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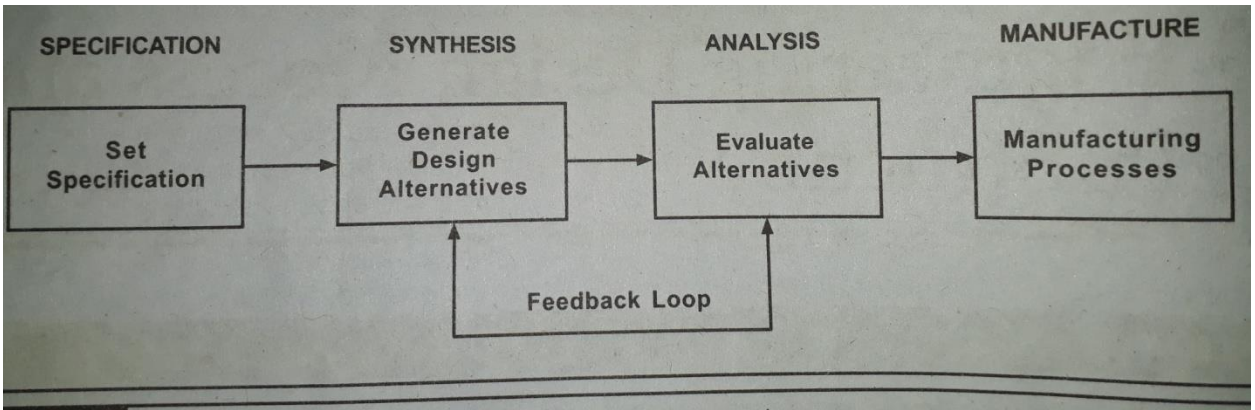
Engineering Design process & Its structure.

INTRODUCTION

Design is creative problem solving. Blue print of the system.

DESIGN PROCESS

1. Varies from industry to industry.
2. It takes different forms in response to the product/system.
3. CAD is used in design process.
4. Standard to respond to a customer requirement.
5. CAD system 2D or 3D drawing packages allow a highly interactive & controlled process.



GURE 1.1 BLOCK DIAGRAM OF A DESIGN PROCESS

IDENTIFICATION & ANALYSIS OF NEED

1. Product design success depends on analysis of need.
2. Design process start point is need.
3. Designer had to design artifact to satisfy the needs of his/her customer who pays for desired product.
4. Essential for designer to understand completely the customer's need. Before she/he starts any design process.

Analysis of preliminary needs

1. It is taken from **structural functional design**.
2. Need decomposed into sub needs & so forth.
3. The task of designer is to analyze the expressed needs, values, opinions' & ideas, evaluate them & find the actual, demonstrable & one hope, satisfy needs.
4. **Differ Areas of needs**

a. Organizational. b. Informational. c. Procedural.

5. Need aims at project definition, human resource allocation, financial limitations etc.
6. Procedural needs are operational requirements.

Need & customer satisfaction

1. Avoid communication gap b/w agencies.
2. Future needs addition to present need.
3. Check suitable needs.

4. Quantify o/p & I/P for a problem.
5. Use service departments.

Analysis – customer satisfaction – depends on product attributes.

1. Accuracy. 2. Reliability & quality 3. Easy to operate.
4. Good appearance. 5. Easy to operate.

PREPARATION OF DESIGN SPECIFICATION

Specifications are detailed descriptions of the required characteristics of the equipment, system (or) process.

Family of specification groups

1. Customer specifications. 2. Product design specifications. 3. Manufacturing. 4. Sales

Customer's specifications

Selling price, luxury, aesthetic, considerations, safety requirements, limitations, hazards, environment considerations, type of user, performance, appearance, reliability, design life, rate of deterioration, service & maintenance considerations.

Product design specifications

Define characteristics, capabilities and limitations of the product.

1. Product description. 2. Life (no of operations/cycles). 3. Degradation rate
4. O/P/performance parameter. 5. Reliability. 6. Performance parameters.

Manufacturing specification

1. Include description of everything.
2. Component, details of tools, sigs fixtures & measuring equipment, calibration requirements, material specification, testing methods, assembly & packing, storage & transport customer training & requirements, company trade, standards.

Sales specification

Product appearance, performance characteristics, stmt, dimensions or features, economy, maintainability, safety & reliability.

Need vis – a vis specification

STANDARDS OF PERFORMANCE & CONSTRAINTS:

1. Each system has to perform, function to the desired level of requirements. Reliability safety, case of maintains a cost, maintainability.
2. Performance depends on no of parameters.

SEARCHING FOR DESIGN CONCEPTS-02

DESIGN CONCEPT

1. Blue of the system
2. Engineering industry prepare new product's do improvements to satisfy all customer needs & demands of society.
3. Designer create product with excellent functionality.
4. **Design functions**

a. Product design (Involve development of specifications)
b. Process design (Method of product manufacture)

5. Product specifications
6. Low cost & high quality & reliability reworking, stock replacement.

DESIGN TECHNIQUES: (5 PHASES)

Problem has optimal solutions to get several factors & sub tasks.

1. Problem identification new product (or) improve existing to meet customer needs.
2. Data collection from market assessments for – ve & +ve inferences.

Hypothesis

1. Intuition & technical expertise merge together to produce solutions for a problem.
2. Here potential configurations emerge & are evaluated.

Experimentation

It has opportunity to examine the various problem solutions critically & to detect & correct error's before the article is put into problem.

Final solution

Here refinements needed to satisfy special methods of manufacture in order to simplyify the product so that it can easily be assembled.
Industrial, design, production, safety, product maintenance specialist, ergonomist & other engineer's are required.

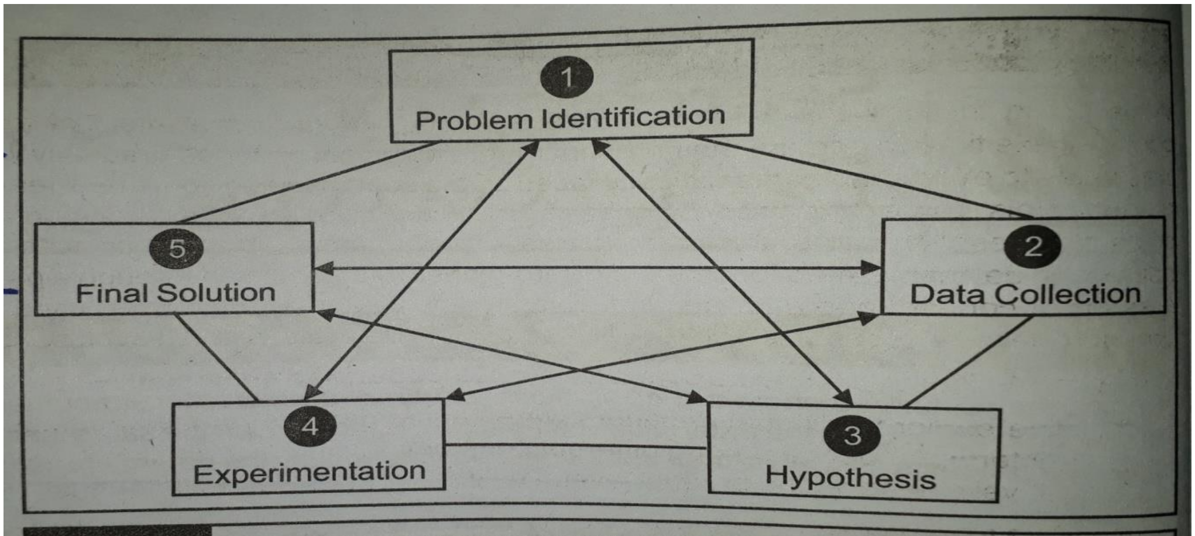


FIGURE 2.1 BLOCK DIAGRAM OF A DESIGN PROCESS

ELEMENTS OF GRAPHICAL REPRESENTATIONS

A visual symbol for graphical represent design ideas normally.

1. Lines. 2. Planes. 3. Forms. 4. Surface qualities.

2D & 3D design objects components.

PRINCIPLES OF MODERN DESIGN

Products must be

1. Useful, functional & expressive
2. Incorporate latest advancements in science, computer application & process technologies.
3. Good appearances (color & texture)
4. Prevailing aesthetics
5. Avoid unnecessary decoration.

DESIGN BY EVOLUTION

Find tools, equipment, implements, etc, with passage of time & each change was made to overcome some difficulty faced by the user (or) to add some new features to increases its usefulness.

Modern design situations

Past	Present
1. One component engineer's do work	more components
2. Small scale production	large-scale production
3. Not suitable for all situation's	Suitable for all situations
4. Future requirements & change less	More

ALTER TECHNIQUES & DESIGN REVIEW

Points of view for design review

1. Performance. 2. Manufacturability/producibility. 3. Maintainability.

Success of design review depends on upper mgmt (customer requirement reliability, ease of manufacture, ease of assembly, ease of maintenance, service, appearance & safety).

1. Design review must be planned & scheduled.
2. 1st priority customer requirements

Design review stages

1. Feasibility stage: Here existing knowledge of customer requirements are compared with the feasible methods of satisfying the requirements.

2. Intermediate results: It evaluates results of feasibility studies, prototype tests, information, performance claims, and design life & reliability date.

3. Final review

a. Examine the complete product conforms close to the customer requirements.

b. It concerned with the manufacturing methods, material, processes & assembly methods in order to ensure the optimum cost & quality of manufacture.

Reasons for altering design process

1. Standardization of production process
2. Due to outcome of differ tests such as performance maintainability, reliability etc.
3. Cost techniques.

4. Design review board recommendations
5. Mgmt decisions.

ARTIFICIAL INTELLIGENCE IN DESIGN
1. Computer powerful & not comparable to human intelligence.
2. Human’s do task’s & computer’s can’t
3. A & address this field by
a. Subjective judgments.
b. Brute strength by factor’s relevant
c. Generalize what factors.
4. Syntactic knowledge
It can lead to the configuration of a design (knowledge of elements along with their manipulation & configuration)
5. Mapping behavior variables with structural variables known as casual knowledge.
6. Behavioral variables (% of light transmitted, construction cost, maintenance cost, strength etc.

Design categories

1. Routine design:	Instantiate values for structural variables.
2. Innovative design:	Modify/extended certain aspects of defined design
3. Creative design:	Design space is created.

DESIGN THROUGH MORPHOLOGICAL ANALYSIS
1. Morphology is a systematic search for alternatives by looking at the possible combinations of diverse & previously unrelated parameters.
2. It generates a large number of solutions.
3. Compared cost estimate, time-cost for research & development.
4. Reliability, quality & performance.

Step by step of morphology design
1. Feasibility study (phase 1)
Achieve a set of useful solutions to the design problem parameter’s, constraints & major design criteria.
2. Preliminary design (phase 2): Preferred alternatives are the best design concept.
3. Detailed design (phase 3)
a. Furnish the engineering description of a tested & producible design.
b. Final decision for a particular design concept to be made.
4. Planning for production process (phase 4)
a. Plan manufacturing process for every part, sub assembly & final assembly.
b. Tools & fixtures
c. Quality control system
d. Production
e. Information flow system
f. Financial planning
5. Planning for distribution (phase 5): Packing, promotion activity & distribution
6. Planning for consumption (phase 6)
Incorporate, design, and feature for product improvement.

Steps

1. Maintenance.	2. Reliability.	3. Safety.	4. Convenience.
5. Aesthetic features.	6. Duration of service.	7. Product improvement.	

6. Planning for obsolescence of product (phase 7)

1. Disposal of the obsolete product.
2. Physical life, reusable material, long lived components & laboratory service terminated products.

BRAIN STORMING

Practice a conference technique by which a group attempts to find out a workable solution for a specific problem by accumulating all idea's spontaneously contributed group of experts.

1. Each member ideas
2. No idea pass (stupid treated)
3. Free flow ideas
4. Clarity should be maintained by leader
5. Black board, papers, transparent sheets, projector used for listing out ideas.
6. Use 5Ws principle (what, why, when, where & who).
7. Outsider joins the process.
8. Record references.

SHORT FALLS IN TRADITIONAL PRODUCT DESIGN METHODOLOGY

1. Uncertainty time in product definition.
2. Uncooperative altitude, Isolated engineering.
3. Cosmetic additions on products rather than improved feature
4. Lack of standardization parts
5. Poor manufacturing processes & capabilities.

DETAILED DESIGN

Development & production of new idea's (or) products can take place through teamwork & concurrent engineering.

Design for Manufacturability

Products are designed without giving any concern to the production capabilities, manufacturing process & the wastage involved resulting in costly design changes.

Quality & Reliability: Involved in the design process to guarantee the product performance according to customer's requirements & costly design changes.

Maintainability: Duration of performance after failure.

Safety: Keeping all sparks, ignitions ect in closed space, avoiding extruded parts sharp corner. Enclosing all running parts etc.

Product design customization: Deliver products according to the customer's desires in the shortest possible time & just in time mode.

DESIGN FOR ASSEMBLY

DESIGN CHECKS FOR CLARITY, SIMPLICITY & SAFETY & CLARITY: Design must have clarity that means the designer must have clear thinking about the shape, size & functions of a particular product.

Simple: So that assembly process as well as servicing of units becomes easy.
Safety: Examined properly from all angles depending on the scope of use of the product, possible environments of use, population of user's, possible hazards associated with other design features considering human factors.

DESIGN FOR RELIABILITY (ABILITY/INABILITY): It is defined probability of a system performing its purpose adequately in the desired manner for the period of time predetermined under a specific operating environment/conditions mean time between failure = MTBF.

MTBF = 1/T T = failure rate

Reliability prediction: Based on all components reliability.

MANUFACTURING PROCESSES

INTRODUCTION

1. Materials used by industry to industry differ & shapes
2. Manufacturing converts the raw material into finished products to be used for some purposes.
3. Product manufactured using 2/more processing by engineer's by design point of view.

Input – output model

Manufacturing process

Used for transformation of set of input elements into a set of desired O/P elements.
I/P – independent & dependent variables.

Independent	work piece materials, part geometry types of machining process, tool materials, cutting parameter's cutting fluid etc.
Dependent	cutting forces, power, surface finish, size & geometry of part, tool wear & tool failure etc.

CLASSIFICATION OF MANUFACTURING PROCESS

1. Casting, foundry (or) moulding process.
2. Forming/metal working process.
3. Machining (metal removal) processes.
4. Joining & assembly.
5. Surface treatments (finishing).
6. Heat treatments.

4, 6 – laser used. Forming & sharing – hot & cold Machining – metal removal

Basic machining processes

1. Shaping.
2. Drilling.
3. Turning.
4. Milling.
5. Sawing.
6. Broaching.
7. Abrasive machining.

Metal removal – heat/chemical/electro chemical

CASTING PROCESS

1. It is a process of forming metallic products by melting the metal, pouring it into the cavity known as mould & allowing it to solidify.
2. Molten metal takes the shape of the mould cavity.
3. Mould is made with the help of a pattern which may be made of wood, metal (or) non-metal like polystyrene/sand core of desired shape with help of core box.

Terminology used in casting

1. Drag = lower moulding box
2. Cope = upper moulding box
3. Check = intermediate moulding box
4. Pattern = replica of desired final product with some modifications.
5. **Parting line:** It is dividing line between 2/more moulding boxes
6. **Facing sand**

It is high quality sand having higher sintering point & low thermal expansion used on the face on the mould.

7. **Parting sand**

Used to prevent the joint between the halues of a mould from adher in to one another when the 2parts of a moulding box are separated.

Backing sand: Used to fill the flasks to cover path.
Core: Used for making hollow cavity in casting
Core print: Provided in the pattern, core & mould to locate & support the core within the mould.

Mould cavity
a. Mould material & the core combine to form mould cavity.
b. It is hollow portion of mould in which the molten metal is poured to get the casing.

Permeability/porosity: It refers to the ability of moulding sand to provide the passage of gaseous materials/water & stream vapour.
Pouring basin: A small funnel shaped cavity at the top of the mould into which the molten metal is poured.
Runner: The passage in the parting surface through which molten metal flow is regulated before the metal reaches the mould cavity
Gate: Entry point through which molten metal enters the mould cavity.
Chaplet: Support the core inside the mould cavity to take care of its weight & overcome the metallostatic pressures.
Chill: Are metal objects which are placed in the mould to increase the cooling rate of casting so as to provide uniform.
Riser: Acts as a reservoir of molten metal provided in the mould so that the hot metal can flow back into the mould cavity when there is shrinkage due to solidification.

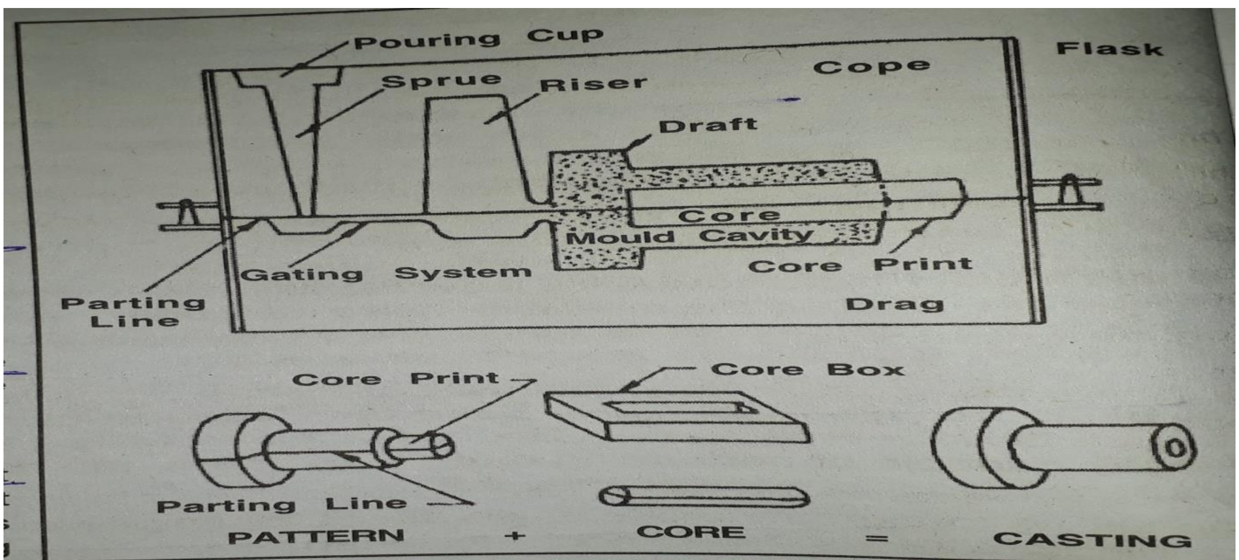
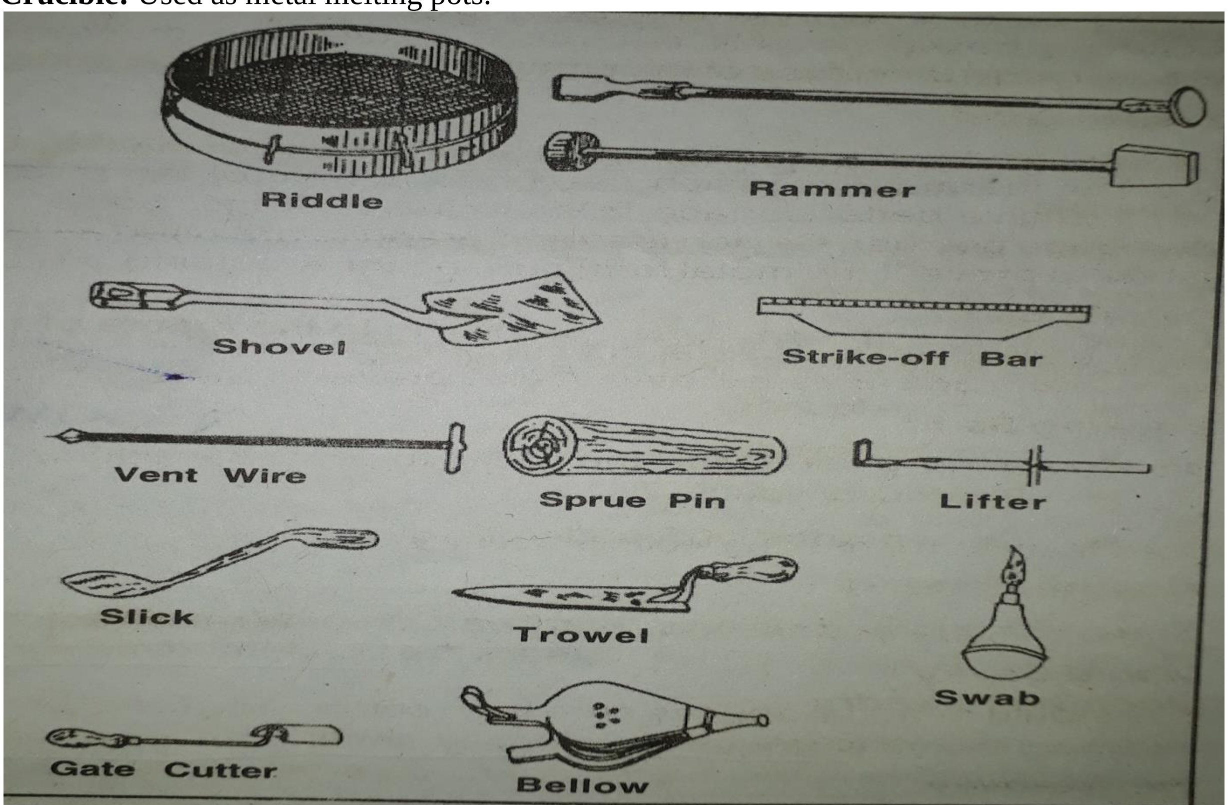


FIGURE 3.1 VARIOUS COMPONENTS PRESENT IN MOULD STRUCTURE

Tools & Equipment
Riddle: It is wooden frame with a wire mesh bottom used to remove foreign materials such as nails/splinters of wood etc.

Rammer: Used for packing the sand into the mould.
Shovel: Used for mixing & tempering moulding sand & for moving sand from the pile to the flask.
Strike off bar: Used to remove the surplus sand from the mould after the ramming has been completed.
Vent wire: Wire rod used for making opening called vents in the mould to allow the escape of gas & stream from the mould during the pouring operation.
Sprue pin: Wooden / metallic pin to make an opening in the mould through which the metal is poured.
Lifter: Used for patching deep sections of a mould & removing loose sand from pockets of the mould.
Slick: Used for repairing & finishing moulds.
Trowel: Making joints & finishing flat surface of the mould.
Swab: Used for applying water to the would around the edge of the pattern before removing the same from the mould.
Gate cutter: Used to cut opening (gate) that connects the sprue with mould cavity.
Bellow: Used to blow loose sand out of the mould & are used more frequently.
Moulding Board: It one which the pattern & the flask are placed during the moulding.
Gagger: Used for reinforcement of sand in the cope.
Ladle: Used to receive molten metal from the melting furnace & is use to pour the same into the mould.
Crucible: Used as metal melting pots.



GURE 3.2 TOOLS AND EQUIPMENT USED IN THE CASTING PROCESS

Types of foundries: Foundry produces casting.
1. Captive foundry:
a. Integral part of manufacturing organization.
b. Consumed mainly in the products being manufactured by the organization.
2. Jobbing foundry: Produce small number of castings of a given type for different custormers.
3. Production foundry: Produce casting economically on mass production.
4. Semi production foundry (spf) SPF = (job + production) foundry.

Step's of casting process
1. Pattern making. 2. Mould & core making.
3. Melting & pouring. 4. Cleaning of casting.
5. Inspection & quality control.

Pattern making
It is a model of desired casting component made from Wood, Metal, Plastic, Plaster and Wax

Wood:
Characteristics are Cheap, Availability, and Ease of fabrication, Light weight and Good surface finish.

Metal: High cost, High weigh and tenderly of rusting
Plastic
Characteristics are less weight, High strength, High resistance, Low cash and Fine surface finish

Plaster of Paris: Smalls patterns & core boxes contain shapes required dimensions.
Wax: Used for separation of 2 halves.

Pattern selection factors
1. No of castings produced. 2. Mould material
3. Type of moulding process 4. Accuracy. 5. Thickness.

Types of pattern (Used for die)
1. Single piece pattern. 2. Multiple piece patterns.
3. Split pattern. 4. Cope & drag pattern.
5. Follow board pattern. 6. Gated pattern.
7. Skeleton pattern. 8. Match plate pattern. 9. Sweep pattern.

Single piece pattern: It is made in 1 piece & carries no joint, partiation (or) loose pieces.

Multiple piece patterns
Parts order to facilitate an easy moulding & withdrawal of pattern.

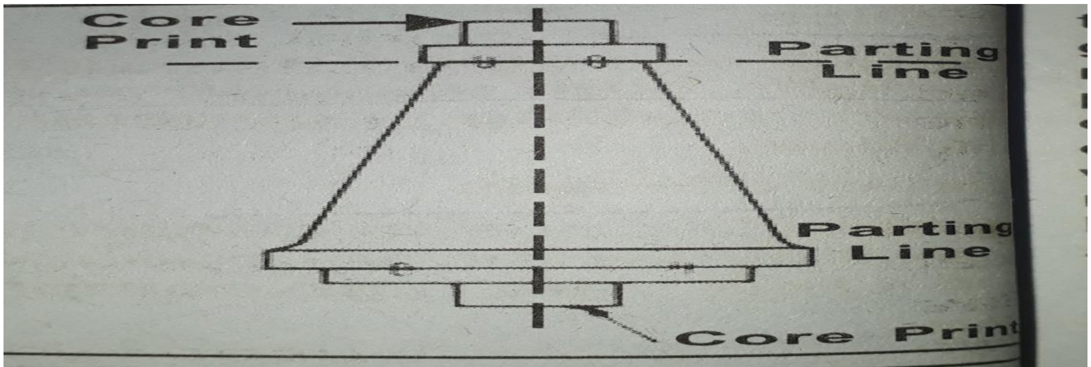


FIGURE 3.5 A VIEW OF A MULTIPLE-PIECE PATTERN

Split pattern
2 parts which are joined at the parting line by means of dowels.

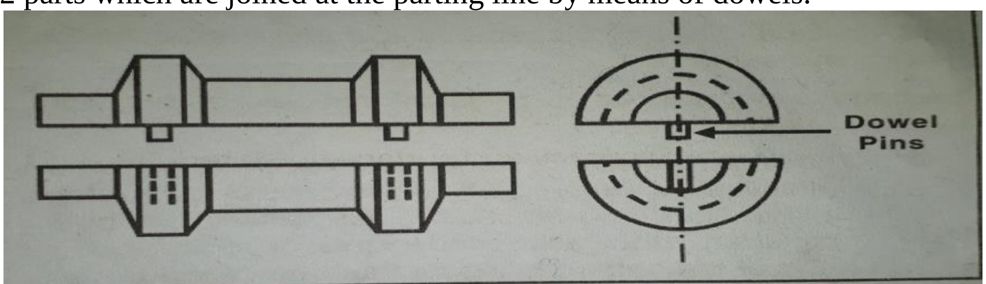


FIGURE 3.6 SCHEMATIC REPRESENTATION OF A SPLIT PATTERN

Cope & drag pattern
Pattern made in 2 parts which are mould separately in differ moulding box after completion of moulds 2 boxes are assembled to form complete cavity of which one part is contained by the drag & other in cope.

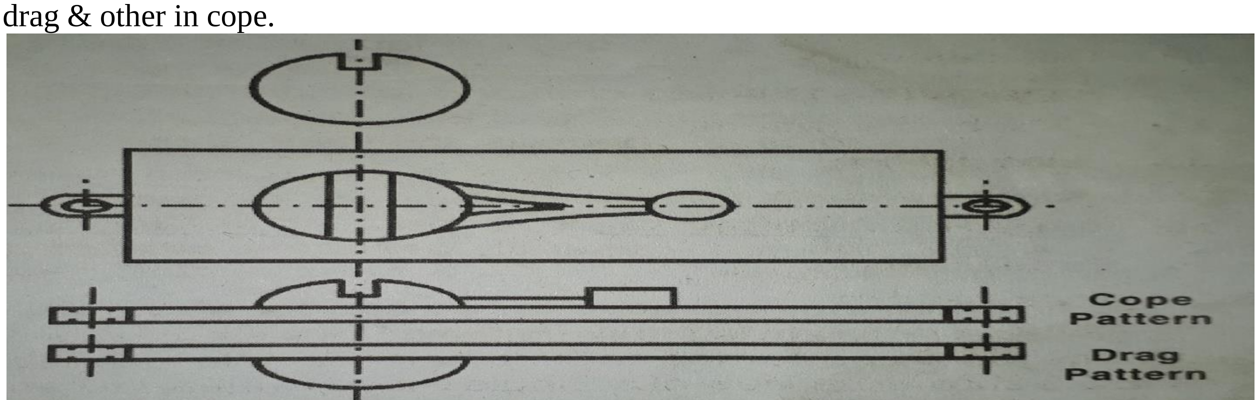


FIGURE 3.7 VIEW OF A COPE AND DRAG PATTERN

Follow Board pattern: It is wooden board which is used to support a pattern during moulding it acts a seat for the pattern.

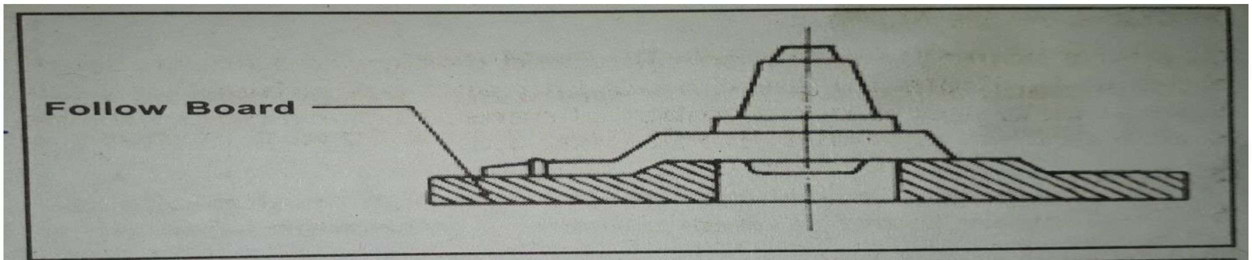


FIGURE 3.8 SCHEMATIC REPRESENTATION OF A FOLLOW BOARD PATTERN

Gated pattern

Used for mass production of small casting. Casting is connected to each other by means of gate former's which provide suitable channels sand for feeding the molten metal to cavities.

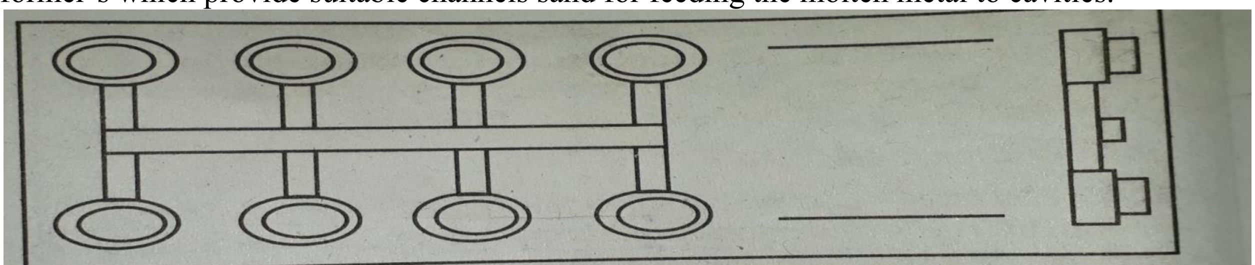


FIGURE 3.9 VIEW OF A GATED PATTERN

Skeleton pattern

Consists of wooden frame & stips & used when the size of the casting is very large, but easy to shape & only a few number's are to be made.

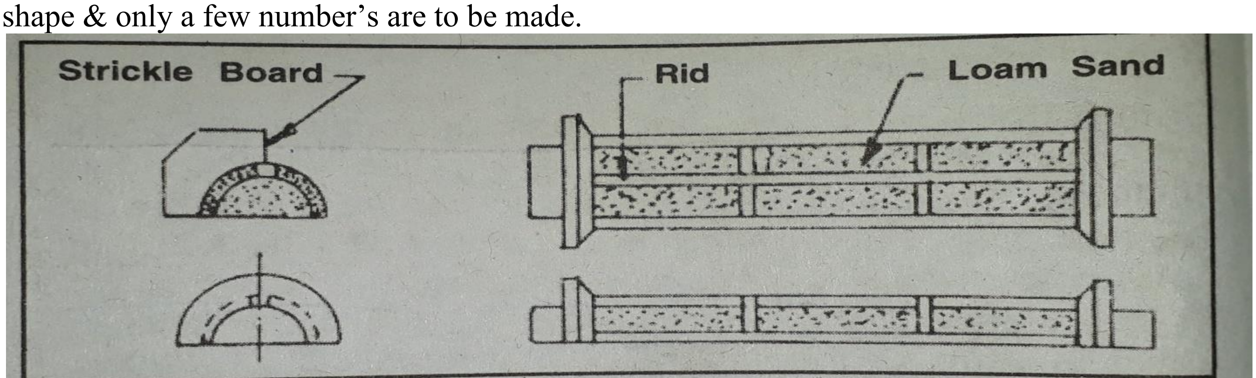


FIGURE 3.10 SCHEMATIC REPRESENTATION OF A SKELETON PATTERN

Match plate pattern

a. Rapid production of small & accurate castings is desired on a large scale.

b. These patterns are made in 2 pieces, one piece mounted on one side & other on the other side called match plate.

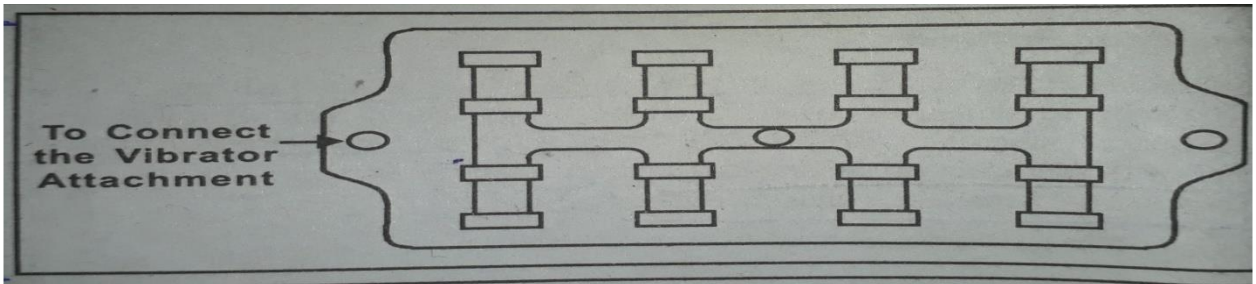


FIGURE 3.11 VIEW OF A MATCH PLATE PATTERN

Sweep pattern

For preparing moulds of large symmetrical casting. Particularly of circular cross section. Wooden template called sweep outer end sweep to shape of the desired casting. Central holes is located, externsions called as core prints have been added to the patter. Pattern colour code.

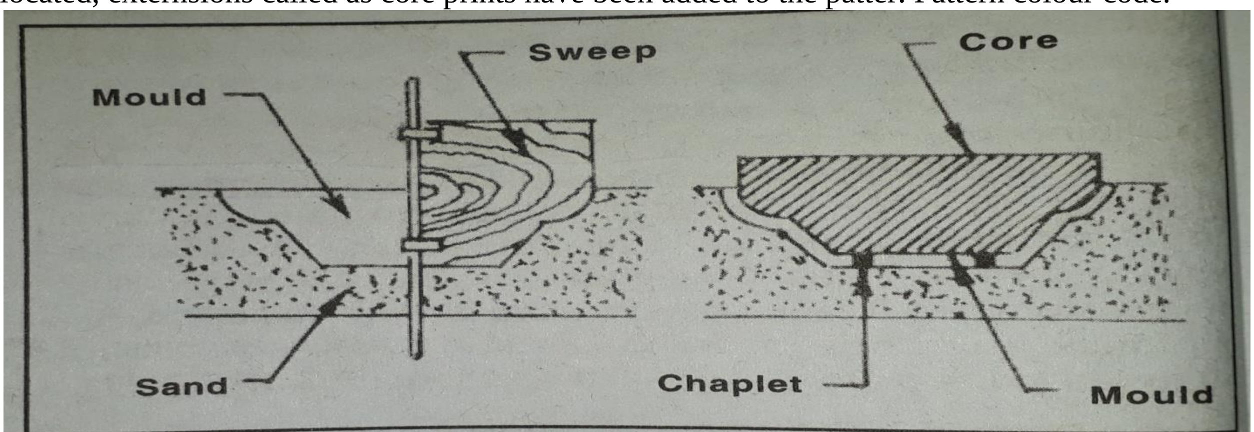


FIGURE 3.12 SCHEMATIC REPRESENTATION OF A SWEEP PATTERN

Mould & core making

Moulding materials may be metallic (or) non metallic.
Metallic – castiron, steel anodized aluminum etc.
Non metallic – sand, plaster of paris, graphite, silicon carbide, ceramic

Selection of materials for moulding are depends on factors.

1. Material cost.
2. Quality of cating.
3. Cast material.
4. No of casting to be cast.
5. Accuracy.
6. Size & shape of the casting.

Classifications of sands

1. Natural moulding sand

a. Contain natural boarding clays is called natural sands/green sands.
b. Used in foundry for hand moulding work for light casting iron & non-ferrous allays.

2. High silica sand

a. <2% - clay
b. Used for production of medium & heavy iron casting & steel casting when synthetic sand mixes are used.

Moulding sand tests

1. Moisture. 2. Permeability. 3. Green strength.
4. Clay content. 5. Combustibles. 6. Green shear.
7. Shalter index. 8. Dry compressive strength.

Mould process/methods

1. Bench moulding. 2. Floor. 3. Pit. 4. Machine.

Classification of moulding based on materials

Sand moulding
a. Small jobs
b. Moulding box 2 parts(Upper – cope, Lower – drag and Middle box – check)
Floor moulding: Casting are made in pits instead of moulding boxes because of their big size.
Machine moulding
a. Save labour & work time & accuracy
b. Important for large quantities.

Sand moulding classification

1. Green sand moulding: Contain moisture at the time of metal pouring.
2. Dry sand moulding: It used at the time of metal pouring.
3. Skin dried moulding: Compromise b/w the green sand & dry sand mould.
4. Core sand moudling: Made of oil & resin bonded sands.
5. Cement bond sand moulding: It = sand (8-12)% + (4-6)% water hardness & strength by the setting action of Portland cement.
6. Loam moulding: It is made with bricks & iron reinforcements & are given thick coating of loam mortar all over the shape.
7. Carbondioxide moulding: Co2/sodium silicate process: It = sand + (1.5-6)% liquid silicate.
8. Shell moulding: Form of casting

Core making

1. Core sand preparation. 2. Core making. 3. Core baking. 4. Core finish.
Core sand preparation machine: Homogeneous mix

Core making machine

1. Core blowing machine. 2. Core ramming machine. 3. Core drawing machine

Core baking: Baked in baking furnace
Core finishing: Finally set mould
Investment casting: Used for production of steel casting.

PRINCIPLES OF MACHINING

INTRODUCTION

1. Metal cutting processes are used for machining parts to required dimensions.
2. Product's dimensional accuracy. Machine tools (remove metal – small chips).

Power driven machines used for cutting metal

Metal cutting processes include

Turing, Planning, Shaping, Milling, Drilling, Boring and Grinding

1. Metal cutting basis engg industry work on reciprocating (or) rotator principle developing component.
2. Machining relies their operation on shearing molecules of the material from the adjacent molecular force.

3. Shearing:

It is the application of concentrated force to the small area by means of a tool/knife while supporting the immediately adjacent material. This can be seen in tailor's scissor's (or) powered guillotine.

4. The force available may be applied out a long edge. As in blanking of shape from such materials as felt/paper using a shaped knife/rule & a semi-resilient support for the material. May be concentrated at one (or) more points by applying shear to the blade. As in a guillotine.
5. The application of the force may be linear, vertical (guillotine), horizontal (as in bread slicer) or rotational (as in ham slicer).

<table>
<tr><td rowspan="4">Force application</td><td>Linear</td><td colspan="2">Machining operation categories</td></tr>
<tr><td>Vertical (guillotine)</td><td rowspan="3">Working is moving, tool is stationery Ex : turning</td><td rowspan="3">Work is stationery tool is moving
ex : drilling, milling</td></tr>
<tr><td>Horizontal (bread slicer)</td></tr>
<tr><td>Rotational (ham slicer)</td></tr>
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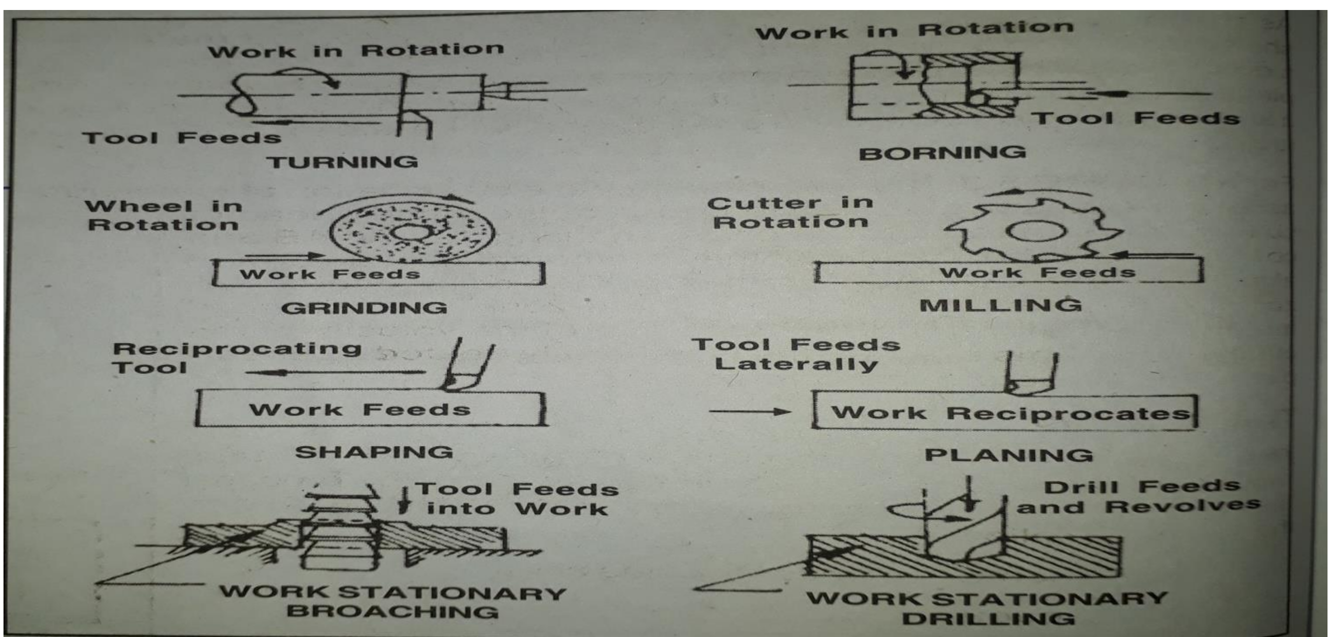


FIGURE 5.1 SCHEMATIC REPRESENTATION OF BASIC MACHINING PROCESSES

MECHANICS OF METAL CUTTING

Wedge shaped is fed to move relative to the work piece in such a way that a layer of metal is removed in the form of chip.

Orthogonal cutting: The cutting edge of the tool is at right angle to the direction of relative motion between the tool & the workspace

Cutting: Single point tool and Multipoint tool

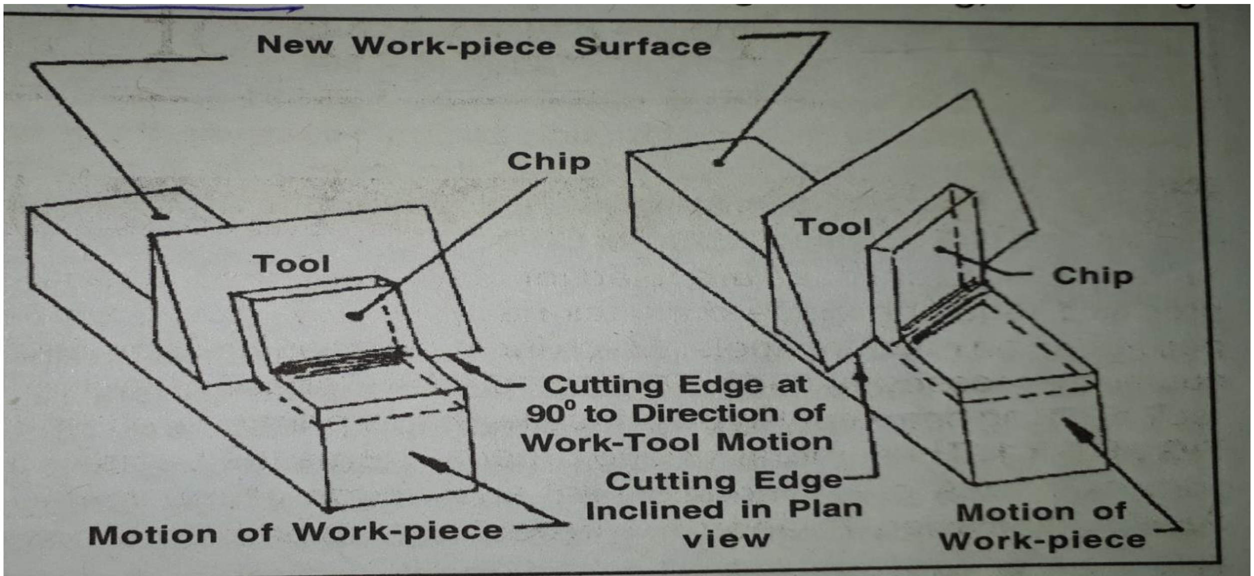


FIGURE 5.2 ORTHOGONAL AND OBLIQUE CUTTING OF METAL

Chip formation

1. Cutting tool advances into the work piece stressed & internal shearing action in the metal, cutting edge yields & starts flowing plastically in the form of a chip.
2. Plastic flow takes place in a localized region called the shear – plane.
3. Region ABCD = shear region.

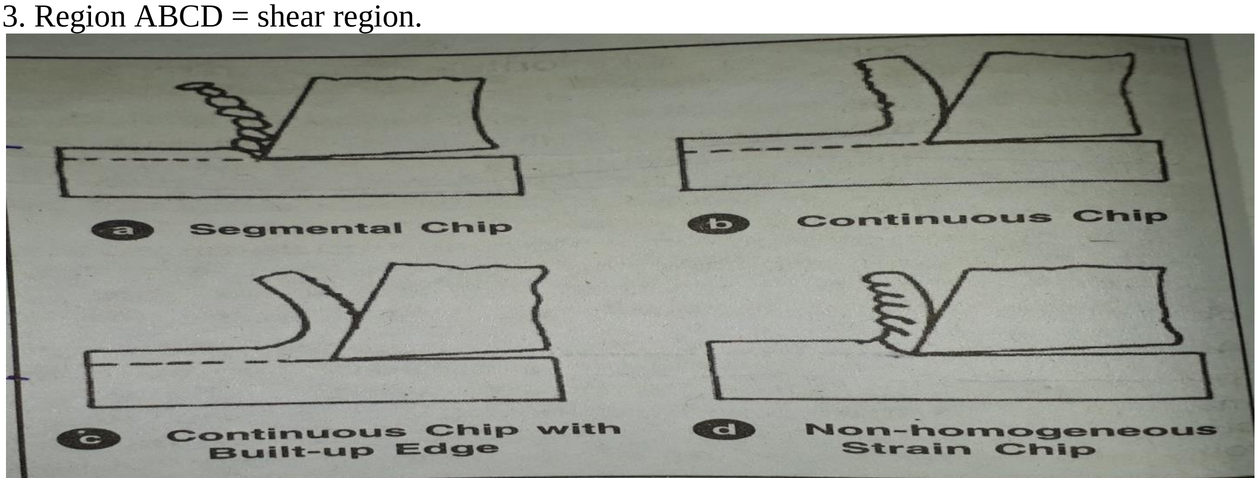


FIGURE 5.4 TYPES OF CHIPS OBTAINED FROM METAL CUTTING PROCESS

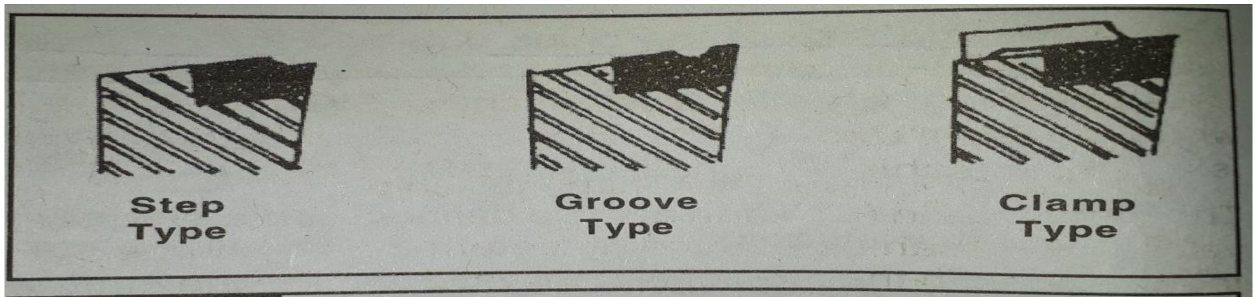


FIGURE 5.5 TYPES OF CHIP BREAKERS USED ON SINGLE POINT TOOLS

Types of chip

1. Shape & size of chips obtained from a metal cutting process indicates the type quality of the process.
2. **4 types of chips**

a. Segmental/discontinuous chip. b. Continuous chip.
c. Continuous chip with built-up edge. d. Non homogeneous strain chip.

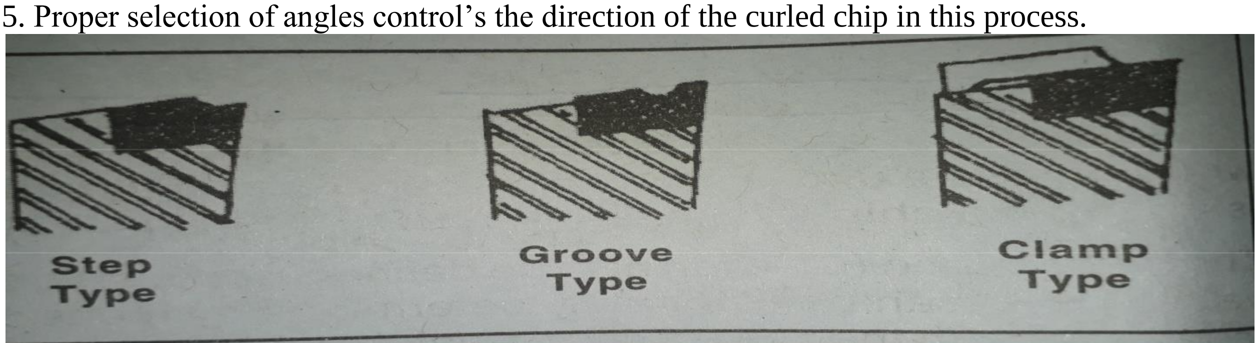
Segmental: It represents a condition in which the metal ahead of the cutting tool is fractured into small pieces. Like cast iron & bronze.
Continuous: It is obtained in cutting ductile materials having a low coefficient of friction.
Continuous chip with built up edge: High coefficient of friction.

Non homogeneous strain chip

Which are produced owning to non-uniform strain in the material during chip formation are characterized by hotches on the free side of chip while the side adjoining the tool face is smooth.

Chip control

1. During Turing, the control & disposal of chips is important to protect both the operator & tools.
2. Chip breakers are used on single point tools.
3. The chip breaker curls & highly stresses the chips so that they break into short lengths for easy removal from the machine.
4. Grinding on the face of the tool along the cutting edge is known as step-type cheip breaker.
5. Proper selection of angles control's the direction of the curled chip in this process.



IGURE 5.5 TYPES OF CHIP BREAKERS USED ON SINGLE POINT TOOLS

Analysis of chip formation

Analysis of various factors such as shear plane, cutting ratio, shear angle, shear strain & chip velocity & velocity of shear which govern the chip formation process.

Shear plane

1. Material is sheared in a narrow zone extending from the cutting edge to the work surface.
2. For analysis, this zone of shear is treated as single plane & termed as the shear plane.
3. Cutting ratio (or) chip compression factor

CR = Thickness of chip before removal- thickness after removal from the material being cut

CR = t1 – t2 = undeformed chip thickness-man chip thickness

CR = chip velocity – cutting speed = v0 = v2 = e mo= e4 (TT – 2

Chip velocity = length of chip with a string for a particular cutting time measured with the help of a stop watch.

4. Shear angle

a. It is the angle made by the shear plane with the direction of tool travel.

b. It larger shear angle large greater force required to remove chip & important in metal cutting.

Shear angel – large piece removal

Coefficient of friction = tan0

Tan0 = cos- e-4-TT 2-y

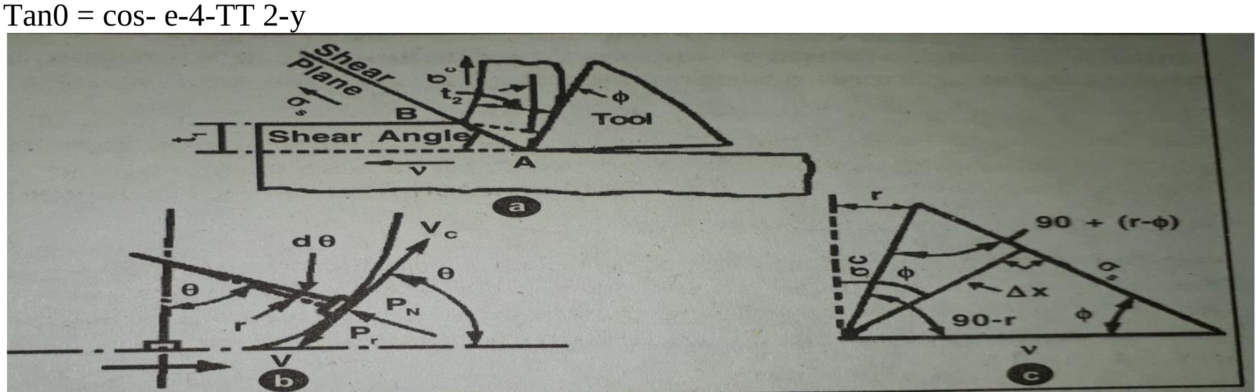


FIGURE 5.6 SHEAR ANGLE AND CUTTING RATIO

Shear strain

It is the ratio of displacement of the layer as along the shear plane to the thickness of the layer x.

R = rake angle	X = thickness of layer
0 = shear angle	S = displacement of layer

E = plastic deformation

E = s- x = cos- sin0 cos(0-Y)

Chip velocity & velocity of shear

The velocity with which the chip moves over the took rake face where as the velocity of shear is the velocity with which the metal sheard along the shear plane.

Vc-v = sin0-cos(0-Y) = cos – cos(0-y)

FORCE RELATIONSHIPS

For 1. Orthogonal cutting. 2. Oblique cutting.

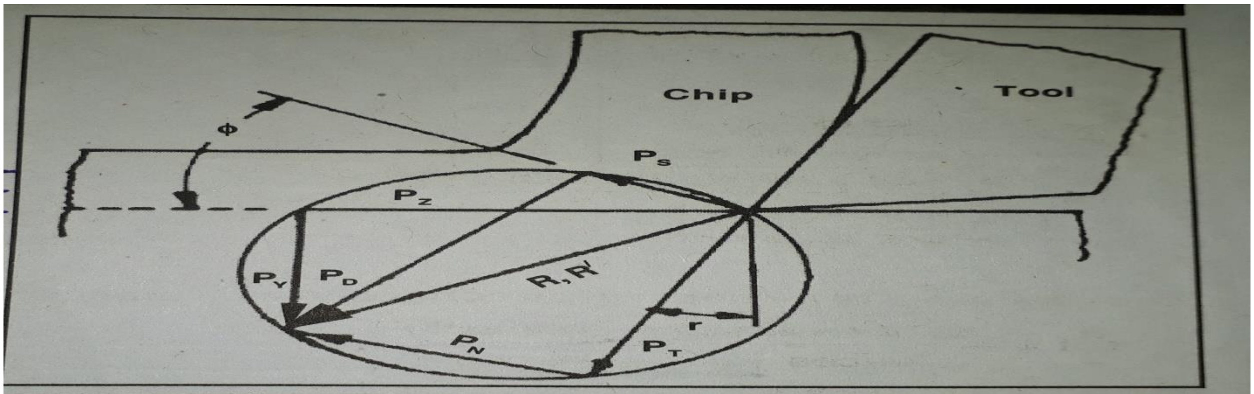


FIGURE 5.7 SCHEMATIC REPRESENTATION OF FORCE IN ORTHOGONAL CUTTING

Orthogonal cutting
1. Single plane, shear plane
2. Force R between tool face & chip
3. Force R between work piece & the chip
4. R, R1 can act at the tool point are represented by the diameter of a reference circle.

Force components
P2 – horizontal
Py – vertical
Ps – perpendicular
Pd – perpendicular to shear plane
Pt – perpendicular
Pn – perpendicular to tool face
Pr – acts along tool face
Pr – P2 cos0 – Py – sin0
Pd – P2 sin0 – Py cos0
Pt – p2 sin y – py cos y
Pn – P2 cosy – Py sin y

Oblique cutting
1. The cutting edge is inclined to the direction of tool travel & the cutting direction.
2 . Force acting on the cutting tool during oblique cutting.

Coefficient of friction
M = pt – pn = py + p2 tan y – p2 + py tan y

U controllable factors
1. Cutting fluid. 2. Rake angle. 3. Cutting speeds 4. Additives to work piece
Cutting ration r = em (TT/2 – y) = tan B M = log (1/r) – (TT/2-y)

CUTTING SPEED & FEED DURING METAL CUTTING
1. It refers to the rate at which a work-piece revolves past a fixed point of a cutting tool.
2. In lathe work, the cutting point is at the turned diameter. Diameter measured in m
Cutting speed = (diameter * TT) x rpm – 1000

Feed / chip thickness
Used to express the distance that the tool moves for each revolution of the work.

Cutting speed influencing factor's
1. Tool material for cutting. 2. Work piece material. 3. Geometry of cutting tool.
4. Chip breaker. 5. Tool life. 6. Cutting fluid.
7. Type of cut (rough / finish).

Turning: Old machining process.

Basic lathe
A lathe is a tool that rotates the work piece about an axis of rotation to perform, various operations such as cutting sanding, knurling, drilling, deformation, facing, turning with tools that are applied to the work piece to create an object with symmetry about that axis.
Head stock carries & drives work piece. That is screwed held in a collect (or) chuck. Turning dig into the end grain & provide drive.

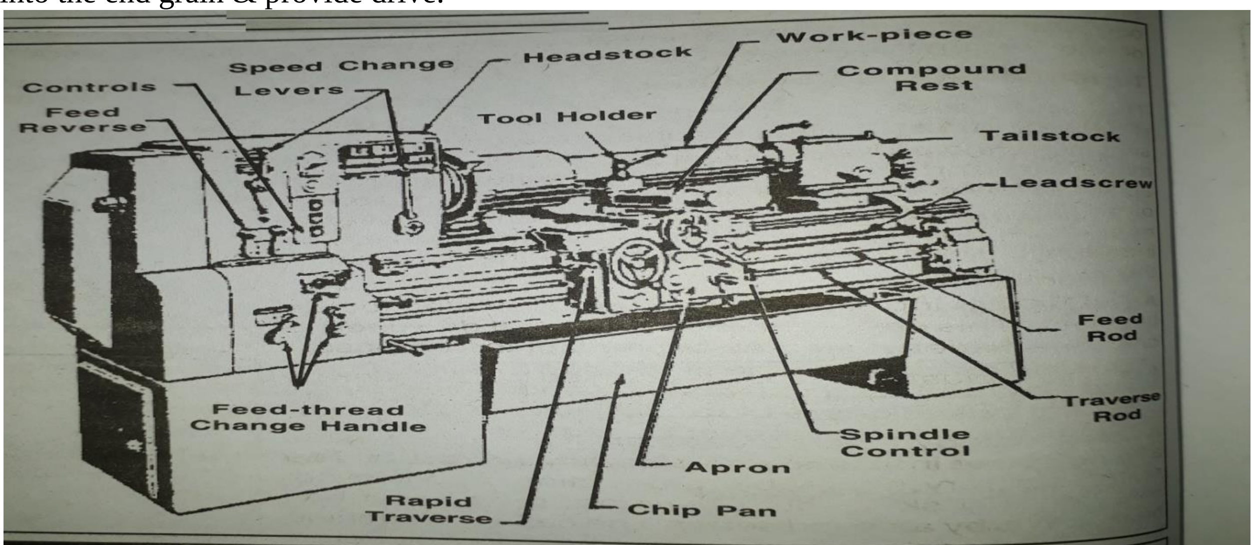


FIGURE 5.9 A TYPICAL HEAVY DUTY METAL-CUTTING LATHE

Turret lathe
1. It is a production machine for use by an unskilled operator is the turret lathe.
2. A saddle moving longitudinally is substituted for the tail stock.
3. Variant of this is vertical lathe.

Automatic lathe
Here machining cycle no longer controlled by operator & is controlled by machine itself usually by cam activated motions.

Types of automatic lathes
1. Single spindle/multi spindle. 2. Vertical/horizontal spindle. 3. Bar, chucking (or) coilfed.

Single spindle auto
Does 2 operations
a. Cut using single point tooling in 2D material is held in the collect of the sliding head & passes through a steady bush close to the cutting point.

b. Load/unload the components done by controlling through a cam (or) sequential & the machine will stop on completion of the work.

Multispindle auto
1. Machining takes place at all spindles concurrently.
2. One spindle position is utilized for loading usually by some form of automated feed device.
Vertical auto: Easy loading for large & more complex parts which cant be feed automatically

Soil – fed lathes
1. Adaption of the tuning principle to enable the turned part to be produced from coil storck.
2. Sliding head auto profiles are generated by a combination of tool feed & bar feed.

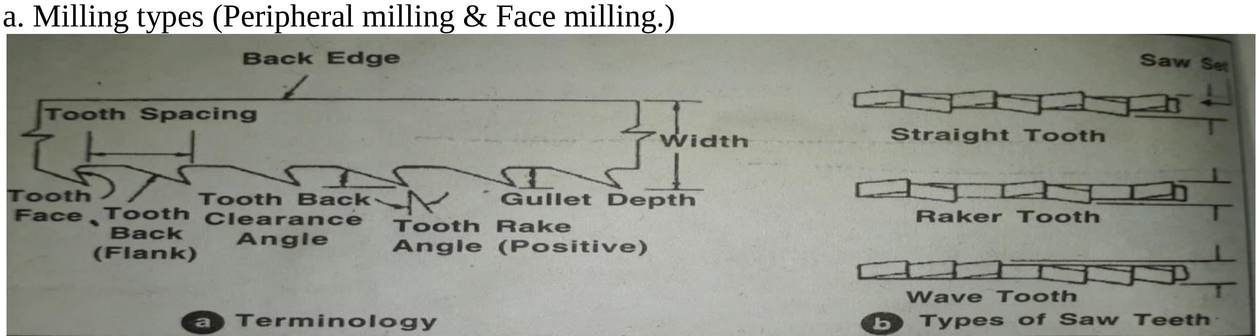
CNC lathe
Computer numerical control (CNC) substitution of positional controlled drives for the hand wheels of the conventional lathe allows for the control of side positions by of generating an unlimited variety of profiles using continuous positional control of the slies.

Twin spindle CNC lathe: Enable the production of completely finished turned parts.
Moving tool maching: Cutting type of operation
Single point cutting: Rotary use of a single point tool known as fly cutting (or) trepannil
Sawing: Oscillating saws driven by water power.

Shaping
1. It is the process of material removal in which a thin layer is removed from a flat surface.
2. Shaping performed by a machine called shaper.

Shaper construction
Forward motion – cutting, shaper = cutting tool cutting tool & auxiliary motion.
Hydraulic shaper: Tool cutting.
Planner
1. Similar to shaper in terms of the surface that can be generated. 2. Used for maching

Milling
It is the metal removal process in which the work piece advances against multipoint tool.
a. Milling types (Peripheral milling & Face milling.)



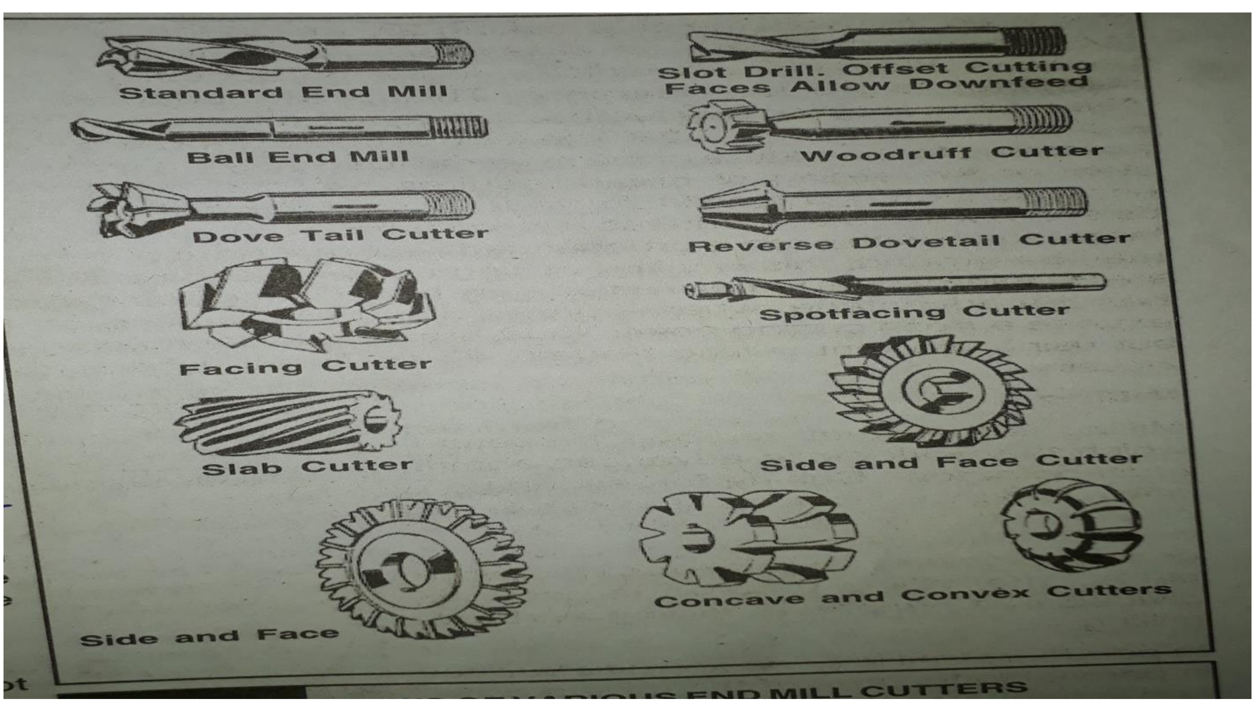
IGURE 5.26 SCHEMATIC REPRESENTATION OF A TEETH CUTTER, STAGGERED TO PROVIDE CLEARANCE TO PREVENT BINDING

Peripheral milling: The finished surface is parallel to the axis of the milling cutter & is generated by teeth located on periphery of the culter.
Face milling: The finished surface is a right angle with the culter axis & is generated by the teeth located on the periphery & the flat end of the culter.

Interrupted cutting: Removes material for only a part of the rotation of the milling culter as a result cutting edge has time to cool before it again removes material.

Small size of chip variation in chip thickness milling culters end mill
Have the cutting edge running through the length of the cutting portion as well as on the face radially up to certain length.
Slot drill: End mill with cutting edge up to the centre are called slot drills & have the ability to cut into the solid material.
Solid milling cutter: Used for machining large & flat surfaces.
Machines tool types
a. Horizontal spindles – surfacing materials wood-working industries
b. Vertical spindles machine – engg production
Combination machine computer control: Applied to both vertical & horizontal machines.
Drilling: Holes by rotating drill bit of some form
Drill material: Carbon steel drill – high speed steel. Tungsten carbide – small drills

Ream
1. It improves the finish & provides closer tolerances.
2. Drilling, reaming is a cutting action.
3. It is multifluted, as it relies on multiple contacts with the drilled hole for its alignment & stability of cut slow speed.
Special Application: Drill – less cost



FUNDAMENTALS OF GRINDING & FINISHING OPERATIONS

INTRODUCTION

1. **Grinding** = machining process where abrasives are bonded to the shape of a wheal, which roatates at a very high speed & interacts with work piece.

2. Grinding classification

a. **Surface grinding** – horizontal spindle – vertical spindle

b. **Cylindrical grinding** – external work piece – grinding wheel – work piece. – Internal work piece.

c. **Centre less grinding** – grinding wheel – work piece grinding wheel.

3. Grinding wheels – many shapes, sizes,

4. Factor's of selecting grinding wheels

a. Type of grinding. b. Material to be ground.
c. Amount of Material to be ground. d. Severity of operation.
e. Surface finish. f. Area of grinding wheel contact.
g. Wheel speed. h. Speed to work. i. Machine condition.

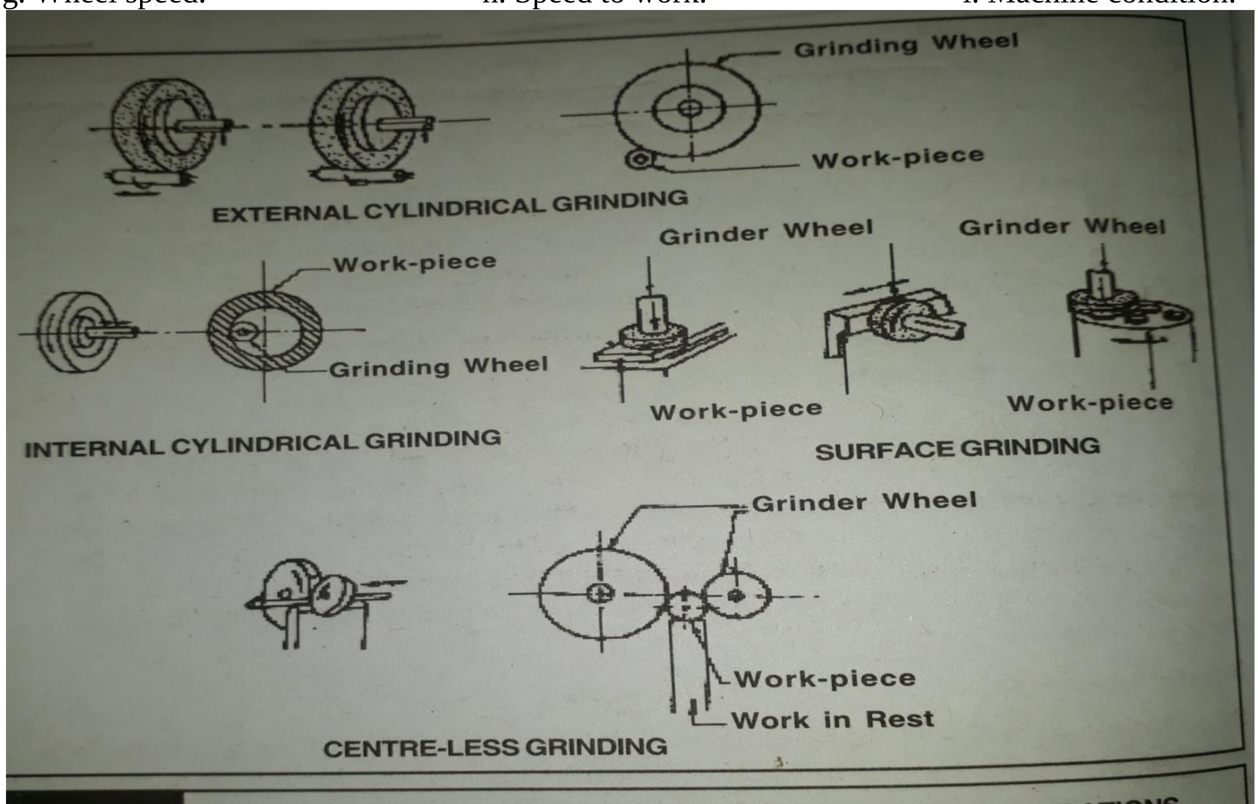


FIGURE 6.1 SCHEMATIC REPRESENTATION OF COMMON GRINDING OPERATIONS

Grinding wheel performance depends on factors

1. Abrasive material. 2. Bonding material 3. Grain size. 4. Structure & grade.

Abrasive material

1. Grinding wheel made of hard material with adequate toughness which acts as cutting edges for a sufficiently long time.
2. There also have the ability to fracture into small pieces when the force increases which is called as friability. This property gives the abrasive.

3. The necessary self-sharpening capability
a. aluminum oxide (A1203). b. Silicon carbide (sic).
c. Cubic boron nitride (CBN) Etc used as abrasives

Bonding material
They keep abrasive grains together under the action of grinding forces.
Ex. Vitrified silicate, synthetic, rise, metal, shellac, rubber, etc.

Grain size (or) grit
1. It represent's approximate size of abrasive materials.
2. The selection of grain size depends upon a number of factors namely
Amount of material to be removed, quality of finish requires physical properties of the waste material.
3. Grain size of abrasive material represented to a number of meshes per inch of the screen through which the grains of abrasive material passed for grading
Ex : 10, 12, 14, 16, 20, 24 (coarse) 80, 100, 120, 150, 180 (fine), etc.
Coarse used high material removal rate. Fine – better surface finish.

Structure & grade
Grade = hardness of wheel = indicate force holding grains.
Grade (wheel) depends on kind of bond structure of wheel & amount of abrasive grains. Bond harder grinding wheel structure of grinding wheel represents the grain spacing. It can be open/dense the spacing is allowed b/w the grains for collection of chip's. This helps to avoid loading of the wheel. Open structure is used for more material removel & gives rough surface finish while denser structure is used for precision works.

OTHER SURFACE FINISH OPERATION
1. Honing. 2. Lapping. 3. Super finishing. 4. Buffing.
Other surface finish operation (material removal rate is less compared to grinding.

Honing
It is process by which bores are finished. Here abrasives in the form of sticks/honing sticks are mounted on a mandrel which is then given a reciprocating movement superimposed on a uniform rotary motion. Reciprocating motion – work piece – work surface – honing sticks.

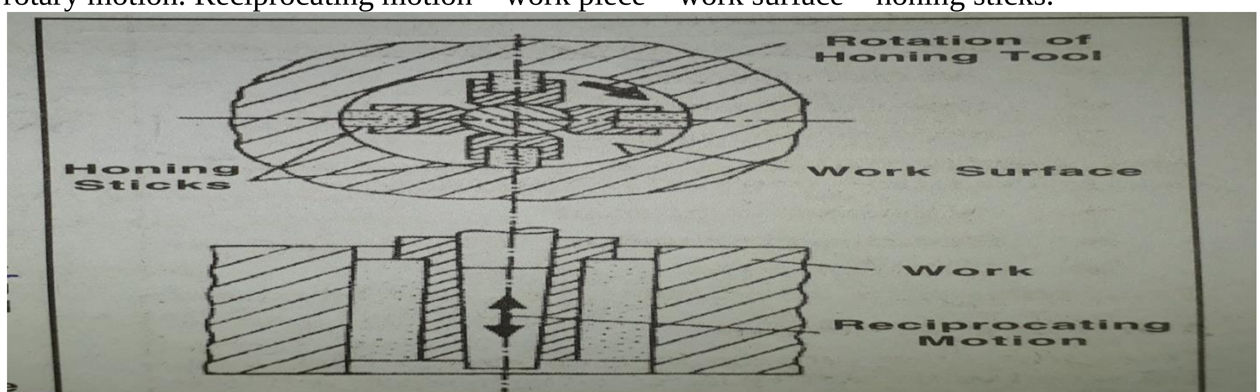


FIGURE 6.2 SCHEMATIC REPRESENTATION OF THE HONING OPERATION

Lapping
1. It is a process by which flat surfaces are finished.
2. The work piece is held against the lap & moved in unrepeated paths. Suitable cutting fluid & abrasive power are used in this operation (0.0020mm material removed soft materials – lapped with aluminiumoxide. Hard material – diamond/silicon carbide.
3. It is a finishing process done either with the help of loose grain/with the boned abrasive wheels.

Super finishing
1. It is similar to honing process but it is applied primarily to outside surfaces.
2. Useful in finishing bearing surfaces this process a gentle pressure is applied over a wide contact area.
3. Flat surface – super finished.
4. Surface irregularities are reduced to very high surface finish.

Buffing
Used for making surface smoother along with a glossy finish. Buffing wheels are mode of cloth (or) such material which is soft & has cushioning effect. The abrasive grains, which are dipped in a medium, such as grease are applied at suitable intervals to the buffing wheel.
Very small amount of material is removed in buffing with a very fine luster obtained on the buffed surface & dimensional accuracy no affected.

NON CONVENTIONAL MANUFACTURING TECHNIQUE
Advancement of industries (aerospace, nuclear) along with development of high strength temperature resistance materials & alloys, fiber-reinforced composites, ceramics, etc. the machining & shaping beyond the scope of the existing convention (or) traditional manufacturing processes

CLASSIFICATION & APPLICATION
Classification of non-conventional methods of machining.
1. Type of energy (mechanical, chemical electro-chemical & thermal & electro thermal). To shape materials.
2. Basic mechanism (erosion, ionic dissolution vapourization) involved in the process.
3. Source of energy (hydrostatic pressure, high current, density, high voltage & ionized material) for material removal.
4. Medium for transfer of the energies (high velocity particles, electrolyte, electron & hot gasses).

Mechanical process
1. Abrasive jet machining (ajm). 2. Ultrasonic machining (usm). 3. Liquid jet machining (ljm).
Material removed by mechanical erosion of the work piece material

Chemical & electro chemical process
1. Electro chemical machining (ecm).
2. Electro chemical grinding (ecg).
3. Electro chemical honing (ech).

4. Chemical/machining chemical milling (chm).
Work piece material in ocontact with chemical solution is etched (anodic dissolution).

Thermal & electro thermal process
1. Electric discharge machining (edm). 2. Electron beam machining (ebm).
3. Laser beam machining (lbm). 4. Ion beam machining (ibm).
5. Plasma arc machining (pam).
Heat energy is concentrated on a small area of the work piece to melt & vapourize the tiny bits of work piece material.

For non-materil's	– ceramics, plastics & glass, usm, ajm, ebm, lbm, used.
For refractories	– usm, ajm, edm, ebm.
For titanium	– edm
For super allosy	– AJM, ECM, EDM, PAM
For steel	– ECM, CHM, EDM, PAM
For micro holes	– LBM & EBM
For shallow holes	– EDM, USM, AJM, CHM, EBM,
For deep holes	– ECM
For precision	– USM, EDM
For surfacing	– ECM
For etching	– ECM
For depth	– ECM, PAM
Max powr consumption	– LBM
Min power consumption	– PAM
Accuracy	– USM, EMB, CHM, EDM, LBM.

Processing source of energy material removel rate surface finish tool material brass accuracy remark
EDM – spark generator
ECM – rectifier & electrolyte solution.

Process source of energy remarks
LBM – monochromatic beam of light amplified & focused by lens system on the work piece. – drill holes in materials.
IBM - high voltage power supply, ion gas in the vaccum chamber & plasma source. – removal of absorbed water & hydrocarbons from the surface of the work piece.
PBM – DC generator argon & hydrogen geas. – cuts plates.
USM – high frequency sound wave 70 khz. – hard & brittle materials.
WJM – high velocity water jet 900 m/s. – used for wood, non metals.
AJM – high velocity jet carrying abrasive particles. – high sensitive, britle materials, glass, titanium & composites.

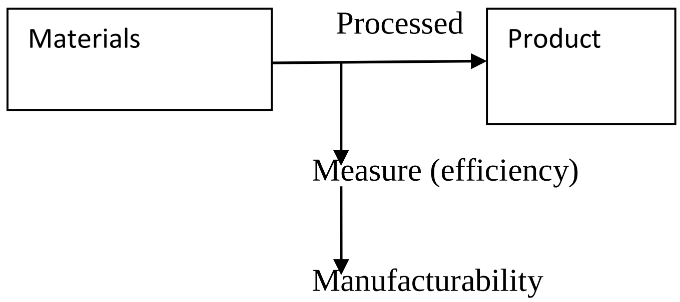
Material removal rate – slow, very slow
Surface finish range (ym) – depends
Accuracy – depends
Tool materials – PDAM -6-5.

DESIGN FOR MANUFACTURABILITY

INTRODUCTION

Manufacturability

1. It is a measure of efficiency with which materials can be processed in order to create a product.



2. It implies that all aspects of product planning which are used to create a product.

Comparison of manufacturability

Guide lines for better manufacturability

1. Reduce no. of product parts.
2. Use modular parts wherever possible.
3. Use standard parts.
4. Strive for z-axis assembly.
5. Reduce no. of Threaded fastener’s in design.
6. Use symmetrical part’s to simplify the assembly.
7. Use human assemblers (hand). i.e. human hand is an ideal assembly tool.
8. Simplify part designs (quick, economical). i.e Design for ease in fabrication.
9. Design part’s that are impossible to assemble incorrectly.
10. Automate assembly systems.

MANUFACTURABILITY & ITS REQUIREMENTS

1. Design for manufacturability /Design for assembly/Design for automation/Design for robotization/Design for production.   Production → product
2. Manufacturing engineering must be an integral part of the design process. With production & design engineers.
3. Production engineers should participate in design development & design engineers should participate in production planning to ensure design compatibility with production.

Production/manufacturing engineer’s assist the design engineer in the producibility analysis by identifying the following:

1. Processes, materials, components & Vendors.
2. Standard’s, capabilities & limitations.
3. Design criteria for fabrication & assembly methods.
4. Production, test, integration & repair procedures.
5. Risks.

Manufacturing engineers perform
1. Process studies (capabilities).
2. Design analysis (simplification).
3. Value analysis & engineering.
4. Tolerance analysis to identify problem areas.
5. Manufacturing testing of alternative design approaches.
6. Manufacturing Documentation.

Note:
1. Design's remember engg. Drawing, procedures& report's foundation for developing manufacturing & requirements.
2. Review of design documentation will avoid many of the problems.

Better Producibility in manufacturing organization:
1. Corporate Policy =a + b:
a. Strategies, plan's, procedures & standard's.
b. Multi-disciplined engineering design process.
2. Proven Design practices:
a. Simplification by customer option's (part reduction & functional analysis).
b. Standardization (standard part's tolerances & part families, component selection with preferred parts.
c. Testability & Repairability (built-in test, modularity, test points &maintainability).
d. Developmental Testing (quality improvement, part qualification & Environmental stress screening).

Manufacturing Process Analysis (For better productivity)
1. Use of high quality, low cost, low-risk manufacturing methods & processes.
2. Process Capability Analysis.
3. Use prototypes for verification.
4. Vendor qualification & ctrl.

Specific Design Criteria (For selected manufacturing process)
a. Type of process.
b. Manual/automated.
Its aim to obtain required quality in product at minimum cost.

Considerations Include
1. Product & Process Design.
2. Selection of manufacturing processes.

Product & Process Design:
1. Designer's concerned with material processing because they are right/wrong ways of designing them.
2. Each process has design considerations.
Ex: Part consists of considerations.
a. Avoid deep narrow groves, long thin less & under cuts.

b. Avoid sharp corners, bevels & chamfers.
c. Avoid abrupt changing cross section.

1. Provide fillets & rounds.
2. Uniform cross section possible.
3. Dimensional ctrl.
4. Symmetric design for hallow Area.
5. Rib stiffness to reduce twisting.

Design Factors
1. Improve quality, strength & economics of extruded pasts.
2. Casting provides fillets, rounds & eliminates undercuts.

Casting Processes (cp)
1. Sand.
2. Pressure die (cp).
3. Injection Moulding (cp).

Holes generated & designer's must have through knowledge of each & must specify according to functional behavior of products. Knowledgeable Designer examines differ types of machine processes characteristics & Designs for them.

Selection of manufacturing processes
Factors affect selection of a manufacturing method for a particular product.
1. Shape
2. Property (Mechanical and Physical)
3. Service
4. Manufacturing
5. Cost (Consideration's above)

Shape considerations
1. Shape complexity.
2. How many Dimensions.
3. Precise Dimensions.
4. Components interactions?
5. Surface characterizes (smooth/hard finished)
6. Dimensional change by wear of corrosion.
7. Change in shape improves suitability of part (↑ strength, Reliability, fracture, resistance e.t.c).

Property Considerations
Mechanical Properties:
1. Component overload may fracture or fail.
2. Loading impacts, type & magnitude.
3. Cyclic loading, type, magnitude frequency.
4. Resistance needed (how much, deep)
5. Temperature range.
6. Material Deflect, Stretch/compress & function property.

Physical Properties
1. Magnetic properties desired.
2. Thermal properties desired.
3. Optical requirements?
4. Weight factor significance.

5. Appearance. 6. Thermal conductivity.

Service Consideration

Service environment of the product throughout its life cycle.

1. Component operating temperature (high, low, normal) is likely to change.
2. Desired properties in temperature range.
3. Life time of product desired service.
4. Liability of product fail?
5. Product recycling in mind.

Manufacturing Considerations

1. Standard component’s & sizes.
2. Design requirements, ease of manufacture, mach inability, weld ability, form ability, harden ability, cast ability.
3. How many components, rate.
4. Quality level desired similar to market.
5. Quality ctrl anticipated.
6. Assembly concerns.

Cost Consideration

Design stage – manufacturing & Assembly problems.

Design phase – 70%

Actual production – 20%

Product functional needs meet.

Design for assembly

1. Optimize number of parts.
2. Assembly method
3. Ease of handling & construction

Material selection

1. Bulk. 2. Coating.

Design for part manufacture

a. Process selection. B. Design for processing. C. Tooling design.

Quality & reliability, Standardization & variety reduction.

Small components for powder metallurgy methods considerations

1. Machining
2. Casting
3. Powder metallurgy
4. Fastening & joining
5. Forging

Design for machining

1. Avoid machining operations

2. Surface finish & dimensional tolerances
3. Part easy fixing & secure holding during machining operations.
4. Avoid sharp corners & points in tools.
    1. Use dimensions.
    2. Suit location & clamping
    3. Use cutting tool
    4. Reduce tool deflection
    5. Reduce cost
    6. Avoid interrupted cuts
    7. Part design using clamping & machining without distortion
    8. Avoid tapara & contours
    9. Reduce no. of size of shoulders
    10. Avoid under cut
    11. Avoid hardened machine materials
    12. Provide room cutler's bushing & fixture elements.
    13. Avoid draft surfaces as clamping (or) locating surfaces
    14. Avoid projections

Design for casting considerations
1. Moulding methods
2. Flow ctrl & behavior of metals during casting process.
3. Assist fitting
4. Location & shape of joint surfaces
5. Draw angles & re-entrant shapes
6. Location of bosses
7. Thickness of sections & ribs, bosses
8. Design of cores & core supports
9. Prevention of stresses & fracture during cooling
10. Location of runner's & risers
11. Ease of removal of finished component from die
12. Extend life & reduce wear
13. Filet & corner radii
14. Inserts
15. Accuracy

Design for powder metallurgy
1. Behaviour of powder during compacting
2. Ejection of compact from the die
3. Simplified die set & its extended life
4. Design for Accuracy of parts produced.

Design for Fastening & joining
Fastening methods:
Screw threads, fasteners, pins, rivets & differ joining methods are soldering, welding & bonding by adhesives.
1. Permanency required

2. Sizes & shapes of the pieces to be joined
3. Strength of assembly
4. Materials properties involve – composition, mechanical, physical
5. Heat effect on environment factors
6. Ease of separation of component
7. Appearance of Appearance of product

Design for forging

1. Development of uniform & fine grains
2. Development of directional strength
3. Minimizing the number of operations & dies

Die forging considerations

1. Behaviour of work piece material during forging.
2. Separation of forging from dies.
3. Die manufacture & their extended life.
4. Design of forged product.

INTEGRATED MANUFACTURING SYSTEM

Introduction:

1. Computer's ------------- controlling machines } both do operation's in their field's
   Robots -------------- performing processes } efficiently then human's.
2. Degree (Automation) → Serve with Aid of computer & robot to small batches

   Mass production

Production line → Require → Automation → Emerging market's requirements

INTEGRATED MANUFACTURING SYSTEM-09

INTRODUCTION

1. Computer's – controlling machines. Robots – performing processes. Both do operation's in their field's efficiently the human's.
2. Degree (automation)→Serve with aid of computer & robot to small batches→Mass production
Production line require – automation – emerging – markets requirement

Integrated system

Knowledge loss between design systems

Mean's end of stage info may be lost
Knowledge

Step's for increased profitability to integrate manufacturing

1. Recognize/perceive the need.
2. Develop a strategic plan.
3. Simplify & communicate.
4. Integrate.
5. Apply technology (hardware).
6. Computerize the software in stages.

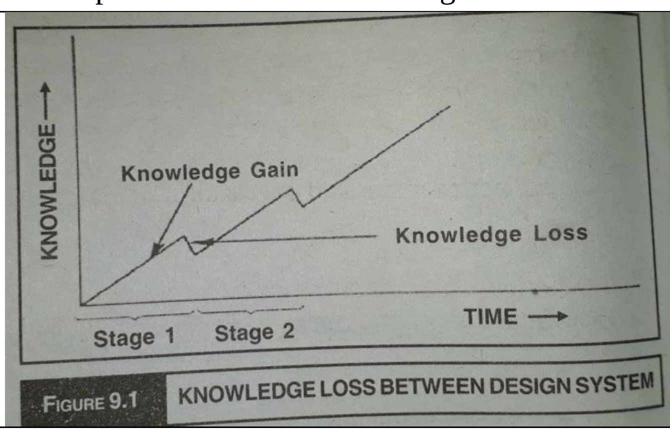


FIGURE 9.1 KNOWLEDGE LOSS BETWEEN DESIGN SYSTEM

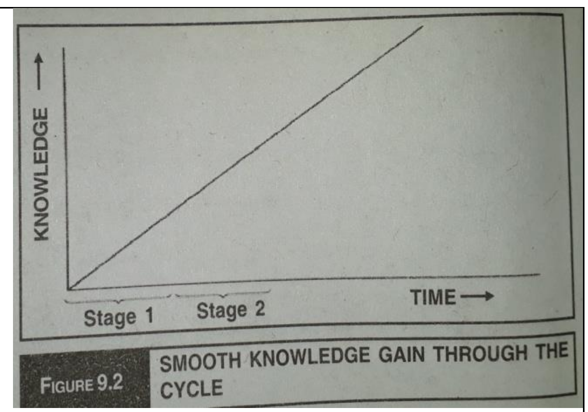


FIGURE 9.2 SMOOTH KNOWLEDGE GAIN THROUGH THE CYCLE

INTEGRATION, INTERFACING & COMMONALITY

1. Integration needed, identifying possible areas of commonality & choosing the correct commonality which results in integration.
Area's→Identify→Commonality (integration used)
2. It is used in computer integrated manufacturing (CIM).
Example: human body = integrated system (cells, nervous system & blood)
3. Bones are structured part's interfaced & not integrated with the musculature.
4. Correct commonality results in coherency efficiency & increased productivity in every area.
5. In a factory all the things can't be integrated & it depends on technology & nature of thing's.
6. Something can't be integrated physically but only interfaced.

Guidelines for integration

It requires understanding, intelligence, commitment & persistence.

1. Know what results are required (specific).
2. Examine area's to be integrated.
3. Select correct commonality.
4. Select correct commonality.
5. Sequence various integration efforts.
6. Implement each integrated effort in phase.
7. Measure the results & compare it with expectations.

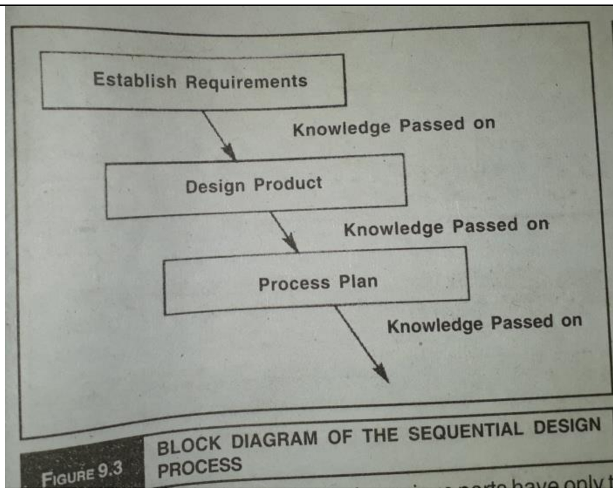


FIGURE 9.3 BLOCK DIAGRAM OF THE SEQUENTIAL DESIGN PROCESS

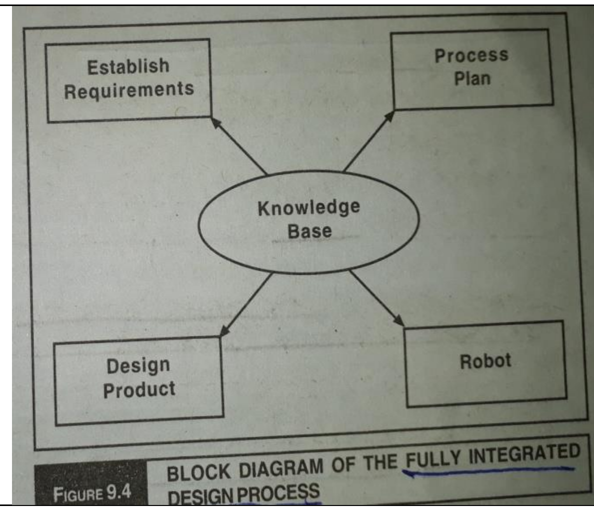


FIGURE 9.4 BLOCK DIAGRAM OF THE FULLY INTEGRATED DESIGN PROCESS

INFORMATION TECHNOLOGY & DB MGMT

Information is data that have been put into meaningful & useful context & communicated to a recipient who uses it to make decisions.

Info = communication + reception (knowledge)

Info = data + image's + text documents etc.

Organized meaningful.

Tools of information technology

Info technology implemented with objective.

1. Improving operational efficiency.
2. Minimizing paper work.
3. Expediting message delivery.
4. Accelerating services to customers.
5. Improving security.

Information technology tools in

1. Airlines
2. Railways

3. Bank's
a. Transaction handling terminals.   b. Job processing terminals.   c. Personal computer's.

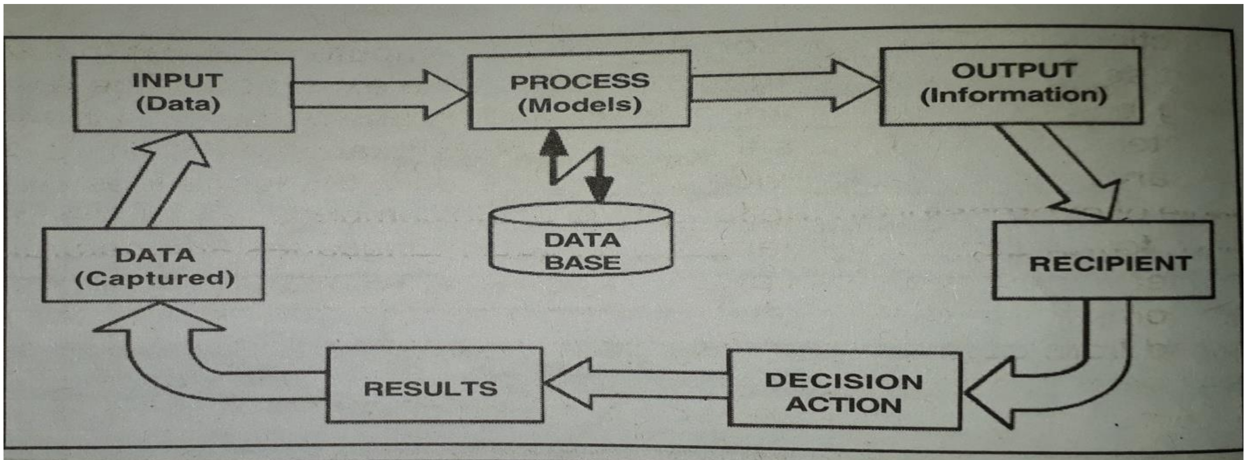


FIGURE 9.5 THE CONCEPT OF INFORMATION CYCLE

COMPUTERS AND PERIPHERALS
I/P, CPU, ALU, Storage, O/P, CU – execute instructions.
Auxiliary storage devices
Magnetic tape store voluminous data
Magnetic disk
Mass storage
Optical disk

MT
Data recorded on 7, 8, 9, 10 channel tape in magnetized spots. Tape width = 1.27 cm, 1.90 5cm 2.54cm, 7.72 cm. Magnetic disk system = direct access storage device (DASD).
Contain metal platter's on which data stored. Direct = random entry of transition data & random inquiry. 16 billion/trillion bytes – capacity storage

Optical disk technology types
1. CD-Rom.   2. Write once read many (worm).   3. Erasable optical disks.

Software management
1. Software consists of operating systems, languages, application & service programme & development packages.
2. Operating systems of a computer supervise the functions of the processor, control the computer systems I/P/O/P functions & provide several other important support services.
3. Virtual machine, application s/w.

4. Programming languages easier with the use of 3rd, 4th generation languages query languages & natural languages, which allow the users to interact with the computer without the aid of programmer's with the help of menu's, windows etc.

INFORMATION SYSTEM BUILDING BLOCKS

Made of 6 building blocks

1. I/P.	2. Models.	3. O/P.
4. Technology.	5. Data base.	6. Controls.

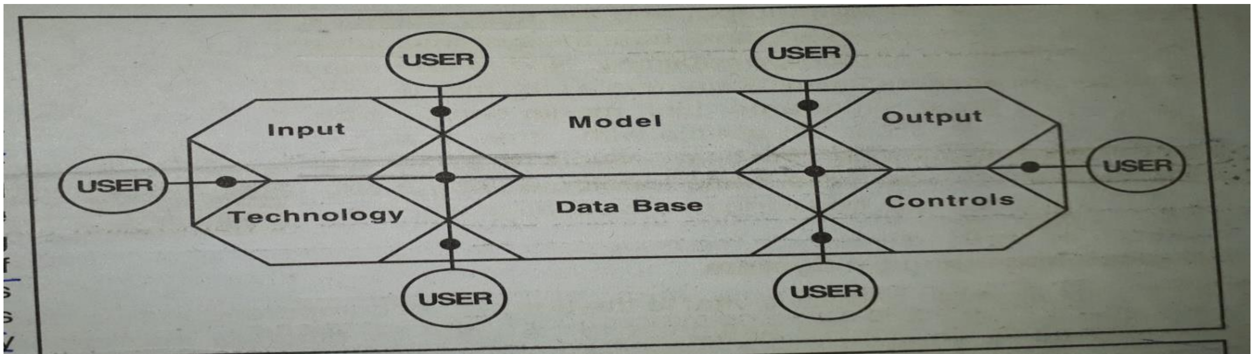


FIGURE 9.6 THE INFORMATION SYSTEM BUILDING BLOCKS

Made of different shapes, values & content & look & work. Understanding these building blocks their relationships & coupling, logical & physical content provide the basic knowledge for describing, developing & designing information system.

I/P block

Consists of transactions, requests, queries, instructions & messages which can be made by means of hand writing, paper forms, key boards joy sticks, touch sensor's, optical & magnetic character's etc.

Model block

Consists of logic-mathematical model that manipulate I/P & stored data in a variety of ways to produce the desired results or O/P

Diagram required.

Integrated information system

1. It is designed with tight coupling b/w the office & plant.
2. It tied together for full synchronization & coordination of operations.

Computer integrated manufacturing (CIM) & programmable robots force interactions b/w designing, planning, scheduling, cost accounting &marketing.

Robots used for

1. Increase productivity & quality of O/P
2. Eliminate tedious jobs

3. Explore hazardous & hostile environment
4. Benefit economics.

Networking

It permits one computer to work with a file stored on another computer, to print a report on another computer printer (or) to send a message to co-worker who is working on another computer.

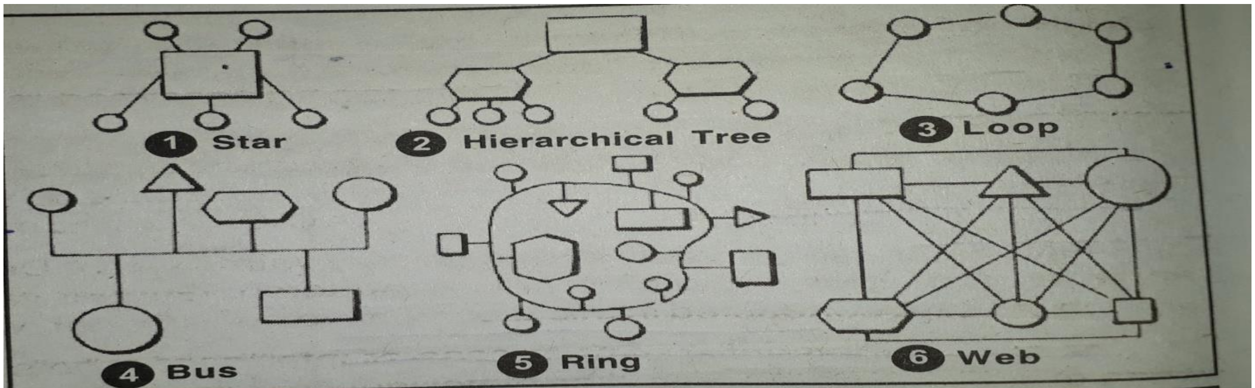


FIGURE 9.7 SCHEMATIC REPRESENTATION OF DIFFERENT TYPES OF NETWORKING

N/W components

a. Nodes b. links

Node accept data into the N/W (or) I/P information or both.

1. Sub nodes acts as relay devices that manage information b/w I/P O/P nodes.
2. Front end & backend information traffic controller’s that provide polling & queuing tasks.
3. Links/paths/channels for the flow of information b/w I/P & O/P & relay nodes.
4. System configuration
5. Network topologies.

Data base management system

1. DB = (collection of data)
2. Its purpose/objective of DB mgmt is the planning & controlling of data used by a company.
3. Data available to differ uses
4. Backup, security & privacy.

Basic elements of integrated system

Ex : robot. Automated guided vehicle (AGV) is used to deliver work pieces to & from a material station.

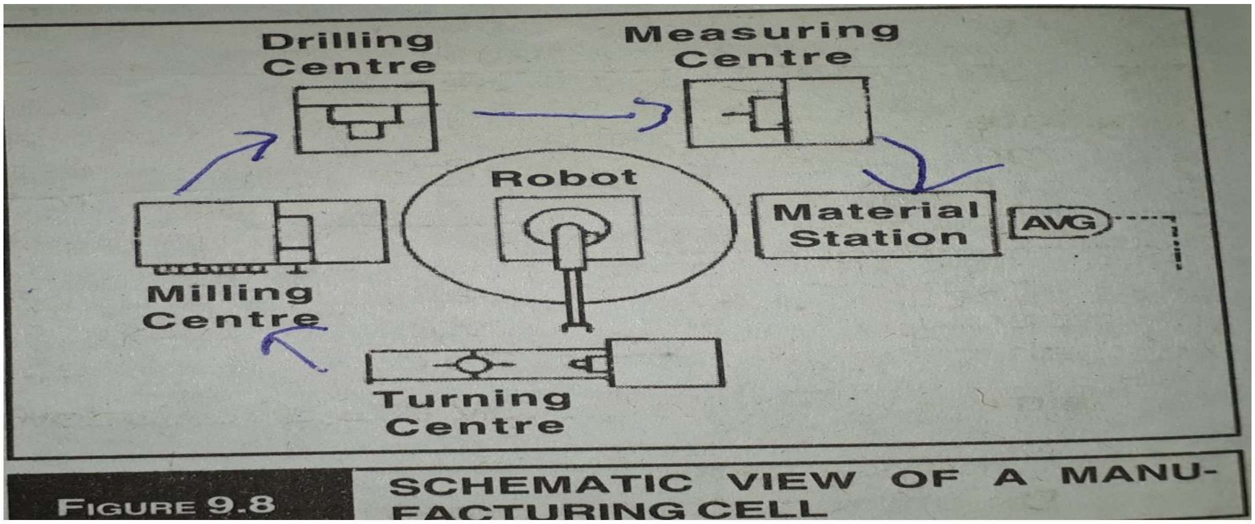


FIGURE 9.8 SCHEMATIC VIEW OF A MANUFACTURING CELL

Robots

Used for reducing delivery time, lower production cost & increasing overall production capacity.

Robot basic elements

Manipulator, Controller, End effectors, Sensor’s and Energy source

Manipulator

1. Consists of a base, an arm & wirst.
2. It comprises mechanical parts like links, joints & transmission lines, etc which execute the robot to move any number of degrees of freedom.
3. It describe relation to its coordinate system like cylindrical spherical & cartestion etc.

Controller

1. It is brain of the robot & is based a computer/system of computer’s.
2. Its function is to store, sequence & to position the data in memory, to initiate & stop motions of manipulator as per instructions given to interact with the environment.
3. It has 2 components.

a. H/W b. S/W.

End effector tool

1. It interact directly with job.
2. It may be gripper, aspray painting torch or a welding torch.

Sensors

1. Make robot intelligent with this sense the environment.
2. Capabilities are vision, hand, eye coordination, to touch & hearing.
3. Sensor types (a. Contact b. non-contact)
4. Functions(Searching, Recognition, Grasping and Moving)

Non contact includes proximity sensors, visual, acoustic sensor’s & range detector.

Automatic guided vehicles

1. It is a robot type vehicle used to carry objects from one-place to another & can be programmed to travel in a predefined path.
2. Carry 3000kg to 6000 kg.
3. Time, work progress, wait time.

AVG components

1. Mechanical structure.
2. Driving & steering mechanical structure.
3. Servo controllers.
4. On board computer facility.
5. Servo amplifiers.
6. Feedback components.
7. On board power system.

AVG functions:

1. Follow predetermined path
2. Optimize router
3. Avoid collisions.

COMPUTER INTEGRATED MANUFACTURING

1. CIM = CAD + CAM
2. CAD = computer aided design
3. CAM = computer aided manufacturing
4. CAD, CAM are necessary part’s of any manufacturing industry
5. CAD use a computer to assist the design of an individual part/system.
Ex : aircraft, automobiles.
6. The process usually involves computer graphics to display the designed object on a screen.
CAD – features (product).
Ex : strength, stiffness & weight
7. Computer graphics enables the designer to study the object by rotating it on the screen, separating it into segments, enlarging specific portion of the component in order to observe it in detail.

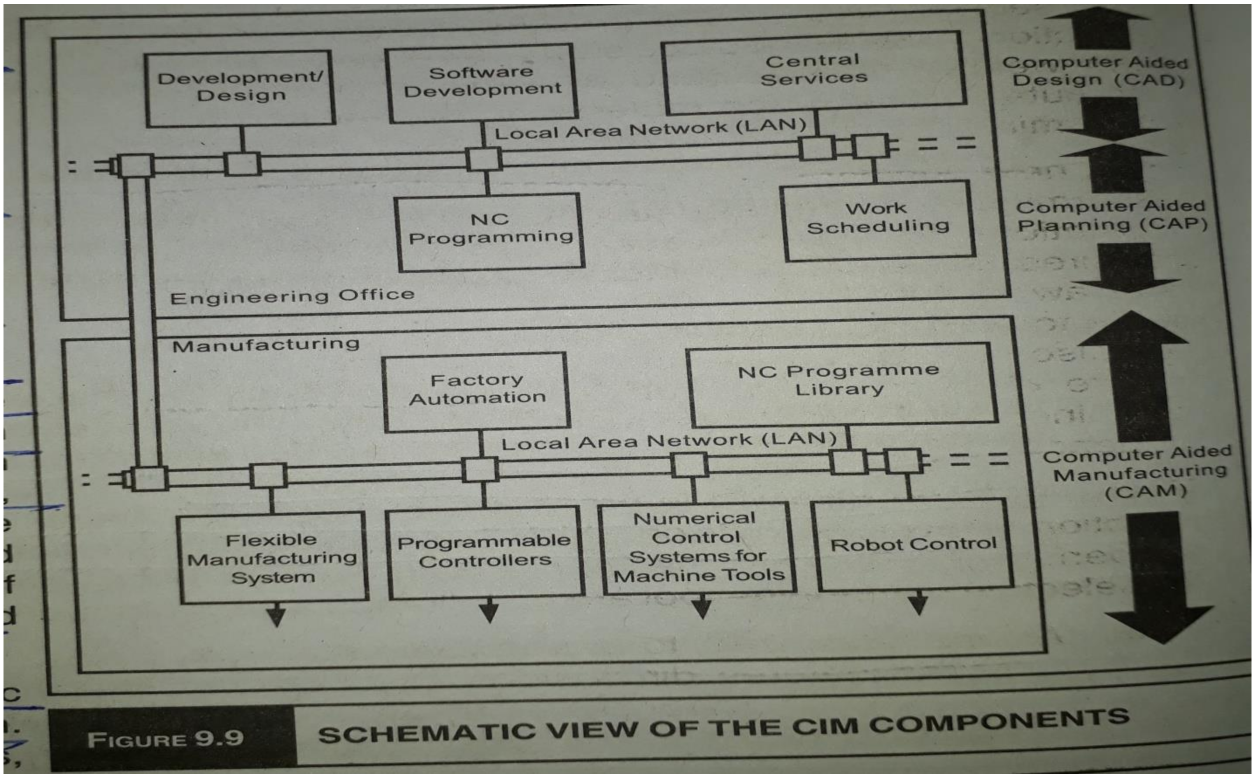


FIGURE 9.9 SCHEMATIC VIEW OF THE CIM COMPONENTS

CAD S/W

1. Design automation. 2. Man-machine interaction. 3. DB mgmt.

CAM

1. Used computer to assist in the manufacture of a part of a machine.
2. It divides into 2 main classes

a. Online applications (such as CNC, automatic control systems of tools & robot control).

b. Off-line applications (preparation of part programmes on punched tapes).

3. CAM concerned with 3 areas

a. Numerical control. b. Process planning. c. Robotic

4. CAM is a system used for planning, managing, monitoring & controlling various phases of manufacturing processes.
5. CAD functions geometric modeling. Analysis, testing, drafting & document.

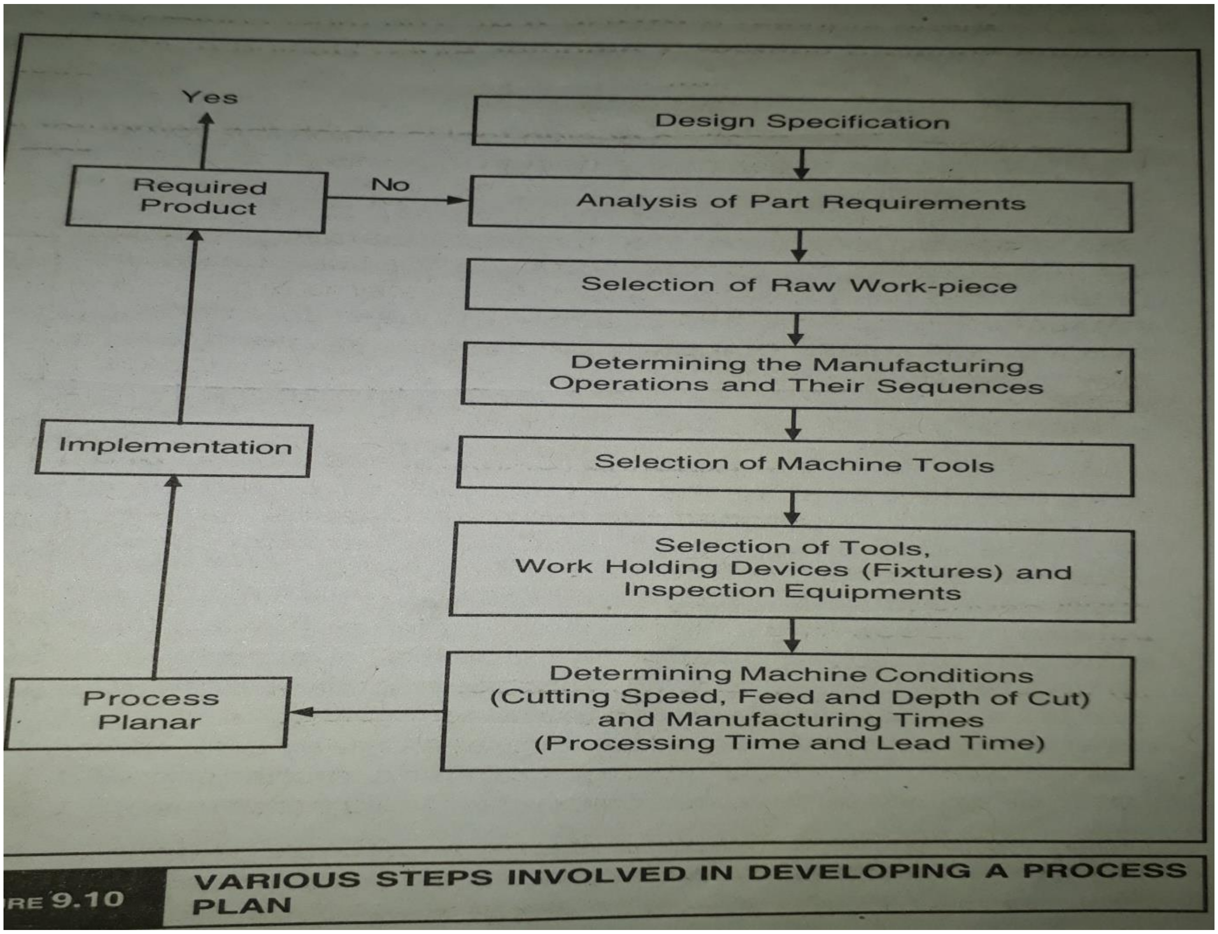
Computer aided process planning

1. In manufacturing, the goal is to produce components that meet the design specifications
2. Next assemble these components to final product.
3. Design bridge manufacturing: Process planning.

By translating design specification into the details of a manufacturing process.

4. Process planning is a production organization activity that transforms a product design into a set at instructions (sequem machine tool set up etc.) to manufacture machined parts economically & competitively.

5. The info provided in design includes dimensional specification (geometric shape & its feature & technical specification. (Tolerance, surface, finish, etc.



RE 9.10 VARIOUS STEPS INVOLVED IN DEVELOPING A PROCESS PLAN

Basic step's in developing a process plan

Attributes related to	
Work piece	Desired features, dimensions, of work piece, dimensional tolerances & raw materials form
Machine tools	Process capability size, mode of operation, tooling capabilities & automatic tool changing capabilities
Production volume	Production quantity & order frequency

Next step in process planning is the selection of tools, work holding devices & inspection equipment work holding devices are used to locate & hold the work piece to generate features. Dimensional accuracy, tolerance & surface finish on the feature inspection equipment required.

Next step: determination of machining condition & manufacturing time cost/piece, max production rate & manufacture lead time are parameter's of the model to be optimized for high production & least cost.

Group technology

INTRODUCTION

1. It is a manufacting philosophy which identify similar part’s & grouped together.
2. It takes advantage of similarities in design & manufacturing
   GT ------ (similar part’s) groups (or) families
3. GT involves analysis (parts (families)) & classified into similar group’s (or) families.
4. It find common solution for group of problem (or) family (problems) their by reducing the number of solutions.
5. Part’s are grouped based on size & geometric shape.

Types of families

1. Family types A – similar shape, All operation common.
2. Family type B – Apparently dissimilar, more common features (or) identical technological parts.

GT – realization – problem’s – group – problems
Single solution – for (problem’s).

Note: GT improve productivity, material handling, mgmt & control of typical batch manufacting system.

Group & family

1. Group = (machines) = contain facilities to manufacture given family (part’s).
2. G & F forms a circle.
3. Part’s relate to a group & group relates to a family.

Part’s relates group relates family

Composite component (CC)

1. They are part’s that embody all design features of a design family/design sub family.
2. Component’s have – shape.
3. Such components grouped in design family

Parts – component’s – design families.

4. New design created by modifying an existing component design from same family of component’s.

WORKING PRINCIPLES OF GT

1. It begins with input data through a classification & coding system.
2. Classification & coding describes the attributes of parts & group them according to descriptions.

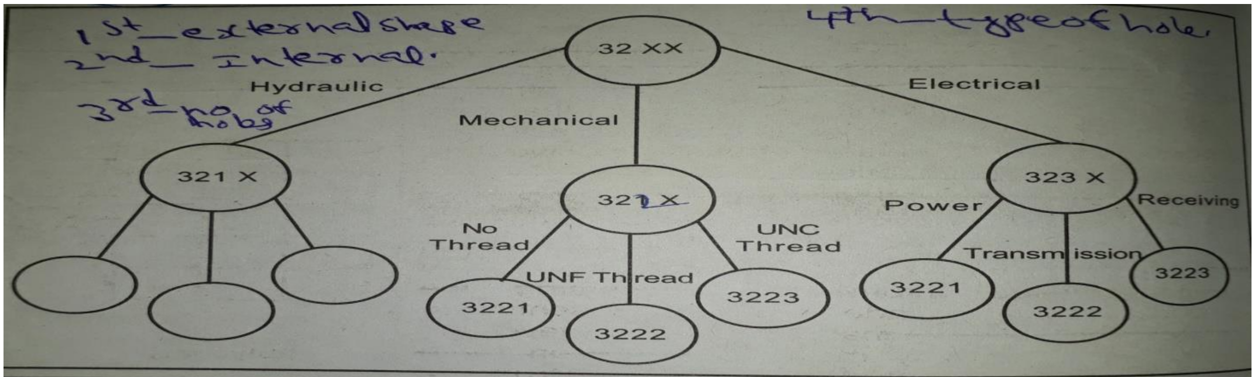


FIGURE 10.2 HIERARCHICAL STRUCTURE OF A GROUP TECHNOLOGY

Code structure types	
Hierarchical (or) mono code	Attribute (or) poly code

1st digit – external shape
2nd – internal shape
3rd – no of holes
4th – type of hole

GROUP TECHNOLOGY SYSTEM

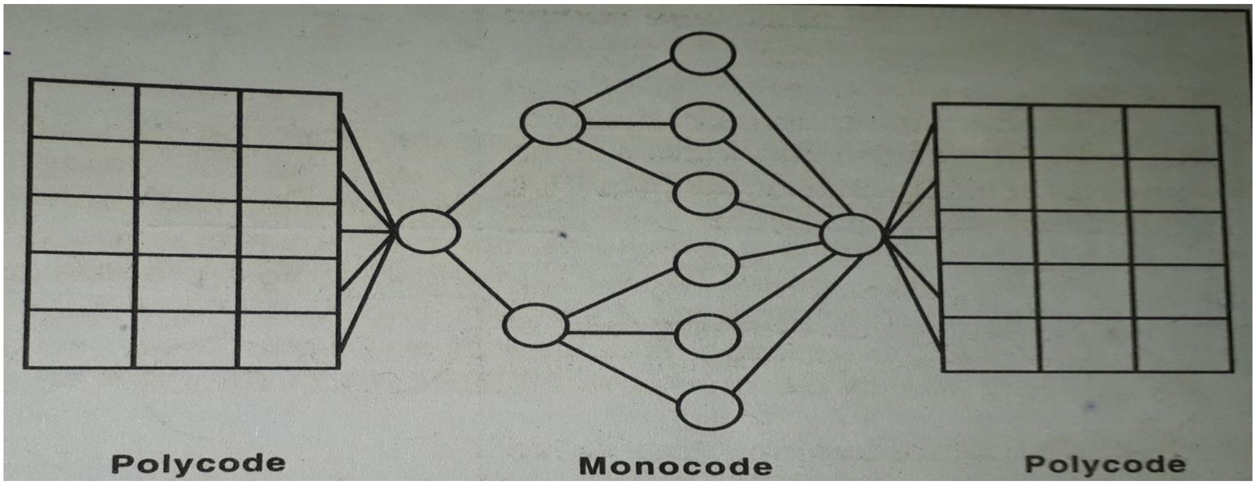
Digit position	1	2
Class of feature	External shape	Internal shape
Possible value		
1	Shape 1	Shape 1
2	Shape 2	Shape 2
3	Shape 3	Shape 3
4		

E 10.2 DESIGN AND MANUFACTURING PART ATTRIBUTES TYPICALLY INCLUDED IN A GT CLASSIFICATION SYST

Part Design Attributes	
Basic external shape	Major dimensions
Basic internal shape	Minor dimension
Length/diameter ratio	Tolerances
Material type Part function	Surface finish
Part Manufacturing Attributes	
Major process	Operation sequences
Minor operation	Production time
Major dimension	Batch size
Length/ diameter ratio	Annual production
Surface finish	Fixtures needed
Machine tool	Cutting tools

Polycode

Approach for computerized analysis. Classification & coding system put information into a DB..



GROUP TECHNOLOGY CODING

1. Coding a GT technique can be used to model a component without all the details.
2. Drafting & geometric modeling are detailed representations of an engineering design.

Coding system attributes

1. Components population (placement – circular metal sheet etc.)
2. Code detail should represent
3. Code structure (chain, hierarchical hybrid)
4. Digital representation (binary, octal, nexa, alphanumeric etc)

Coding system classification / parts

System based on

1. Part design attributes
2. Part manufacturing attributes
3. Part both design & manufacturing attributes

1^{st} design retrieval + standardization

2^{nd} tool design + production functions related.

3^{rd} 1^{st} + 2^{nd} combination.

Types some of system

1. Optiz classification system (Germany Aachen, Tech University)
2. Code system (manufacturing data system, USA)
3. KK 3 system (Japan)
4. MI class (Netherlands, TNO)
5. D class (Birmingham)

6. Coform (Purdue University).

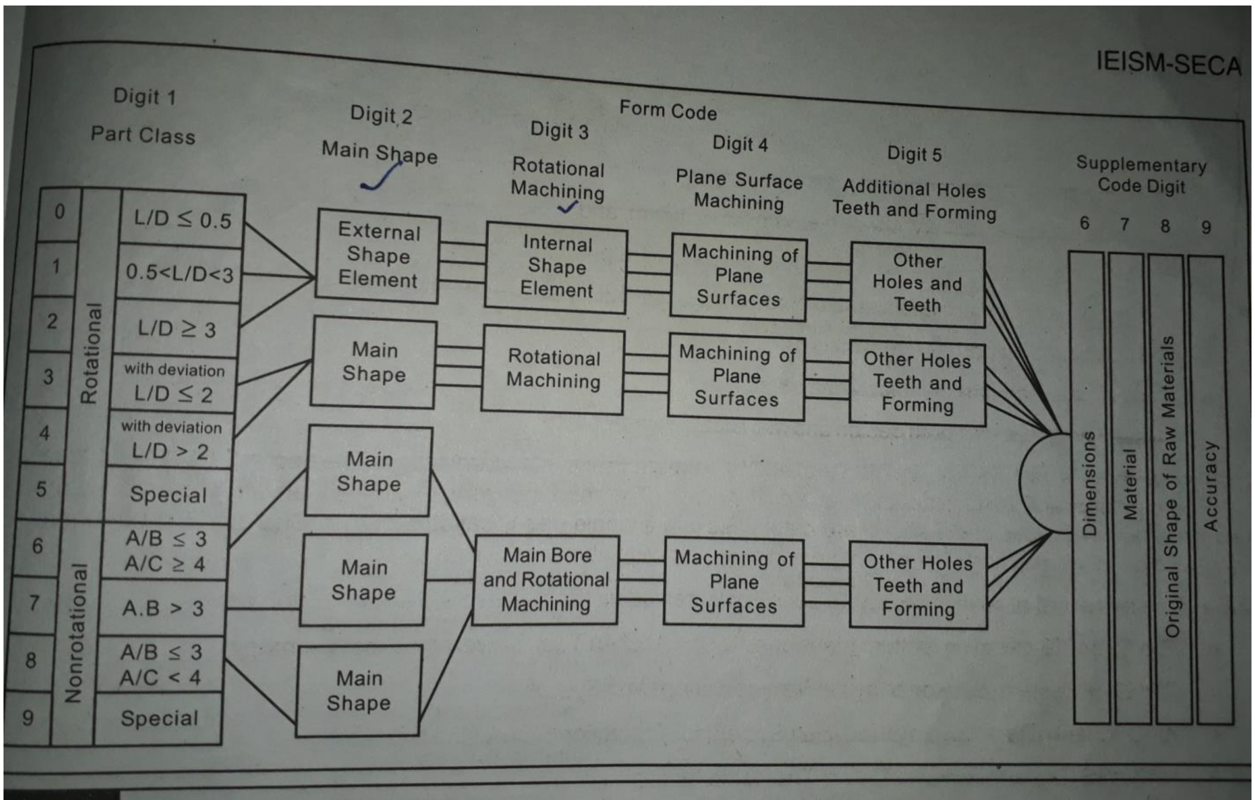
Optiz classification system

Code = 9 digits + 4 extended.

Ex : 123456789 ABCD

123456789 = convey design & manufacturing data + attributes.

ABCD = supplementary code describe the manufacturing attributes.



GURE 10.4 BASIC STRUCTURE OF THE OPTIZ SYSTEM

Code system

Code = 8 digits

Each digit = 16 values possible (D through 1 & A through F). Used to describe the part design & manufacturing characteristics.

1^{st} digit position = part geometry.

2^{nd} & 3^{rd} = basic geometry & manufacturing process of part.

5^{th} & 6^{th} – 2^{ndary} manufacturing process

(Ex : threads, groves etc.)

7^{th} & 8^{th} – part size overall.

	1	2	3	4	5	6	7	8
1	Concentric Other than Profiled	Outside Dia or Section	Centre Holes	Other Holes	Grooves Threads	Slots and Protrusion	Dimensional: Outside Dia	Dimensional: Length
2	Concentric Profile	Specific Profile, such as, Teeth and Grooves		Centre Hole	Profile Shape	Number of Teeth Splines or Grooves	Dimensional: Outside Dia	Dimensional: Length
3	Bend Rod or Tube	Send Angle	Direction of Ends	Type of Ends	Typical Section	Dimensional: Outside Dia	Dimensional: Width	Dimensional: Length
4	Bent or Seemingly Bent Other than Rod or Tube	Number of Bends	Other Bends	Bend Angle or Arc	Protrusion Cut-offs Cut-outs	Dimensional: Thickness	Dimensional: Width	Dimensional: Length
5	Flat	Number of Sides	Hole Types	Cut-off Cut-out	Thickness Protrusion Slot Groove Holes	Dimensional: Thickness	Dimensional: Width	Dimensional: Length

FIGURE 10.5 SUMMARY OF CODE MAJOR DIVISIONS

KK – 3 systems

21 digit decimal system

Digit		Item/s	Rotational Components
1		Part	General classification
2		Name	Detail classification
3		Material	General classification
4			Detail classification
5		Chief dimensions	Length
6			Diameter
7			Primary shapes and ratio of major dimensions
8	Shape details and kinds of processes		External surface and outer primary shape
9			Concentric screw threaded parts
10		External surface	Functional cut-off parts
11			Extraordinary shaped parts
12			Forming
13			Cylindrical surface
14			Internal primary shape
15		Internal surface	Internal curved surface
16			Internal flat surface and cylindrical surface
17			End surface
18		Non-concentric holes	Regularly located holes
19			Special holes
20			Non-cutting process
21			Accuracy

RE 10.6 SCHEMATIC REPRESENTATION OF THE STRUCTURE OF A KK-3 (ROTATIONAL COMPONENTS) SYSTEM

1st digit	:	Main shape
2nd and 3rd digits	:	Shape elements
4th digit	:	Position of shape elemen
5th and 6th digits	:	Main dimensions
7th digit	:	Dimension ratio
8th digit	:	Auxiliary dimension
9th and 10th digits	:	Tolerance codes
11th and 12th digits	:	Material codes

MI class system

Used to automate & standardize a number of design, production & mgmt functions which include standardization of engineering drawings, retrieval of drawings according to classification's number, standization of process routing, automated process planning, selection of parts for processing on particular group of machine tools.

System = 12 to 30 digits.

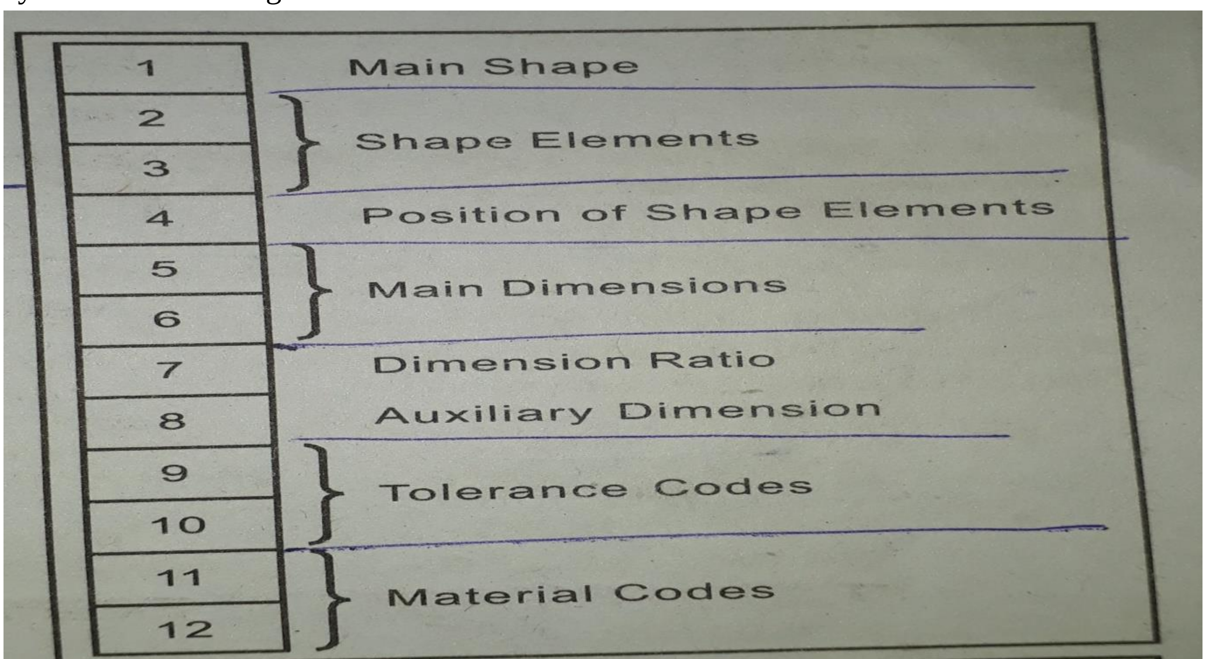


FIGURE 10.7 DETAIL OF MICLASS CODE STRUCTURE

Dclass system

Used for to be decision making & classification system. It generate codes for components material, processes machines & tools.

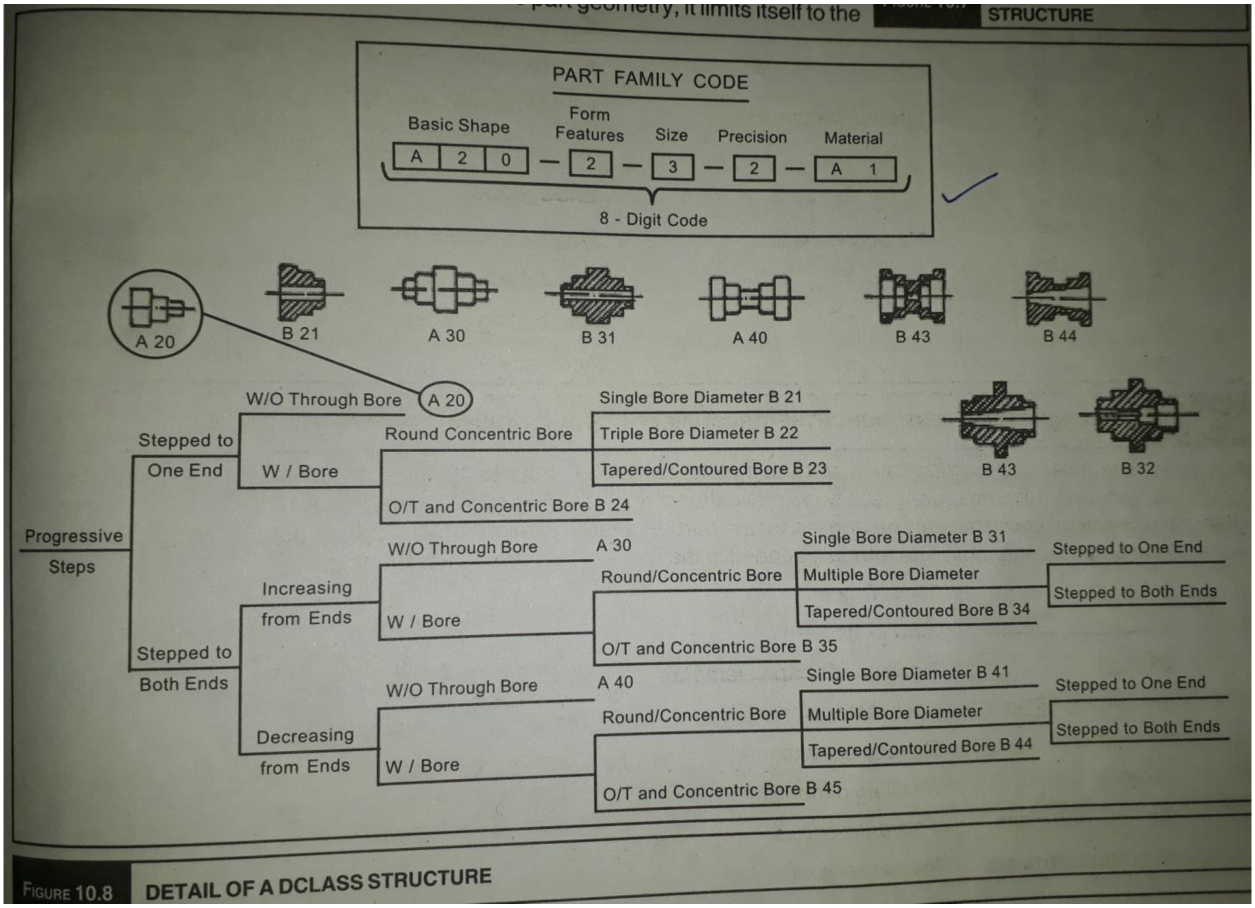
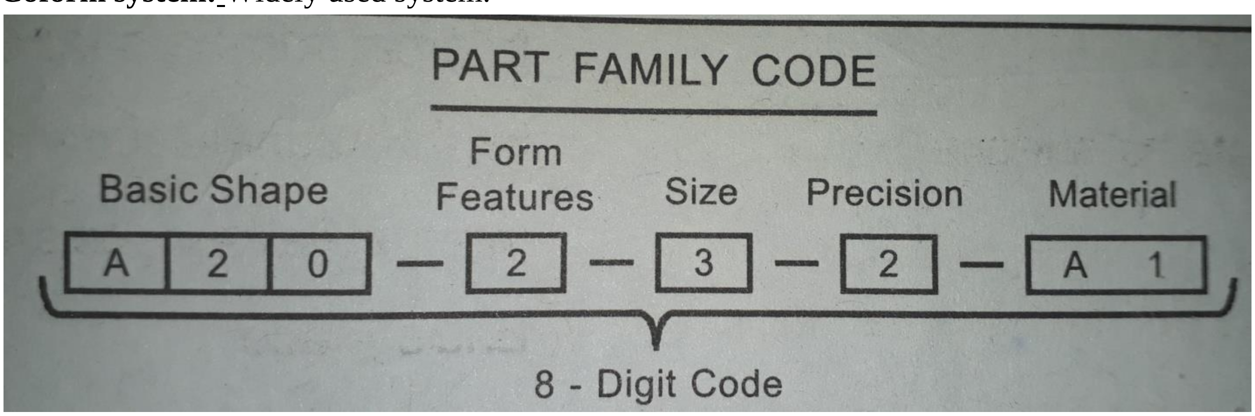


FIGURE 10.8 DETAIL OF A DCLASS STRUCTURE

Coform system: Widely used system.



STAGES OF ADOPTING A PLAN FOR GT

Success/failures of GT plan depends on various stages. Component parts, families of components, marketing department, no of machines & their types. Primary phase is called family formation.

Stage details of GT plan

1. Component analysis
2. Rough codetermination of machine group’s

3. Assess components demand
4. Determine closer machine groups
5. Labour requirement balanced with machine utilization.
6. Planning the work programmes with group plus incentives plus foremanship. Component analysis, machine tools, component analysis, group of machines labour requirement, planning with group. Size + character – component IMP.

Stage	System	Remarks
Stage 1	Component analysis	Family formation based on best information available
Stage 2	Machine tools	Based upon families, rough machine groups emerge
Stage 3	Component analysis	Information from sales and production forecasts fed into the system to determine the forward component requirement
Stage 4	Group of machines	The closer specification of the machines required, the number of each type and size
Stage 5	Labour requirement	The number of type of operator and shift basis are planned. Overload conditions are also pre-planned
Stage 6	Planning with group	Tooling, sequencing, bonus and administration are planed with continuous assessment during early trails

0.5 DETAILED ACTIVITIES BETWEEN STAGES

Stage	Activity
1 and 2	Component information from production planning sheets and drawing continually required.
2 and 3	Component-feature information within families demands machine tool information, so that the components can be manufactured.
3 and 4	Constant requirement to marry component demand to best machines for volumes of work.
4 and 5	Balancing machine and labour utilization, to take account of demand fluctuations, shift adjustment flexibility of pool of labour from outside GT layout.
5 and 6	Foreman's and operators integration with plan. Team work from smooth operation.

GT 3 decision's of mgmt
Design, Services and Production

Benefits derived from GT
1. Reduce through put (components).
2. Max efficiency.
3. Reduce paper work.
4. Reduce labour.
5. Easy to create/update of products.
6. Less cost.

Group technology layout
1. it's a plant

2. It gives/depend on relationship b/w member of product items/p) to be produced & their production qualities.
3. (p-q) layout of plant is determined.

Line layout: Used in process industries of continous assembly (90-95) %.
Batch production: With functional layout.
Functional layout: All machines of the same type.
Group technology flow line
Type (layout) made when each of the "part families" to be produced has almost the same processing route resulting in the same production flow through the machine tool.

GT cell
GT layout in which all the machining operations for one or more families can be accomplished in a collection of machine tools namely a GT cell. Cell type layout allows feasible operation sequences depending upon the type of parts.

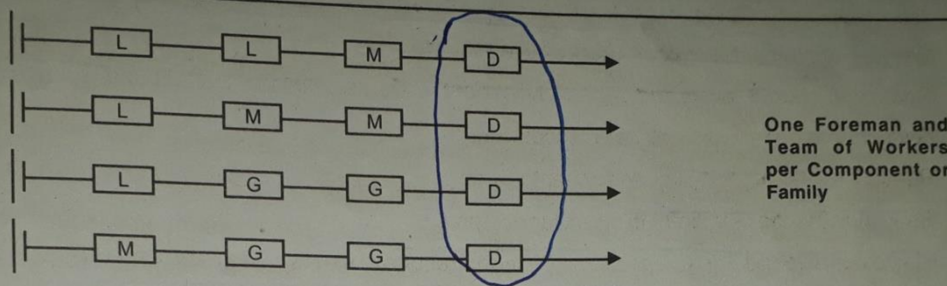
GT centre: It consist of a work place layout in such a way that a part. Family can be processed by the same type of operation.

Simulation
By developing models, computer based simulation can help the decision maker to understand the real situation how the real system operates under changes in system variables.

Simulation model built to
1. Evaluate performance of systems
2. Optimize system
3. Determine effects on system performance
4. Evaluate advance the performance of conceptual system.

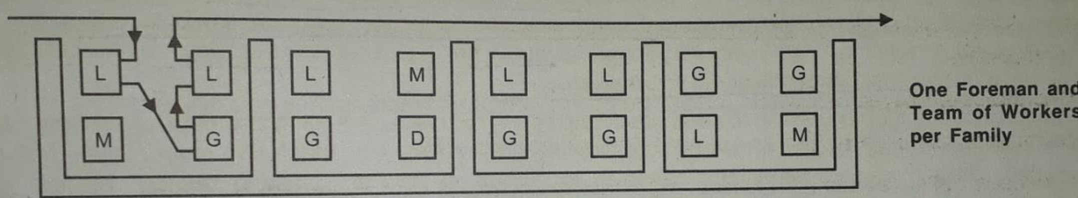
Application of simulation
Planning, design & control of manufacturing system. CAD – flexible manufacturing system (FMS).FMS – used in automated guided vehicle system in group of machine tools inter connected by automatic material handling.

Design simulation: Reduce the number of unnecessary.



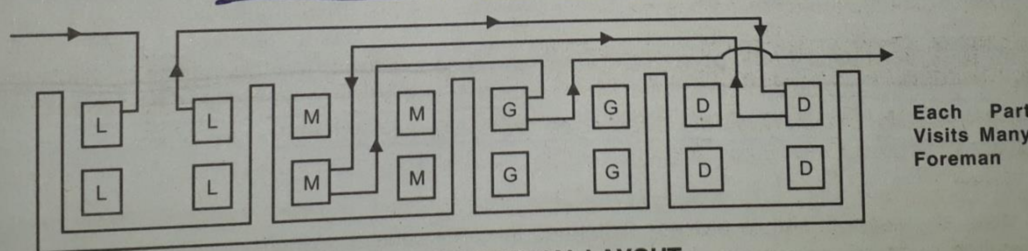
(A) LINE LAYOUT

Component specialization : one line per component or family with families machines always used in same sequence



(B) GROUP LAYOUT

Component specialization : one group per family with no restriction on machine usage sequence



(C) FUNCTIONAL LAYOUT

Process specialization : machines grouped by process

KEY : L : Lathe M : Miller G : Grinder, D : Driller

FIGURE 10.9 VARIOUS TYPES OF GROUP LAYOUT