The Comprehensive Guide to Textile Manufacturing

Guilford of Maine®

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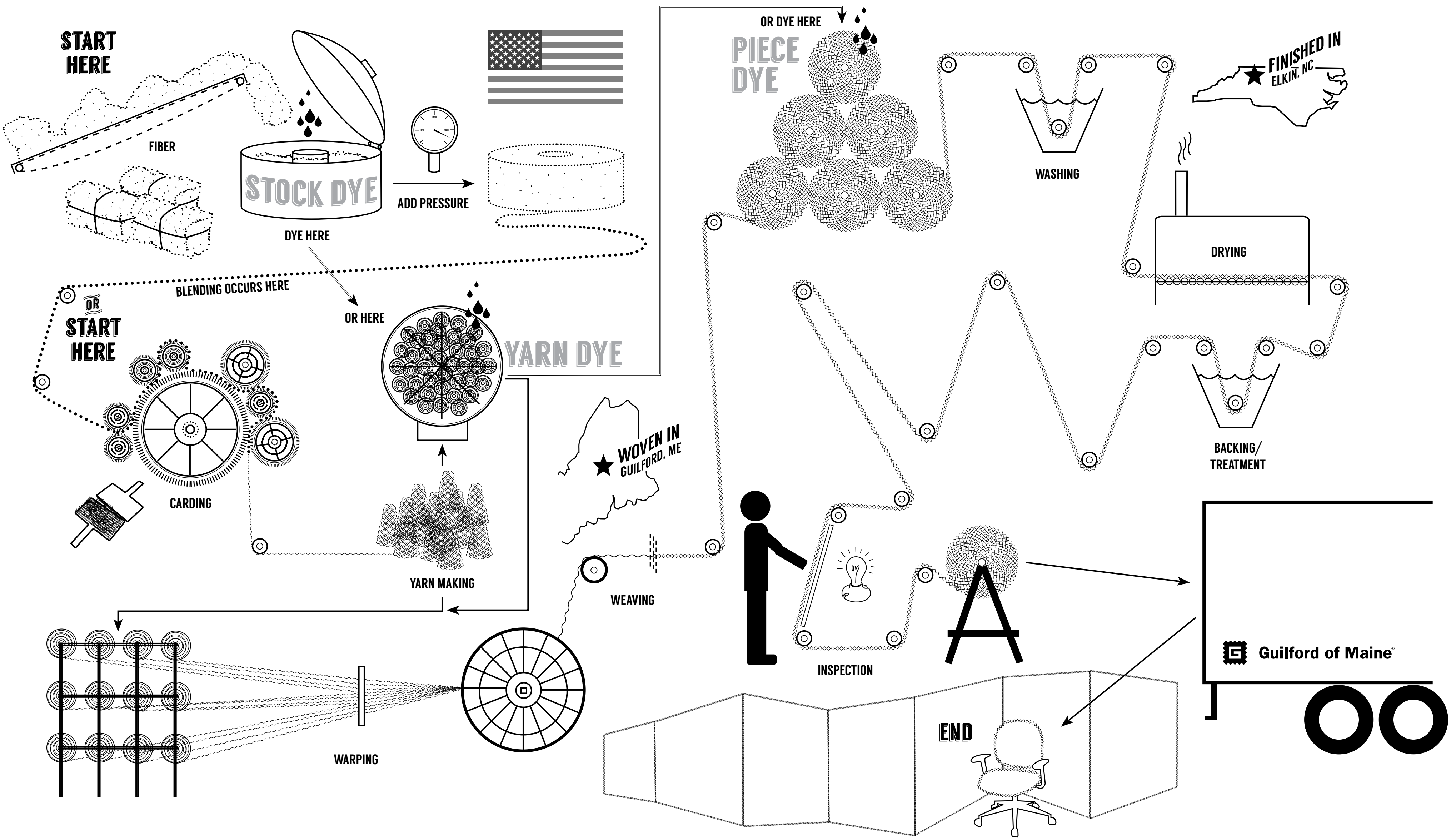
Introduction

Inspired to do what's right for you, we at Guilford of Maine draw on our rich history of weaving textiles that dates back to 1865 to craft fine woven goods, continuously reinventing ourselves as our customers' needs have evolved. We take pride in the fact that we are one of the only US mills to be vertically integrated, capable of designing and producing 100% of our yarns and fabrics every step of the way. Giving our customers the peace of mind in knowing where their textile was made.

We hope you find the following information both enjoyable and informational. If you have any comments, or questions, please let us know! Email us here.


START HERE
FIBER
DYE HERE
STOCK DYE
ADD PRESSURE
BLENDING OCCURS HERE
OR START HERE
CARDING
OR HERE
YARN DYE
YARN MAKING
WARPING
WEAVING
WOVEN IN GUILFORD, ME
OR DYE HERE
PIECE DYE
WASHING
FINISHED IN ELKIN, NC
DRYING
BACKING/ TREATMENT
INSPECTION
Guilford of Maine
END

A Brief History of Textiles

Early Textile History
107,000 BCE – Modern human ancestors are thought to have worn clothes
34,000 BCE – The age of dyed flax fibers found in a cave in the Republic of Georgia
27,000 BCE – The oldest known evidence of weaving, found in the Czech Republic
6000 – 3000 BCE – Evidence of the use of flax, wool, silk and other fibers found in a variety of ancient cultures
100 BCE – 1400 AD – Travel along The Silk Routes spread commerce and culture throughout Asia, the Middle East and the Mediterranean

Industrial Revolution and Modern Textile History
1733 – The Flying Shuttle is patented by John Kay
1771 – Richard Arkwright opens the first water powered mill, in Cromford, England
1801 – Joseph-Marie Jacquard invents the Jacquard Loom
1856 William Henry Perkin invents the first synthetic dye
1892 – Cross, Bevan and Beadle invent rayon
1935 – Nylon developed by Wallace Carothers, at DuPont

- There are 4 processes we use at True Textiles (parent company of Guilford of Maine) to achieve different colors in textiles

  1) Pre-Fiber - Solution Dyeing/Polymer Extrusion
  2) Fiber - Stock Dyeing
  3) Yarn - Package (Yarn) Dyeing
  4) Fabric - Piece Dye

- The following pages explain each in further detail

- Fiber is created from colored plastic pellets and is forced through a spinneret which resembles a shower head
- Since the color pigment is throughout the fiber, this creates a fiber/yarn/textile that has a much higher color-fastness to light rating.
- For more on the process of polymer extrusion, see the fiber section

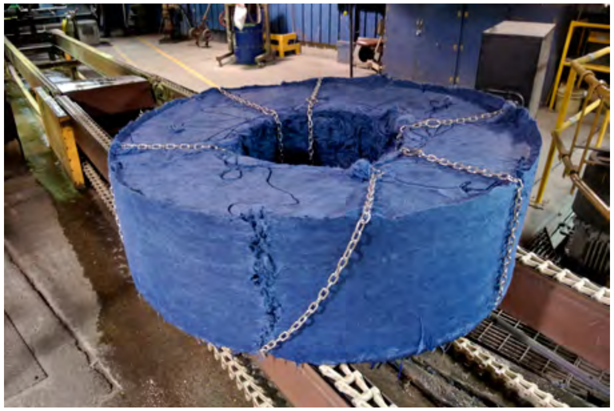
- This dyeing takes place at the fiber stage
- Raw fiber is compressed and heated in large cylinders
- The dye is then run through the fibers

Raw fiber ready to be dyed

The fiber goes up a conveyor belt and into the vat

The vats where the dyeing takes place

The fiber after dyeing



From here the dye cake goes to our Newport facility to be blended

Dyeing > Package (Yarn) Dyeing

- This dyeing takes place at the yarn stage before being woven

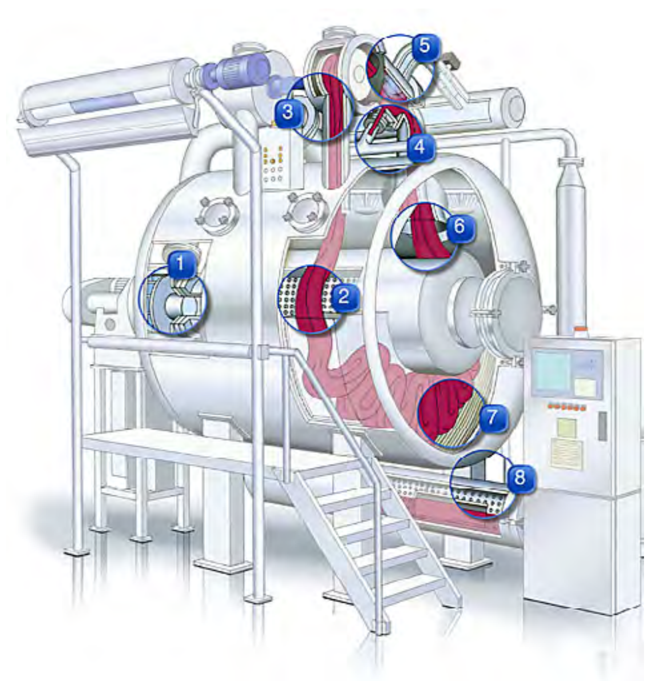
- There are many types of yarn dyeing. The process we use is Package Dyeing.

The yarn is wound on a perforated tube called a package and placed together on a rack.

The white yarn is placed into the dyeing machine.

Finished dyed yarn.

- The dyeing of the textile after it has been woven
- Does not lend itself well to multi-color textiles
- Sometimes different yarns can be used to create multiple colors, based on whether the yarn absorbs the dye or not



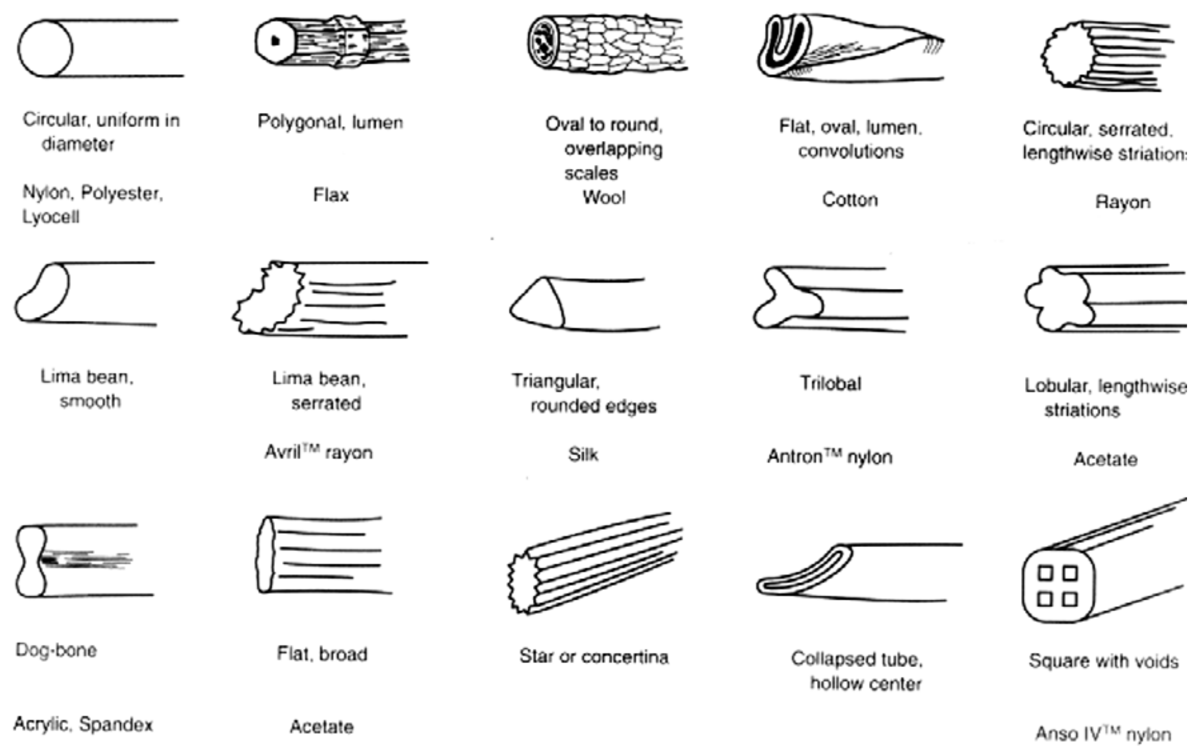
What is a Fiber

- Has a high length to width ratio
- Has high flexibility
- Can either be natural or manufactured
- Fiber is either staple fiber (small lengths, i.e. wool), or continuous filament fiber (continuous lengths, i.e. polypropylene)

Fiber Characteristics

- Strength
- Cohesiveness
- Uniformity
- Size
- Luster/Cross Section
- Color
- Moisture Absorption
- Elongation and Recovery
- Flammability
- Abrasion Resistance

Fiber Optical Properties Cross Section Chart



Different cross section's change the optical properties of the fiber

Fibers, that are turned into yarns, and ultimately textiles, come from many places, both manmade and natural. Below are two charts showing the source of the fiber and its classification.

Natural Fibers

Protein (animal)	Cellulosic (vegetable)	Mineral
Silk	Cotton	Asbestos
Wool	Kapok	
Alpaca	Flax	
Mohair	Hemp	
Cashmere	Jute	
Angora	Sisal	

Manufactured Fibers

Cellulosic (regenerated)	Non-Cellulosic (aka thermoplastics)	Mineral
Rayon	Polyester	Fiberglass
Acetate	Olefins	Metallic
Triacetate	Nylon	
PLA	Acrylic	
	ModAcrylic	
	Aramids	

The main fiber/yarn/content types that we weave with are polyester, solution dyed nylon, nylon, and olefin/polypropylene. Below and on the follwing page are the main characteristics of each.

Polyester

- In appearance it can range from bright to dull sheen, and a crisp to soft feel
- Strong and durable with good resistance to abrasion
- It stands up well to sunlight, mildew and insects
- Polyester blends beautifully with other fibers, such as cotton, and can have a silk like appearance
- Water-based stains can be easily cleaned
- Has an affinity for oil-based stains, which can be very difficult to clean
- Looks and feels most like cotton
- Will absorb very little water
- Can be used as upholstery, cubicle or vertical surface

Olefin (Polypropylene & Polyethylene are types of Olefin)

- Resists mildew and chemicals
- Abrasion, fire, and chemical resistant
- Water-based stains can be easily cleaned
- Has an affinity for oil-based stains, which can be very difficult to clean
- Bleach cleanable
- Great lightfastness
- Will not absorb water
- Color is solution-dyed
- Creases when folded
- Lightweight
- Can be used as upholstery, cubicle or vertical surface

Nylon

- Dyes and drapes well, and has a good luster
- Extremely resistant to abrasion
- Does a terrific job of resisting mildew, insects and wrinkling
- Can be permanently stained by acidic water-based stains that can dye the fabric (e.g. red wine, Kool-Aid, tomato sauce, etc.)
- Can be degraded by sunlight
- Because of its strength, nylon is utilized in seat belts, carpets and military items
- Will absorb more water than polyester
- Poor choice for vertical surfaces, because of its moisture retention

Solution-Dyed Nylon (SDN)

- Color is added during the extrusion process, as opposed to nylon, which is dyed at a later stage
- Bleach cleanable
- Most expensive fiber/content type we offer
- Dyes and drapes well, and has a good luster
- Extremely resistant to abrasion
- Does a terrific job of resisting mildew, insects and wrinkling
- Can be permanently stained by acidic water-based stains that can dye the fabric (e.g. red wine, Kool-Aid, tomato sauce, etc.)
- Excellent colorfastness to light when UV inhibitors are adding during the extrusion process
- Because of its strength, nylon is utilized in seat belts, carpets and military items
- Will absorb more water than polyester
- Poor choice for vertical surfaces, because of its moisture retention

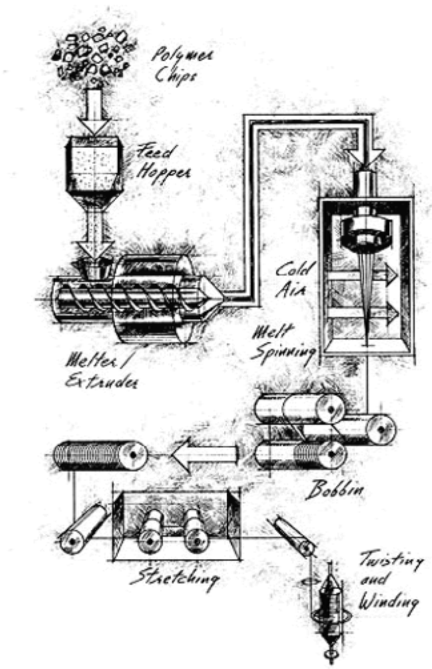
- The extrusion process starts with taking solid pellets of either recycled or virgin material and converting it into a fluid state for extrusion. This is usually achieved by melting them or dissolving them in a solvent.

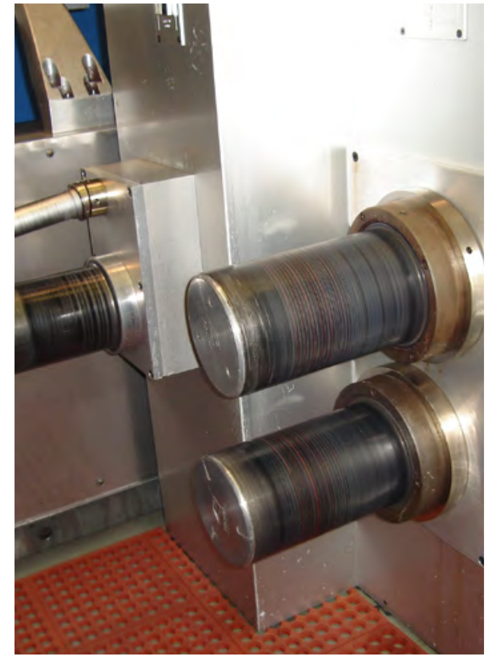
- Most synthetic and cellulosic manufactured fibers are created by “extrusion” — forcing a thick, viscous liquid (about the consistency of cold honey) through the tiny holes of a device called a spinneret to form continuous strands of a semi solid material.

- The spinnerets used in the production of most manufactured fibers are similar, in principle, to a bathroom shower head. A spinneret may have from one to several hundred holes. The tiny openings are very sensitive to impurities and corrosion.

- As the filaments emerge from the holes in the spinneret, the liquid polymer is converted first to a rubbery state and then solidified. This process of extrusion and solidification of endless filaments is called spinning. Not to be confused with the textile operation of the same name, where short pieces of staple fiber are twisted into yarn.

- Since the color pigment is throughout the fiber, this creates a fiber/yarn/textile that has a much higher colorfastness to light rating.





Blending

- Blending is the combining of different fibers thoroughly together to achieve a desired product characteristic. Blends can influence coloring, strength, softness, absorbency, ease of washing, resistance to wrinkling, ease of spinning, cost, etc.

- This process takes place after the stock dyeing process, where necessary. Different amounts of each fiber color are combined and blown into a “room” to evenly combine the different color fibers to achieve the desired yarn color.

Fiber being fluffed after being compressed in the dye cakes

Fiber being blown in order to mix it consistently

Carding

- Carding is the process in which the staple fiber is aligned in one direction and formed into a continuous strand called “sliver” (pronounced like “diver”). The production of sliver is the first step in the textile operation that brings staple fiber into a form that can be drawn and then twisted into spun yarn.

- Carding is accomplished by the fibers passing between closely spaced wire pins that spin on drums. This arranges the fibers so they are all aligned in the same direction. The whole process takes place in one long machine, with loose fiber entering at one end, with completed sliver at the other end. The sliver is then turned into roving and placed on a bobbin and is ready for spinning, which is where the yarn is created.

These drums are covered in wire pins. The drums spin to arrange the fibers in the same direction.

Once the fibers are aligned, it creates a loose webbing of sorts.

At the end of the carding machine, the fibers are slit into narrow widths and spun onto a spool. This is sliver.

- Yarn is an assemblage of textile fibers or filaments twisted into a continuous strand
- Types of yarns include spun yarn, filament yarn and novelty yarns
- Yarns are made by utilizing either staple or filament fibers or by combining both
- Twist is the most common method of holding spun yarn together

- There are 3 main types of yarn manufacturing processes, based on the types of fibers used and their fiber lengths. We at True Textiles / Guilford of Maine use the Woolen System. Polyester, the primary fiber we work with, acts similar to wool.

- Cotton System
  - ¾–1½ inch fibers

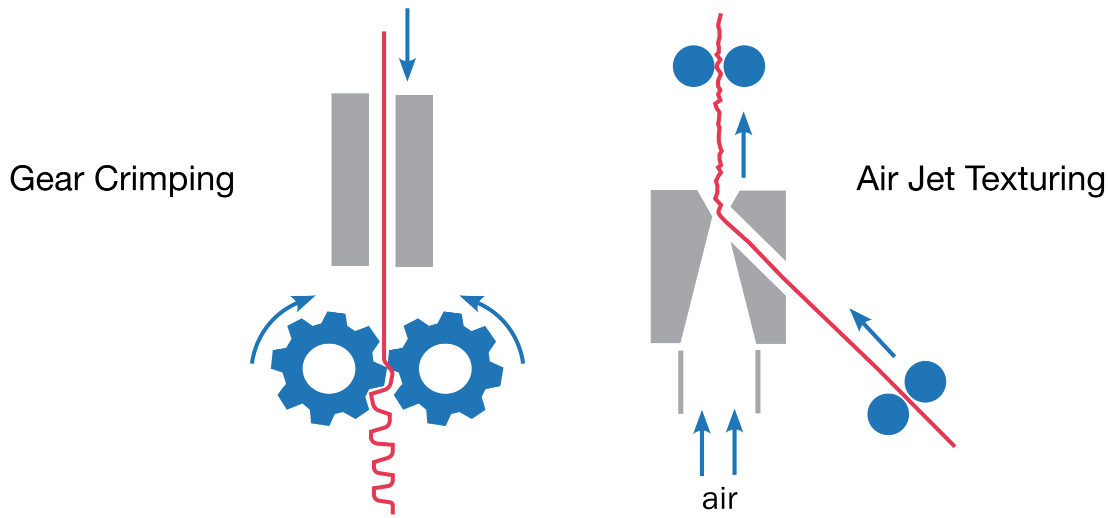
- Woolen System
  - 2–4 inch fibers

- Worsted System
  - 3–6 inch fibers

- Below are the steps in creating yarn using the Woolen System, which is the system we use
  1) Fiber Preparation - Blending
  2) Straightening - Carding, Combing
  3) Spinning - Roving, Spinning
  4) Quality - Autoconing (putting the spun yarn onto a larger spool in a consistent manner)
  5) Plying (optional) - Twisting two yarns together

Yarn texturing

- The act of modifying straight continuous filament yarn to add bulk and/or additional stretch



Novelty Yarns

- Straight yarns are combined in various ways to create intentional unevenness, exaggerated texture or color effects
- Examples include Bouclé, Slub and Chenille yarns


Slub yarn


Bouclé yarn


Chenille yarn

Warping

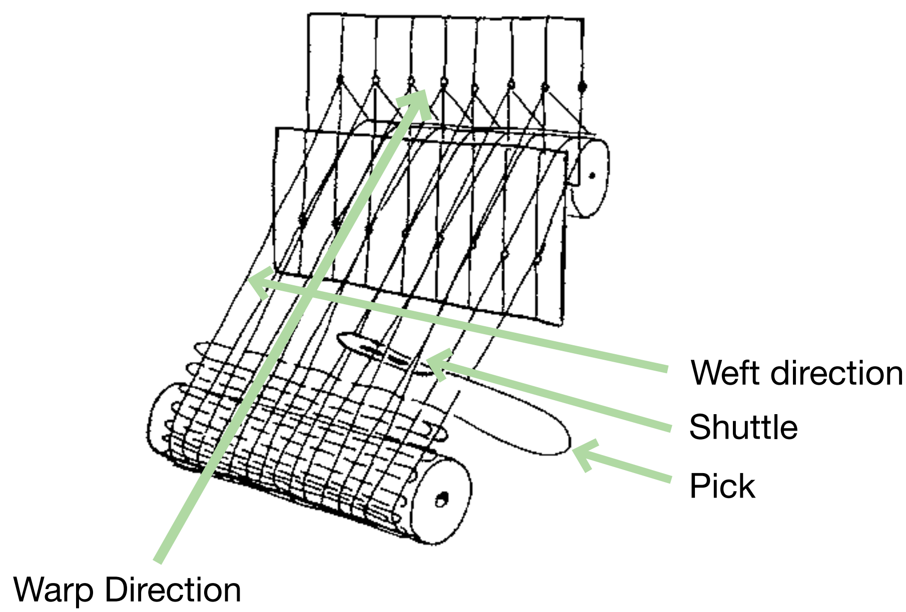
- This is the department where the warp (vertical yarns) of the fabric is created
- A warp has hundreds or thousands of individual strands all wound around a large spool
- The width of the warp determines the width of fabric when it is woven
- Warps can be up to 3,500 yards in length, which would weave fabric 3,500 yards long

This shows the creel, which holds the spools of yard that are wound onto the warping drum.

A close-up of the warping drum on which the yarns are wound and built up in sections. The warping drum spins to wind the yarn around it.

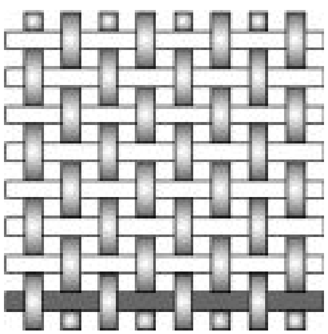
A completed warp, also showing it transferred from the tapered warper to the beamer, which looks like a giant spool. From here it will be transported to the loom.

- Weaving is the process that creates fabric by interlacing yarn at right angles
- The yarn in the vertical direction is called the warp
- The yarn in the horizontal direction is called the weft
- We have 3 types of looms
    1) Dornier Rapier dobby
    2) Dornier Rapier Jacquard
    3) Dornier Air Jet Jacquard
- Different types of weaves create different designs and performance qualities
- Picks refer to each individual filling yarn. Fabrics are often described by the number of picks per inch.



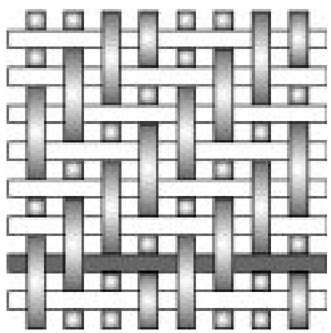
- A fabrics integrity is maintained by the mechanical interlocking of fibers. Drape, smoothness and stability of a fabric are controlled primarily by weave style.
- Different simple and complex fabric design is produced by the weave structure
- All patterns, however complex, derive from either a plain, twill or satin weave

Plain Weave



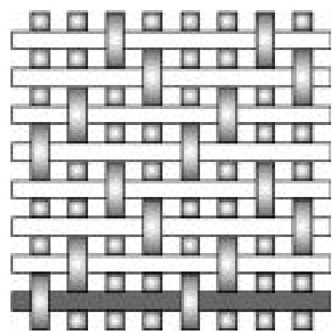
Each warp yarn passes alternately under and over each weft fiber.

Twill



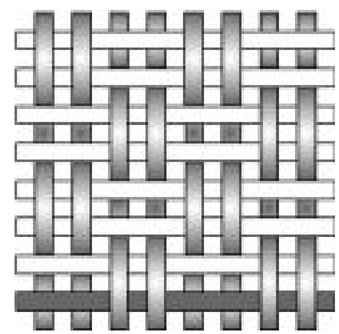
One or more warp yarns alternately weave over and under two or more weft yarns in a regular repeated manner. Appearance is a diagonal rib like pattern.

Satin



Fundamentally a modified twill weave with fewer intersections of warp and weft.

Basket



Fundamentally the same as a plain weave except that two or more warp yarns alternately interlace with two or more weft yarns.

- Used for small, usually geometric patterns
- The rapier, a metal piece that carries the weft half way across the fabric, is caught by a second rapier and pulled the rest of the throw. A rapier is an alternative to a shuttle.

This shows the harnesses that move up and down during weaving to create the pattern.

Similar to a player piano, the harnesses are controlled by a mylar card

An example of a simple weave produced on a dobby loom

A close-up showing the harnesses and heddles

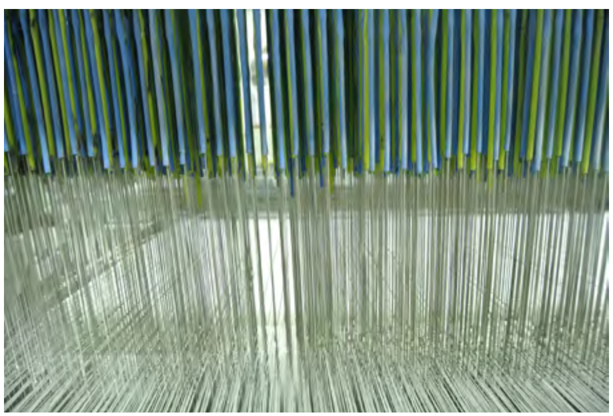
Here you can see the warp beam hooked up to the loom

Weaving > Jacquard Loom

- Capable of creating large pattern repeats
- Each warp yarn can be controlled individually. We have various versions that control one, two, or 4 ends (warp yarns)
- Controlled by a computer located above the flexible harnesses
- We have two types: Rapier and Air Jet looms. The difference is how the weft (fill) yarn is moved back and forth. One uses a rapier (a piece of metal) and the other uses air to shoot the yarn across

You can immediately spot a Jacquard loom because of the harnesses extending upward to the controller.

Different sections of the harnesses are being lifted to create the intricate pattern



Close up of the harnesses connecting to the heddles

The computer that controls the harnesses of a Jacquard loom

Here you can see the selvadge being removed

- All our finishing happens at our Elkin, North Carolina facility
- Involves the application of chemical and/or mechanical treatments to a textile in order to produce a variety of aesthetic and/or functional effects.
- Some aesthetic effects:
  - Softness, Color, Drape, Brightness, Colorfastness, Stiffness
- Some functional effects:
  - Shrinkage Control, Antimicrobial, Odor Control, Abrasion Resistance, Antistatic, Flame Resistance, Soil-Release, Water Repellent, Stability
- Finishing may include wet (chemical) and/or dry (mechanical) processing.
- Woven fabrics cannot be processed into finished goods until the fabrics have passed through several water-intensive, wet processing stages.

- The application of chemical finishes to textiles can impart a variety of properties ranging from decreasing static cling to increasing flame resistance.
- The most common chemical finishes are those that ease fabric care, such as permanent press, soil release, and stain-repellent finishes.
- Chemical finishes are usually followed by drying, curing, and cooling steps.
- The application of chemical finishes is often done in conjunction with mechanical finishing steps.

Scouring/washing process

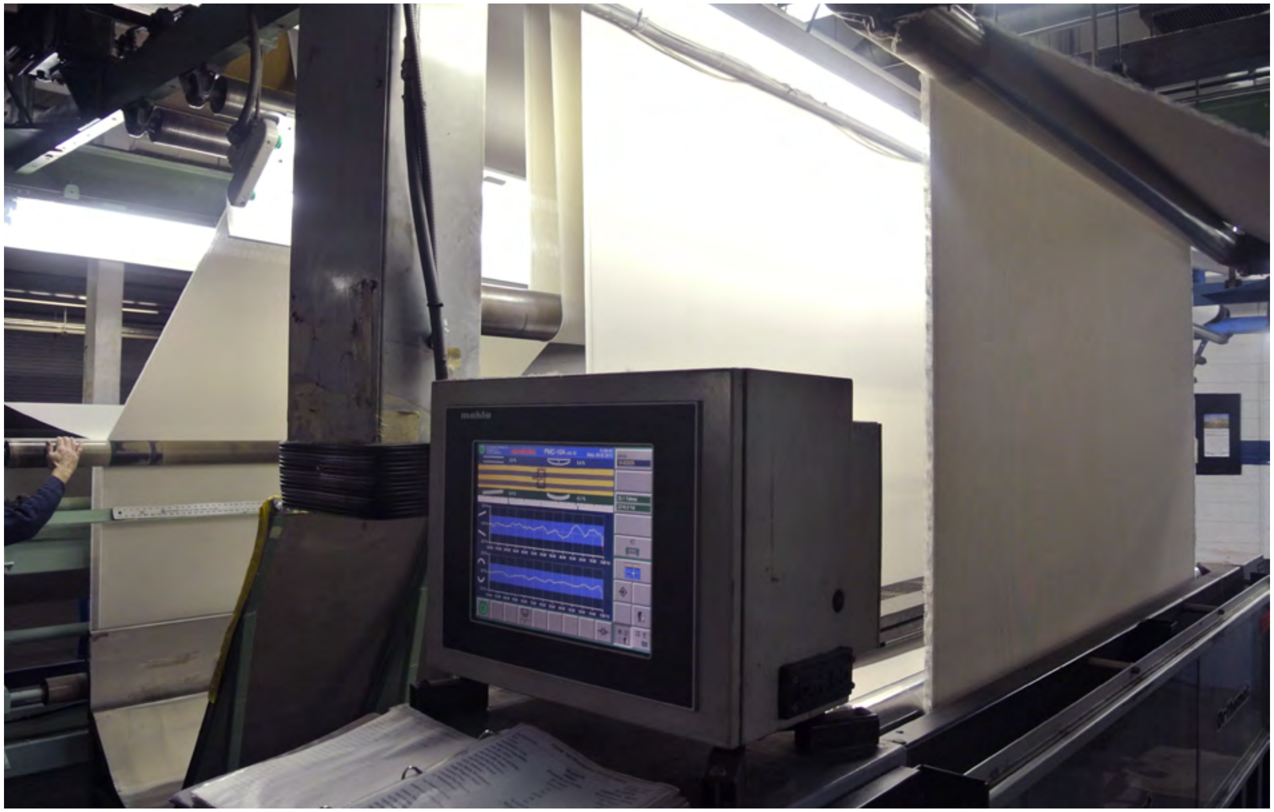
Scouring range

Finishing > Overview Cont.

- Backcoating – The application of a semi-liquid material such as a latex to the back side of the fabric. Once the coating is dried, it forms a bond with the fabric.

- Framing – The process of drying a fabric to a set specification on a tenter frame.

- Pattern Straightener – A piece of equipment installed on a tenter frame that is used to correct bow and skew in fabrics.



- Chemical finishing – Chemical additives are primarily applied on a tenter frame. They may be applied in either a pad or foam application.

- Chemical finishing involves a pad or a foam applicator and a tenter frame.

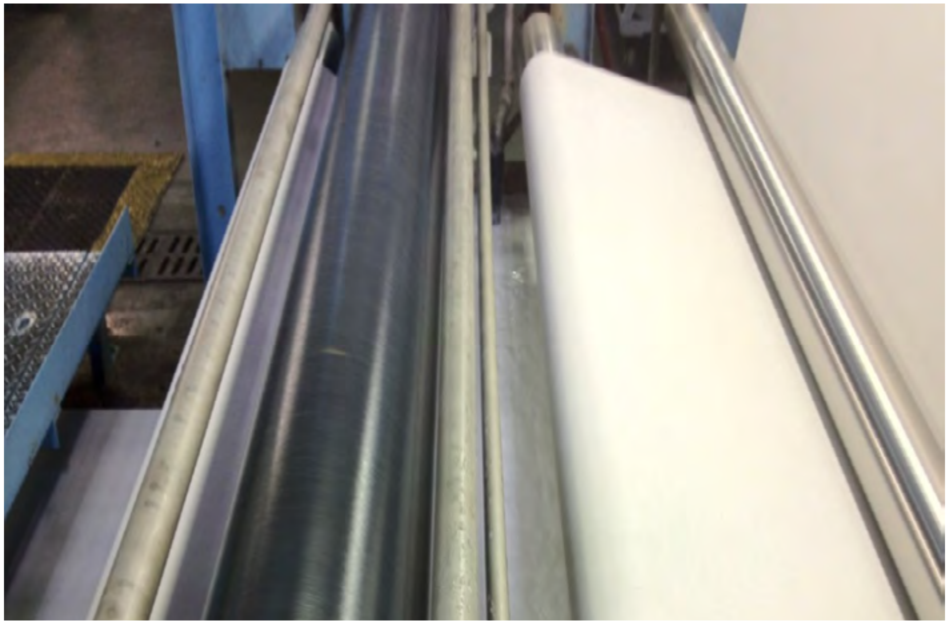
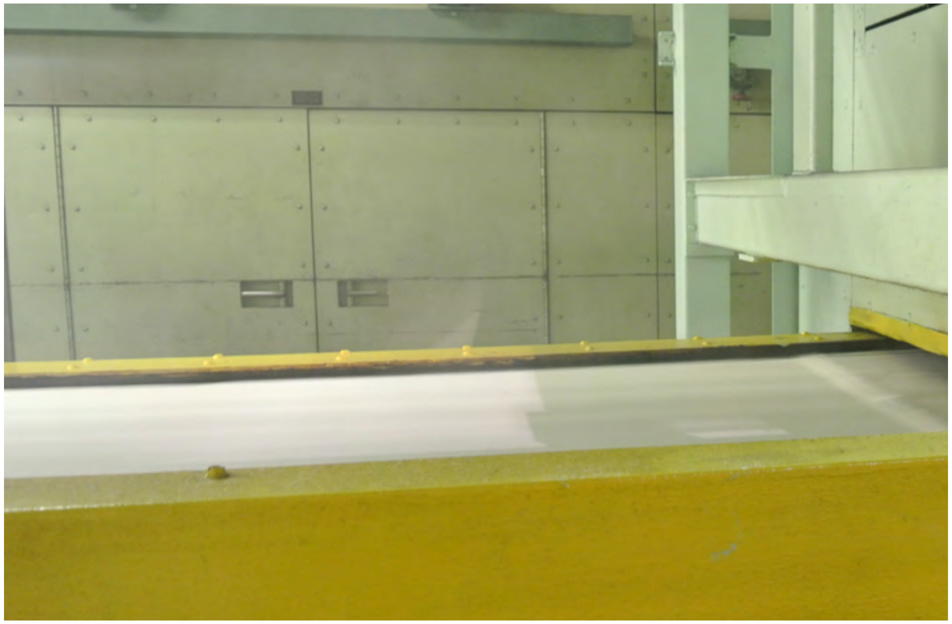


Photo showing the pad applicator

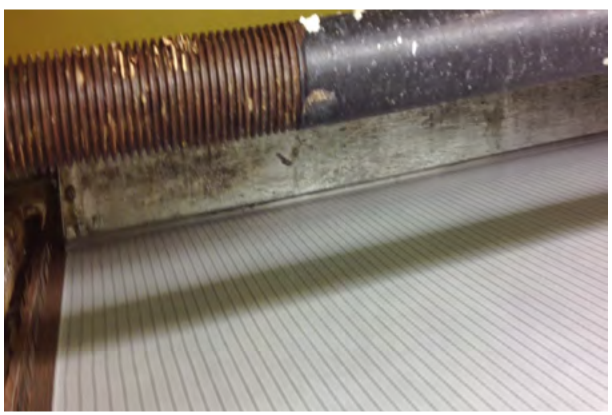


Fabric coming through the oven after being treated

- Mechanical finishing includes those processes in which the appearance or the physical properties of a fabric are altered by a mechanical process.
- Shearing – A process in which projecting fibers are mechanically cut or trimmed from the surface of the fabric.
- Napping – A process in which fibers are raised from the surface of the fabric by passing over wire rollers.
- Lamination – A process in which a scrim, web, or barrier fabric is thermally bonded to a fabric for various performance requirements.
- Needling – A process in which barbed needles, that are set in a board, punch fiber towards the back of the fabric leaving the fibers entangled. This process is intended to strengthen the fabric and prepare the fabric surface for the application of a backcoating.

Inside the needleloom

Backcoating, with latex added to the blade



Backcoated fabric exiting the blade

- Shade Change and Measurement:
  - Finishing can alter the shade of a fabric depending upon fiber content, chemical or backcoating applied, and the amount of processing required to finish the fabric. Shade is measured after finishing both visually and with a Sprectro-photometer.

  - Visually the fabric is compared to a Master sample of fabric as well as production history.

  - The Spectrophotometer measures the shade of the fabric to the master sample of fabric to determine if it is considered a commercial match, defined as a Delta E CMC of less than 1.0. This measurement represents the total color difference value of the sample.

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