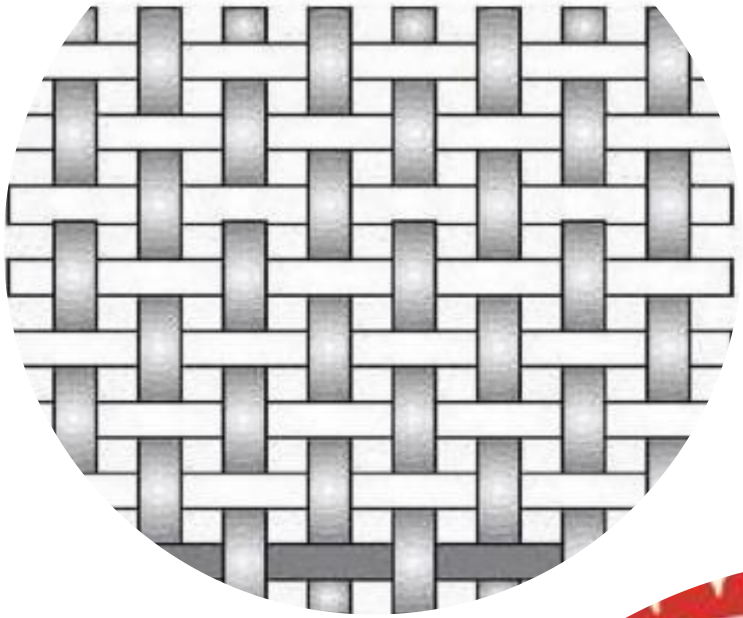
Fabric Manufacturing I (TXL231)



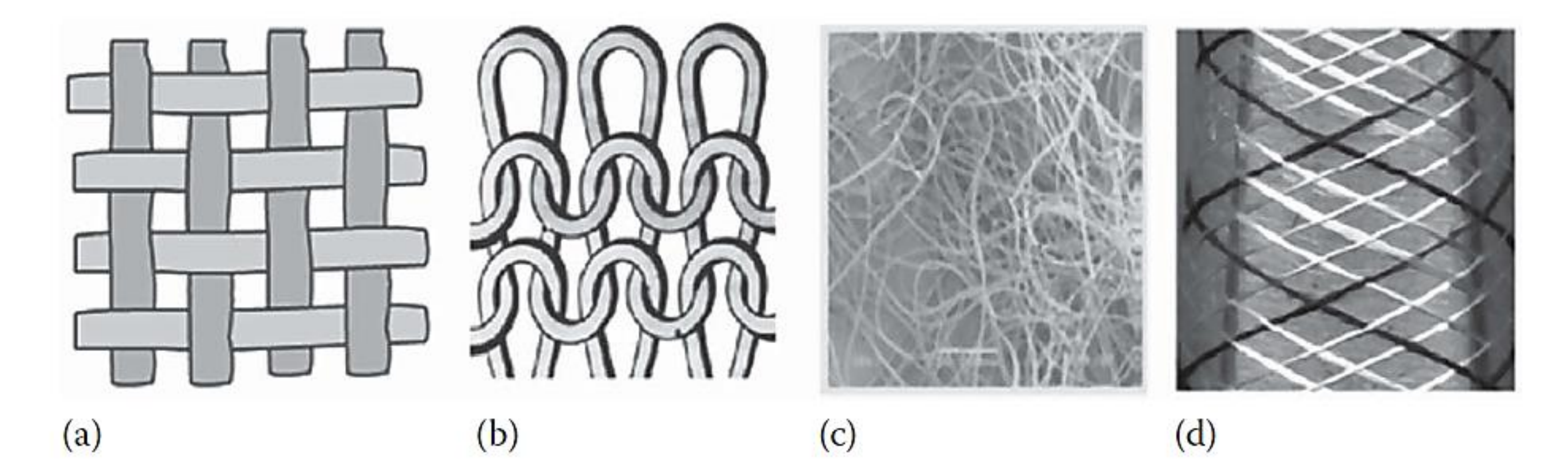
Dr. Sumit Sinha Ray

Asst. Professor

Department of Textile and Fibre Engineering

Recap of Previous Class

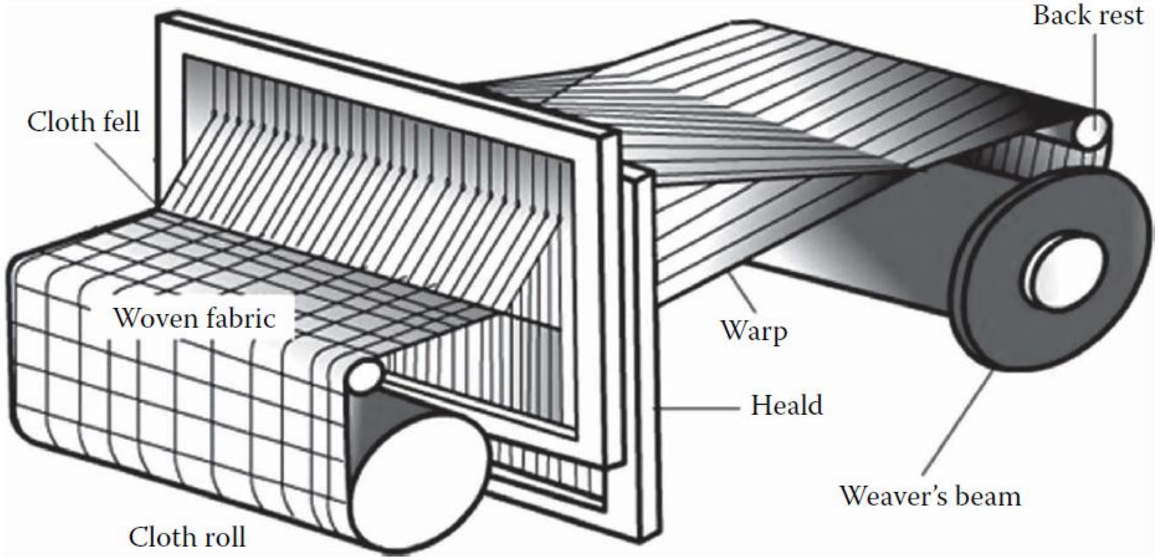
- We talked about the ab initio weaving and its modernization
- Methods of fabric formation-

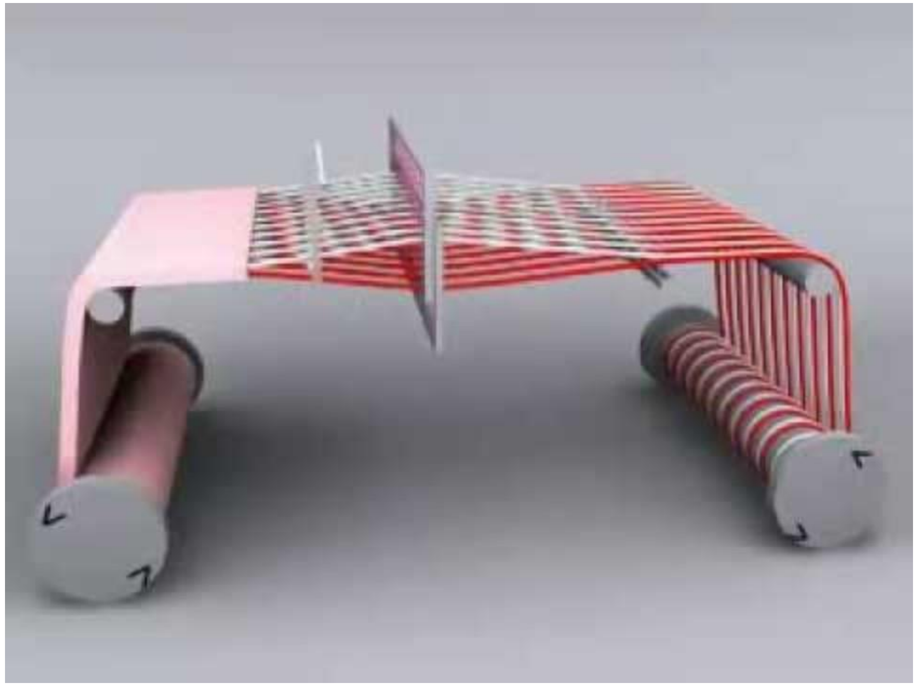


Woven **Knitted** **Nonwoven** **Braided**

- Economic impacts of different fabric manufacturing industries and their growth scenario

Stages of Weaving





https://www.youtube.com/watch?v=worKmsWZqYE

A few motions to consider:

a) Primary
b) Secondary
c) Auxiliary

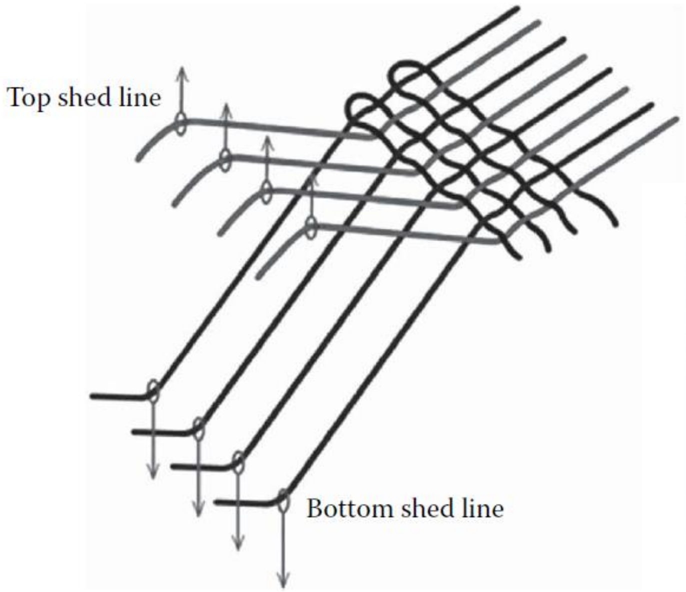
- **Motions**
  - **Primary**
    - Shedding
    - Picking
    - Beat-up
  - **Secondary**
    - Take-up
    - Let-off
  - **Auxiliary**
    - Warp stop
    - Weft stop
    - Warp protector

Types of Looms

- Hand loom: This is mainly used in the unorganized sector. Operations such as shedding and picking are done by using manual power. This is one of the major sources of employment generation in rural areas of India and many other countries.
- Power loom (non-automatic): All the operations of non-automatic power loom are driven by motor except pirn changing
- Automatic loom: In this power loom, the exhausted pirn is replenished by the full one without stoppage. This is possible only in under-pick system
- Shuttleless loom: Weft is carried by projectiles, rapiers or fluids in case of shuttleless looms. The rate of fabric production is much higher for these looms.

Primary Motion: Shedding

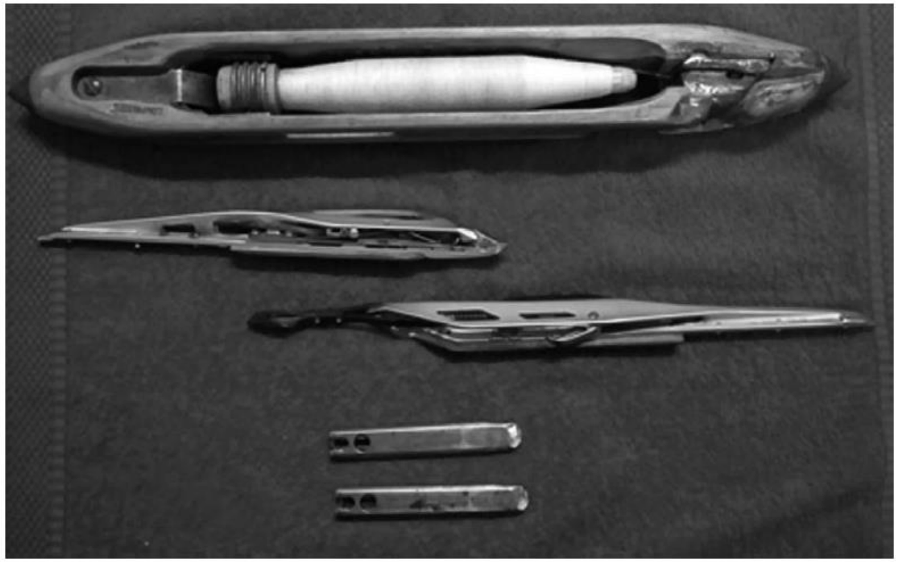
- Shedding is the process by which the warp sheet is divided into two groups so that a clear passage is created for the weft yarn or for the weft-carrying device to pass through it. One group of yarns either moves in the upward direction or stays in the up position (if they are already in that position), thus forming the top shed line. Another group of yarns either moves in the downward direction or stays in the down position (if they are already in that position), thus forming the bottom shed line.



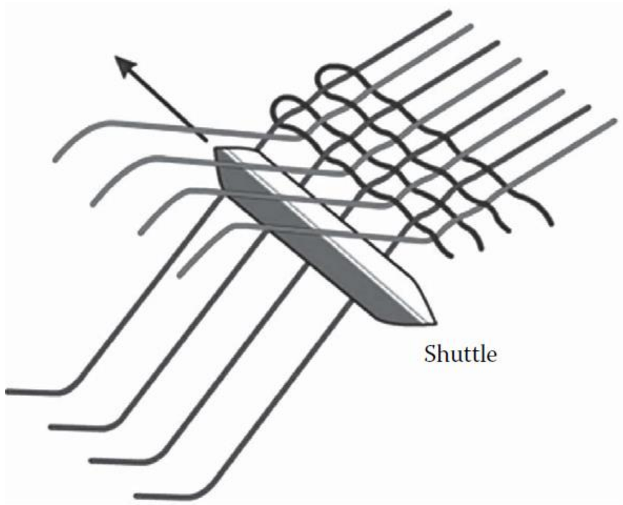
Healds are used to control a large number of warp yarns. The warp yarn actually passes through the heald eye. Therefore, as the heald moves, all the warp yarns which are controlled by that head also move

Primary Motion: Picking

- The insertion of weft or weft-carrying device (shuttle, projectile or rapier) through the shed is known as picking. Based on the picking system, looms can be classified as- Shuttle, Projectile, Rapier, Air jet, Water jet loom. With the exception of shuttle loom, weft is always inserted from only one side of the loom. The timing of picking is extremely important, especially in case of shuttle loom.

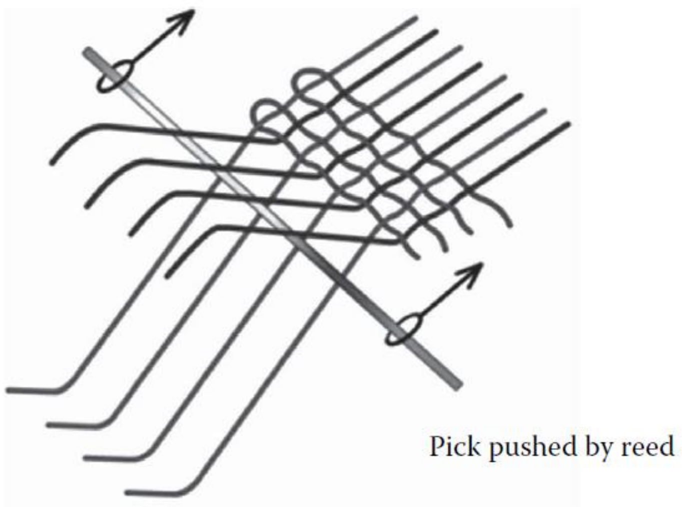


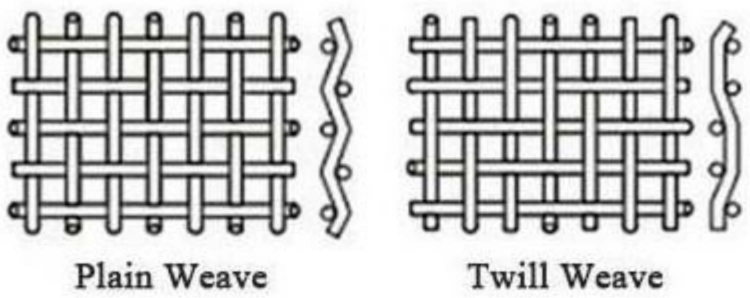
Shuttle, rapier heads and projectile (from top to bottom)



Primary Motion: Beat up

- Beat-up is the action by which the newly inserted weft yarn or pick is pushed up to the cloth fell. Cloth fell is the boundary up to which the fabric has been woven. The loom component responsible for the beat-up is called 'reed'





Reed is like a metallic comb. It can have different count. For example, 80s Stockport reed has 80 dents in 2 inches. Generally, one or two warp yarns are passed through a single dent, and these are called 'one in a dent' or 'two in a dent', respectively

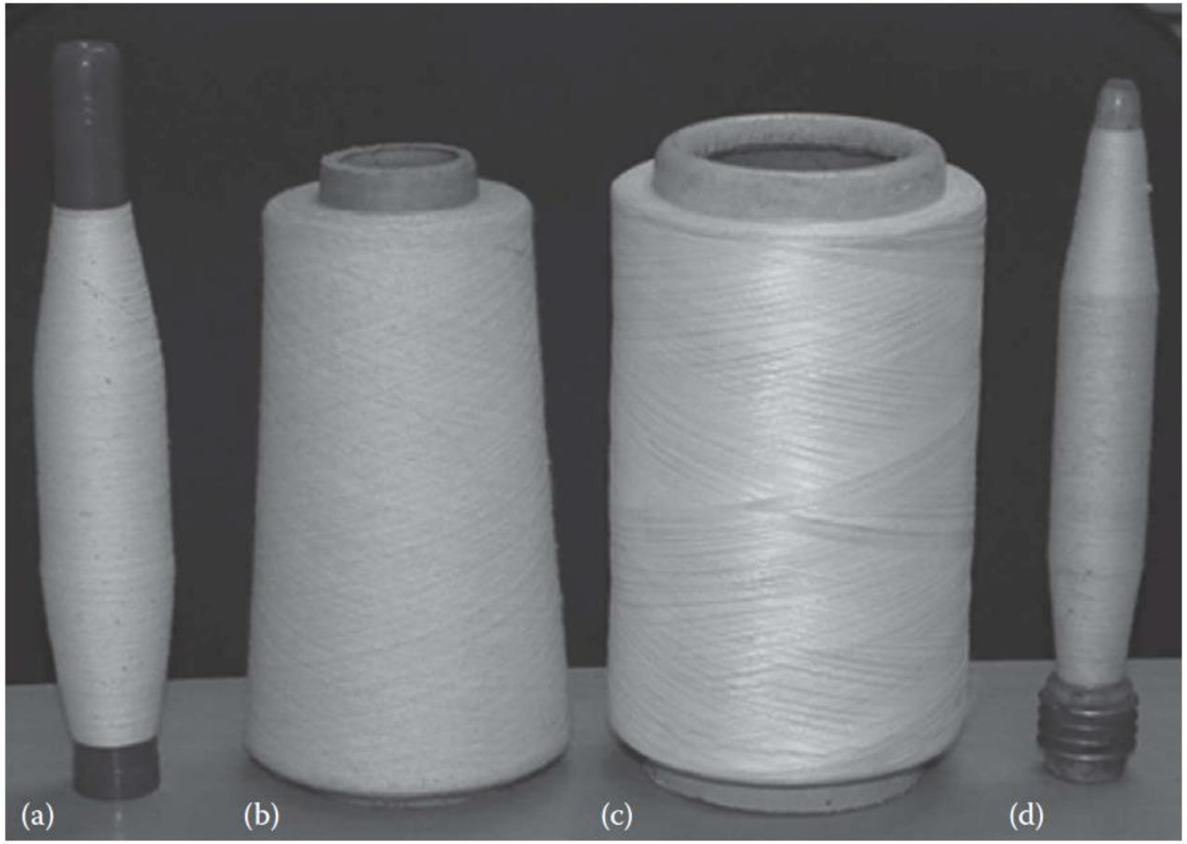
Secondary and Auxiliary Motions

- **Take-up** motion winds the newly formed fabric on the cloth roller either continuously or intermittently after the beat-up. The take-up speed also determines the picks/cm value in the fabric at loom state. As the take-up motion winds the newly formed fabric, tension in the warp sheet increases. To compensate this, the weaver’s beam is rotated by the **let-off** mechanism so that adequate length of warp is released

- Auxiliary motions are mainly related to the activation of stop motions in case of any malfunctioning such as warp breakage (Warp Stop), weft breakage (Weft Stop) or shuttle trapping within the shed (Warp Protector)

However, before all of these, comes the most important part- the raw material (Yarn- Fibres)

Before Weaving

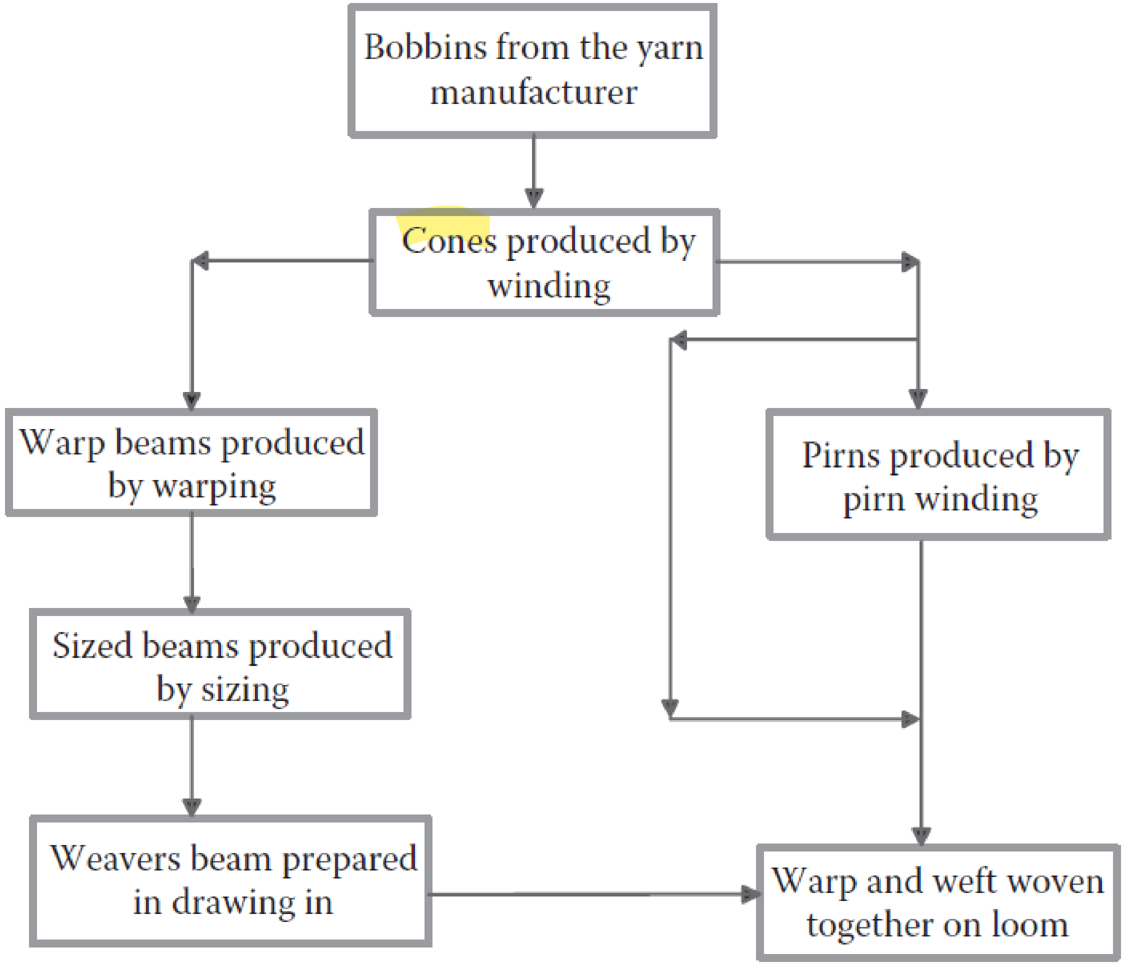


(a) Ringframe bobbin or cop, (b) cone, (c)cheese and (d) pirn

- During yarn formation such bobbins (~2000 m), contain many objectionable faults. Such faults need to be removed, and the resultant clean yarns from the supply bobbins need to be joined together to form a package of suitable dimension containing a sufficiently long length of yarn.

Before weaving comes 'Preparatory Stages'- Winding, Warping, Sizing, and *drawing, denting*

Before Weaving



The yarn itself is, in several instances, assembled from discontinuous fibres in a still more elaborate yarn-formation process. Thus, a large lag time is inherent in this textile system of conversion of fibres to yarns first followed by conversion of yarns to fabric.

Some Necessary Definitions: Knowing the Yarn

Yarn Count:

1. Direct systems (example: Tex, Denier)
2. Indirect systems (example: new English, i.e. Ne, Metric, i.e. Nm)

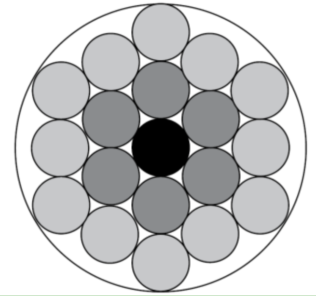
Direct systems revolve around expressing the mass of yarn per unit length. In contrast, indirect system expresses the length of yarn per unit mass. 10 tex yarn implies that a piece of 1000 m long yarn will have a mass of 10 g. Similarly, for 10 denier, a piece of 9000 m long yarn will have a mass of 10 g. 10 Ne implies that a 1-pound yarn will have a length of 10 × 840 yards

$$\text{Tex} = \frac{590.5}{\text{Ne}}, \quad \text{Denier} = 9 \times \text{Tex} \quad \text{and} \quad \text{Denier} = \frac{5315}{\text{Ne}}$$

Packing Factor or Packing Coefficient:

Packing factor or packing coefficient represents the extent of closeness of fibres within the yarn structure. For the same yarn linear density, if the fibres are closely packed, then yarn diameter will be less.

$$\text{Packing factor} = \frac{\text{Cumulative area of all fibres}}{\text{Area of yarn cross section}} = \frac{\text{Yarn density}}{\text{Fibre density}}$$



For spun yarns, packing factor generally lies between 0.55 and 0.65. Yarns with lower packing factor are expected to be bulkier and softer.

Some Necessary Definitions: Knowing the Yarn

Crimp:

Once the warp and weft are interlaced, both assume wavy or sinusoidal-like path. Thus the length of the yarn becomes more than that of the fabric within which the former is constrained. Crimp is a measure of the degree of waviness present in the yarns inside a woven fabric.

$$\text{Crimp \%} = \frac{\text{Length of yarn} - \text{Length of fabric}}{\text{Length of fabric}} \times 100$$

$$\text{Contraction \%} = \frac{\text{Length of yarn} - \text{Length of fabric}}{\text{Length of yarn}} \times 100$$

Fractional Cover and Cover Factor:

Fractional cover is the ratio of the area covered by the yarns to the total area of the fabric. If diameter of warp yarn is d_1 inch and spacing, that is gap between the two consecutive ends is p_1 inch, then fractional cover for warp (k_1) is d_1/p_1. For cotton yarns, having packing factor of 0.6, the relationship between yarn diameter (d) in inch and yarn count (Ne) is-

$$d = \frac{1}{28\sqrt{\text{Ne}}}$$

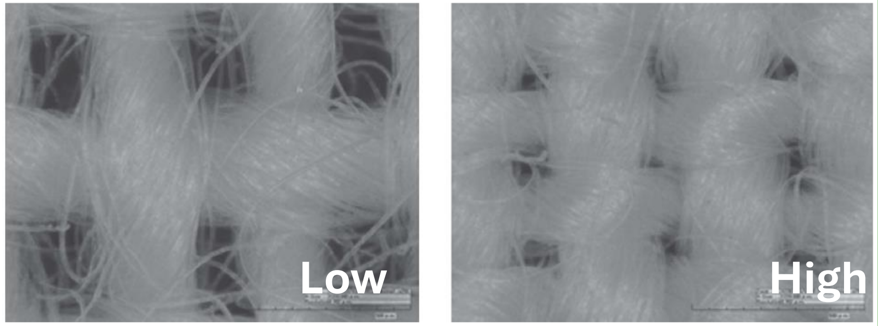
$$k_1 = \frac{n_1}{28\sqrt{\text{Ne}_1}}$$

The relationship between end spacing (p_1) and ends per inch (n_1) is-

$$n_1 = \frac{1}{p_1}$$

Cover factor is obtained by multiplying fractional cover with 28

$$\text{Warp cover factor} = k_w = 28 \times k_1 = \frac{n_1}{\sqrt{\text{Ne}_1}}$$



Some Necessary Definitions: Knowing the Yarn

Porosity:

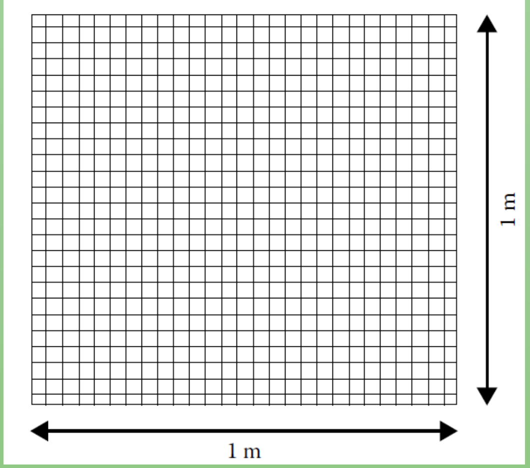
Porosity is a measure of presence of void or air inside the fabric or fibrous assemblies. It indicates the percentage of volume of fabric that has been occupied by the air. If, Fabric areal density or gram per square meter (GSM) = G (g/m^{2}) Thickness of fabric = T (m), Density of Fibre = ρ (g/m^3) , Porosity (%) = P

$$\text{porosity}(\%) = \left(1 - \frac{G}{T \times \rho}\right) \times 100$$

Areal Density:

Areal density is expressed by the mass of the fabric per unit area (g/m^2, popularly called GSM). Areal density of the fabric will depend on the following parameters-

- Warp yarn count (tex): T_1
- Weft yarn count (tex): T_2
- Ends per unit length (EPcm): N_1
- Picks per unit length (PPcm): N_2
- Crimp % in warp: C_1
- Crimp % in weft: C_2



$$\text{Total length of ends (warp)}$$
$$= \text{Total number of ends} \times \text{straightened length of one end}$$
$$= 100N_1 \times \left(1 + \frac{C_1}{100}\right) \text{ m.}$$

$$\text{Mass of warp yarns (g)} = \frac{\text{Total length of ends in m}}{1000} \times \text{tex of warp}$$
$$= \frac{100N_1 \times \left(1 + \frac{C_1}{100}\right)}{1000} \times T_1 = \frac{N_1 T_1}{10}\left(1 + \frac{C_1}{100}\right)$$

$$\text{The mass of weft yarns (g)} = \frac{N_2 T_2}{10}\left(1 + \frac{C_2}{100}\right)$$

$$\text{Areal density of fabric or GSM} = \frac{1}{10}\left[N_1 T_1\left(1 + \frac{C_1}{100}\right) + N_2 T_2\left(1 + \frac{C_2}{100}\right)\right]$$