Short Staple Yarn Manufacturing
Characteristics Of Spun Yarns

- Composed of short staple fibers
- Made from cotton, flax or wool staple fibers
- Made from natural or man-made filaments which are cut into filament staple
- Individual fiber lengths vary
- Fuzzy appearance and feel
- Uneven number of fibers throughout
- Range from soft, loose construction to hard fine twist yarn
- Thick and thin areas
- Highly twisted
- Fall apart when untwisted
- Dull or flat in appearance
- Rough to the touch
- Natural textural appearance and feel
- Bulkier to the feel
- Provide good covering power
- Snagging depends on fabric structure
- Pilling depends on fiber content
Material Processing On The Short Staple System

1. Carded Ring Spun Yarns

- Opening
- Carding
- Drawing (2)
- Roving
- Spinning
- Winding

2. Open End Rotor Yarns

- Opening
- Carding
- Drawing (2)

Open-End Spinning
3. Air Jet Spun Yarns

- Opening
- Carding
- Drawing (3)
- Air Jet Spinning

4. Combed Cotton Ring Spun Yarns

- Opening
- Carding
- Drawing
- Sliver Lapping
- Combing
- Drawing (2)
- Roving
- Spinning
- Winding

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5-4 Short Staple Yarn Manufacturing
Functions Of The Opening Process

- Open (opens fibers to a fluffy state, usually carded prior)
- Clean (natural fibers)
- Blend
Creating The Proper Bale Laydown

Coordination with Fiber Properties

- More variables in raw stock means more bales needed to laydown

- Must decide which variables have the greatest influence in yarn manufacturing.

Coordination with Fiber Inventory

- Laydown should be a "mini" representation of the warehouse inventory.

- Laydown should be as consistent as possible from day-to-day, week-to-week, and month-to-month.
Blending

*Blending is a process involving*

- Measurement of the important fiber properties of length, fineness, strength, grade, color, etc.

- Proportioning and combining these properties under controlled conditions and in such a way that the physical properties of resultant blend can be predicted, are known, and are reproducible.
Fiber Opening And Cleaning

- Why fiber must be opened

- Principles of opening

- Why cotton must be cleaned

- Principles of cleaning
Figure 5-1 Blending and Weighpan Feeder
Figure 5-2 Axial Flow Cleaner And Incline Cleaner

AXIAL FLOW CLEANER

INCLINE CLEANER
Carding

Materials Processed
Input - Mat of fiber
Output - Card Sliver, measured in grains per yard (1 lb = 7000 grains)

Objectives of the Process
1. Open

2. Clean

3. Straighten - main function

4. Blend

5. Draft

6. Package

Card Feeding Systems
A Typical Card Line

opening/cleaning equipment
Figure 5-3 Revolving Flat Card
Drawing

**Material Processed**
Input - Card sliver
Output - Drawn sliver

**Objectives of the Process**
1. Improve sliver uniformity
   A. Doubling

2. Straighten fibers
   A. Drafting

3. Package sliver

**Some General Definitions**
Figure 5-4 Drawing Frame
The Combing Process

**Purpose of Combing**
- Remove short fibers, trash, and nep.

**Comber Preparation**

**Combining Organization**

**Basic Operations of Combing**
1. Feeding the stock from a prepared lap.
2. Combing out short fibers, foreign particles and neps; parallelizing fibers.
3. Detaching the combed fibers from the lap.
4. Piecing up the fleecy tuft of combed fibers with the fibers in the returned web.
5. Condensing the combed web into sliver and doubling the sliver on the table.
6. Drafting the doubled slivers through the draw box.
7. Calendering and packaging the combed sliver into a container for further handling and processing.
Figure 5-5 Combing

A B C D

Short Staple Yarn Manufacturing 5-17
Roving

Materials Processed
Input - drawn or carded combed sliver
Output - roving on a bobbin

Objectives of the Process
1. Draft

2. Twist

3. Package

Operations on Roving Frame
1. Drafting

2. Twisting

3. Laying

4. Winding

5. Building
Figure 5-6 Roving
Ring Spinning

MATERIAL PROCESSED

INPUT -

OUTPUT -

MAIN FUNCTIONS

DRAFT

TWIST

WIND

Roving
final yarn
final twist
but not final package

Yarn is threaded through traveler
Figure 5-7  Ring Spinning

Diagram:
- Draft Rollers
- Delivery Rolls
- Thread Guide
- Ring Rail
- Bobbin
- Traveler Ring
- Spindle Rail

Roving
Rotor - Type Open End Spinning

Material Processed
Input - sliver
Output - final yarn package

Objectives of the Process
1. Open
2. Draft
3. Align
4. Twist
5. Wind
Figure 5-8  The Principal Of Open-End Spinning
Figure 5-9 Schematic Diagram - Open End Spinning
Figure 5-10 A Typical O.E. Machine
Figure 5-11  Yarn Formation: Ring vs Open End

Ring Spun Yarn Being Formed From The Outside In

Open End Yarn Being Formed From The Inside Out
Figure 5-12  Surface Characteristic Differences of Ring and Open End Yarns

Bridging Fibers

Formation of Bridging or Wrapper Fibers on the Surface of Open End Yarn

Ring Spun

Open End
Table 5-1 Comparisons of Properties
Ring Spun vs Open End

<table>
<thead>
<tr>
<th>Property</th>
<th>Ring Spun</th>
<th>Open End</th>
</tr>
</thead>
<tbody>
<tr>
<td>Evenness</td>
<td></td>
<td>+</td>
</tr>
<tr>
<td>Strength</td>
<td>+</td>
<td></td>
</tr>
<tr>
<td>Strength Uniformity</td>
<td>+</td>
<td></td>
</tr>
<tr>
<td>Elongation</td>
<td>+</td>
<td></td>
</tr>
<tr>
<td>Slubs, Thick, &amp; Thin</td>
<td></td>
<td>+</td>
</tr>
<tr>
<td>Twist</td>
<td></td>
<td>Higher</td>
</tr>
<tr>
<td>Liveliness</td>
<td>+</td>
<td></td>
</tr>
<tr>
<td>Fiber Orientation</td>
<td>+</td>
<td></td>
</tr>
<tr>
<td>Hairiness</td>
<td>More</td>
<td></td>
</tr>
<tr>
<td>Luster</td>
<td>More</td>
<td></td>
</tr>
<tr>
<td>Handle</td>
<td>+</td>
<td></td>
</tr>
<tr>
<td>Count Range</td>
<td>Finer</td>
<td>40's</td>
</tr>
<tr>
<td>Diameter</td>
<td></td>
<td>Thicker</td>
</tr>
<tr>
<td>Absorption</td>
<td>+</td>
<td></td>
</tr>
<tr>
<td>Cost/Productivity</td>
<td>+</td>
<td></td>
</tr>
</tbody>
</table>
Figure 5-13 Formation And Structures Of Air Jet Spun Yarns
Figure 5-14 Wrap Spinning Process

Roving

Drafting Unit

Hollow spindle with filament package.

Tangential Belt

Take Off Rolls
Methods Of Expressing Twist

Spindle rotating **clockwise** produces **Z Twist**.
Spindle rotating **counter-clockwise** produces **S Twist**.

**Spun Yarns**
Singles use T.M.
Ply use T.M. and T.P.I.

**Filament Yarns**
Use T.P.I.

T.P.I. = $T.M. \sqrt{\text{Count}}$

**For Cotton Yarns**

- Knitting T.M. 2.2 to 3.5
- Filling T.M. 3.5 to 4.2
- Warp T.M. 4.2 to 5.0
- Voile & Crepe T.M. 5.0 to 7.0
Effects Of Twist On Yarn And Fabric Properties

*Degree of Yarn Twist Affects the Yarns*

- Diameter or fineness
- Contraction
- Softness or hardness (hand)
- Bending behavior
- Absorbency
- Covering power
- Permeability
- Tensile strength
- Elastic performance/Extension and recovery
- Resistance to creases and abrasion
- Pilling behavior
- Luster
Degree of Yarn Twist Affects the Fabrics

- Hand
- Appearance
- Texture
- Drapability qualities
- Performance expectations
- Durability
- Serviceability
Plied Yarn

Yarn Is Plied To
- Introduce different fiber yarns
- Combine spun and filament yarns
- Add to or increase the strength of single strand yarns
- Utilize multi-strands of fine yarns to produce a thick strand
- Produce a smoother yarn
- Produce a yarn with uniform diameter
- Introduce textured or novelty yarns
- Add color interest

Characteristics of Plied Yarns
- Thicker and heavier
- Coarse
- Differ in count
- Less flexible than single yarns
- Affect drapability quality of fabric
- May be constructed with no twist at all
- May be highly twisted
- May differ in tension and direction of twist
Figure 5-15 Novelty Yarns

LOOP  SLUB  BOUCLE  CORE SPUN