UNIT-1

Computer-aided Design: First and third angle projection. Orthographic Projection: projection of point, Projection of solids, Principles of isometric projection — isometric scale –Isometric projections of simple solid with AutoCAD 3D interface. Morphology of Design, mapping of design phase with CAD functions, product cycle computer-aided design

Projection

When straight lines are drawn from various points on the contour of an object to intersect with a plane, the process is known as projecting the object onto that plane. The resulting figure, formed by joining the points where these lines meet the plane, is referred to as the projection of the object.

In this process, the straight lines that extend from the object to the plane are called projectors. These projectors help in mapping the three-dimensional shape of the object onto a two-dimensional plane, allowing for a clear representation of the object’s shape and dimensions. This method is fundamental in engineering drawing, as it enables the accurate depiction of objects for purposes such as design, manufacturing, and analysis.

First and third angle projection. Orthographic Projection: projection of point, Projection of solids, Principles of isometric projection — isometric scale –

ORTHOGRAPHIC PROJECTION

Principle of projections

* If the rays of light made to fall on the wall across the object, shadow / image of that object will appear on that wall. That means, object is being projected on the wall.

* If straight lines are drawn from various points on the contour of an object to meet a plane, the object is said to be projected on that plane.

* The image we are getting on that plane is called projection (view) of the object.

* The lines from the object to the plane are called projectors.

Methods of projection

1. Orthographic projection
2. Isometric projection
3. Oblique projection
4. Perspective projection

Methods of Projection

In engineering drawing following four methods of projection are commonly used, they are:

(1) Orthographic projection

(2) Isometric projection

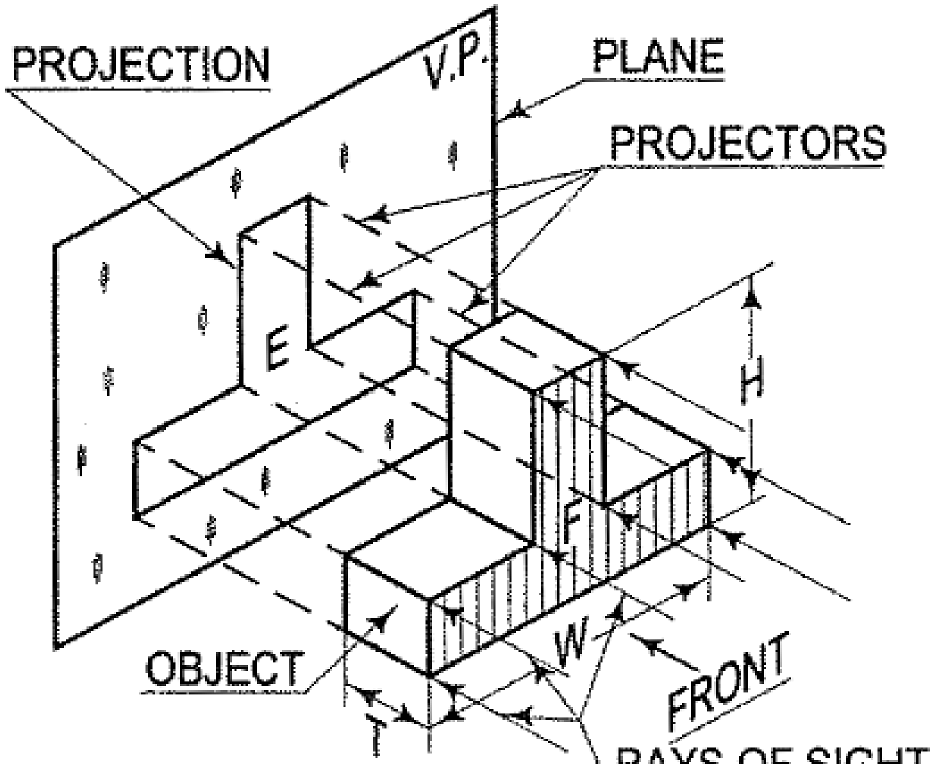
(3) Oblique projection

(4) Perspective projection.

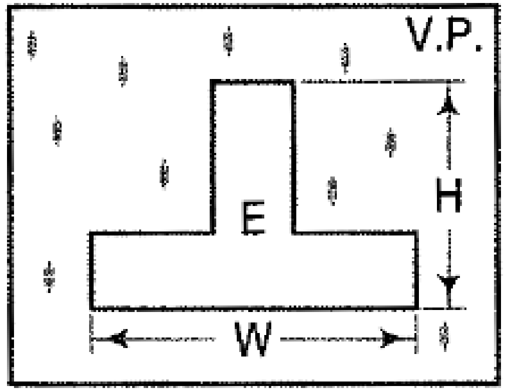
Orthographic projection

When the projectors are parallel to each other and perpendicular to the projection plane, the resulting projection is known as **orthographic projection**. In this method, the object is depicted in such a way that each face of the object is projected onto the plane as if viewed directly from the front, top, or side, without any perspective distortion.

Orthographic projection

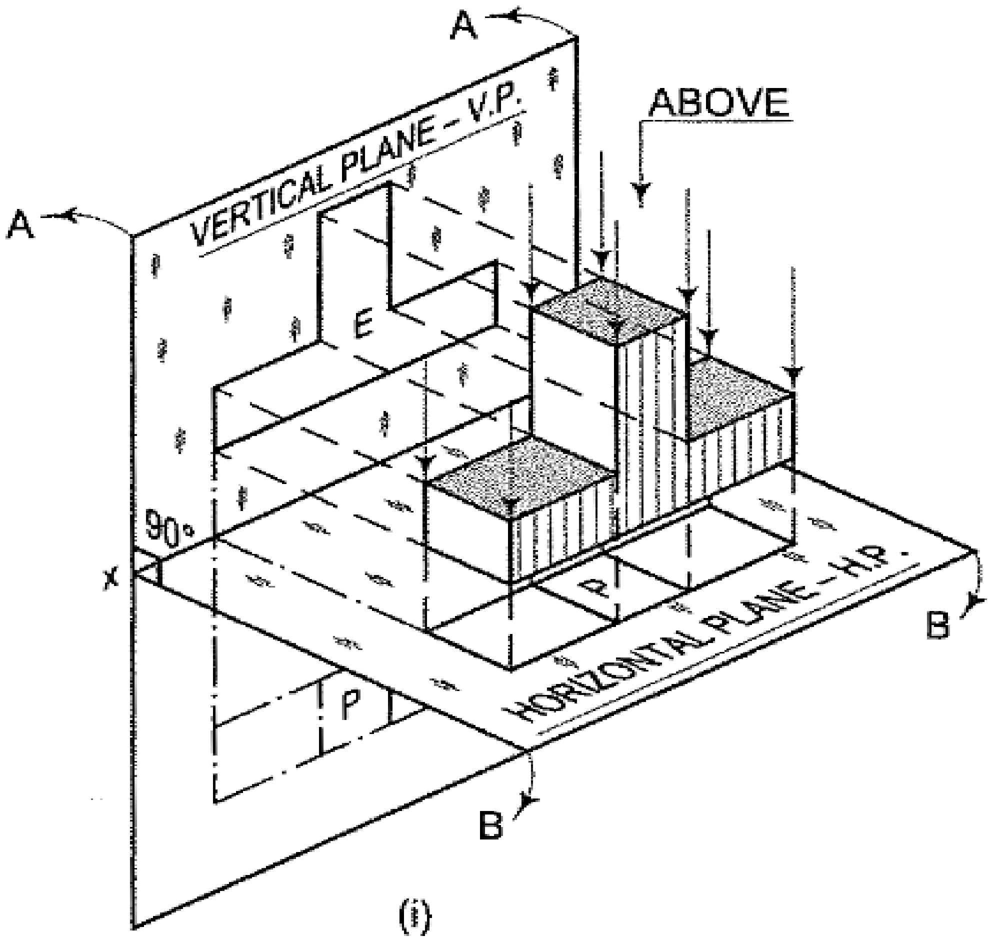


(i)

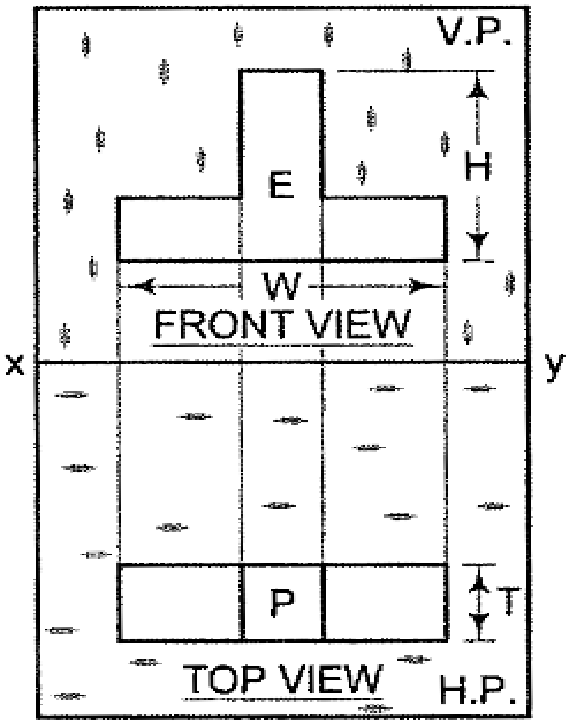


(ii)

Orthographic projection



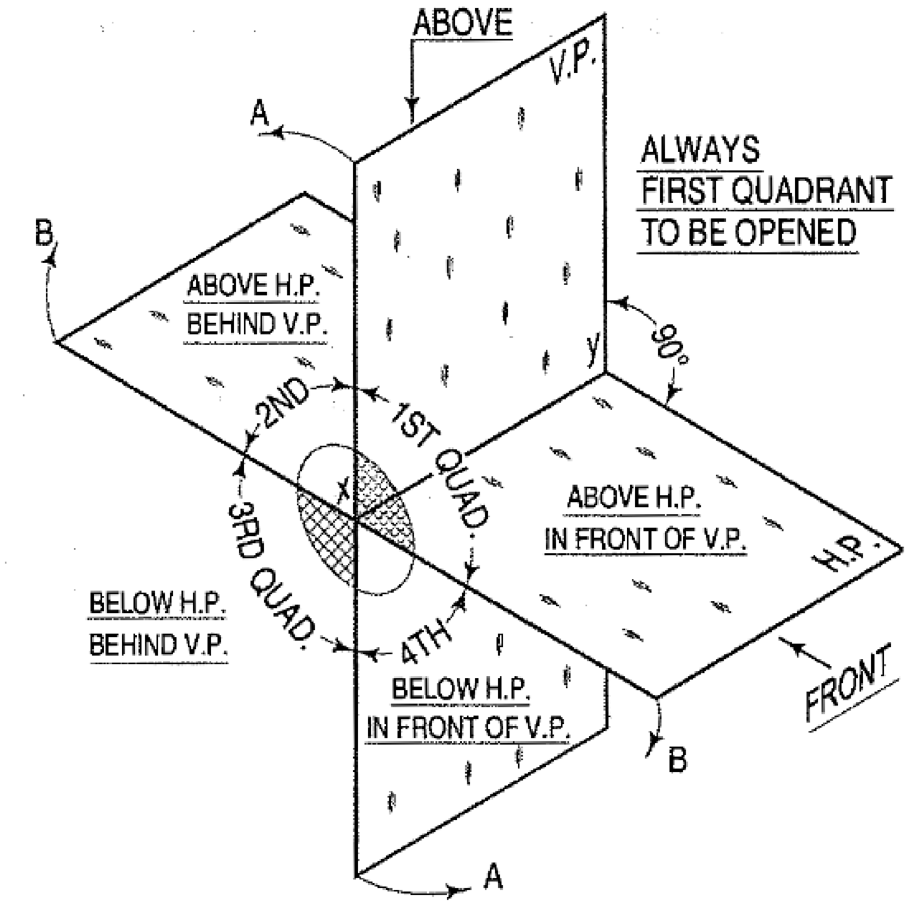
(i)



(ii)

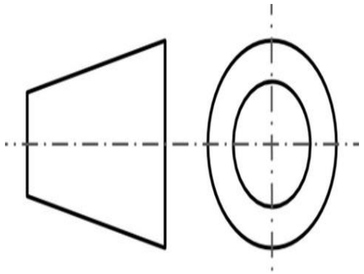
Four Quadrants

When the planes of projection are extended beyond the line of intersection, they form four quadrants or dihedral angles which may be numbered as in fig. below.



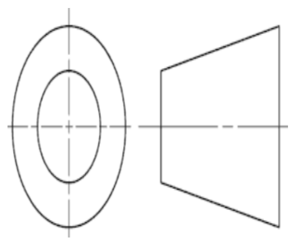
First angle Projection

We have assumed the object to be situated in front of the V.P. and above the H.P. i.e. in the first quadrant and then projected it on these planes. This method of projection is known as first-angle projection method. The object lies between the observer and the plane of projection. In this method, when the views are drawn in their relative positions, the top view comes below the front view. In other words, the view seen from above is placed on the other side of (i.e. below) the front view. Each projection shows the view of that surface (of the object) which is remote from the plane on which it is projected and which is nearest to the observer.

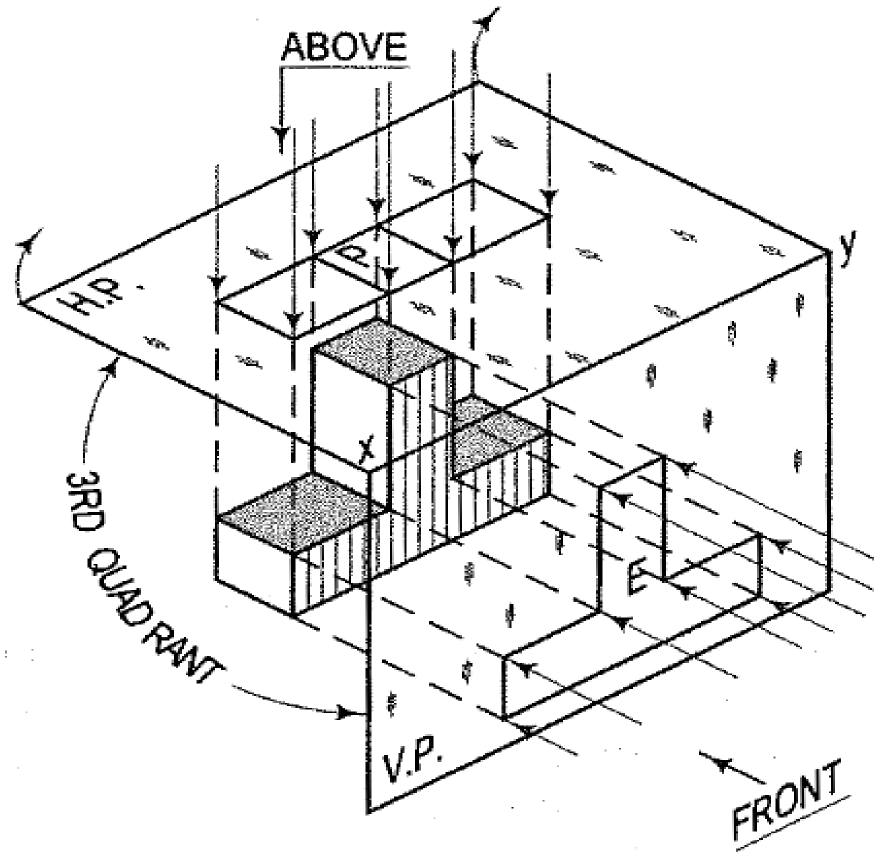


Third angle Projection

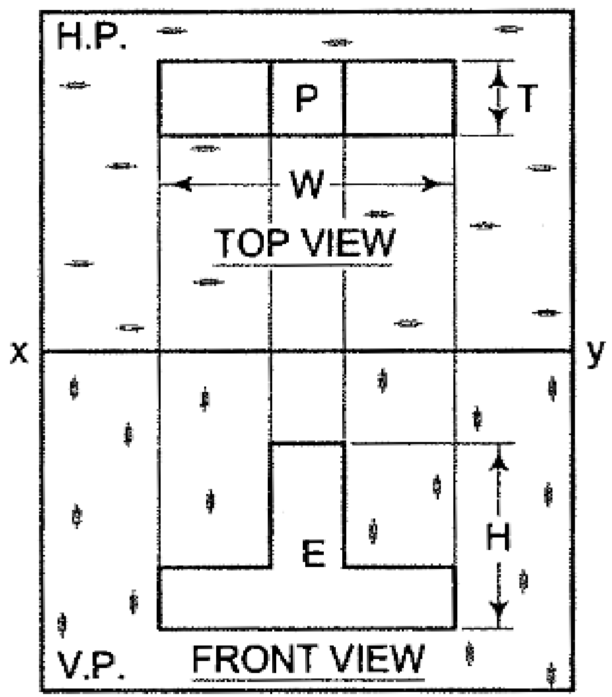
In this method of projection, the object is assumed to be situated in the third quadrant [fig. (i) below]. The planes of projection are assumed to be transparent. They lie between the object and the observer. When the observer views the object from the front, the rays of sight intersect the V.P. The figure formed by joining the points of intersection in correct sequence is the front view of the object. The top view is obtained in a similar manner by looking from above. When the two planes are brought in line with each other, the views will be seen as shown in fig. (ii) below. The top view in this case comes above the front view.



Third angle Projection



(i)



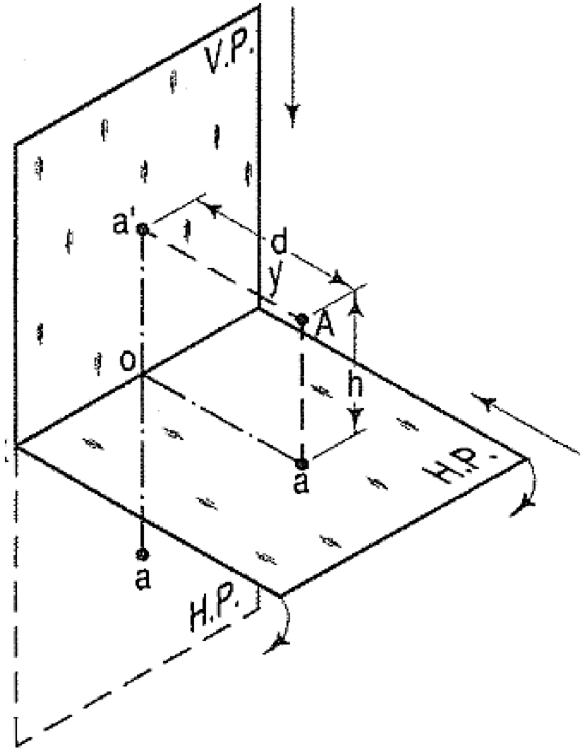
(ii)

Projection of Points

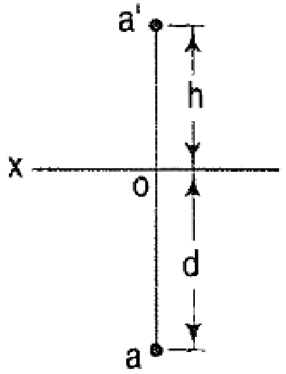
A point may be situated, in space, in any one of the four quadrants formed by the two principal planes of projection or may lie in any one or both of them. Its projections are obtained by extending projectors perpendicular to the planes. One of the planes is then rotated so that the first and third quadrants are opened out. The projections are shown on a flat surface in their respective positions either above or below or in xy.

Projection of Points

(A)A Point in First Quadrant: Following pictorial view [fig. (i)] shows a point A situated above the H.P. and in front of the V.P., i.e. in the first quadrant. a' is its front view and a the top view. After rotation of the plane, these projections will be seen as shown in fig. (ii) below.



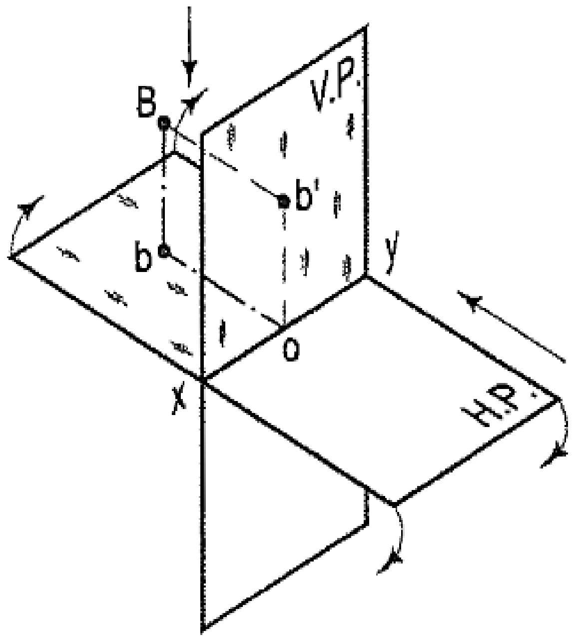
(i)

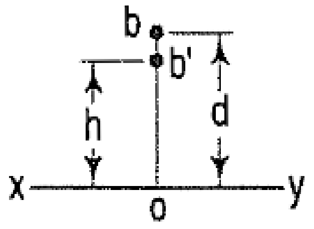


(ii)

Projection of Points

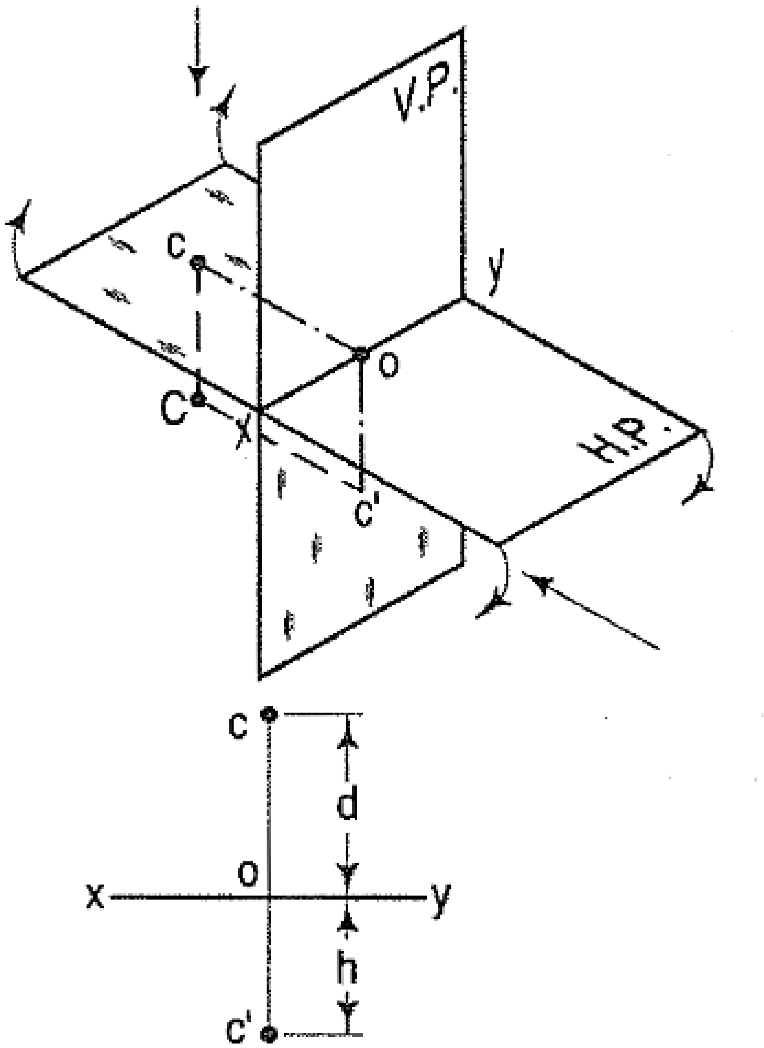
(B) A Point in Second Quadrant: A point B (fig. below) is above the H.P. and behind the V.P., i.e. in the second quadrant. b' is the front view and b the top view. When the planes are rotated, both the views are seen above xy. Note that b'o = Bb and bo = Bb'.





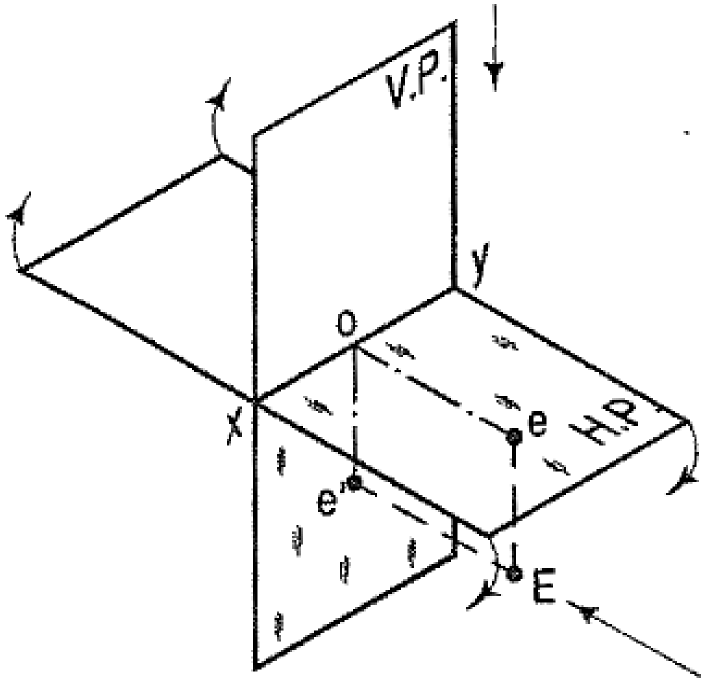
Projection of Points

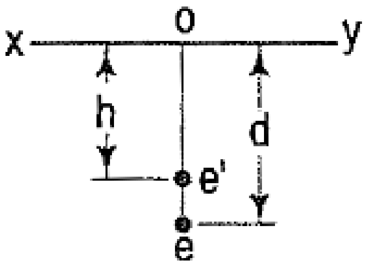
(C) A Point in Third Quadrant: A point C (fig. below) is below the H.P. and behind the Y.P., i.e. in the third quadrant. Its front view c' is below xy and the top view c above xy. Also c'o = Cc and co = Cc'



Projection of Points

(D) A Point in Fourth Quadrant:A point f (fig. below) is below the H.P. and in front of the V.P., i.e. in the fourth quadrant. Both its projections are below xy, and e'o = Ee and eo = Ee'.

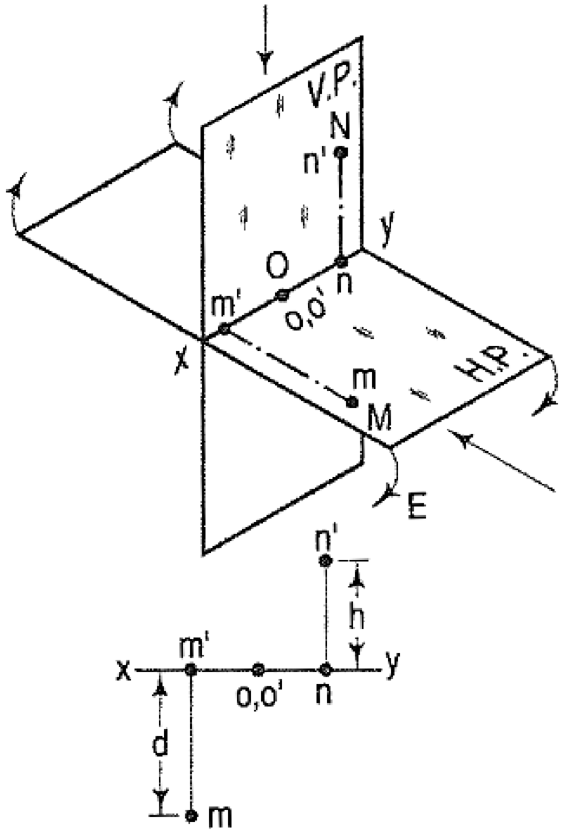




(i) A point M is in the H.P. and in front of the V.P. Its front view m' is in xy and the top view m below it.

(ii) (ii) A point N is in the V.P. and above the H.P. Its top view n is in xy and the front view n' above it.

(iii) A point O is in both the H.P. and the V.P. Its projection o and o' coincide with each other in xy.



Projection of Solids

A solid, being a three-dimensional object, has length, breadth, and thickness. When representing such a solid on a flat surface that only accommodates two dimensions (length and breadth), it is usually necessary to provide at least two orthographic views to convey the complete geometry of the object.

These views, typically the front and top views, offer different perspectives that together give a clearer understanding of the solid's shape and structure. However, in some cases, the complexity of the object may require additional views projected onto auxiliary planes. These auxiliary views help in fully describing the solid by revealing features or details that may not be clearly visible in the standard orthographic projections, ensuring a complete and accurate representation.

Projection of Solids

Types of solids:

Solids may be divided into two main groups:

(1) Polyhedra

(2) Solids of revolution.

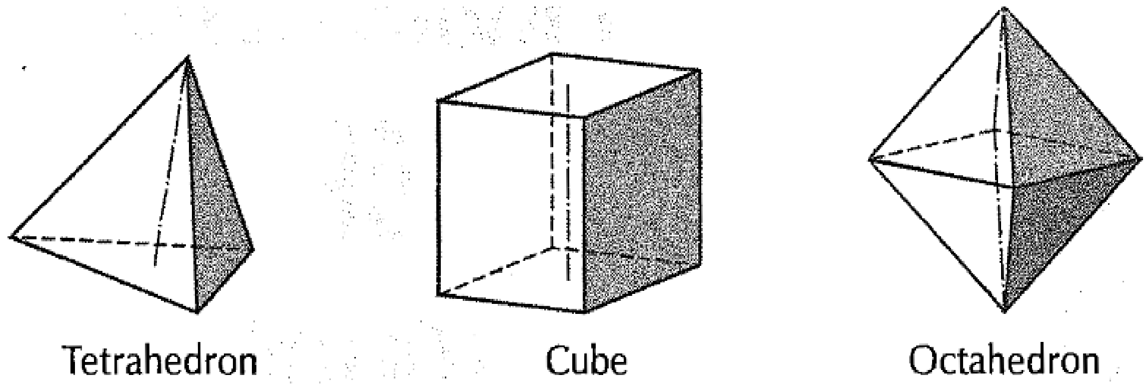
Projection of Solids

(1) Polyhedra : A polyhedron is defined as a solid bounded by planes called faces. When all faces are equal and regular, the polyhedron is said to be regular. There are seven regular polyhedra which may be defined as stated below:

(i) Tetrahedron: It has four equal faces, each an equilateral triangle.

(ii) Cube or hexahedron : It has six faces, all equal squares.

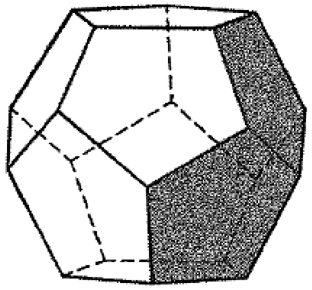
(iii) Octahedron : It has eight equal equilateral triangles as faces.



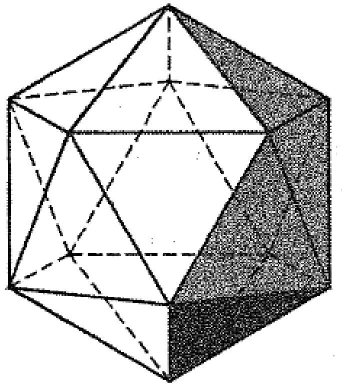
Projection of Solids

(iv) Dodecahedron : It has twelve equal and regular pentagons as faces.

(v) Icosahedron : It has twenty faces, all equal equilateral triangles.



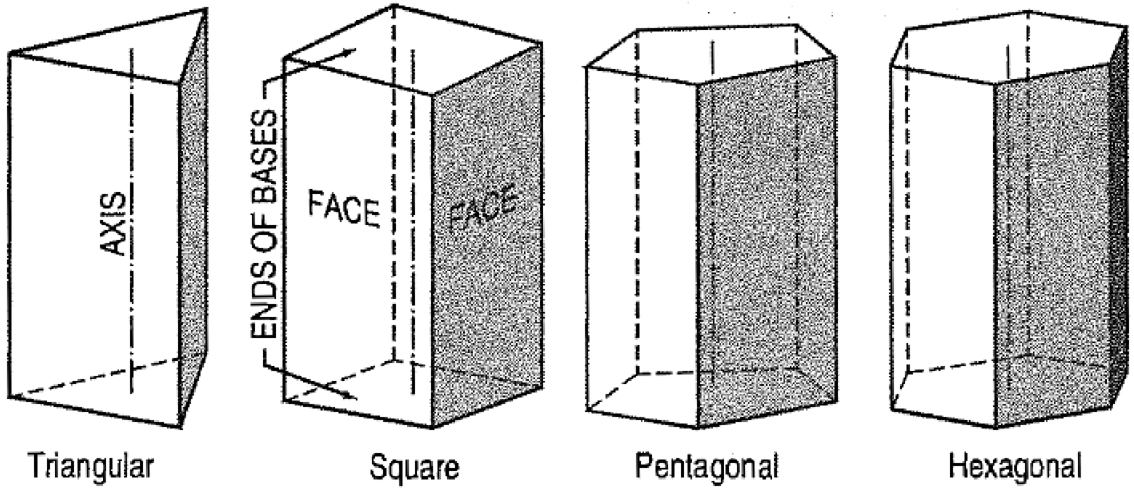
Dodecahedron



Icosahedron

Projection of Solids

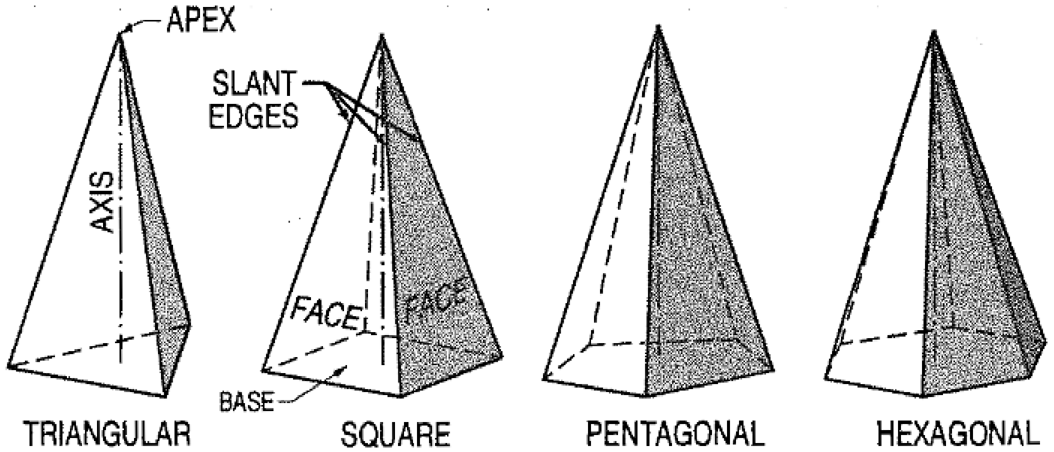
(vi) Prism: This is a polyhedron having two equal and similar faces called its ends or bases, parallel to each other and joined by other faces which are parallelograms. The imaginary line joining the centres of the bases is called the axis. A right and regular prism has its axis perpendicular to the bases. All its faces are equal rectangles.



Prisms

Projection of Solids

(vii) Pyramid: This is a polyhedron having a plane figure as a base and a number of triangular faces meeting at a point called the vertex or apex. The imaginary line joining the apex with the centre of the base is its axis. A right and regular pyramid has its axis perpendicular to the base which is a regular plane figure. Its faces are all equal isosceles triangles. Prisms and pyramids are named according to the shape of their bases, as triangular, square, pentagonal, hexagonal etc.

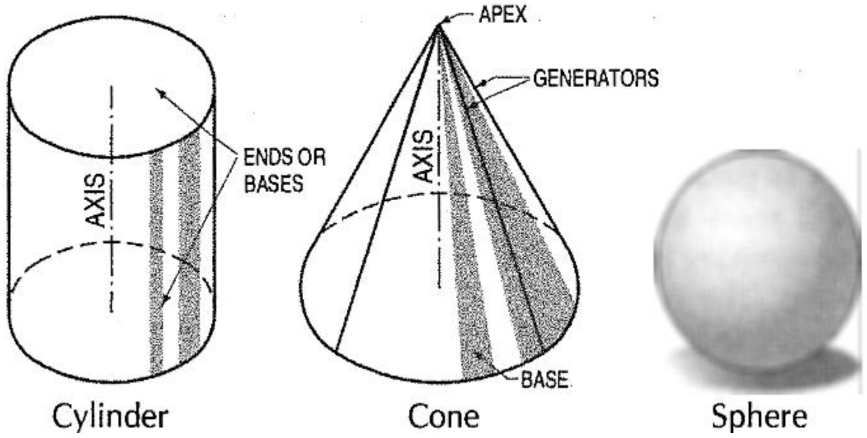


Pyramids

Projection of Solids

(2) Solids of revolution:

(i) Cylinder: A right circular cylinder is a solid generated by the revolution of a rectangle about one of its sides which remains fixed. It has two equal circular bases. The line joining the centres of the bases is the axis. It is perpendicular to the bases.



Projection of Solids

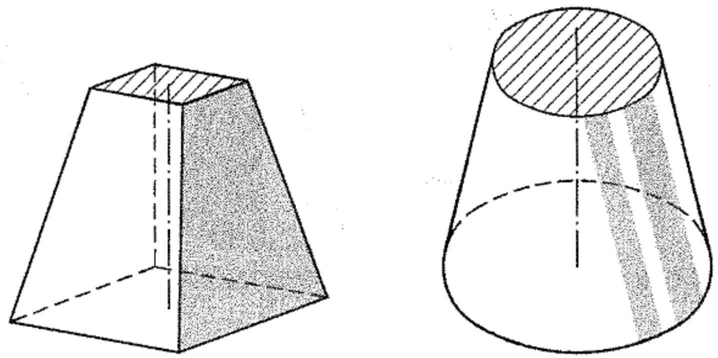
(ii) Cone : A right circular cone is a solid generated by the revolution of a right-angled triangle about one of its perpendicular sides which is fixed. It has one circular base. Its axis joins the apex with the centre of the base to which it is perpendicular. Straight lines drawn from the apex to the circumference of the base-circle are all equal and are called generators of the cone. The length of the generator is the slant height of the cone.

(iii) Sphere : A sphere is a solid generated by the revolution of a semi-circle about its diameter as the axis. The mid-point of the diameter is the centre of the sphere. All points on the surface of the sphere are equidistant from its centre.

Oblique cylinders and cones have their axes inclined to their bases.

Projection of Solids

(iv) Frustum: When a pyramid or a cone is cut by a plane parallel to its base, thus removing the top portion, the remaining portion is called its frustum.



Frustums

(v) Truncated: When a solid is cut by a plane inclined to the base it is said to be truncated. In these notes mostly right and regular solids are dealt with. Hence, when a solid is named without any qualification, it should be understood as being right and regular.

Projection of Solids

A solid in simple position may have its axis perpendicular to one reference plane or parallel to both. When the axis is perpendicular to one reference plane, it is parallel to the other. Also, when the axis of a solid is perpendicular to a plane, its base will be parallel to that plane. We have already seen that when a plane is parallel to a reference plane, its projection on that plane shows its true shape and size. Therefore, the projection of a solid on the plane to which its axis is perpendicular, will show the true shape and size of its base. Hence, when the axis is perpendicular to the ground, i.e. to the H.P., the top view should be drawn first and the front view projected from it. When the axis is perpendicular to the V.P., beginning should be made with the front view. The top view should then be projected from it. When the axis is parallel to both the H.P. and the V.P., neither the top view nor the front view will show the actual shape of the base. In this case, the projection of the solid on an auxiliary plane perpendicular to both the planes, viz. the side view must be drawn first. The front view and the top view are then projected from the side view. The projections in such cases may also be drawn in two stages.

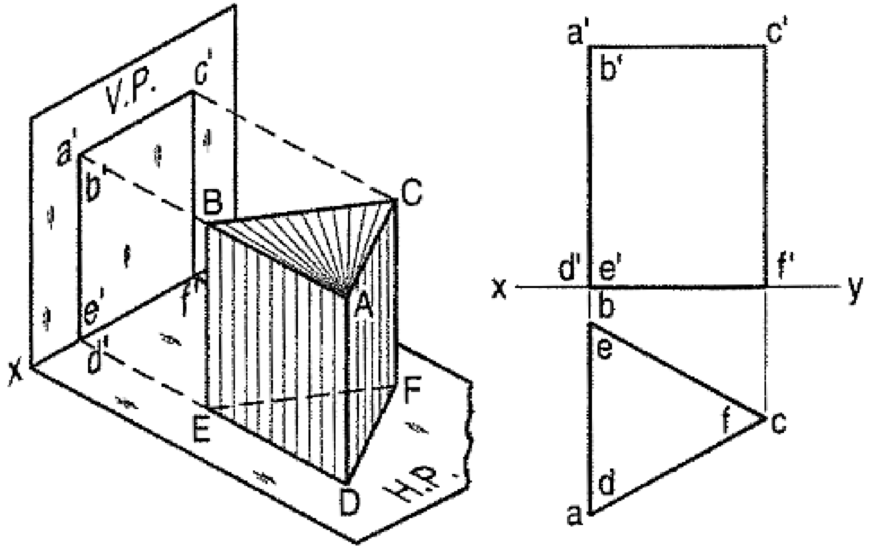
Projection of Solids

(1) Axis perpendicular to the H.P.:

Problem S1: Draw the projections of a triangular prism, base 40 mm side and axis 50 mm long, resting on one of its bases on the H.P. with a vertical face perpendicular to the V.P.

(i) As the axis is perpendicular to the ground i.e. the H.P. begin with the top view. It will be an equilateral triangle of sides 40 mm long, with one of its sides perpendicular to xy. Name the corners as shown, thus completing the top view. The corners d, e and fare hidden and coincide with the top corners a, b and c respectively.

(ii) Project the front view, which will be a rectangle. Name the corners. The line b'e' coincides with a'd'.

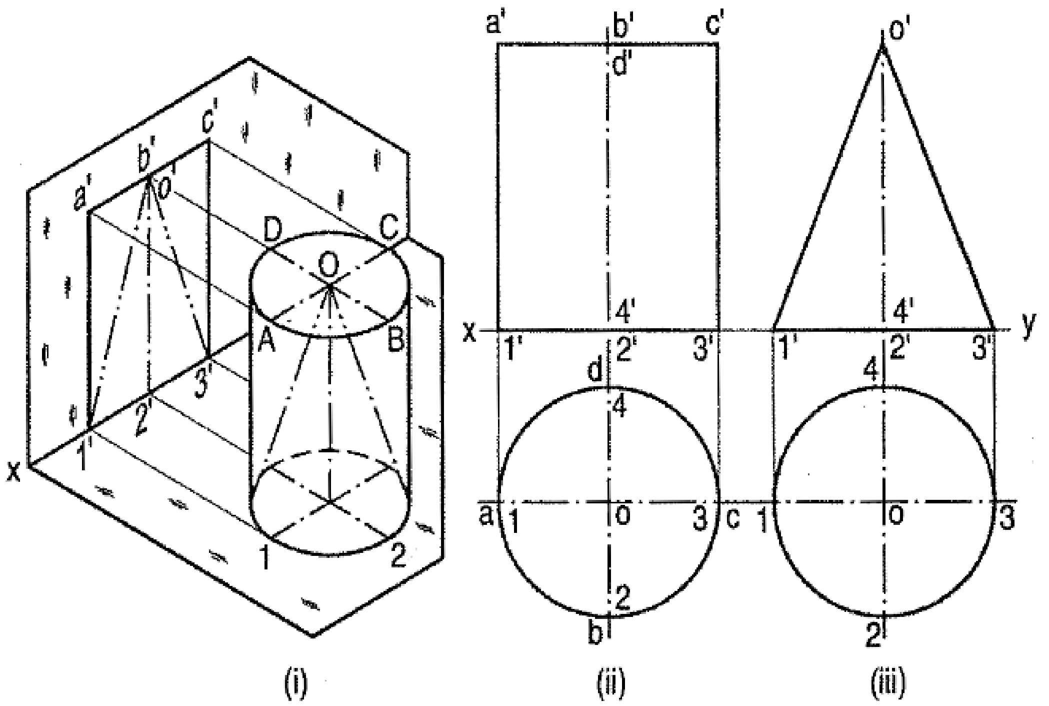


Projection of Solids

Problem . Draw the projections of (i) a cylinder, base 40 mm diameter and axis 50 mm Jong, and (ii) a cone, base 40 mm diameter and axis 50 mm long, resting on the H.P. on their respective bases.

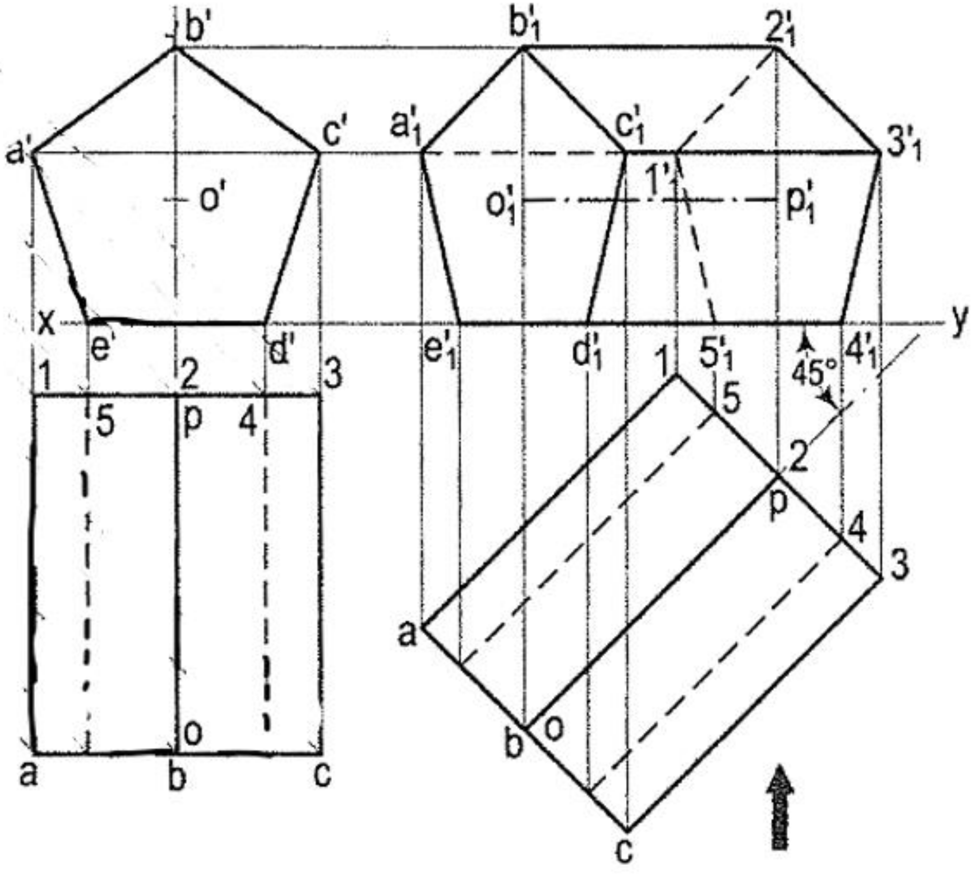
(i) Draw a circle of 40 mm diameter in the top view and project the front view which will be a rectangle .

(ii) Draw the top view. Through the centre o, project the apex o', 50 mm above xy. Complete the triangle in the front view as shown.



Projection of Solids With Axis Inclined To One of The Reference Planes and Parallel To Other

Problem S4: Draw the projection of a pentagonal prism, base 25 mm side and axis 50 mm long resting on one of its rectangular faces on the H.P.; with the axis inclined at 45^0 to the V.P. In the simple position, assume the prism to be on one of its faces on the ground with the axis perpendicular to the V.P. Draw the pentagon in the front view with one side in xy and project the top view. The shape and size of the figure in the top view will not change, so long as the prism has its face on the H.P. … nt view from xy will also remain constant



(i) (ii)

Projection of Solids

(i) Alter the position of the top view, i.e. reproduce it so that the axis is inclined at 45° to xy. Project all the points upwards from this top view and horizontally from the first front view, e.g. a vertical from a intersecting a horizontal from a' at a point a'1 .

(ii) Complete the pentagon a'1b'1c' 1 d' 1e' 1 for the fully visible end of the prism. Next, draw the lines for the longer edges and finally, draw the lines for the edges of the other end. Note carefully that the lines a'1 1 '1, 1 '12'1 and 1 '15'1 are dashed lines. e'1 5'1 is also hidden but it coincides with other visible lines.

Projection of Solids when Axis Inclined to Both H.P. and V.P.

The projections of a solid with its axis inclined to both the planes are drawn in three stages:

(i) Simple position

(ii) Axis inclined to one plane and parallel to the other

(iii) Final position.

The second and final positions may be obtained either by the alteration of the positions of the solid, i.e. the views, or by the alteration of reference lines.

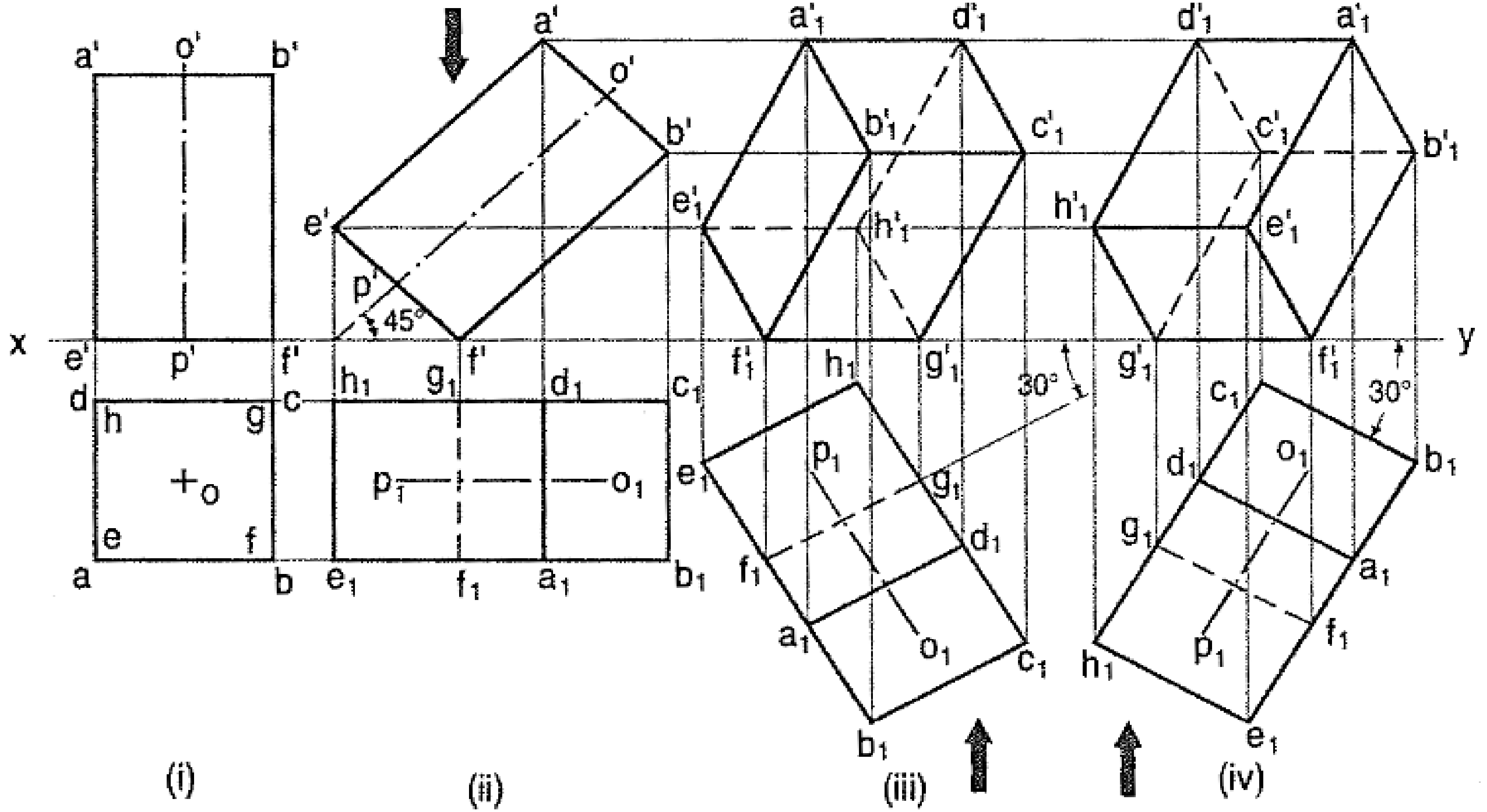
Projection of Solids when Axis Inclined to Both H.P. and V.P.

Problem S6. A square prism, base 40 mm side and height 65 mm, has its axis inclined at 45° to the H.P. and has an edge of its base, on the H.P and inclined at 30° to the V.P. Draw its projections.

(i) Assuming the prism to be resting on its base on the ground with an edge of the base perpendicular to the V.P., draw its projections. Assume the prism to be tilted about the edge which is perpendicular to theV.P., so that the axis makes 45° angle with the H.P.

(ii) Hence, change the position of the front view so that the axis is inclined at 45° to xy and f' (or e') is in xy. Project the second top view

Projection of Solids when Axis Inclined to Both H.P. and V.P.

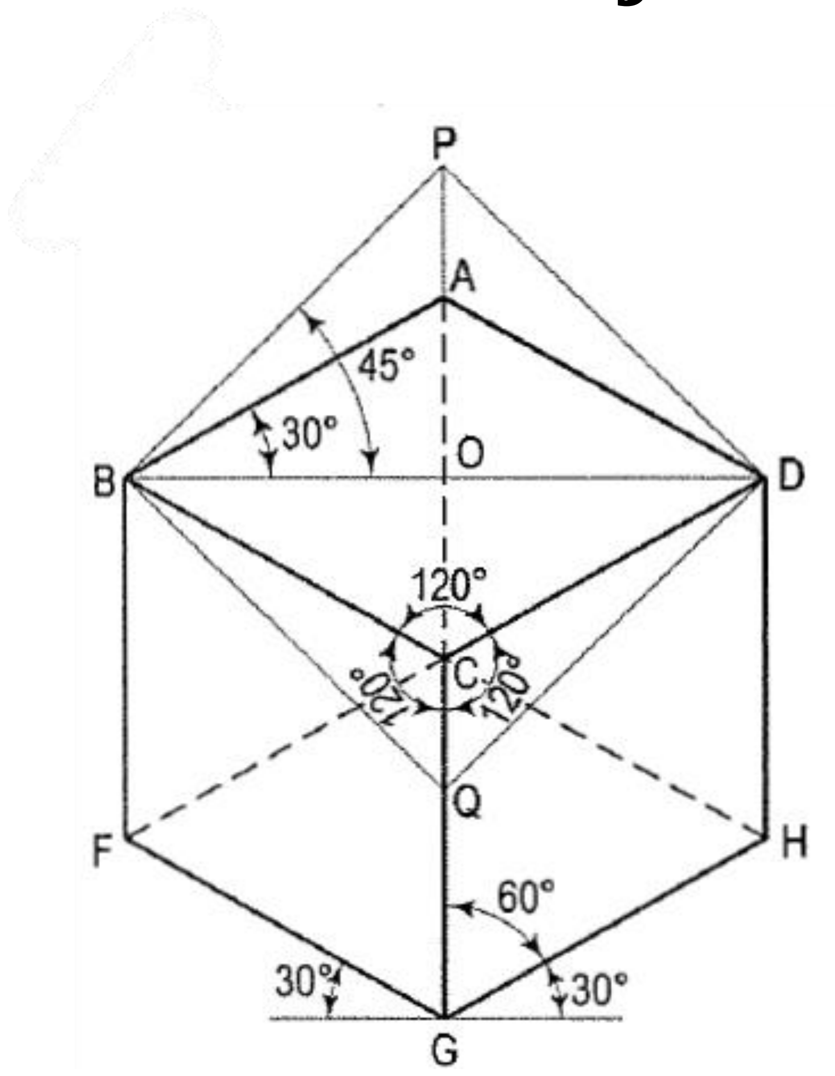


Isometric Projection

Isometric projection is a type of pictorial projection in which the three dimensions of a solid are not only shown in one view, but their actual sizes can be measured directly from it. If a cube is placed on one of its corners on the ground with a solid diagonal perpendicular to the V.P., the front view is the *isometric projection* of the cube. The step-by-step construction is shown in fig.

To draw the projections of a cube of 25 mm long edges resting on the ground on one of its corners with a solid diagonal perpendicular to the V.P., assume the cube to be resting on one of its faces on the ground with a solid diagonal parallel to the V.P.

Isometric Projection



Isometric Scale

As all the edges of the cube are equally foreshortened, the square faces are seen as rhombuses. The rhombus *ABCD* following figure shows the isometric projection of the top square face of the cube in which *BO* is the true length of the diagonal. Construct a square *BQDP* around *BO* as a diagonal. Then *BP* shows the true length of *BA*.

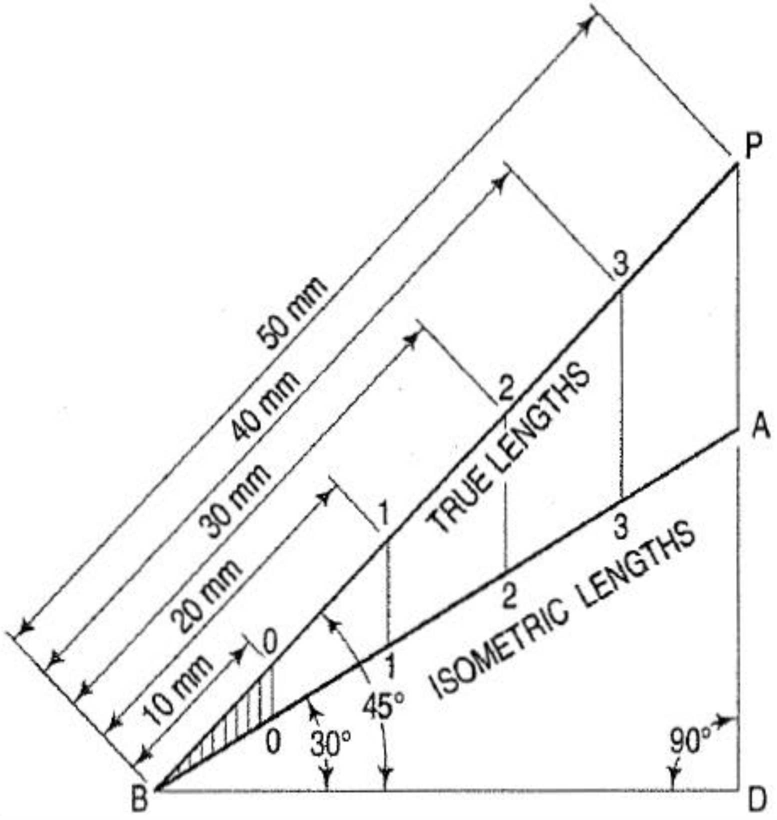
In triangle *ABO*, $\dfrac{BA}{BO} = \dfrac{1}{\cos 30°} = \dfrac{2}{\sqrt{3}}$

In triangle *PBO*, $\dfrac{BP}{BO} = \dfrac{1}{\cos 45°} = \dfrac{\sqrt{2}}{1}$

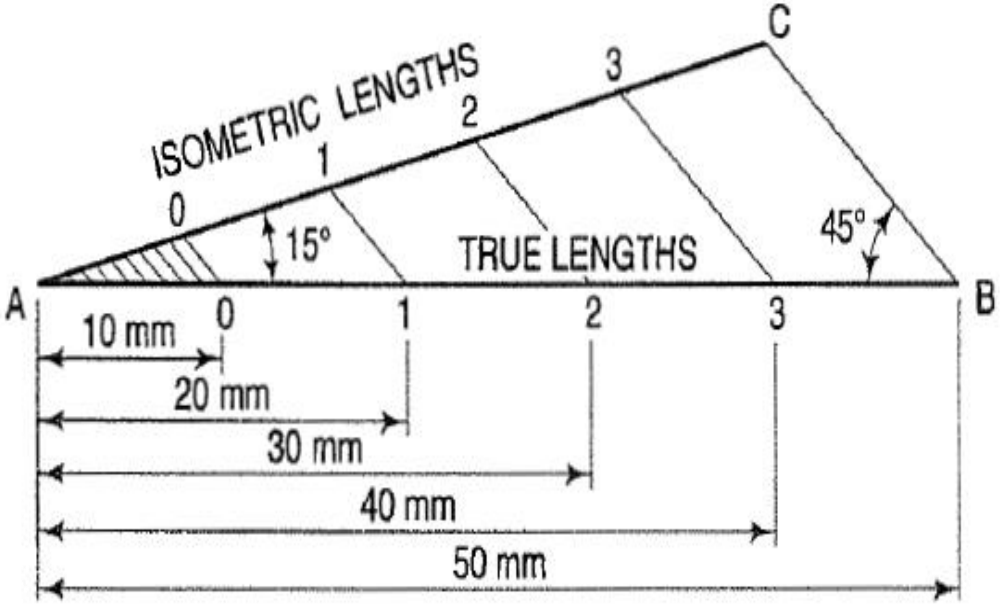
$$\frac{BA}{BP} = \frac{2}{\sqrt{3}} \times \frac{1}{\sqrt{2}} = \frac{\sqrt{2}}{\sqrt{3}} = 0.815$$

The ratio, $\dfrac{\text{isometric length}}{\text{true length}} = \dfrac{BA}{BP} = \dfrac{\sqrt{2}}{\sqrt{3}} = 0.815 \text{ or } \dfrac{9}{11}$ (approx.).

Thus, the isometric projection is reduced in the ratio $\sqrt{2} : \sqrt{3}$, i.e. *the isometric lengths are 0.815 of the true lengths.*



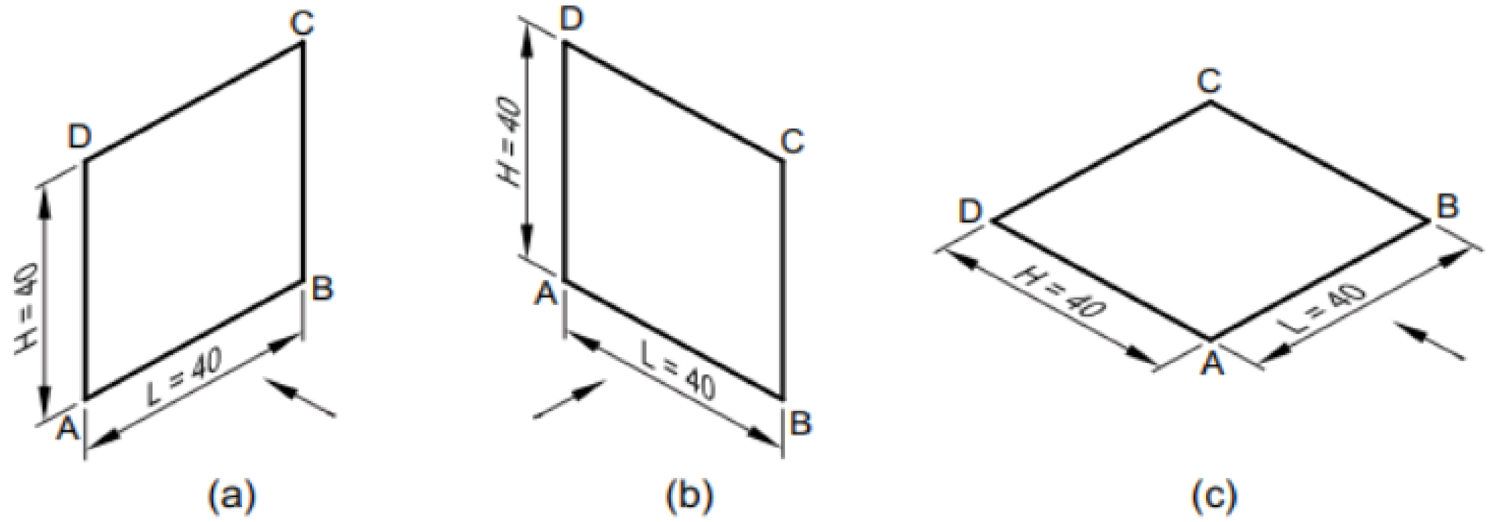
P
A
B
D
50 mm
40 mm
30 mm
20 mm
10 mm
TRUE LENGTHS
ISOMETRIC LENGTHS
0
1
2
3
30°
45°
90°



C
A
B
ISOMETRIC LENGTHS
TRUE LENGTHS
0
1
2
3
15°
45°
10 mm
20 mm
30 mm
40 mm
50 mm

Isometric Projection

Problem: 2. Draw the isometric view of a square of side 40mm kept in (a) vertical Position and (b) horizontal position



Isometric Projection

1. Do one of the following:

• On the status bar, click Find.

• At the Command prompt, enter ISODRAFT.

2. Choose which isoplane orientation that you want to use: Left, Right, or Top.

• Press F5 or Ctrl+E to cycle through the different isoplanes

• On the status bar, Isodraft button, click the dropdown arrow and choose an option

• At the Isodraft prompt in the Command window, enter an option

3. At the Command prompt, enter Line.

4. The Polyline option is available only when an isometric drawing plane is active.

5. Specify the coordinates of the square to draw the square.

Therefore, while drawing an *isometric projection,* it is necessary to convert true lengths into isometric lengths for measuring and marking the sizes. This is conveniently done by constructing and making use of an isometric scale as shown below.

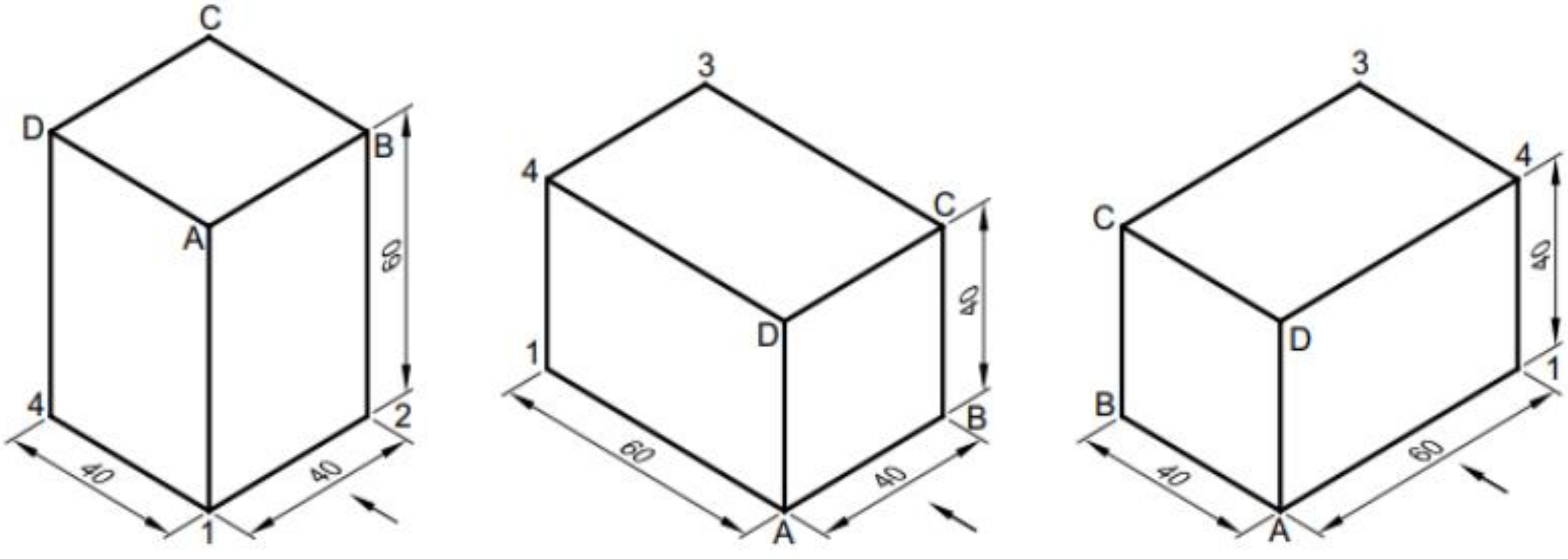
(a) Draw a horizontal line *BO* of any length. At the end *B,* draw lines *BA* and *BP,* such that *L OBA* = 30° and

L OBP = 45°. Mark divisions of true length on the line *BP* and from each division-point, draw verticals to *BO* meeting *BA* at respective points. The divisions thus obtained on *BA* give lengths on isometric scale

(b) The same scale may also be drawn with divisions of natural scale on a horizontal line *AB.* At the ends A and *B,* draw lines *AC* and *BC* making 15° and 45° angles with *AB r*espectively, and inter-secting each other at C.

From division-points of true lengths on *AB,* draw lines parallel to *BC* and meeting *AC* at respective points. The divisions along *AC* give lengths to isometric scale. The lines *BO* and *AC* represent equal diagonals of a square face of the cube, but are not equally shortened in isometric projection. *BO* retains its true length, while *AC* is considerably shortened. Thus, it is seen that lines which are not parallel to the isometric axes are not reduced according to any fixed ratio. Such lines are called non-isometric lines. The measurements should, therefore, be made on *isometric axes and isometric lines only.* The non-isometric lines are drawn by locating positions of their ends on isometric planes and then joining them.

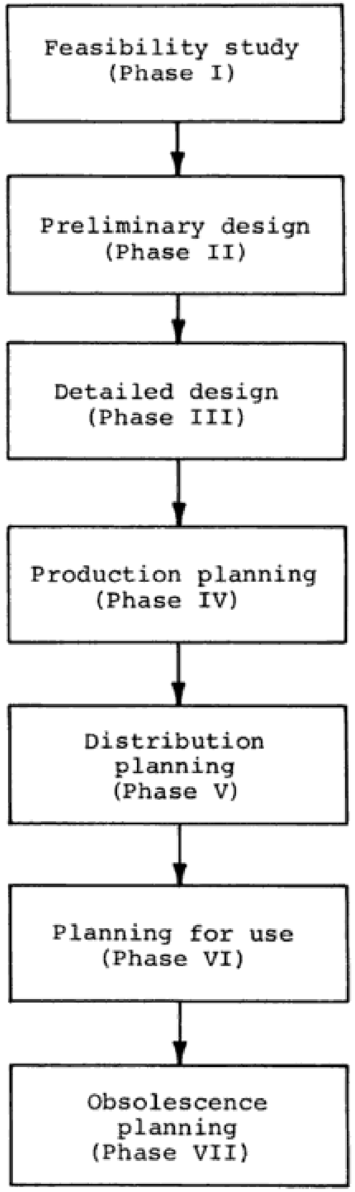
Problem: Draw the isometric view of a square prism of base side 40 mm and axis 60 mm resting on the H.P. on the (a) base with axis perpendicular to the H.P., (b) rectangular face with axis perpendicular to the V.P., and (c) rectangular face with axis parallel to the V.P.



(a) (b) (c)

1. At first, you need to change your snap settings to isometric. Type DS on the command line and press enter.
2. Drafting settings window will pop up from this window select snap and grid tab and make sure Isometric snap radio button is checked. Click OK to exit drafting settings window.
3. Now make sure ortho mode is turned on from the status bar, if it is not turned on then press F8 to turn it on.
4. You can now select isometric plane for your drawing by pressing the F5 key. The three Isoplanes available for selection are Isoplane top, right and left.
5. Press F5 key to activate Isoplane top and then select line command and click anywhere in the drawing area to start your line. Specify a direction and type 5 on the command line then press enter, repeat this process by changing directions of line to make a closed square.

MORPHOLOGY OF DESIGN
(THE SEVEN STEPS)



Design is progression from the abstract to the concrete. This gives a chronologically horizontal structure to a design project. The seven phases of design proposed by Asimow are:

MORPHOLOGY OF DESIGN

Of the seven phases, the first three phases belong to design, and the remaining four phases belong to production, distribution, consumption and retirement.

Phase I - Feasibility Study

It is done to

- To demonstrate that the original need has current existence.
- To explore the design problem and identify elements like parameters, constraints, major design criteria etc.
- To conceive a number of possible solutions.
- To sort out potentially useful solutions on the basis of physical reliability, economic worthwhileness, and financial feasibility

MORPHOLOGY OF DESIGN

Phase II - Preliminary Design

Establishes which the best design concept is. Various steps involved Preliminary design are;

- To subject each alternative solution to order of magnitude analysis until one is proved to be the best.
- To initiate synthesis studies for establishing the fineness of the range within which the major design parameters must be controlled.
- To study how the design will meet consumer’s taste, how it will match with products of competitors, whether scarce and critical raw materials will continue to be available, rate of obsolescence.
- The rate of deterioration of performance with corrosion, wear fatigue, etc.
- To test the critical aspects of the design in order to validate the design concept and provide information for subsequent phases.

MORPHOLOGY OF DESIGN

Phase III-Detailed Design

The detailed design phase begins with the concept evolved in the preliminary design. Its purpose is to furnish the engineering description of a tested and producible design. It furnishes the engineering description of a feasible design.

Various steps of Detailed design are;

- To develop an overall, provisional synthesis as a master layout.
- To prepare specifications of components.
- To initiate experimental design by constructing models to check out untried ideas.
- To test prototypes and using information obtained as basis of redesign and refinement.

MORPHOLOGY OF DESIGN

Phase IV - Planning the Production Process

The above-mentioned three phases were particularly in the area of engineering design; much

of the responsibility for phase 4 will be shared with other areas of management.

A new battery of skills, those of tool design and production engineering, come into play.

The production planning phase involves many steps which will vary in form and detail

according to the particular industry. The following shortened list is typical of the mass

production industries

MORPHOLOGY OF DESIGN

1. Detailed process planning is required for every part, subassembly and the final assembly. The information is usually displayed on process sheets, one for each part of subassembly. The process sheet contains a sequential list of operations which must be performed to produce the part. It specifies the raw material, clarifies special instructions, and indicates the tools and machines required. This step is particularly important, because design features that lead to difficulties in production are revealed. Such difficulties should have been minimized earlier by timely consultations between product designers and tool designers. Similarly, questions about materials should have been resolved by consultation with metallurgists.

2. Design of tools and fixtures: This design work proceeds generally from the

information developed in the operations analysis on the process sheets.

3. Planning, specifying or designing new production and plant facilities.

4. Planning the quality control system

5. Planning for production personnel: Job-specifications are developed, standard times are determined, and labour costs estimated.

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6. Planning for production control: Work schedules and inventory controls are evolved. Standard costs for labour, materials, and services are established and integrated with the accounting system.

7. Planning the information-flow system: The information necessary for transmission of instructions and provision of feedback for control is determined. Appropriate forms and records are designed and integrated with computers when available. How patterns and routines are established.

8. Financial planning: Usually, large sums of money are required to initiate production of a new product. The source of the financing must be carefully established, and the means and rate of recovering the capital determined.

MORPHOLOGY OF DESIGN

Phase V - Planning for Distribution

Production is the first process in the production-consumption cycle. The second is distribution. The purpose of this phase is to plan an effective and flexible system of distribution of the designed goods. The short list we now give is indicative of the planning for distribution.

- Designing the packaging of the product
- Planning the warehousing systems
- Planning the promotional activity
- Designing the product for conditions arising in distribution

MORPHOLOGY OF DESIGN

Phase VI - Planning for Consumption

Consumption is the third process in the production-consumption cycle. As a process, it occurs naturally after distribution. The purpose of this phase is to incorporate in the design, adequatebservice features and to provide a rational basis for product improvement and redesign. Designbfor consumption must consider the following factors:

 Design for maintenance

 Design for reliability

 Design for safety

 Design for convenience in use

 Design for aesthetic features

 Design for operational economy

 Design for adequate duration of services

 Obtain service data that can provide a basis for product improvement, for next

generation designs.

MORPHOLOGY OF DESIGN

Phase VII - Planning for Retirement

The fourth process in the production-consumption cycle is the disposal of the retired product. For large an semi-permanent installations, the mere removal may pose difficult engineering problems, as for example, the demolition of a tall building closely surrounded by buildings on either side. Sometimes, the impact on a new design is more immediate as when an old structure or system must be replaced by a. new one with minimum disruption of normal operations. Designing for retirement, according to Asimow, must consider the following aspects:

 Designing to reduce the rate of obsolescence by taking into account the anticipated

effects of technical developments.

 Designing physical life to match anticipated service life.

 Designing for several levels of use so that when service life at higher level of use is

terminated, the product will be adaptable for further use with a less demanding level.

 Designing the product so that reusable materials and long-lived components can be

recovered.

 Examining and testing of service-terminated products in the laboratory to obtain

useful design information.

Mapping of design phase with CAD functions

Mapping the design phase with CAD (Computer-Aided Design) functions is crucial for ensuring that every stage of the design process is supported by the appropriate tools and functionalities. This mapping helps streamline workflows, enhance design accuracy, and facilitate efficient collaboration. Here's a detailed lo

1. Conceptual Design

CAD Functions:

- **Sketching:** Use CAD tools to create initial sketches or drawings to visualize the concept. Tools for freehand drawing, geometric shapes, and annotations are used.
- **2D Drafting:** Develop 2D drafts to define the basic geometry and layout. CAD software supports various drawing tools and dimensions.

Purpose:

- **Idea Exploration:** Quickly iterate and refine initial design ideas.
- **Visualization:** Create visual representations of concepts to evaluate and communicate ideas.

ok at how CAD functions align with various stages of the design phase

2. Detailed Design

CAD Functions:

•**3D Modeling:** Transition from 2D sketches to 3D models using CAD tools. Features like extrude, revolve, and loft help create complex shapes.

•**Assembly Design:** Use CAD assembly functions to combine individual components and check for fit and interference.

•**Parametric Design:** Utilize parameters and constraints to define relationships between different parts and dimensions, allowing for easy modifications.

Purpose:

•**Precision:** Develop detailed and accurate 3D models of the design.

•**Integration:** Ensure that all components work together as intended in the final assembly.

3. Design Validation

CAD Functions:

- **Simulation and Analysis:** Use simulation tools for stress analysis, thermal analysis, and fluid dynamics to evaluate performance under various conditions.
- **Virtual Prototyping:** Create virtual prototypes to test the design in a simulated environment.
- **Design Verification:** Check dimensions, tolerances, and assembly functions to ensure the design meets specifications.

Purpose:

- **Performance Testing:** Validate the design's functionality and performance before physical prototyping.
- **Error Detection:** Identify and correct design flaws early in the process.

4. Documentation

CAD Functions:

- **Technical Drawings:** Generate detailed technical drawings and schematics for manufacturing and assembly. Include dimensions, tolerances, and material specifications.
- **Bill of Materials (BOM):** Create a BOM to list all parts and materials needed for production, along with quantities and specifications.
- **Annotations and Notes:** Add annotations and notes to provide additional information and instructions for manufacturing or assembly.

Purpose:

- **Communication:** Provide clear and accurate documentation for manufacturers, engineers, and other stakeholders.
- **Compliance:** Ensure that the design meets industry standards and regulatory requirements.

5. Design Revision and Iteration

CAD Functions:

•**Version Control:** Track changes and manage different versions of the design using CAD's version control features.

•**Collaboration Tools:** Use collaboration tools to review and discuss design changes with team members. CAD software often integrates with cloud-based platforms for sharing and real-time updates.

•**Rework and Updates:** Modify and refine the design based on feedback, testing results, or new requirements.

Purpose:

•**Adaptability:** Allow for changes and improvements throughout the design phase.

•**Collaboration:** Facilitate teamwork and incorporate feedback effectively.

6. Manufacturing Preparation

CAD Functions:

•**Toolpath Generation:** For designs that will be manufactured using CNC machines, use CAD/CAM software to generate toolpaths and machining instructions.

•**Tolerance Analysis:** Analyze and specify tolerances to ensure manufacturability and fit.

•**Assembly Instructions:** Create detailed assembly instructions and guides based on the CAD model.

Purpose:

•**Production Readiness:** Prepare the design for manufacturing and ensure that it can be produced efficiently and accurately.

•**Quality Assurance:** Define specifications and tolerances to maintain product quality.

Thank You