Woven Fabrics & Their Properties

Basic Weaves and Fabrics
- Fabric: Planar structure pliable enough to be made into three-dimensional products.
- Remember: a fiber is what it is made from; fabric refers to how it is made.

Starting Materials for Fabrication
- Solutions: Films and foams.
- Fibers: Felt and fiberwebs or nonwovens.
- Yarns: Braid, knit, lace, woven, and many others.
- Composite: Fabrics combined together (bonded, laminated, quilted); fabrics combined with solutions, fibers, and yarns.

Fabric Quality
- Freedom from defects, uniformity of structure & appearance, performance during production & use
- Visual or machine inspection
- Fabric grading: based on defect length & frequency
- Performance evaluation based on end use needs
Two or more yarns interlaced at 90 degree angles.

**Warp or ends:** Yarns in fabric's lengthwise direction; threaded through loom.

**Weft, Filling or picks:** Yarns in fabric's crosswise direction; inserted during weaving.

**Weaving:** Process of making fabric on a loom.

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**Woven Fabric**

- Warp beam: Warp yarns wound around large cylinder.
- Warp: Lengthwise yarns threaded through loom.
- Harness: Frame that holds heddles and controls basic weave.
- Heddle: Wires through which warp is threaded; controls basic weaves.
- Shed: Space created by warp when some harnesses rise and others lower.

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**Characteristics**

- Most widely used method with many possibilities.
- Fabrics ravel and fray and have grain.
- Low elasticity
- Same weave fabrics may vary by yarn size or twist, fiber, count, color, design, or finish.
- Used in apparel, furnishings, & industrial products.

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**The Loom**

**Warp:** parallel to selvage (¶)

**Filling:** perpendicular to selvage (≈)

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**Heddle**
The Loom (cont.)

- **Reed** or **batten**: Device pushes filling yarns in place.
- **Dent**: Space in reed through which warp is threaded.
- **Filling yarn insertion device**: Related to loom type, shuttle, rapier, gripper, or jet, it carries filling through shed.
- **Filling**: Yarns interlaced with warp to create fabric cloth.

Steps in Weaving

- **Shedding**: Raising or lowering 1 or more harnesses in sequence to separate warp yarns to create shed.
- **Picking**: Inserting filling yarn through shed.
- **Beating-up**: Pushing filling yarn next to previous filling yarn with reed.
- **Take-up**: Winding up finished fabric onto the fabric beam.

Preparing for Weaving

- **Winding**: Re-packaging yarns for specific loom type; may increase twist or ply yarns.
- **Creeling**: Yarn packages on large frame for winding on warp beam.
- **Warping or dressing the loom**: Yarns threaded through heddles in specific harness (controls structure) and dents (controls density or count).

Loom Advancements

- **Patterning capabilities**: Control of warp yarns to create woven designs; dobby, jacquard, lappet, doup.
- **Computers & electronic monitors**: Minimize hand operations, flaws, & time; individual control of warp yarns, quick style change.
- **Loom efficiency**: Faster & more efficient filling insertion; warp take-up/let-off; devices speed up changing of warp.
**Shuttleless: Quicker, Quieter Than Shuttle Power Looms**

- **Air jet**: Jet of air inserts filling yarn in small shed; limited loom width; 1.5 times faster.
- **Rapier**: Uses two small metal arms, one carries yarn to center; other takes yarn to other side; 2-4 times faster.
- **Water jet**: Water jets insert filling yarn in small shed; limited loom width; 2-3 times faster.
- **Projectile**: Yarn carried across full width by one tiny missile; 2-4 times faster.

**Other Looms**

- **Multi-width looms**: Weave on side-by-side twin (or more) warp beams; often for denim.
- **Multiple shed**: Forms more than one shed at a time; 2 times faster; limited application on simple fabrics.
- **Circular**: Tubular woven fabric for bags, etc.
- **Triaxial**: Three yarn sets needed—two warp sets, one filling set, interlace at 60 degree angle.

**Environmental Impact**

- Noise from shuttle looms
- Water recycling for water jet looms
- Energy use based on loom type
- Treatment of warp yarns with sizing and lubricants; reclaiming and recycling issues
- Fabric quality improvements: fewer seconds, less rework

**Characteristics of Woven Fabrics**

- **Interlacing**: Point where yarn changes its position from fabric's surface to its underside or vice versa.
- **Float**: Point where a yarn crosses over more than one yarn at a time; in twills, satins, basket weaves, & fancy weaves.
- **Warp yarns**: Yarns threaded through loom; parallel to selvage; less stretch, straighter in fabric; less crimp; usually simple; smaller & more regular with higher tpi; rarely novelty or crepe; higher density.
- **Filling yarns**: Yarns inserted through shed during weaving; perpendicular to selvage; more stretch, path not as straight in fabric; more crimp; more likely to be novelty or crepe; less regular with lower tpi; larger; lower density.
- **Grain**: Position of warp yarns to filling yarns; **on-grain** fabrics have yarns at right angles; better quality fabrics.
- **Fabric face and back**
- **Fabric top and bottom**
Off-grain

- Yarns are not at right angles; lower quality fabric.
- **Skew**: Filling yarns are not at a right angle across the fabric.
- **Bow**: Filling yarns do not cross all warp yarns at the same angle; form dip or curve.

**Characteristics of Woven Fabrics**

- **Count or density**: Number of warp & filling yarns per square inch of gray goods; usually as warp X filling (e.g. 40 X 50).
- **Balance**: Ratio of one warp to filling; ratio of 1:1; unbalanced fabric has more of one set, i.e., 2:1 or 1:2.
- **Selvedge**: Edge of fabric where filling yarn returns in a different shed or where filling yarn ends; selvage type determined by loom type.

**Bow and Skew**

**Characteristics of Woven Fabrics**

- **Fabric width**: Distance from selvage to selvage; steadily increasing for better economy.
- **Fabric weight**: Identified as oz/yd² or g/m²
  - Light weight (top weight): less than 4 oz/yd²
  - Medium weight: between 4 and 6 oz/yd²
  - Heavy weight (bottom or suiting weight): more than 6 oz/yd²
- **Woven fabric properties**: Related to count, balance, interlacing pattern, fiber content, yarn structure, & finishes.

**Naming and Diagramming Woven Fabrics**

- Fabric names based on fabric structure, weight, yarn type, balance, and finishes.
- Diagramming woven fabrics
  - Cross-sectional view
  - Checkerboard pattern
- **Designators**
  - Interlacing pattern
  - Yarn groupings: 2 X 2, 2 X 1, etc.
**Plain Weave**
- First basic weave
- Yarns at right angles pass over and under each other.
- Simplest of three basic weaves.
- Balanced and unbalanced

**Unbalanced plain weave**

**Characteristics of Plain Weave**
- Maximum number of interlacings
- No technical face or back due to weave (interesting effects with novelty yarns)
- Plain surface for printing & finishes
- Wrinkles

**Characteristics of Plain Weave**
- Raveling related to count & yarn cohesiveness
- Less absorbent
- Used in apparel, furnishings, & industrial goods
- Weight dictates end use: lighter weights in apparel & curtains; heavier weights in upholstery, draperies, & industrial goods

**Plain Weave Interlacing**

**Balanced Plain Weave**
- **Plain weave fabric**
  - Widest range of end uses; number of warp equals number of filling.
  - **Lightweight**: Very thin, light weight, transparent or semi-transparent due to fine combed or filament yarns of strong fibers or low count or both; high count with very fine yarns.
Lightweight and sheer: ninon, georgette, chiffon, voile, organdy, and organza
Lightweight and opaque: slightly larger yarns; may have higher count; lawn, batiste, china silk, challis
Low count sheers

Lightweight Plain Weave
- Lawn
- Voile
- Chiffon

Medium weight: Most common for apparel.
- Durable: widest range of types and uses and quality levels
- Medium size yarns
- Medium count
- Medium weight range
- Examples: print cloth, percale, plissé, embossed, chintz, polished cotton, true crepe, muslin, flannelette, gingham, chambray, taffeta
**Balanced Plain Weave: Heavy Weight**

- **Heavy weight**: Also known as bottom or suiting weight.
  - More durable
  - More resistant to wrinkling
  - Larger yarns
  - Heaviest
  - Ravels more if count is low
  - Examples: crash, burlap, tweed, suiting, homespun, butcher myon, osnaburg flannel

**Heavy Weight Plain Weave Fabrics**

- Crash
- Tweed
- Flannel

**Unbalanced Plain Weave**

- **Rib or Rep**
  - Balance is 1:2 or 2:1 or more.
  - Count is greater by 2-3 times in one direction.
  - One set of yarns forms fabric surface (wear more likely on this set; slits may develop with wear).
  - Slippage may occur with filament yarns; wear concentrates on one set of yarns.

**Unbalanced Plain Weave Fabrics**

- Crepe de chine
- Poplin
- Taffeta
- Flannette
- Bedford cord

- Yarn size often differs between warp and filling.
  - **Light weight**: not common; dimity, crepe de chine
  - **Medium weight**: common; broadcloth, taffeta, shantung
  - **Heavy weight**: common; poplin, faille, flannelette, Bedford cord
Basket weave

- Second Basic Weave
- Two or more yarns in warp or filling or both in one shed or forms one shed
- Flexible, wrinkle resistant, snags easily
- Types:
  - Full (basket in both directions)
  - Half (basket in warp or filling)
  - Partial (occasional basket feature)

Basket Weave Fabrics

- Oxford Chambray
- Monk’s cloth

Twill Weave

- Third basic weave
- Each warp or filling yarn floats across two or more filling or warp yarns with a progression of interlacing by one to the left or right to form a distinct line or wale; 2 up, 2 down or 2 up, 1 down most common.

Twill Weave Interlacing

Characteristics of Twill Weaves

- May have face/back and up/down orientation
- Interesting surface and texture
- Seldom printed
- Soil less evident
- Softer and more absorbent if low count
- More pliable
- Better wrinkle recovery
- High counts possible (more durable)
- More expensive
- Wale may be prominent
**Wale of Twill Weaves**

- **Direction of wale**
  - **Right-handed**: wale from lower left to upper right (up to the right); usually wool or wool-like fabrics
  - **Left-handed**: wale from lower right to upper left (up to the left); usually cotton or cotton-like fabrics

- **Angle of wale**: related to interlacing pattern and count
  - **Steep**: 63 degrees
  - **Regular**: 45 degrees
  - **Reclining**: 15 degrees (rare)

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**Twill Weaves**

- **Even-sided** (reversible or balanced)
  - Exposes same amount of warp and filling
  - No face or back due to weave
  - 2 up, 2 down
  - Fabrics: serge, surah or foulard; herringbone; flannel; houndstooth

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**Twill Weave Fabrics**

- Gabardine
- Suiting
- Houndstooth

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**Satin Weave**

- Fourth basic weave
  - Each warp yarn floats over 4 filling yarns and interlaces with a fifth filling yarn with an interlacing progression by two to the left or the right.
  - 4 up, 1 down (most common)
Satin Weave

Warp Faced  Filling Faced

Characteristics of Satin Weaves
- One set of yarns on face and one set on back
- Requires loom of 5 to 12 harnesses
- Lustrous with long floats
- **Very high count satins**: strong, durable, firm, impermeable to air, and have good body
- **Low count satins**: sleazy and weak

Characteristics of Satin Weaves
- Satin made with filament yarns - prone to slip
- Definite face and back
- Unbalanced
- Slick; pliable, wrinkle resistant
- Ravels and frays

Satin Weave Fabrics
- **Warp-faced satin**
  - **Satin**: filament yarns (generally bright)
  - Seldom printed
  - Warp-faced sateen (spun yarns, may be printed)
- **Filling-faced**
  - **Sateen**: spun yarns (filling faced), may be mercerized and printed
  - Satin
  - Antique satin

Satin Weave Fabrics
- Satin
- Sateen

Fancy Weaves and Fabrics
**Fancy Weaves and Fabrics**

- **Fancy fabrics**: Design produced at the same time as the fabric is woven.
- More expensive; more permanent design than applied designs; specialized looms required

**Dobby Fabrics**

- Waffle cloth
- Huck-a-back

**Six-warp Pinwale Piqué**

**Fancy Weaves: Extra yarn weaves**

- Additional yarn set used in localized areas to create patterns; may have long floats on face, cut away on back.
  - Extra warp
  - Extra filling: swivel dot (true dotted Swiss), clipped dot, lappet
- **Piqué (cord weave)**: Fabric with ridges, wales, or cords held up by floats on back; stuffer yarns; Bedford cord, piqué

**Fancy Weaves: Jacquard**

- **Jacquard weave**: Each warp yarn individually controlled; most practical if more than 25 arrangements of warp needed to produce design; microprocessors or punched cards; combines basic weaves (plain, twill, satin); damask, brocade, tapestry
- Damask
Momie (crepe or granite) weave: Made with dobbey attachment; irregular interlacing pattern; sand crepe, granite cloth, moss crepe, bark cloth, crepe.

Crepe

Leno: Doup attachment used to cross warp yarns over each other; marquisette, casement cloth; used to make chenille yarns.

Leno

True double cloth or double cloth: Five sets of yarn (2 warp, 2 filling, and a fifth set, usually warp); creates 2 fabrics connected by the fifth yarn set (velvet).

Double weave or pocket cloth: Four yarn sets (2 warp and 2 filling); 1 W and 1 F work together and alternate position on face with other set of yarns to create pockets in fabric; pocket cloth, matelassé.

Double-faced fabric: Three yarn sets; third set either warp or filling; silence cloth.

Double Cloth
Three-dimensional woven fabric made with an additional warp or filling yarn set that creates the pile.

- **Filling pile**: third (pile) yarn set is filling; long floats woven in, cut and brushed; corduroy, velveteen
- **Warp pile**: third (pile) yarn set is warp; cut, uncut, or combination of cut and uncut; three methods:
  - **Double cloth**: true double cloth method with layers cut apart; velvet
  - **Over wire**: wires interlace with warp pile yarns; friezé
  - **Slack tension**: warp pile yarns have minimal tension, reed pushes up extra length to form pile; terry cloth

**Warp Pile: Double Cloth Method**

- **W interlacing (top)**
- **V interlacing (bottom)**

**Fancy Weaves**

- **Slack-tension weave**: Warp is slack in bands to give puckered area in stripes; seersucker.
- **True tapestry weave**: Discontinuous filling yarns create pattern with color or texture.
- **Narrow fabrics**: Woven elastics and trims for apparel, furnishings, and industrial goods.

**Seersucker**

Slack tension warp yarns are longer in the unraveled portion.
A Fiber is what a fabric is made from; fabric refers to how it is made.

A fabric (whether woven, knit or fabricated in some other form) can be created from solutions, fibers, yarns or a composite of any of the previous.

Most weave have yarns running in 2 directions: the warp and the weft (or filling)
- The yarns run the full length of the fabric and parallel to the selvedge. They also create the groundline of the fabric, which is very important when cutting out fabric. They must be very strong because they are tightly wound across the loom and beams. The warp yarns have less stretch than the weft yarns.
- The weft or filling yarns run cross-wise to the loom, selvedge and grainline. These yarns do not need to be as strong or uniform since they do not take as much tension during the weaving process. Therefore the fancy yarns can be used in this direction if chosen.

Woven fabrics are created on a device called a loom. On the loom, the warp yarns are wound on beams and run through harnesses with heddles that control the design of the weave. Each harness moves up and down to create a shed of warp yarns through which the weft yarns are passed on a shuttle. This is then beat into place with a reed or batten. This creates one line of the weave and can be done by hand or on an automated loom.

In the industry, there are a variety of shuttle-less power looms available including: air jet, water jet, projectile, and rapier; there are several specialized power looms: multi-width, multi-shed, triaxial and circular.

Sometimes the grain of the fabric shifts (most commonly when it is stored on bolts.) The groundline can be skewed or bowed.

The fabric properties are related to thread count, balance, weight, interlacing pattern, fiber content, yarn structure, & finishes.
- Thread count - number of warp and weft yarns in a square inch
- Balance - the ratio of warp yarns to weft yarns – has to do with how thick or thin the warp yarns are compared to how thick or thin the weft yarns are.
- The balanced plain weave is the easiest and has the widest range of end uses. It has the maximum number of interfacings and the number of warp yarns equals the number of weft yarns. There is no technical front or back to the fabric unless it is printed.

- Light weight – chiffon, linen, organza, organ jade; medium weight – gingham, plisse, polished cotton, muslin heavy weight – herring, twill, flannel

The unbalanced plain weave usually creates a ribbed fabric due to the difference in yarn size between the warp and the weft
- Medium – broadcloth, taffeta, shantung heavy – faille, heather cord

- The satin weave has distinctive diagonal lines, or weaves, created by yarns laying over more than one interlacing (floats.) This helps in hide soiling and makes the fabric more expensive.

- Even sided (reversible) – suzani, houndstooth, herringbone, surah; warp-faced – oxford, monk’s cloth, canvas, duck
- Fancy – jacquard, dobby, terry cloth, terry cloth, terry cloth
- Oxford, monk’s cloth, canvas, duck

- The satin weave has long floats (usually over 4 yarns) in either the warp or filling direction. They tend to have high luster and can be done by hand or on an automated loom.

- Narrow – chiffon, silk; wide – broadcloth, taffeta
- Slack – chiffon, silk, organza, organ jade

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- Plain weave – no interlacing pattern
- Yarns are woven in plain or twill in warp and weft
- Warp-faced: satin (silk, synthetics); filling-faced: sateen (cotton or spun yarn fibers), sateen, antique satin
- Suede (suede) – trims, ribbons, etc.

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