A short series of lectures on Engineering Drawing as Part of ENGG1960
Introduction to Biomedical Engineering 1 By Paul Briozzo
What is an Engineering Drawing?

An Engineering Drawing is a technical (not artistic) drawing which clearly defines and communicates a design to other interested parties.

Other parties may have an interest in design collaboration, procurement / purchasing, costing, manufacturing, quality control, marketing, handling / packaging.
Why do we need to know about Engineering Drawings?

• To allow our designs to develop from a thought or concept to a design / sketch on “paper”.

• To enable us to communicate our designs / sketches to colleagues for review.

• To convert our sketches / designs into layout drawings which show how our ideas link up to existing infrastructures.

• To include our design / sketches as part of a proposal for client / management approval and review.

• To provide Manufacturers with working Engineering Drawings based from our original designs / sketches.
Consider the following description of a “V-Block”

The V-block is to be made of cast iron and machined on all surfaces. The overall sizes are 57 mm high, 76 mm wide, and 152 mm long. A V-shaped cut having an included angle of 90° is to be made through the entire length of the block. The cut is to be made with the block resting on the 76 mm by 152 mm surface. The V-cut is to begin 6 mm from the outside edges. At the bottom of the V-cut there is to be a relief slot 3 mm wide by 3 mm deep.

Material: Cast Iron
Pictorial Freehand
Examples of Layout Drawings

Collapsible Canoe Outrigger Design Project, 1998
Undergraduate Design Project under the Leadership of A/Prof. Harry Lipkin, Georgia Tech University
Examples of Layout Drawings
Proposal Drawing

Engineering drawing by Harry C. Shoaf (Space Task Group Engineering Division) of the proposed "lunar lander" to be used with an advanced version of the Mercury spacecraft. (Shoaf, Drawing, Nov. 15, 1961.)
Detail Drawing (Finish Drawing) of Connecting Rod, M. Jacek 1973
The History of Engineering Drawing
Free Hand Sketches – Leonardo DaVinci 1500 AD

Design for a flying machine c1488

Anatomical study of the arm c1510

Sforza monument

Rhombicuboctahedron
Graphical Projections

- Perspective
- Parallel Projection
  - Oblique
    - Axonometric/Isometric
  - Orthogonal
    - Orthographic
      - 1st Angle
      - 2nd Angle
      - 3rd Angle
      - 4th Angle
Perspective

Staircase – two point perspective

Cube – two point perspective

Cube – one point perspective

Cube – two point perspective

Cube – two point perspective
Method and Rules of Projections

**Method**
- Select a view from the most advantageous position.
- Observe overall structure first.
- Note: parallelism, proportions and alignment.

**Rules of Projection**
- Object viewed from $\infty$.
- Parallel lines remain parallel.
- Proportions remain unchanged.
- Circles are always ellipses with the major axis of ellipse perpendicular to the polar axis of circle.
- Transformation of $90^\circ$ angles.
Parallel Projection

- Parallel Projection
  - Oblique
    - Axonometric/Isometric
  - Orthogonal
    - Orthographic
      - 1st Angle
      - 2nd Angle
      - 3rd Angle
      - 4th Angle
Oblique Projection

Visual rays parallel to each other and oblique to plane

LINE OF SIGHT
OBSERVER AT INFINITY

Object
Cavalier views are not preferred. They show lines which represent the depth of the object as being disproportionally long. Even though they are parallel to each other, depth lines appear to diverge away from each other.

Cabinet views are preferred over Cavalier. The issue of depth disproportionality and divergence is “somewhat” eliminated by halving the depth dimension.
Oblique Projection

4 Basic Rules

1. Place the object so that the view with the most detail is parallel to the picture plane.

2. Place the object so that the longest dimension runs horizontally across the sheet.
3. In some cases the previous rules conflict, and when this is so, Rule 1 has preference as the advantage gained by having the irregular face without distortion is greater than that gained by observing Rule 2.

4. Decisions about viewing an object in oblique projection should aim to show the object so that its shape is most clearly presented and is conducive to showing its dimensions.
Axonometric Projection

- Projection lines are perpendicular to Projection Plane.
- Principal axes inclined to Projection Plane.
- \( \alpha = \beta = \gamma \) Isometric (Equal Scaling)
- \( \alpha = \beta \) Dimetric
- \( \alpha \neq \beta \neq \gamma \) Trimetric
Isometric  Dimetric

$\alpha = \beta = \gamma = 120^\circ$

$\alpha = \gamma = 132^\circ$

Iso. Proj.
all $\frac{\sqrt{2}}{3}$ F.S.

Iso. Drawing
all F.S.

Scaling can only be done $\parallel$ to an axis
Orthogonal Projection

Orthogonal

Orthographic

1st Angle
2nd Angle
3rd Angle
4th Angle
3rd Angle Projection

- Standard symbol
- Third-angle projection box
- Designation of views
- Placement of third-angle views
- Box unfolded showing relative position of views
1st Angle Projection

Dihedral Angles – 1st Angle Emphasised

“Emok” 26th of June 2008
Free-Hand Pictorial Sketching

MIT Open Courseware
Why do we need to do this when we all have cameras on our mobile phones and can sketch on our tablets?

Note some of the features and differences between the SolidWorks rendering and the photo:

- Focus
- Scratches / stains / blemishes
- Lack of parallel lines adds distortion
- Hidden features
- Shadows
- Reflection
Construction of Freehand Pictorial Sketching

“The Thing”

Suitable Drawing Size

Lines that are parallel on the object should be parallel on the sketch

Line Drawing only (No Shading)

Proportions of features within the object must remain the same

Three Faces Visible (The faces which show most detail)

Line Quality
Sketching a bounding box for an ellipse

- Box defines the perimeter of the cylinder
- Define two axis midway and parallel to each side of the box
- Minor axis (or Polar axis) of the ellipse goes through the intersection of the two axis and is parallel to the edge of the box
- Minor axis does NOT go through the corners of the box
Sketching an ellipse

Define major axis of the ellipse going through the intersection point and at 90° to the minor axis.

Sketch ellipse noting that minor and major axis define outer limits of the ellipse.

Ellipse curves do NOT necessarily blend at the intersection points.
Projecting an ellipse

Project the ellipse forward to the correct distance along the boss.

Trace the ellipse in the new position and erase the hidden arcs from the original ellipse.

Remove all construction lines.