Manufacturing VS Production:-

Manufacturing simply is the process of converting raw material into a finished product by using machines, labours etc.

It is a process of value addition to the raw material such that final object is having more value in the market, when compare to raw material.

Where as production reffers to the convertion of inputs or intermediate to a final output or service which may or may not used machinary.

Production basically means the creation of utilities out of available resources.

Why advance manufacturing process:-

The end goal of traditional manufacturing is solely to add value to achieve the object

Advance manufacturing on the other hand tipically manufacturing process in specific industries such as aerospace, medical etc. using advance technique and equipment.

Advance manufacturing process should embrace the following characteristics. Products are produced with a high level of design. Products are technolgically superior to the counter part.

Products are more relable, affordable and readly available.

Machining Process:-

Machining is any of various process in which a piece of raw material is cut into a desired final shape and size by a controlled material remove process.

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Non traditional machining process :-

These are special type of machining processes in which there is no direct contact betn the tool and work piece. Here, a form of energy is used to remove unwanted material from a given work piece.

Pros

i) It provides high accuracy and surface finish.

ii) Since there is no physical contact betn tool and work piece, tool wear is neglisible

iii) It doesn't generate chips (may be micro-scopic chips)

iv) These are quiter in operation

v) It can easily be automated

vi) It can machine any complex shape.

Cons

i) High intial or setup cost

ii) Highly skilled labour is required.

iii) More power required for machining.

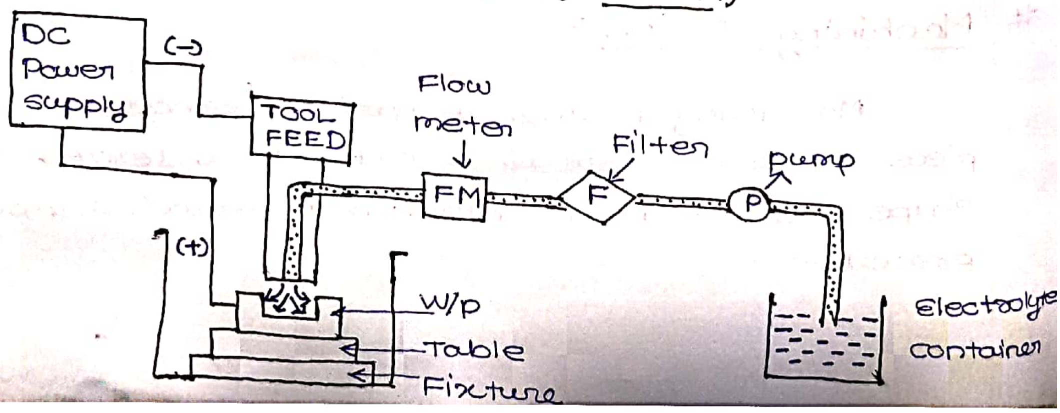
iv) It is not economical for bulk production.

Classification :-

i) Electro chemical machining (E.C.M)
ii) Electron beam machining (E.B.M)
iii) Abrasive Jet machining (AJM)
iv) Plasma arc machining (PAM)
v) Laser beam maching (LBM)
vi) Electro discharge machining (E.D.M)
vii) Ultrasonic Machining (U.S.M)

(i) – (vi): Syllabus

Electro chemical Machining (E.C.M)



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Working principle of ECM :-

ECM is a machining process that may be describe as the reverse of Electroplating.

Electroplating is the process in which material is remove from anode and deposited at cathode. But in ECM the deposition on cathode is restricted.

It is based on the Faraday's Law of electrolysis. which states that amount of material deposited is directly proportional to the current density multiplied with time.

High density direct current is passed through an electrolyte solution into the gap betn cathode (tool) and anode (work piece). Now due to electro chemical reactions material is removed.

Construction :-

The workpiece is made anode in the ECM Process Tool which is shaped to form required cavity in the work piece is mounted in the tool holder and connected to the -ve terminal of the DC power supply

An electrolyte flows through the gap betn tool and work piece and allowed to enter the working zone.

There is no chemical contact betn workpiece and the tool any tendency of the disolve metal to be plated on the ~~anony~~ tool its countered by the flow of electrolyte.

⇒ **Elements :-**

Electrode :-

These are commonly made of copper alloys and stainless steel.

Tool is insulated except at the cutting tip.
It should be published for a smooth finish.

Electrolyte :-

i) Electrolyte which are most commonly used :-
water solution of sodium chloride, potassium chloride, sodium nitride and sodium hydroxide.

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ii) Electrolyte must be sufficiently active chemically to cause efficient metal removal.

iii) It shouldn't be too corrosive.

iv) It must be continuosly filter to remove the disolve metal

Filter / Centrifuge :-

These are used to clean the electrolyte and cooling coils may be provided for large amount of

Power Supply :-

Voltage :- 5V to 24V

current :- 500A to 2500A

Work piece :-

It should be a good conductor of electricity. It should have higher atomic weight and lower valancy for better removal of material.

MRR (Material Removal Rate) :-

$$Z = \frac{e}{\rho} I \times \eta_e$$

where Z = Volume of metal removed / time

e = Electrochemical Equivalent of w/p

I = current

ρ = Density of w/p

η_e = Current efficiency

$$V_f = \frac{Z}{A} = \eta_e \frac{e}{\rho} \times \frac{I}{A}$$

where V_f = tool feed speed

A = Area of w/p surface exposed to electrolyte.

I/A = Current density

To obtain highest machining rule, highest permissible current density should be used.

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Advantages:-

i) There is no significance tool wear.

ii) Metal is removed rapidly

iii) Difficult shape can be easily machined

iv) Hardness of w/p doesnot affect the speed of material removal (except cast iron)

v) Machined surface is stress free.

vi) cutting forces are not involved.

Disadvantages:-

i) The tool are more difficult to design.

ii) Electrolyte is corrosive to working environment.

iv) Intial cost is high.

v) Power consumption is high.

Application:-

i) ECM is useful for machining of small deep holes.

ii) High temp. alloy forging

iii) Turbine wheels with integral blades

iv) Jet engine blades airfoils

v) High strength high hardness material

vi) Deburring of parts

vii) Jet engine blade cooling holes.

viii) Odd shape holes and cavities.

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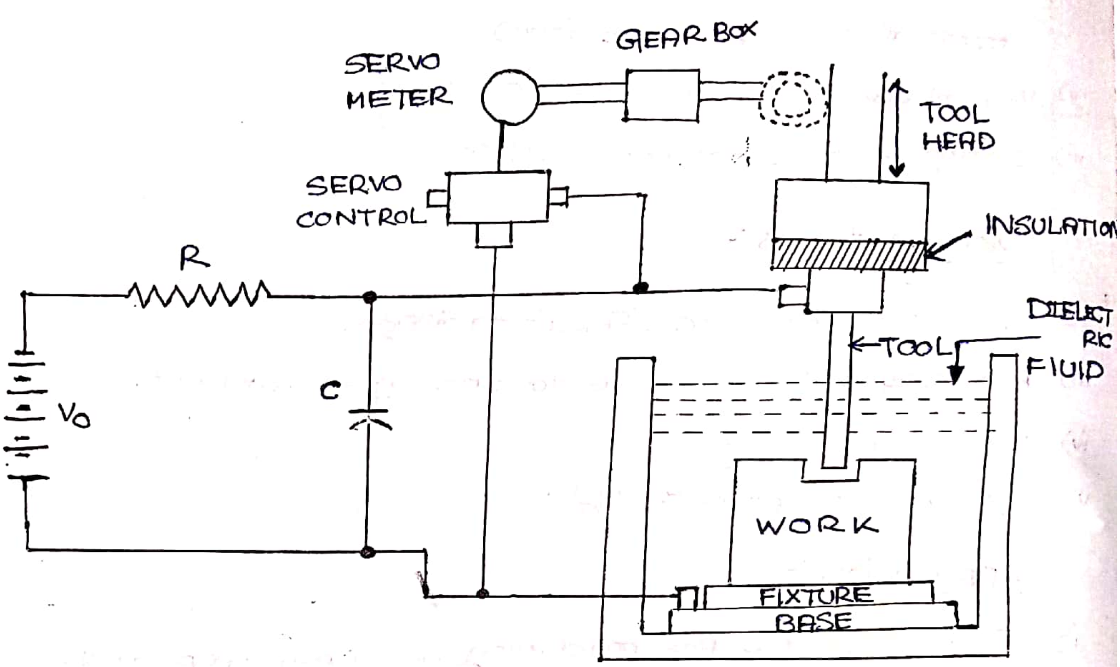
Electro Discharge Machine (EDM):-

i) EDM is also known as spark machining process.

ii) It is used for producing internal shape on the workpiece.



Construction:-

i) An electro discharge machine consists of

ii) A power supply that basically provides direct current and to control the supply (current 0.5–400 A, voltage: 40–300 V)

Tool head :-

i) The tool head is made up of copper, tungsten and graphite alloy. Electrode can be compared with the cutting tool of conventional machining.

ii) A servo mechanism is used to accurately control the movements of electrode / tool to maintain the correct distance betn it and workpiece.

iii) A coolant usually is a light mineral oil that forms a dielectric barier betn the tool and workpiece at the gap. It is the distance from the tool in which they spark will penetrate the workpiece and remove material.

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iv) The electrode or tool and the work piece are submerged in the dielectric soln.

v) It serves to Flash particle from the gap.

vi) Keep the electrode and the work piece cool.

vii) It prevent Fusion of the electrode with the workpiece.

Working Principle:-

When the voltage across the gap reaches a point sufficient to cause the dielectric soln to broke down into ions (ionised soln)

As -ve ions move very Fast towards the workpiece, there it forms an envelop or a passage of -ve ions and a spark is produced.

Temperature corresponds to some what around 10,000°c and pressure also get a value much more than the atomospheric.

· Each spark removes small amount of material from the work piece, but since spark occours 20000 to 30000 times per second, appreciable amount of metal is removed.

Advantages:-

i) Any shape can be produced on the workpiece if accordingly tool is designed.

ii) Any material can be machined regardless of strength but it has to be conductive.

iii) Since there is no mechanical force, most delicate or soft material can be machined.

iv) Accuracy achieved is very high.

Disadvantage :-

i) The workpiece and tool must be a good conductor of electricity.

ii) It is a slow machining process.

iii) Due to intense heat thermal distro may occours.

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Application :-

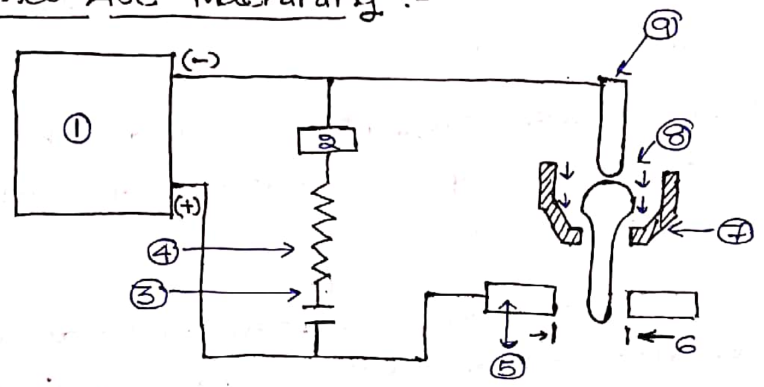
i) In tool making, particularly in the manufacturing of press tool, extrusion dies, forging dies etc.

ii) Very small drill holes can also be produced which are used as fuel injector in diesel engine.

iii) This process is suitable for finishing plane bearings bore of I.C. engine.

~~PEA~~

Plasma Arc Machining :-



① cutting power supply
② High frequency generator
③ Pilot arc relay contact
④ Resister
⑤ Job
⑥ kerf
⑦ Nozzle
⑧ Gas
⑨ Electrode

i) It is a high jet of high temp. ionised gas.

ii) It is considered as 4th state of matter.

iii) When heated at temp. above about 5500°c gases are partially ionised and exists as plasma.

iv) So plasma is a mixture of free electron, +vely charged and natural atoms of the gas.

v) Plasma arc machining is a process where material removal is done by melting a localized area with an arc removing the molten material with a high velocity of

Working Principle :-

i) It makes use of DCSP (electrode negative) with a constituted transferred arc struck betn a tungsten electrode situated with in the torch and the workpiece to be cut.

ii) The cutting arc betn the electrode and the workpiece is initialised by a pilot arc established betn electrode and nozzle.

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iii) The nozzle is connected to ground (+ve) terminal through a current limiting resistor and a pilot arc relay contact.

iv) Pilot arc :- A low current continiously arc betn the electrode and the nozzle that ionised the gas and ignite the main arc or cutting arc.

v) The pilot arc is intiated by a high Frequency generator.

vi) Ionised gas from the pilot arc is blown through the constricting nozzle orifice.

vii) This forms a low resistance path of to ignite the main arc betn the electrode and the workpiece. Once the main arc is ignited the pilot arc goes off.

Plasma Cutting equipments:-

Cutting Torch:-

It may be either manually operated or machined operated in which case the torch is mounted on an automatic travel mechanism.

Torch consists of an electrode holder.

Supply gases:-

N_2, N_2+H_2 or $Ar+H_2$ mixture are used for cutting non-ferrous and stainless steel.

Carbon steel are cut by using compressed air or N_2.

Power Source :-

Open circuit voltage :- 100 - 400V

current :- 250 - 1000A

Advantages:-

Faster cutting process.

It leaves a narrower kerf.

Since primarily it is a melting process it can cut any metal.

Disadvantages:-

Intial cost is high.

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Application :-

i) Application in industries like shipyard, chemical etc.

ii) Used for removing gates and risers in foundary.

iii) It is used to cut any desired pipe contour.

iv) Manufacturing of rail road component.

v) Used to cut non-ferrous ~~metal~~ metal and stainless steel.

vi) which can't be cut by ordinary flame torches.

vi) With some modification PAM also can be used under water.

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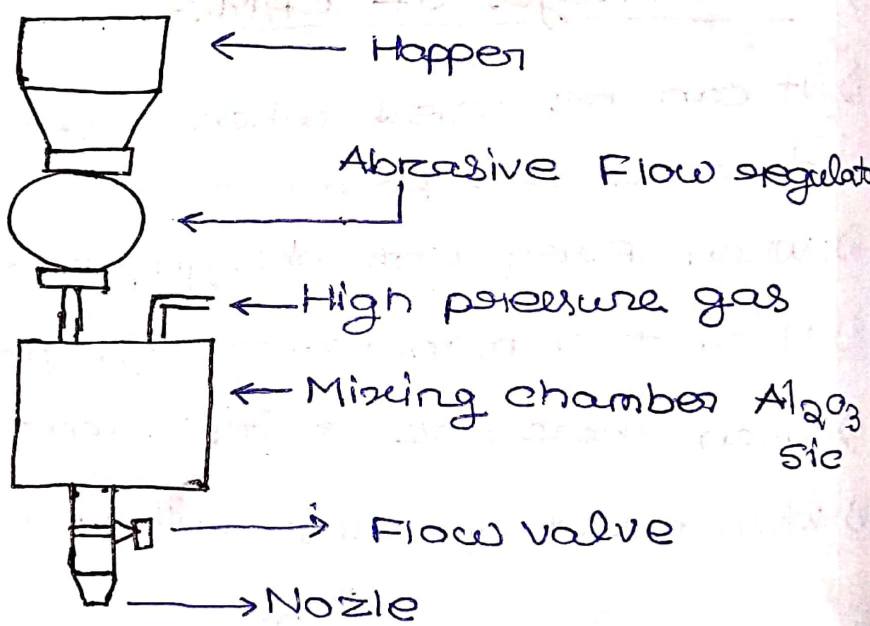
Abrasive Jet Machining :- (AJM)

AJM is a process that removes material by directing a high velocity stream of abrasive particles into a work piece.

Abrasive mean Rough and likely to scratch.

AJM is used mainly to cut materials that are sensitive to heat damage thin section of hard materials and to cut intricate holes.

Principle of operation :-



Abrasive particles are feed from the hopper into the mixing chamber. High pressure air or gas under pressure is supplied to the mixing chamber containing the abbrasive then the mixture of high pressure air or gas and abbrasive emerges from a small nozzle at high velocity.

This steam of abbrasive particles bombards the work place at nearly the speed of sound and cut the material. Since the abbrasive particles are very small MRR is very low.

Elements:-

i) **Nozzle:-**

Since abbrasive particle are directed onto the workpiece through the nozzle, the nozzle must be abrasion. It is made up of tungsten carbide or synthetic sapphire.

ii) **Abbrassive:-**

(a) Al_2O_3 is generally ~~used as~~ purpose of abrasive and is used in nominal diameter like 10, 27 and 56 microns (10^{-6}).

(b) SiC (Silicon Carbide) is used in 25 and 50 micron size.

(c) Dolamite is used for light cleaning and etching.

d) Abbrassive flow rate directly affects the rate of material removal from the work piece.

iii) **Carrier Gas:-**

(a) Generally air, nitrozen or carbon dioxide used as carriergas

(b) Oxygen is never used as a carrier gas because it may oxidise the surface of the material.

(c) High pressure of carrier gas may result in a rapid nozzle wear where as low pressure leads to slow material removal.

Advantages of AJM:-

(i) Ability to cut material without damage

(ii) Ability to cut intricate holes in any material of any hardness.

(iii) Virtual no heat is generated in this process.

(iv) Low capital cost.

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Disadvantages:-

i) Slow material removal rate (MRR)
ii) Accuracy is not good
iii) Embedding of abrasive in the work piece
iv) Abrasive can't be reused.

Application of AJM:-

(i) Cleaning
ii) Cutting the lines
iii) Frosting of glass.
iv) Machining of semiconductors (Ex:- Germanium and Silicon etc)
v) Drilling and cutting of this section or hardend metal.

⇒ Laser Beam Machining (LBM):-

LASER :- Light Amplification of Simulated emission of Radiation.

~~Laser stands for~~

Laser iteract with the material the energy of the photon is absorve by the work material loading to substancial raise in local temp. this in turn result in melting and vaporisation of work material and finally material removal.

The Lasing Process:-

It describes the basic operation of laser i.e. generation of coherent beam of light by using light amplification by stimulated emission.

Stimulated emission :- It is the process by which incoming photon of specific frequency interact with an excited electron resulting of draw to a low energy lable.

In the model of atom negatively changed electron at ground stage can be excited to higher energy level.

On reaching the higher level the electrons tend to come back to its ground state with in a very small time by releasing a photon.

But instead of coming back to the ground state immediately it stays at the elevated temperature. Now electrons interact with a suitable frequency of photon which helps to come back to its ground state (stimulated emission).

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Lasing medium :-

Depending on lasing medium lasers are classified as solid state laser and gas laser.

Solid state laser	Gas laser
Ruby (Chromium - Aluminium alloy)	Helium, Neon, Argon, CO_2
Neodymium (Nd) - Glass laser	

Application of LBM

i) Laser can be used for welding, marking, surface treatment, drilling and cutting.

ii) It is used in automobile, ship building, arrow space, steal, electronic and medical industries for precession making of complex part.

iii) In medical industries LBM can be used for cosmatic surgery and air remover.

iv) In the electronic industry LBM is used for skiving of circuit.

v) Lasers can be used to change the surface properties of a work piece.

Advantages :-

i) High precession and accuracy.

ii) Maintance cost is low comparatively as low rate of wear and tear due to no physical contact betn tool and work piece.

iii) This process can be opted for nearly all material unlikely of traditional machining process.

iv) Since the rays of a laser beem are monocromatic and parallel. It can be focus to a small diameter increasing the precession of process.

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Disadvantages :-

i) This is not suitable for mass production.

ii) It consumes a lot of energy.

iii) Handaling and maintaining the machine require high trained individual.

iv) Intial cost of accuring a leser is moderately high.

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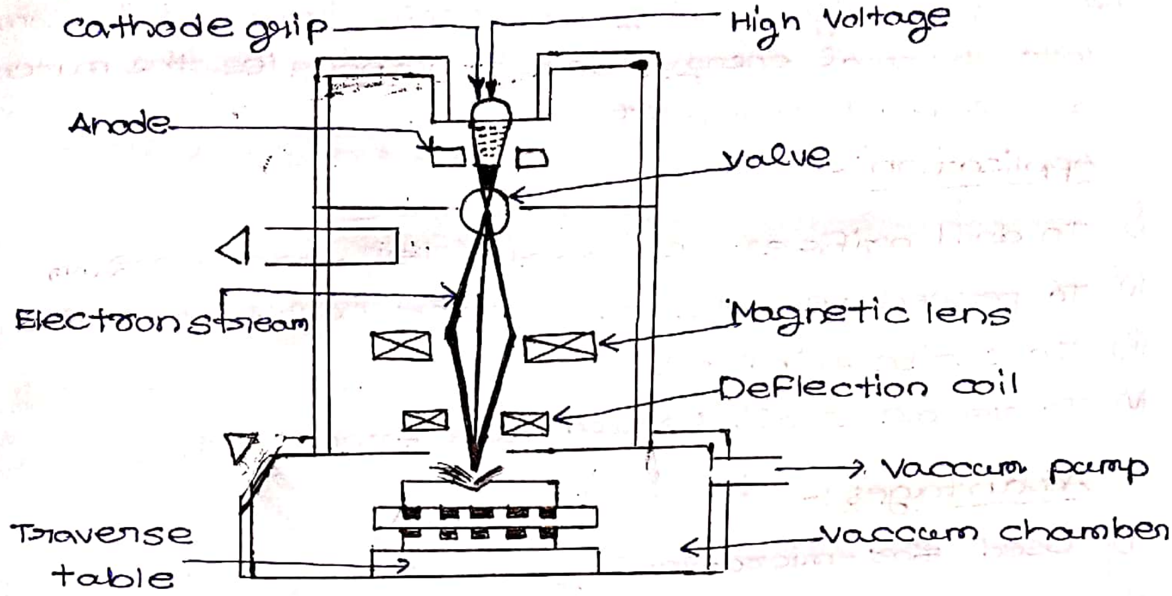
Electron Beam Machining :- (E.B.M)



E.B.M is the metal removal process by a high velocity focoused stream of electrons which heats, melts and vapourises the work material at the point of bombardment.

The production of free electrons is obtained from cathodes where metal is heated to the temp. at which the electrons accuire sufficient energy for escaping to the space around cathode.

The kinetic energy of a beam of electron is transformed into heat energy as a result of the interaction of electrons with the work piece. Therefore EBM is a thermoelectric process.

The electron gun from which beam of electron is emitted consists of

(i) Cathode (which is a hot tungsten filamen 2500°c)

(ii) Grid cup

(iii) An anode (through this high velocity electron pass)

The electrons passing through anode are excited to 2/3 of light velocity by applying 50 to 150 kv DC supply at the anode. With the help of Grid cup the electrons are focoused and made to flow in the form of a conversing beam through a hole in the anode.

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As the beam impacts on the work piece kinetic energy of high velocity electrons immediately converted into thermal energy and it vapourise the material at the point of impact.

Application:-

i) To drill orifices of diameter less than 0.002mm

ii) To procedure holes in injector nozzle in disel engine.

iii) To scribe thin films.

iv) To remove small broken taps from holes.

Advantages:-

i) Used for microfinishing.

ii) It can drill holes which other wise can't be made.

iii) No cutting tool pressure and wear high dimensional tollerance can be achived.

iv) Any material can be cut that can exist in vaccum.

Disadvantages:-

i) High Intial cost.

ii) High equipment cost.

iii) Highly skilled operator require.

iv) Only small cuts can be produce.

v) Requirement of vaccum.

=> **Formulae:-**

i) **Velocity of electron impingment:-**

$$V_S = 600\sqrt{E_S} \quad km/s$$

where E_S = Voltage of electric field

ii) **Power of electron beam:-**

$$P_b = E_S \times I_b \quad watt$$

I_b = Electron beam current

iii) **Electron beam Force:-**

$$F_b = 0.34 \times I_b\sqrt{E_S} \quad dyne$$

Beam Force;

$$\frac{F_b}{A} = 0.34 \times \text{current density} \times \sqrt{E_S} = \frac{dyne}{cm^2}$$

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iv) **Thermal velocity accuired by electron :-**

$$V_a = \sqrt{\frac{2k\theta}{M_a}} \quad M/s$$

where k = Boltz's man's const.

θ = Temp. raised through electron bombardment (in kelvin)

M_a = Mass of one atom of work piece (kg)

Question :-

i) In EBM calculate V_s, P_b, F_b and V_a.

Given; voltage electric field = 2×10^5 volt

Beam current = 2.5×10^{-5} amp.

Current density = 2×10^{-3} amp/cm2

Vaporisation temp. = 3027'c

mass of electron = 9.1×10^{-28} kg.

Answer :-

$$V_s = 600\sqrt{E_s} = 600\times\sqrt{2\times10^5} = 268328.157 \text{ km/s}$$

$$P_b = E_s\times I_b = 2\times10^5\times2.5\times10^{-5} = 5 \text{ watt}$$

$$F_b = 0.34\times2\times10^{-3}\times\sqrt{2\times10^5} = 0.304 \frac{\text{dyne}}{\text{cm}^2}$$

$$V_a = \sqrt{\frac{2k\theta}{M_a}} = \sqrt{\frac{2\times1.36\times10^{-28}\times3300}{9.1\times10^{-28}}}$$

$$= 10004.394 \text{ M/s.}$$

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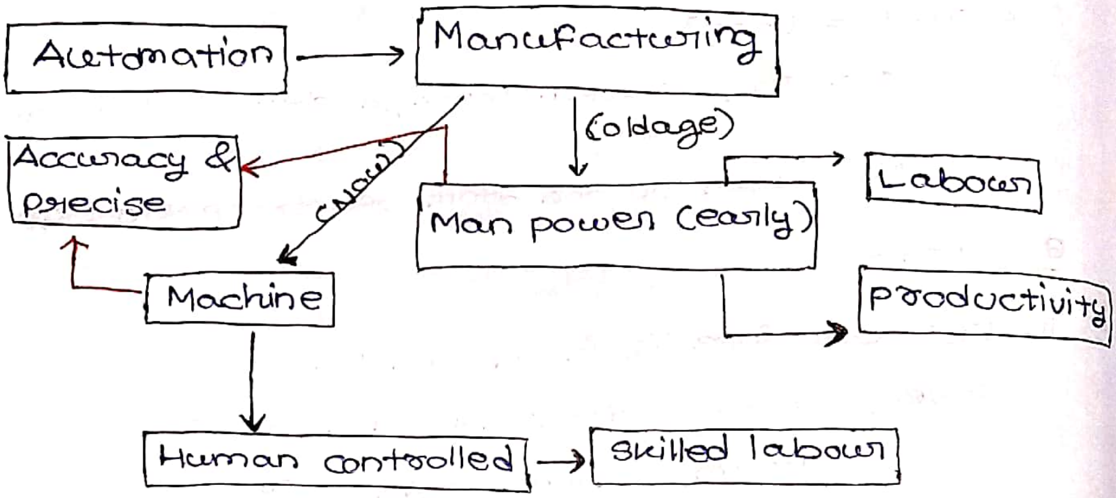
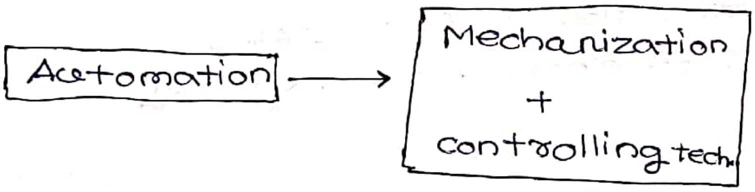
Automation : 2nd Chapter





Automation may be defined as a term applied to all measures taken which will cause a process to be carried out wholly or partly according to a previously set program without the intervention of human activity or its control.

Automation is a term used to denote the continuous automatic production of a product.

A truly automated system must have

i> The ability to make a decession

ii) The ability to carry out those decession.

iii) The ability to evaluate and correct performance.

Automation is a technology concerned with the operation of mechanical, electronic and computer based system to operate and controlled production.

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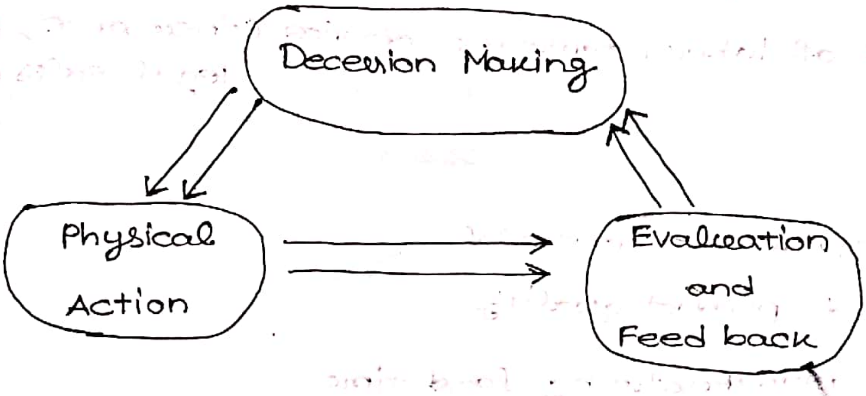
Production is acomplished by using a machine that automatically performs one or more of the five fundamental manufacturing process. Such as making, inspecting, assembling, testing and packaging and also has a feed back arrangement.



Automation includes:-

i) Automatic machine tools to process parts.

ii) Automatic assembly machine.

iii) Industrial robots.

iv) Automatic material handling and storage system.

v) Automatic inspection and quality control.

vi) Feed back control and computer process control.

vii) Computer system for planning, data collection and decession making to support the manufacturing activity.

<u>Benefits</u>

) Reduction or total elemination of Tedious and routing operation like loading and unloading expection assembling etc.

) Creation of new and more intrested jobs.

) Increase in the productive capacity of industry.

) Greator flexibility through the use of standard production unit.

) Higher standard of living.

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Reasons For automation :-

i) increase productivity (Greater output per hour of labour i/p)

ii) High cost of labour

iii) Labour shortage

iv) Trained of labour towards service (insurance, personal legal sales etc.)

v) Safety.

vi) High cost of raw material

vii) Improoved product quality

viii) Reduce manufacturing lead time

ix) Reduction of inprocess inventory

x) High cost of non automative.

Types of Automation :-

Automated production systems can be classified into three basic types.

i) Fixed Automation

ii) Programmable automation

iii) Flexible automation.

i) Fixed Automation :-

It is characterised by having the sequence of operation necessary to manufacture or assemble a product fixed by equipment configuration.

The production line are designed to produce standardise product such as engine block valve, gears etc.

It is specially associated with high production rate or mass production.

The machine employed in Fixed automation application are usually built on building block principle and generally called as transfer machine.

This type of automation may be seen only when product design are stable and product life cycle are long.

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Advantages:-

i) Unit cost is low
ii) Very high efficiency
iii) High production rate.

Disadvantages:-

i) High Intial investment
ii) Inflexibility.

ii) Programmable Automation:-

The production equipment is designed with the capability to change the sequence of operation to accomodate different product configuration.

As the name programmable sugest, one set of task can be easily switch over to another set by changing the computerised instruction.

Equipment is highly reprogrammable to accomodate high product variety but has low production rate relative to fixed automation.

Parts are tipically loaded into programmable automated production system in batches. Each batch consists of a different parts.

Change over from one batch to the next batch requires a change in physical setup of the machine tool such change over results in loss of production time.

Advantages:-

For large batch unit cost is low.
Flexibility is more.

Disadvantages:-

Set up time is more.
production rate is slow.

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Flexible Automation:-

It can be considered as an extension of programmable automation.

It is a system capable of producing variety of products with virtually no time loss for change over from one product to the next.

The ability to change part programs and to change the physical setup of production system with little or no loss of production time is the primary difference betn flexible and programmable automation.

Advantages:-

- Parts with complex shape can produce.
- customised products can be produced.

Disadvantages:-

- High intial investment
- Unit cost is relatively high.

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CAD/CAM

CAD
- → Integration of computer science technologies for engg. design. (Computer Aided Design)
- → Includes use of both computer hardware and software.

3D- Modeling :-

It is the process of developing a mathematical representation of any surface of an object in 3dimensions via specialised software.

CAD(computer Aided Design) :-

Use of computer to interact with a designer in developing and testing product idea without actually building prototypes.

CAM (Computer Aided Manufacturing) :-

The computer control of manufacturing process.

The main concept of CAD/CAM system is generation of a common Data base which is used for all the designing and manufacturing activity such as:-

i) specification of the product

ii) Conceptual design

iii) Final design iv) Manufacturing etc.

The integration of CAD and CAM allow for important coordination betn design and manufacturing.

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⇒ CAD (Computer Aided Design) :-

It means the use of computer to assist in the design of an individual part or a system using computer graphics.

Lables of design :-

i) Conceptual Design
ii) Periliminary Design
iii) Final Design

i) CAD uses computer systems to assist in the creation, modification and optimisation of a design.

ii) CAD includes computer hardwares like of keyboards and other periferal equipment.

iii) The CAD software consists of computer program to implement computer graphics as well as application programs to facilitate the engg. function of component.

iv) The Hardware consist of a central processing Unit (CPU) one or more work station and devices such as printers ploters and drafting equipment.

v) Various design related task to formed by a CAT system can be grouped into 4 functional areas.

(a) Geometric modeling
(b) Engg. Analysis
(c) Design, Review and evaluation
(d) Automated Drafting.

(a) Geometric Modeling :-

i) In CAD Geometry modeling is consist with computer computable mathematical discription of the geometry of an object.

ii) To use it, the designer constructs the graphical image of the object by the help of 3 types of commands.

iii) The first type of command generates basic geometric elements such as points, lines and circules etc.

* The second command type is used to acomplish and calling rotation or other transformation of the elements.

* The third type of command causes the elements to be joined into the desired of the object.

iii) During this process the computer converts the commands into a mathematical model, stores it into the computer data file and displaced it as an image on the screen.

Engineering Analysis :-

i) It is required in the formation of almost all the engg. products.

ii) The analysis may involves stress, strain calculations, use of differential equations to describe the dinamic behaviour of the product will be design.

iii) CAD system uses the power Full analysis's features called Finite element methods. With this technique the object is devided into a larger number of finite element and by determining individual behaviour of entire object can be assessed.

Design, Review and evaluation :-

i) Checking the accuracy of the design can be accomplished conventially on the graphic terminal.

ii) Procedure called layering is offen help full in design review

iii) Evaluation feature called as kinematics is widely use by the designers in order to enimate the motion of simple design mechanism.

Automated Drafting :-

i) It involves the creation of hand copy engg. drawings directly from the CAD data base.

ii) Most CAD system are capable of generating as many as six views of the part.

Benefits of CAD :-

i) Improved engg. productivity.
ii) Reduced engg personnel requirement.
iii) Customer modification are easier to made
iv) Improved accuracy design.
v) Reduced prototype testing. due to better function analysis.

vi) Quality assurance is improved.

vii) Saving of material and machining time.

viii) Better engg. drawing.

ix) Assestiance in inspection of complicated parts.

⇒ ## Computer Aided Manufacturing (CAM)

It is the use of software and computer controlled machinary to automate a manufacturing process.

Based on the defination we need 3 components for a CAM system to function.

i) Software :-

It takes a machine how to make a product by generating tool path.

ii) Machinary :-

It can turn raw material into a finished product.

iii) Post Processing :-

It converts tool paths into a language that machine can understand.

Without CAM there is no CAD. CAD focuses on the design of a product or part, how it looks, how it functions. CAM focuses on how to make the product.

CAD software prepares a model for machining by working through the following function.

(a) Checking if the model have any geometrical error, that will impact the manufacturing process.

(b) Creating a tool path for the model which is a set of coordinate the machine will follow during the maching process.

(c) Setting any required machine parameter like cutting, speed, voltage, cut height etc.

⇒ Advantages of CAM :-

i) It can be used when several different parts with variable demands are produced.

ii) When frequent design changes are made.

iii) When the manufacturing process is complex.

iv) When there are multiple machining operation on one part.

v) When exact operator skill and close control is required.

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⇒ Computer Integrated Manufacturing (CIM):-

It is the manufacturing approach of using computers to control the entire production process. It is the complete integration of CAD, CAM and F.M.S.

CIM represents the union of hardware, software, data base management and communication to plan and control production activities from planning and design to manufacturing and distribution.

Advantages:-

Better quantity.

Reduced waste.

High equipment utilization.

Better management control.

Shorter design period.

Reduced direct and indirect labour, cost per unit of production.

Lower in process inventory, because the parts spend relatively a short time in the system. So the number of parts being processed is low.

⇒

Numerical Control Chapter : 3

Numerical system is the expression of something by number. Numerical control consists of directing, guiding or restraining power over something by the use of number.

NC machine tool reffers to the operation of tools using numerical data stored on paper or magnetic tape or tabulating cards computer storage or direct information.

NC can be defind as a form of programmable automation. in which the process is controlled by number, letter and symbol.

A NC machine tool is basically a conventional machine tool where the operator is replaced by feed back control equipment which is usually controlled by a type of containing various maching instrument.

American Society of Tool & Manufacturing Engineers (ASTME) Defines NC as a technique for automatically controlling machine tool, equipment or process.

NC Program:-

Number, letters and symbols gather together logically organised to direct a machine tool for a special task are called NC programming.

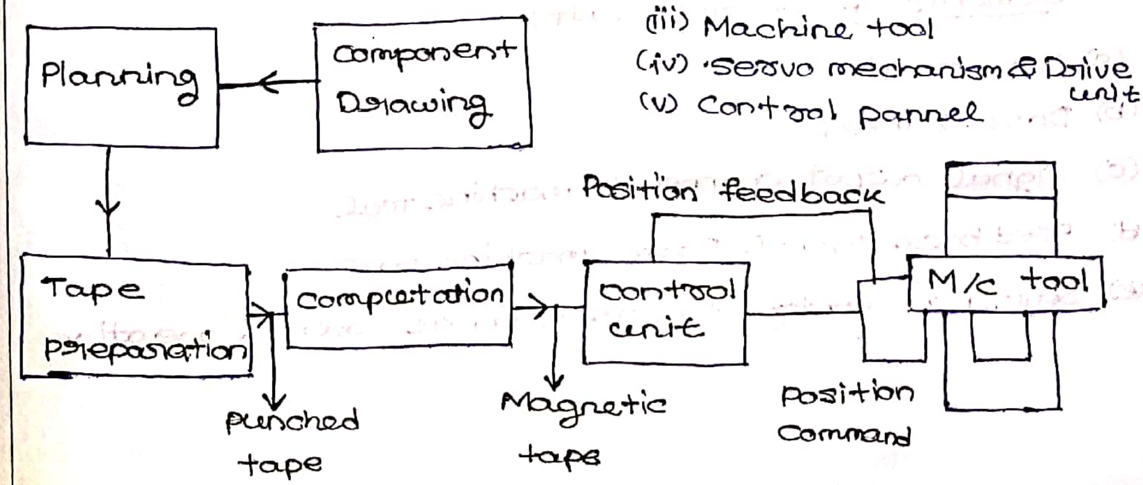
NC Ratio:-

$$\text{NC Ratio} = \frac{\text{Production of NC machine tool}}{\text{Total production of machine tool}}$$

Main Components of NC system:-

An operational NC system consist of the following basic components.

(i) Program of instruction
(ii) Control Unit
(iii) Machine tool
(iv) Servo mechanism & Drive unit
(v) Control pannel



Program of Instructions :-

It is prepared by Part Programmer. It is the detail step by step set of direction which tell the machine what to do.

It is coded in Numerical or Symbolic Form on some type of include medium that can be interprinted by controller unit.

NC program is interprinted by the controller unit and accordingly instruction are fed to machine tool to perform all the required moment that produce a Final part.

Instructional data may be fed into controller unit by manual, this method is called as Manual Data Input (MDI). It is suitable for relatively simple jobs.

The second method of input is by means of a direct link which is a computer and this is called as direct numerical control.

DNC :-

It is a technology that allows a single computer to be network with one or more machines that use com numerical control.

Controller Unit / MCU

It consist of electronics and hardwares that read and interpreat the program of instruction and conve into mechanical action of machine tool.

Elements of controller unit :-

(a) Tap reader
(b) Data buffer
(c) Signal output channel to machine tool
(d) Feed back chanel From machine tool
(e) Sequence control to co-ordinate overall operation.

CNC

NC systems in which micro computers are used as controler unit are called Computer Numerical control CNC.

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Computer Numerical Control

M/c Tool → In the most common example of NC m/c, one designed to perform m/cing operations, the m/c tool consists of the work table, and spindle as well as the motors and controls necessary to drive them. It also includes cutting tools, work fixtures & other equipments needed in the operation.

* Working

→ Steps involved in working of CNC

1) Motion control
2) Machining centres
3) Automated tool changer
4) Spindle speed & activation
5) Coolant supply & control

→ All CNC m/c have two or more programmable direction of motion called axes. An axis of motion can be linear or rotary.

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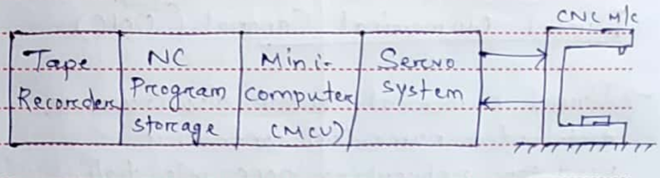
→ No. of axis states for the complexity of CNC m/c. More no. of axis, more complex will be the m/c.

→ As we know, a CNC program is most important in working of the m/c; it is nothing more than another kind of instruction set. As per the format & sequence written in the program, m/c will execute according to that.

→ CNC control will interprete the program and activate the series of command in sequential order.

→ By activation of command, it means activation of m/c functions which in turn results in axis motion.



→ Application of CNC

1) Batch Production
2) Repeat Orders
3) Complex part geometry
4) Useful in metal removal industries like automobile, aerospace etc.
5) in making jewellery
6) Used in metal fabrication industries

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Advantage of CNC

1) Non-productive time is reduced
2) Greater accuracy & repeatability
3) Inspection requirement reduces.
4) Simpler fixtures are needed.
5) Reduced part inventory
6) Less floor space
7) Less skill operator is required.

* CNC m/cs are more expensive and require a greater initial investment than m/cs that can be controlled manually.

Direct Numerical Control (DNC)

→ Direct numerical control, also known as, distributed numerical control, is used for networking CNC m/c t/s.

→ It can be defined as a manufacturing system in which a number of m/cs are controlled by a computer through ~~which~~ direct connection in real time.

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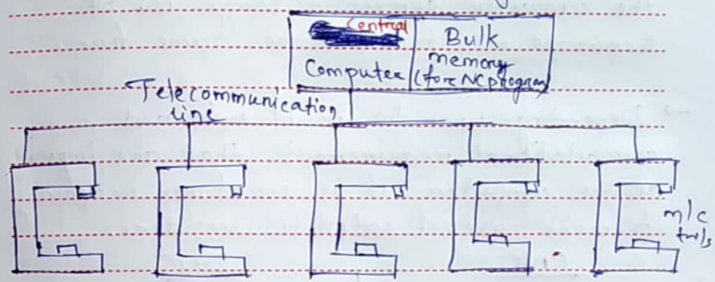
→ The tape reader is ~~omitted~~ committed in DNC thus relieving the system of its reliable component.

→ Instead of using tape reader, the part program is transmitted to the m/c t/l directly from computer memory.



→ System consist of four components.
a) Central Computer
b) Bulk memory which stores NC program
c) Tele communication lines
d) M/c t/ls

→ Computer calls the part program instructions from Bulk storage & sends data back from the m/cs.

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→ This two way information flow occurs in real time, which means that machine's requests for instructions must be satisfied almost instantaneously.

→ Remarkable feature of DNC system is that the computer serves a large no. of separate m/c tools at the same time.

→ Depending upon the no. of m/cs and computational requirements that are imposed on the computer, it is sometimes necessary to make use of satellite computers.

CNC	DNC
1) CNC computers control only one m/c or a small no. of machines.	1) DNC computers distribute instructional data to a large no. of machines.
2) CNC computers are located very near to their m/c tools.	2) DNC computers occupy a location that is typically remote from machines under their control.

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Classifications of NC system

1. Point to Point or Contouring : depending on whether m/c cuts metal while the w/p moves relative to the tool.

2. Incremental or Absolute : depending on type of coordinate system adopted to parameterise the motion commands.

• Point to Point System (PTP)

→ PTP systems are the ones where, either the w/p or cutting tool ~~~~ is moved w.r.t other as stationary ~~~~ until it arrives at the desired posⁿ and then cutting tool performs the required task with the motion axes stationary.

→ Such systems are used, typically, to perform hole operations such as drilling, boring, reaming, tapping & punching.

→ In a PTP system, the path of cutting tool and its feed rate while travelling from one point to next are not

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significant, since tool is not cutting while there is motion.

→ Therefore, such system require only control of only the final posⁿ of the tool. The path from starting point to final posⁿ need not be controlled.

◦ Contouring System

→ In this system, the tool is cutting while the axes of motion are moving, such as in a milling m/c.

→ All axes of motion might move simultaneously, each at different velocity.

→ A contouring system needs the capability of controlling its drive motors independently at various speeds as tool moves towards specified posⁿ.

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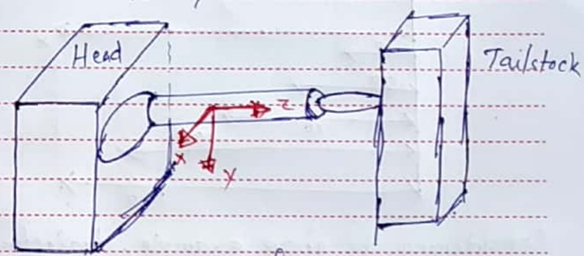
Note: Co-ordinate System

→ The co-ordinate system is defined by the definition of the translational and rotational motion co-ordinates.

→ Each translational axis of motion defines a direction ~~in which the~~ in which the cutting tool moves relative to the work piece. The main three axes of motion are referred to as X, Y & Z axes. The Z-axis is perpendicular to both X & Y in order to create a right hand co-ordinate system.



(Co-ordinate system for turning.)

For a lathe, infeed/radial axis → X-axis
carriage/length axis → Z-axis

No need of Y-axis here, as tool moves in a plane through rotational centre of work.

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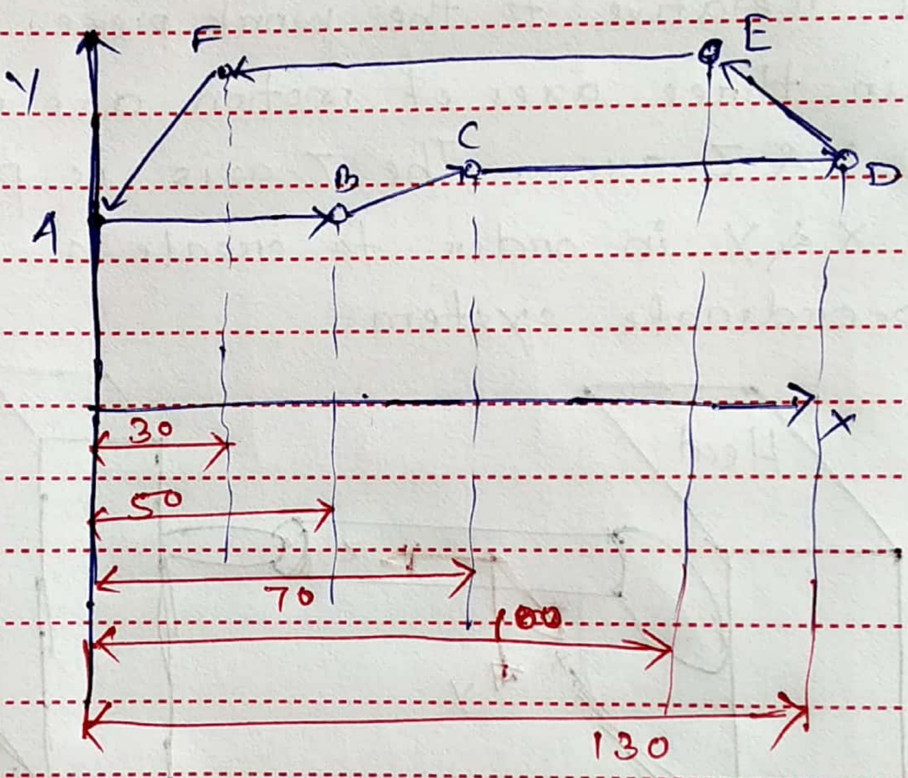
• Incremental System

→ In an incremental system, the movements in each part program block are expressed as the displacement along each co-ordinate axes with reference to final posⁿ achieved at the end of executing the previous program block.



Considering the above example, trajectory of rectilinear motions for a PTP system.
In an incremental system, the motion parameters along X-axis for segments, A-B, B-C, C-D, D-E, E-F & F-A, would be given as 50, 20, 60, -30, -70 & -30 respectively.

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Absolute System

→ An absolute NC system is one in which all position co-ordinates are referred to one fixed origin called the zero point.
→ The zero point may be defined at any suitable point within the limits of the m/c tool table and can be referred time to time.

In the previous consideration, considering the X-co-ordinate for Point A as zero, the X-coordinate for points B & C would be 50 & 70 respectievely.

⇒ Part Programming

→ Previously we know, part program is a set of instructions often referred to as blocks, each of which refers to a segment of the m/cing operations performed by m/c tool.
→ These provide.
(i) Co-ordinate values (X, Y, Z etc.) to specify desired motion of a tool relative to a work piece. The co-ordinate values are specified within motion codeword & related interpolation parameters to indicate the type of motion required.

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(2) Machining parameters such as feed rate, spindle speed, tool number, tool offset, compensation parameter etc.

(3) Codes for intiating m/c tool funⁿ like starting & stopping of spindle, on/off control of coolant flow and optional stop.

(4) Programme execution control codes, such as block skip or end of block codes.

(5) Statements for configuring the subsystems on m/c tools.

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Example of Part program.

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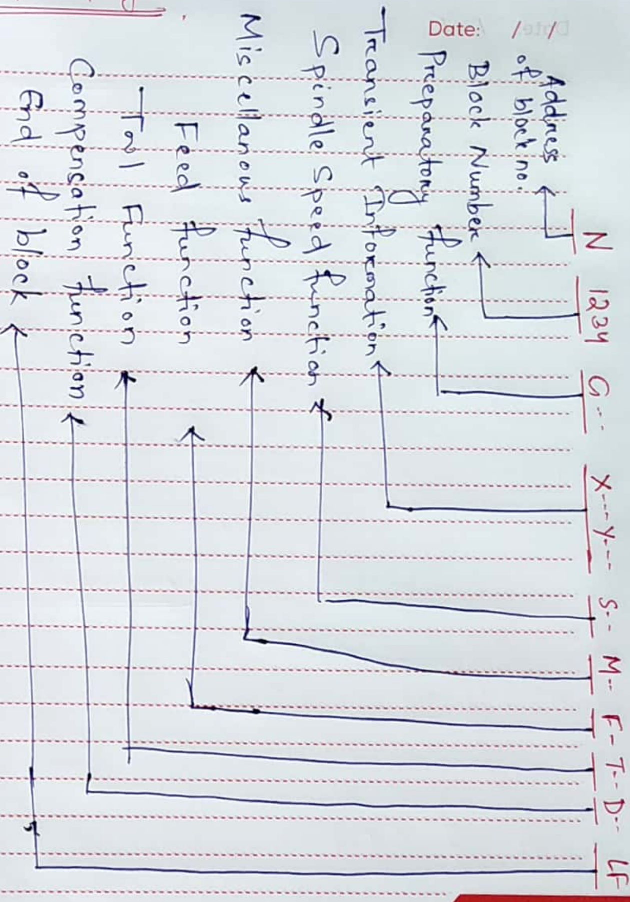

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A basic list of ‘G’ operation codes is given below. These direct motion of the tool.

G00 - Rapid move (not cutting)
G01 - Linear move
G02 - Clockwise circular motion
G03 - Counterclockwise circular motion
G04 - Dwell
G05 - Pause (for operator intervention)
G08 - Acceleration
G09 - Deceleration
G17 - x-y plane for circular interpolation
G18 - z-x plane for circular interpolation
G19 - y-z plane for circular interpolation
G20 - turning cycle or inch data specification
G21 - thread cutting cycle or metric data specification
G24 - face turning cycle
G25 - wait for input to go low
G26 - wait for input to go high
G28 - return to reference point
G29 - return from reference point
G31 - Stop on input
G33-35 - thread cutting functions
G35 - wait for input to go low
G36 - wait for input to go high
G40 - cutter compensation cancel
G41 - cutter compensation to the left
G42 - cutter compensation to the right
G43 - tool length compensation, positive
G44 - tool length compensation, negative
G50 - Preset position
G70 - set inch based units or finishing cycle
G71 - set metric units or stock removal
G72 - indicate finishing cycle
G72 - 3D circular interpolation clockwise
G73 - turning cycle contour
G73 - 3D circular interpolation counter clockwise
G74 - facing cycle contour
G74.1 - disable 360 deg arcs
G75 - pattern repeating
G75.1 - enable 360 degree arcs
G76 - deep hole drilling, cut cycle in z-axis
G77 - cut-in cycle in x-axis

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G78 - multiple threading cycle
G80 - fixed cycle cancel
G81-89 - fixed cycles specified by machine tool manufacturers
G81 - drilling cycle
G82 - straight drilling cycle with dwell
G83 - drilling cycle
G83 - peck drilling cycle
G84 - taping cycle
G85 - reaming cycle
G85 - boring cycle
G86 - boring with spindle off and dwell cycle
G89 - boring cycle with dwell
G90 - absolute dimension program
G91 - incremental dimensions
G92 - Spindle speed limit
G93 - Coordinate system setting
G94 - Feed rate in ipm
G95 - Feed rate in ipr
G96 - Surface cutting speed
G97 - Rotational speed rpm
G98 - withdraw the tool to the starting point or feed per minute
G99 - withdraw the tool to a safe plane or feed per revolution
G101 - Spline interpolation

M-Codes control machine functions.

M00 - program stop
M01 - optional stop using stop button
M02 - end of program
M03 - spindle on CW
M04 - spindle on CCW
M05 - spindle off
M06 - tool change
M07 - flood with coolant
M08 - mist with coolant
M08 - turn on accessory (e.g. AC power outlet)
M09 - coolant off
M09 - turn off accessory
M10 - turn on accessory
M11 - turn off accessory or tool change
M17 - subroutine end
M20 - tailstock back
M20 - Chain to next program
M21 - tailstock forward
M22 - Write current position to data file
M25 - open chuck
M25 - set output #1 off
M26 - close chuck
M26 - set output #1 on

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M30 - end of tape (rewind)
M35 - set output #2 off
M36 - set output #2 on
M38 - put stepper motors on low power standby
M47 - restart a program continuously, or a fixed number of times
M71 - puff blowing on
M72 - puff blowing off
M96 - compensate for rounded external curves
M97 - compensate for sharp external curves
M98 - subprogram call
M99 - return from subprogram, jump instruction
M101 - move x-axis home
M102 - move y-axis home
M103 - move z-axis home

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Flexible Manufacturing System

· What is FMS ?

A flexible manufacturing system is a highly automated machine cell, consisting of a group of processing workstations (usually CNC machine tools), interconnected by an automated material ~~building~~ handling and storage system and controlled by a distributed computer system. The reason the FMS is called flexible is that it is capable of processing a variety of different part styles simultaneously at the various workstations and the mix of part styles and quantities of production can be adjusted in response to changing demand patterns. The FMS is most suited for the mid-variety, mid volume production range.

NEED OF FMS :

* Increased machine utilization :

FMSs achieve a higher average utilization than machines in a conventional batch production machine shop. Reasons for this include:

(1) 24 hr / day operation
(2) Automatic tool changing machine tools
(3) Automatic pallet changing at workstations
(4) Queues of parts at stations
(5) Dynamic scheduling of production

It should be possible to approach 80-90% asset utilization by implementing FMS technology

* Fewer machines required :

Fewer machines are required because of higher machine utilization.

* Reduction in factory floor space :

FMS requires less floor area compared with a job shop of equivalent capacity. Reductions in floor space requirements are estimated to be 40-50%.

* Greater responsiveness to change :

FMS improves response capability to part design changes. Introduction of new parts, changes in production schedule, & machine breakdowns & cutting tool failures. Adjustments can be made in the production schedule from one day to the next to respond to rush orders & special customer requests.

Reduced inventory requirements :

Because different parts are processed together rather than separately in batches, Work-in-process (WIP) is less than in a batch production mode. The inventory of starting & finished parts can be reduced upto 60-80% as estimated.

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Lower manufacturing lead times:

Closely correlated with reduced WIP is the time spent in process by the parts. This means faster customer deliveries.

Reduced direct labor:

High production rates and lower reliance on direct labor translate to greater productivity per labor hour with an FMS than with conventional production methods. Labor savings of 30-50% are estimated.

Opportunity for unattended production:

The high level of automation in an FMS allows it to operate for extended periods of time without human attention. In the most optimistic scenario, parts and tools are loaded into the system at the end of day shift & FMS continues to operate throughout the night so that the finished part can be unloaded the next morning.

ROBOT TECHNOLOGY

Introduction:

Robots are devices that are programmed to move parts or to do work with a tool. The motion of these man made mechanical devices are modelled, planned, sensed and controlled through "Programming". Robots are called "intelligent" if they succeed in achieving specified task in an unstructured environment.

Note: Robotics is a multidisciplinary engineering field dedicated to the development of autonomous devices including manipulators & mobile vehicles.

Defination:

The term is derived from Czech word robota meaning "forced labor".

An industrial robot is defined by ISO as an automatically controlled, reprogrammable, multipurpose manipulator programmable in three or more axes. The applications of robots include welding, painting, assembly, pick and place (such as packaging, palletizing & SMT), product inspection and testing; all accomplised with high endurance, speed & precision.

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Robot Anatomy :

The anatomy of robot is known as structure of robot. The basic components in anatomy of robots are –

* The RIA (Robotics Industries Association) has officially given the defination for Industrial Robots. According to RIA, "An Industrial Robot is a reprogrammable, multifunctional manipulator designed to move materials, parts, tools or special devices through variable programmed motions for the performance of a variety of tasks".

The Anatomy of Industrial Robots deals with the assembling of outer components of a robot such as wrist, arm and body. Before jumping into Robot Configuration here are some of the key facts ÷

* End Effectors : A hand of a robot is called as end effectors. The grippers and tools are two important types of end effectors. The grippers are used to pick and place an object while the tools are used to carry out operations like spray painting, spot welding etc on a work piece.

* Robot Joints : The joints in an industrial robot are helpful to perform sliding and rotating movements of a component.

* Manipulator : The manipulators in a robot are developed by the integration of links & joints. In the body & arm, it is applied for moving the tools in the work volume. It is also used in the wrist to adjust the tools.

* Kinematics : It concerns with the assembling of robot links and joints. It is also used to illustrate the robot motions.

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