Fabrics Outline

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  - Open-mesh
  - Tufted
  - Braided
  - Embroidered
Introduction

- Knowledge of fabric construction techniques is beneficial in selecting the appropriate fabric for a specific use.

- Fabrics produced around the world are constructed in many ways:
  - **Hand techniques** - knitting (needles), crocheting (hooks), and weaving (simple hand looms).
  - **Mechanized techniques** - weaving (looms), knitting (by machine), and bonding (to produce nonwovens).

- This section focuses on woven, knitted, and nonwoven fabrics, the three most widely used methods of fabric construction. Other types of construction are described briefly under "Other Fabrics.”
Side View of a Loom Used for Hand Weaving
Side View of a Loom Used for Mechanized Weaving
Introduction

- **Woven fabrics** are produced by interlacing perpendicular yarns.
  - Yarns running parallel to the length of a fabric are called *warp* or *ends*, and yarns running perpendicular to the warp yarns are called *filling*, *weft*, or *picks*.

- **Knitted fabrics** are formed by interlooping yarns in a horizontal or vertical direction.
  - The loops along the length of a fabric are called *wales*, and loops across the width are *courses*.

- **Nonwoven fabrics**, or *fiberwebs*, are manufactured directly from fibers.

Unraveling the yarns in a fabric assists in differentiating between woven and knitted fabrics. In wovens, yarns can be unraveled in two directions (length and width), whereas in knits they cannot be unraveled in both directions. Nonwoven fabrics have no yarns.
Comparison of Woven, Knitted and Nonwoven Fabrics

**Woven**
- Yarns in both directions
- Interlacing of yarns

**Knitted**
- Yarns in one direction
- Interlooping of yarns

**Nonwoven**
- No yarns
- Fiberweb formation
Fabric Face and Back

- The fabric **face** or “right side” is the side used on the outside of the garment or product.
- The fabric **back** or “wrong side” is the side used on the inside of the garment or product.
- In some fabrics (antique satin), the side considered “technically” the back during manufacturing is considered the face of the fabric in use. **Technical face** and **technical back**, or **design face** and **design back** clarify the right and wrong sides of a fabric.

- Fabrics appearing the same on both sides are **reversible**.
Examples to Illustrate Fabric Face and Back

- technical face
- design face*
- reversible**
- technical back
- design back*
- reversible**

* design face is technical back and design back is technical face.
** either side can be considered face or back.
Weaving

- Weaving typically requires at least one set of warp yarns that are kept taut on a loom, and a means for the filling yarns to interlace with the warp yarns as they move horizontally from one side to the other.

- Weaving has evolved from simple techniques such as card and backstrap weaving, to weaving on the very sophisticated, computerized, shuttleless weaving machines that operate at very high speeds.

- Despite the technological advances, fabrics are still woven using simple tools and looms in several regions of the world.

- The width, quality, and cost of a woven fabric vary considerably based on the type of loom.
Basic Steps in Weaving:

- **Shedding** – Harnesses are raised and lowered to form a shed.
- **Picking** – Filling yarn is passed through the shed (using a shuttle or other mechanism).
- **Battening** – Pressing of the filling yarn towards the woven fabric with a beater.
Weaving

- **Shuttle loom** - a shuttle is used to carry the filling yarn from one selvage to the other.
  - These looms are used for hand and mechanized weaving.
  - Fly shuttle loom revolutionized the weaving process.

- **Shuttleless loom** – the filling yarn is carried from one selvage to another without the use of the shuttle.
  - Yarn carrying mechanisms are:
    - Projectile
    - Rapier
    - Air jet
    - Water jet
  - Fabrics are produced at very high speeds.
  - Wide-width fabrics are produced for items such as table linen, bed linen, bedspreads, and comforters.
Weaving – Cotton, plain weave fabric woven on a shuttle loom

Photographed with permission of NTC Mills
Woven Fabrics

- Woven Fabrics are composed of two sets of yarns, **warp** and **filling**.
  - **Warp (ends)** refers to yarns running lengthwise on the loom. They are parallel to the selvage and perpendicular to the filling yarns.
    - Warp yarns must withstand stress during weaving. They are coated with sizing to protect them in weaving.
    - Yarns are stronger and closer together than filling yarns.
  - **Filling (weft or picks)** refers to yarn running crosswise on the loom, perpendicular to the selvage and the warp yarns.

- Fabrics are formed by **interlacing (interweaving)** warp and filling yarns.
Woven Fabrics

- **Selvage** is the narrow edge of woven fabric that runs parallel to the warp.
  - It is made with stronger yarns in a tighter construction than the body of the fabric to prevent raveling.
**Fabric Weight**

**Top weight** and **bottom weight** categorize apparel fabrics based on weight and intended use.
- Top weight is lighter fabric for shirts, blouses, etc.
- Bottom weight is heavier fabric for pants and shorts.
Fabric Weight

- **Lightweight** (100 g/sq m or less; 3 oz/sq yd or less)
  - E.g., batiste, buckram, cheesecloth, chiffon, crinoline, gauze, lawn, madras, ninon, organdy, organza, voile.
  - Further categorized into sheer and low count/open weave fabrics based on opacity and count.

- **Mediumweight** (between 100 g/sq m and 200 g/sq m; between 3 oz/sq yd and 6 oz/sq yd)
  - E.g., broadcloth, challis, chambray, calico, muslin, oxford, percale, taffeta.

- **Heavyweight** (200 g/sq m and higher; 6 oz/sq yd and higher)
  - E.g., burlap, canvas, duck, osnaburg, poplin, gabardine, chino, denim, serge. (Some are available in lighter weights.)

Fabric weight is sometimes included in garment description. For example, a pant description may state “8.5 oz.” The weight in ounces (oz) is the weight of the fabric per square yard (sq yd) or OSY.
**Fabric Count and Thread Count**

- **Fabric count** or **yarn count** is “the number of ends (warp yarns) and picks (filling/weft yarns) counted per inch in a woven fabric.” *
  - Fabric count is written as the “number of ends x number of picks.”
    - For example, count for a fabric with 72 ends per inch and 66 picks per inch is written as “72 x 66” and read as “72 by 66.”

- **Thread Count** is “the number of ends (warp yarns) PLUS the number of picks (filling/weft yarns) counted per inch in a woven fabric.
  - For example, a 180 thread count sheet has 90 warp yarns in one inch and 90 fill/weft yarns in one inch.
  - The two numbers are added together to give the total thread count per inch.” *

* Source - *Dictionary of Fiber and Textile Technology.*
The sample is a magnified view of .5x.5 inch fabric. To measure approximate fabric count:

1. Count the number of warp yarns that cross the orange line and then the number of filling yarns that cross the yellow line.

2. Multiply each number by 2 to get an approximate fabric count per inch.

3. Compare your count with the answer given below the sample. The ends refer to warp yarns and picks to filling.

72 ends x 66 picks / inch
Thread Count of Bed Linen

- Plain weave cotton and cotton blend sheeting is generally referred to either as muslin (lower thread count) or percale (higher thread count). Quality sheets generally have a thread count of 200 or higher.

- Satin and satin stripe (jacquard weave) fabrics are used to manufacture some finer quality sheets. The interlacing of warp and filling yarns in these fabrics enables production of smoother fabrics with higher thread count.

- Some sheets have thread counts of 400 or higher. The primary reason for extremely high count is the perception among consumers that the higher the count the better the quality of the sheets. Fabric count higher than 400 may not indicate higher quality. For example:
  - To achieve very high counts, some manufacturers use 2-ply yarns and double the actual count as they count each strand as a yarn. This practice is regarded as a deceptive practice by the Federal Trade Commission (click here for details).
  - Very high counts may result in stiff fabrics. Moreover, the durability of the fabric may also be affected by high counts, especially in cotton satin and satin stripe sheets.
  - Higher count sheets produced with microfiber filament yarns do not reflect quality.
Bed Linen - Muslin, 120 thread count, plain weave

1.25 cm (0.5 inch) square

Magnified view
Bed Linen - Percale, 220 thread count, plain weave
Balance

- **Balanced Weave** is “a woven construction in which the same size yarn and the same number of threads per inch are used in both warp and filling directions.”*
  - Strength and wrinkle recovery are similar in the warp and filling directions.

- **Unbalanced Weave** is “an unequal number of yarns when comparing the number of yarns per inch for the warp and weft.”*
  - Yarns in one direction are thicker than in the other direction.
  - Unbalanced weaves often create a “ribbed” effect on the fabric surface.
    - E.g., taffeta, broadcloth, ottoman
  - Strength and wrinkle recovery are typically different in the warp and filling directions.

*Source - *Dictionary of Fiber and Textile Technology*
Examples of Balanced Weave Fabrics
Examples of Unbalanced Weaves

- Broadcloth
- Poplin
- Canvas
- Faille
- Bengaline
- Ottoman
Fabric Width

- **Fabric width** is “a horizontal measurement of a material.”*

- Fabric width is dependent on the loom width and the desired end use.
  - Narrow-width fabrics are 12” or less. Examples: ribbons, trims, and bandages.
  - Standard width fabrics are 45”, 52-54” or 58-60”. Examples: fabrics used for apparel and drapery.
  - Wide-width fabrics are 108” and wider. Examples: fabrics used for bed sheets and comforters.

*Source- *Dictionary of Fiber and Textile Technology*
Narrow-width Fabric

Fabric width 12” or less

2 inches
Fabric Width

45” wide fabrics

22”

yard stick

60” wide fabric

30”

yard stick

62” wide fabric

31”

Note: Fabrics are folded in half along the length; thus, the selvages are only seen along the left edge of the fabrics.
Grain

- A fabric is called "on grain" when the warp and filling yarns are aligned at 90 degrees. The yarns are parallel and perpendicular to one another.

- True bias is at a 45° angle from warp and filling.

- Woven fabrics stretch the least in the warp direction, and stretch the most when pulled diagonally, the true bias.
True Bias - 45 degree angle to the warp and filling directions

maximum stretch when pulled diagonally
Grain Defect

- Fabrics in which warp and filling yarns are not aligned at 90° have grain defect.
  - **Bow** - yarns ‘dip’ to form a curve (no longer 90°).
  - **Skew** - yarns ‘slant’ from selvage to selvage.
    - Note: Fabrics may have a grain defect that is a combination of bow and skew.
- Fabrics with grain defect are called off-grain fabrics. Garments made with off-grain fabrics may not hang or drape correctly.
Off-grain - Grain defect prominent in a windowpane design

filling yarns are not perpendicular to the selvage
Off-grain – Fabric defect prominent in a woven plaid

Note: The fabric is skewed; therefore, the warp and filling yarns are not perpendicular to each other. This defect is more noticeable in woven plaid designs.
Note: The yellow line is drawn perpendicular to the left edge to highlight the fabric defect. The canvas could not be straightened by pulling diagonally because the resin applied to stabilize the canvas was applied while the fabric was stretched incorrectly.
Basic Weaves

- The three basic weaves are **plain, twill,** and **satin.**
- The interlacing patterns and the number of yarns used as a set in the warp and filling directions are different among the three weaves and the sub-categories under each.
Plain Weave

- **Plain** or **tabby weave** is the most basic interlacing of warp and filling yarns.
  - Face and back of a plain weave fabric are the same, unless printed or finished on one side.
  - Examples of plain weave are organza, organdy, chiffon, cheese cloth, voile, batiste, chambray, and percale.
Examples of Different Types of Plain Weave Fabrics

Magnified images of 1 cm squares
Rib Weave

- **Rib**, also known as *unbalanced plain weave*, is a variation of plain weave in which a thick yarn, or more than one yarn, is used in the warp or filling direction to give the fabric a ribbed effect.
  - Rib weaves are reversible, unless printed or finished on one side.
  - Some fabrics have very prominent ribs.
  - Examples: Fabrics with fine ribs include broadcloth, poplin, and canvas. Fabrics with prominent ribs include faille, bengaline, and ottoman.
Examples of Rib Weave Fabrics

- Broadcloth
- Poplin
- Canvas
- Faille
- Bengaline
- Ottoman
Basket Weave

- **Basket weave** is a variation of plain weave where two or more yarns in the warp and/or filling direction are treated as a set.
  - The thickness of each set of yarns is the same.
  - It is identified by the number of yarns in each set; warp X fill.
  - The diagram below shows a 2x2 basket weave.
  - Face and back are the same, unless the fabric is printed or finished on one side.
- Examples of basket weave are oxford cloth and monk’s cloth. Oxford cloth, a 2x1 basket, is also known as half basket.

![Diagram of 2x2 Basket Weave]

- 2/2 Basket - Face
- 2/2 Basket - Back
Examples of Basket Weave Fabrics
Twill weave fabric is characterized by diagonal ridges.

- In left-hand twill, the diagonal is from lower right to upper left.

- In right-hand twill, the diagonal is from lower left to upper right.
Left-hand Twill Weave Fabrics Used for Casual and Work Wear Pants (Slopes Drawn in Red)

Magnified images of 1 cm squares
Twill Weave

- **Uneven-sided:** warp yarn goes over and under a different number of filling yarns.
  - In 2/1 twill weave, the warp yarn goes over two filling yarns and then under one.
  - Examples: denim, drill

- **Even-sided:** warp yarn goes over and under the same number of filling yarns.
  - In 2/2 twill weave, the warp yarn goes over two and under two filling yarns.
  - Examples: surah, serge, houndstooth
Houndstooth Fabrics

Magnified images of 1 cm squares
Twill Variations

- **Herringbone** twill is a variation of even-sided twill.
- The direction of the diagonal changes from left to right at regular intervals.
- A “broken twill” pattern is seen on both sides of the reversible fabric.
Twill Weave Variations
- **Satin weave** is characterized by long floats in the warp or filling direction.

- Floats occur when a yarn is not interlaced, but “floats” over other yarns between points of interlacing.
  - In warp-faced satin, the floats on the technical face are in the warp direction.
  - In filling-faced satin, the floats on the technical face are in the filling direction.
Satin and Sateen

Satin fabrics are warp-faced satin weaves, woven with lustrous filament warp yarns for maximum luster on the face.

- Satin fabrics are typically made with rayon, polyester, acetate, and silk filament yarns.

Sateen fabrics are warp- or weft-faced satin weaves, woven with spun yarns for a softer luster.

- Most sateen fabrics are 4/1 warp-sateen made with cotton yarns; they are stronger than traditional weft-faced sateen.
- Used for drapery, upholstered furniture, shirts, and higher quality bed linens.
Satin Fabrics

The prominence of warp yarns on one side and filling yarns on the other produces fabrics with different face and back characteristics.

- **Crepe-back satin** is produced with lustrous filament warp yarns and crepe filling yarns. If the crepe side is used as the design face, it is called **satin-back crepe**.

- **Antique satin** is woven with lustrous filament warp and uneven (e.g. slub or nub) filling yarns. The technical back is often used as the design face of fabrics used for draperies.
**Satin Fabrics**

- **Flannel-back satin**, for nightwear, is woven with lustrous filament warp yarns visible on fabric face and low twist, spun filling yarns visible on fabric back.
  - The high luster, warp filament yarns enhance the appearance.
  - The low twist, spun filling yarns are napped (brushed) for comfort.
Satin Weave Fabric

- **Moleskin**, a suede-like fabric, is often a satin weave fabric that is woven with filament warp and spun filling yarns. The technical back, used as the design face, is finished to give it a soft, suede-like hand. Moleskin fabrics are used for women’s apparel, draperies, and upholstered furniture.
Performance - Aesthetics

- **Physical Appearance**
  - Plain weave fabric has a matte appearance.
  - Twills generally have obvious diagonal ridges.
  - Satin weave with long floats is used for high luster fabrics.
  
  Note: Fiber and yarn characteristics may minimize the effect of fabric construction.

- **Drape**
  - Fabric count and construction affect fabric drape.
  - High count fabrics are stiffer than low count fabrics made with yarns of the same size and fiber type.
Performance - Aesthetics

- **Dimensional Stability**
  - Due to the interlacing of warp and filling yarns, woven fabrics are generally more dimensionally stable than knit fabrics.

- **Snagging**
  - Open weave fabrics and fabrics with long floats may snag as the fibers on the surface of the yarn, or the yarn itself, is pulled during use.

The white area of the float in printed sateen is seen because the yarn has shifted due to snagging.
Performance - Comfort

- **Stretch and Recovery**
  - Woven fabrics generally do not stretch.
  - These fabrics may restrict body movement.
  - Woven fabrics are not used for tight fitting garments (unless they contain stretch yarns made with elastic fibers).

- **Tactile Properties**
  - **Hand** is a term used to describe the way the fabric feels when touched.
  - Satin weave fabrics with longer floats have a smoother hand than plain weave fabrics.
Performance - Comfort

- **Air Permeability**
  - Air permeability is a *measure of the air flow* through a fabric. It indicates “breathability” of a fabric.
  - Openness of the weave directly relates to fabric breathability.
    - Open weave fabrics are more air permeable, more breathable.
    - Compactly woven fabrics are less air permeable, less breathable.
Performance - Durability

- **Strength**
  - Fabric count and type of weave impact the strength of fabrics.
    - If the yarn and fabric weave are the same for two fabrics, the fabric with a higher fabric count will have a higher tensile strength than a fabric with lower count.
  - Twill weave fabrics are stronger than plain weave fabrics; they can be woven with higher fabric counts.
  - Although satin weaves can be woven with higher counts and strength, they are not suitable for garments where durability is important because the long floats may abrade.

- **Abrasion Resistance**
  - Twill weave fabrics have the best abrasion resistance, followed by plain weave and satin weave.
  - Long floats may abrade and snag, so the fabrics with long floats are not suitable for rugged use.
Damage Due to Flat Abrasion in Cotton Sateen Cushion

Note: This cushion shows damage from everyday use. The surface of the cotton sateen fabric is damaged due to abrasion. The damage is more in the corner of the cushion as the fabric that formed the seam and excess fabric were not trimmed when the cushion was constructed.