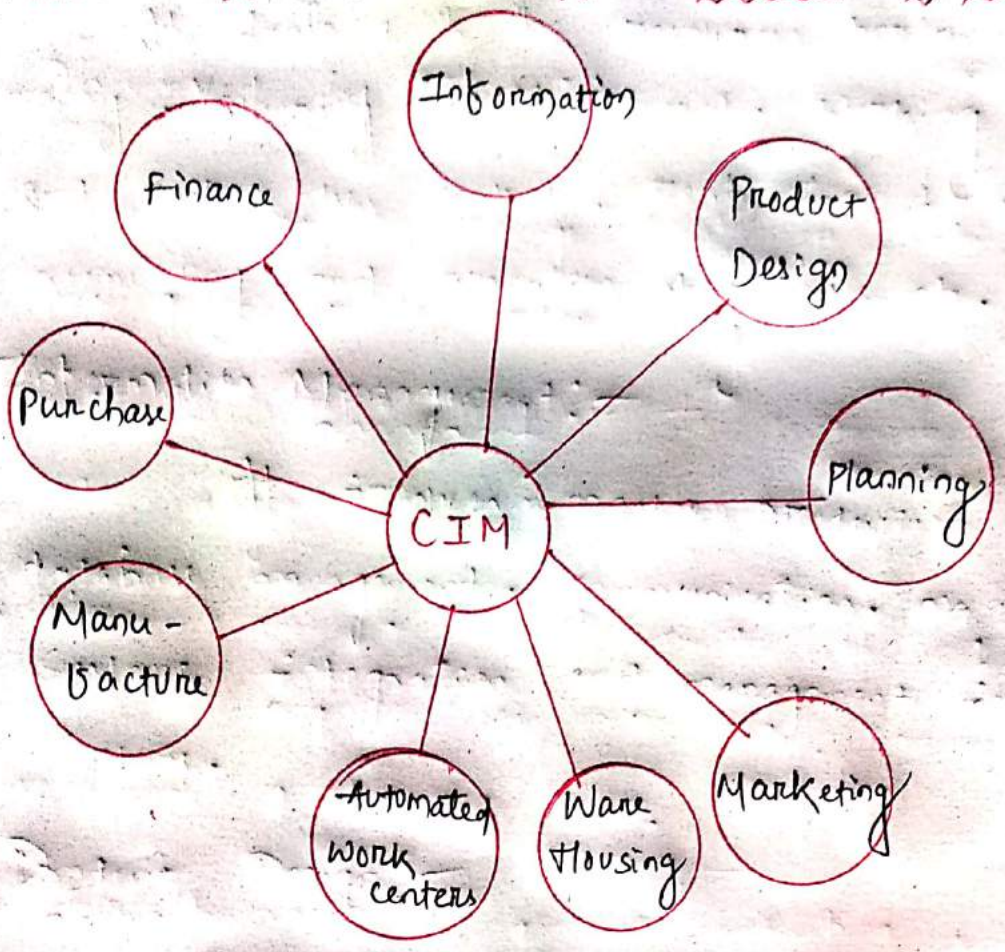
Nature and Role of the Elements of CIM system:-



(Elements of CIM System)

Marketing:-

The need for a product is identified by the marketing division. The specifications of the product, the projection of manufacturing quantities and the strategy for marketing the product are also decided by the marketing department.

Ware Housing:-

Ware housing is the function involving storage and retrieval of raw materials, components, finished goods as well as shipment of items.

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Factory automation hard ware :-

It is enriches the database with equipment and process data, resident either in the operator or the equipment to carry out the production process.

Manufacturing Engineering :-

It is the activity of carrying out the production of the product, involving further enrichment of the database with performance data and information about the production equipment and processes.

* Purchase :-

The purchase department is responsible for placing the purchase orders and follow up, ensure quality in the production process of the vendor, receive the items, arrange ~~for~~ for inspection and supply the items to the stores or arrange timely delivery depending on the production schedule for eventual supply to manufacture and assembly.

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Finance:-

It deals with the resources pertaining to money. planning of investment, working capital, and cash flow control, realization of receipts, accounting and allocation of funds etc.

Information Management:-

It involves master production scheduling, database management, communication, manufacturing systems integration and management information systems.

Product Design:-

The design department of the company establishes the initial database for production of a proposed product. In a CIM system this is accomplished through activities such as geometric modeling and computer aided design while considering the product requirements and concepts generated by the creativity of the design engineer.

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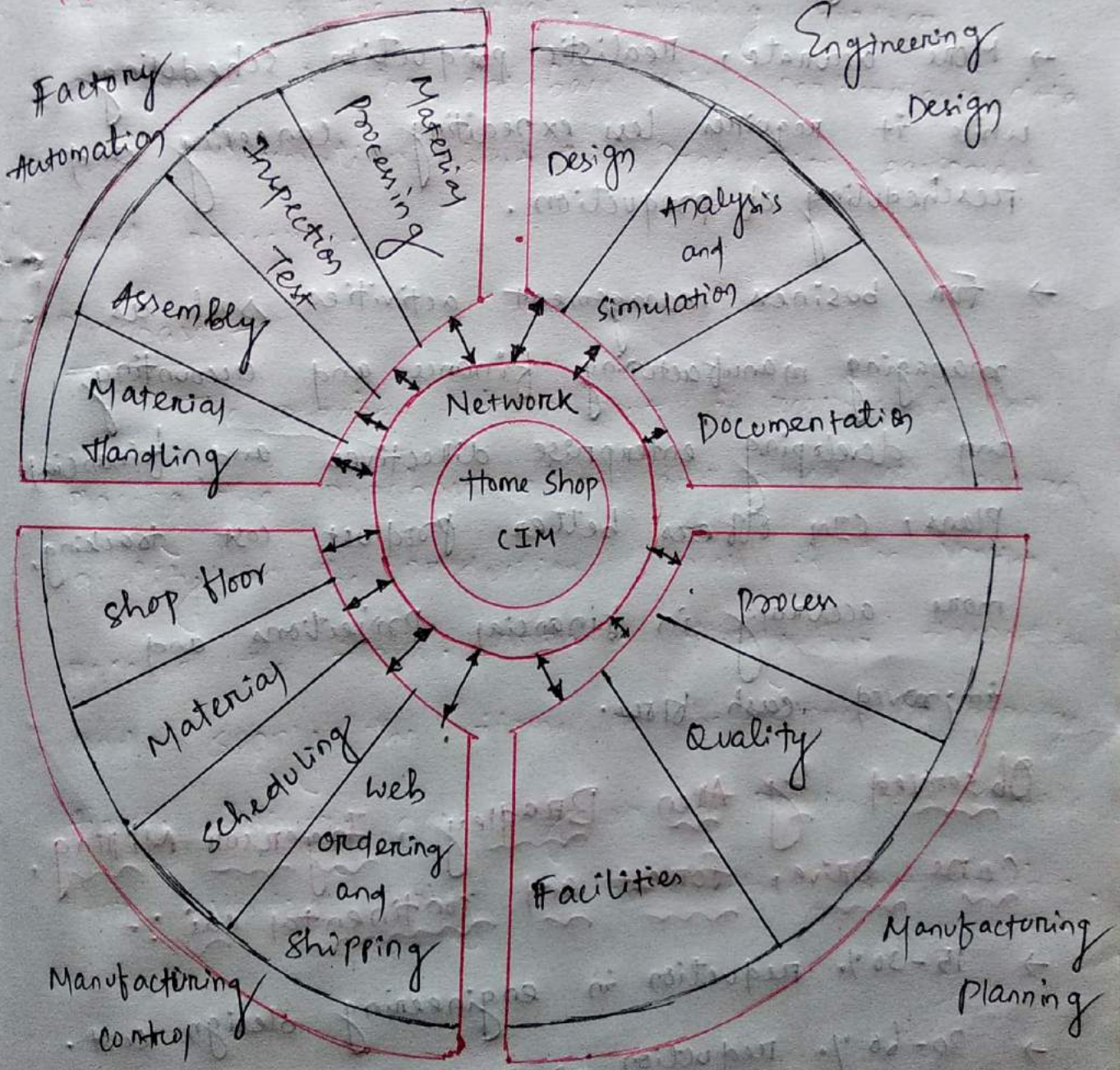
Planning :-

The planning department takes the database established by the design department and enriches it with production data and information to produce a plan for the production of the product.

CIM Wheel :-



(CIM Wheel)

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CIM Benefits:-

Observed by IBM:-

→ It helps to manage customer satisfaction by allowing electronic order entry from customers through faster response to customer enquiries and changes with more accurate sales projections.

→ More accurate, realistic production scheduling while it requires less expediting, canceling and rescheduling of production.

→ For business management activities such as managing manufacturing finance and accounting and developing enterprise directives and financial plans, CIM offers better product cost tracking, more accuracy in financial projections and improved cash flow.

Observed by Allen Bradley, Ingersoll Milling, Cone Drive, Forest and continental cai:-

→ 15-30% reduction in engineering design cost.

→ 30-60% reduction in overall lead times.

→ 40-70% gain in overall production.

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→ 200 – 500 % gain in quality.

→ 30 - 60 % reduction in Working progress.

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