Outline

- Introduction
- Spun and Filament Yarns
- Classification
- Yarn Types
  - Simple Yarns
  - Novelty Yarns
  - Composite Yarns
- Yarn Characteristics
  - Yarn Number
  - Yarn Twist
  - Direction of Twist
  - Yarn Hairiness
  - Blends and Combination Yarns
Introduction

- Yarn is “a generic term for a continuous strand of textile fibers, filaments, or material in a form suitable for knitting, weaving, or otherwise intertwining to form a textile fabric” (Source - ASTM Standard D123, ASTM, Vol. 07.01).

- Majority of fabrics are produced with yarns.

- Also used for sewing and embroidery thread, string, twine, and rope.

- Fabric performance, end use, and care are affected by yarn characteristics.
A Variety of Yarns
Sewing Threads

1. 2-ply heavy duty
2. 2-ply polyester
3. Mercerized cotton covered polyester
4. Transparent monofilament
5. Extra fine mercerized cotton covered polyester
6. 2-ply metallic embroidery

Magnified view
Jute Twine – 2-ply yarn used for horticultural applications
Introduction

- **Spun yarns** are produced by twisting together staple (short) fibers.
  - Made of naturally occurring staple fibers; or
  - Made of filament fibers cut into short lengths.

- **Filament** yarns are produced from filament (continuous) fibers.
  - Made of filament fibers reeled from silk cocoons; or
  - Polymers extruded through a spinneret; or
  - Polymer films that are split or slit.
Spun Yarns

- The cotton system is the most common system used to prepare and twist staple fibers into spun yarns.
  - Short fibers must be aligned and twisted together.

- Two manufacturing processes:
  - Ring spinning.
  - Open-end spinning.
Spun Yarn Manufacture

- **Ring spinning** (Watch cotton yarn manufacturing video.)
  - **Mixing and Cleaning** - Bales are opened and fibers from different bales are mixed and cleaned.
  - **Carding** - Fibers are aligned to form a carded web that is converted into a rope-like sliver.
  - **Drawing** – Several carded or combed slivers are drawn to further align the fibers and reduce the size of the sliver.
  - **Combing** - Fibers are combed to remove short fibers and further align the fibers (only in combed yarns).
  - **Roving** – The slivers are drawn further, twisted slightly, and wound on roving bobbins.
  - **Spinning** - The roving strands are further drawn and twisted to produce yarns.

Note the differences among widths of sliver, roving, and yarn.
Combing

- Combing removes very short fibers from the sliver prior to spinning.
- Extra step for better alignment of fibers in the yarn.
- Finer, smoother, better quality yarns are produced.
  - **Combed cotton** is finer quality yarn produced by combing cotton fibers.
  - **Worsted wool** is finer quality yarn produced by combing wool fibers.
Spun Yarn Manufacture

- **Open-end spinning**
  - Initial steps are similar to those of ring spinning; roving stage is eliminated.
  - Sliver is fed into a machine that separates the fibers and feeds them into a device that twists the fibers to produce yarns.
  - Rotor and jet spinning are examples of open-end spinning systems. In rotor spinning, a mechanical rotating device is used to add twist, whereas air or water jets are used in jet spinning systems.

Source - Dictionary of Fiber and Textile Technology
Figure adapted with permission
Comparison of Ring Spinning and Open-end Spinning

- **Ring spinning**
  - Slower and more expensive.
  - Used for finer, stronger yarns.

- **Open-end spinning**
  - Faster and more cost-effective.
  - Yarns are not as strong, but are smoother on the outside.
Multifilament and Monofilament Yarns

- Yarns made of many filament fibers are known as multifilament yarns. The number of filament fibers depends on:
  - The number of fibers reeled together from silk cocoons; or
  - The number of holes in the spinneret.

- Yarns produced from single filament fibers are monofilament yarns.
  - Monofilament yarns are typically thicker than multifilament yarns.
Manufactured Filament Yarns

- Most manufactured filament yarns are produced with filament fibers extruded through spinnerets.

- Fibers extruded through the spinneret are processed, either immediately after extrusion or as a separate process.

- Manufacture of filament yarns is much faster, and therefore less expensive than the manufacture of spun yarns.

The number of filament fibers in a multifilament yarn often depends on the number of holes in the spinneret.
Textured Yarns

- **Texturing increases bulk and/or stretch.**

- Majority of the textured yarns are made with **thermoplastic** fibers.
  - Partially oriented filament yarns (POY) are heated, drawn, texture inserted, and cooled.
    - They are heated above a temperature that allows molecular motion within the fibers without completely melting them.

- Commonly used texturing methods:
  - **False-twist** - Creates stretch and bulk, but requires thermoplastic fibers.
  - **Air jet** - Creates bulk but does not require thermoplastic fibers.
    - Used to imitate properties of spun yarns; less expensive and faster to make than spun yarns.

- **Bulk Continuous Filament** (BCF) yarns.
  - Increased volume (bulk) and cover factor.
Textured Yarns

Note: All skeins are made of the same nylon yarn and all are of the same weight. The degree of stretch and bulk and overall appearance are dependent on the method used for texturizing. For visual comparison, all skeins were aligned at the top. Side views are given below to illustrate the differences.
Polyester Bulk Continuous Filament (BCF) Yarn
Interlaced Textured Yarns

- **Interlaced** method is used to make the textured filament yarns cohesive without twisting the filament fibers.
  - Yarn twist is replaced by fibers being entangled or interlaced at regular intervals. Nodes at regular intervals, produced by interlacing or tangling fibers with a high pressure air stream, are characteristic of interlaced yarns.

polyester suiting fabric woven with interlaced textured yarns

yarn ends pulled to show nodes

interlace node
Manufactured Filament Yarns - Other minor types

Some filament yarns are produced by slitting or splitting processes. They are considered monofilaments. Terms such as tape and flat yarns are used to describe these yarns.

- Flat yarns with uniform width are produced by slitting sheets or polymer films. Examples are plastic-coated metallic yarns and olefin yarns used for artificial wreaths and tarpaulin.

- Inexpensive tape yarns that are not uniform are produced by splitting polymer films. For example, yarns used for produce bags are examples of split yarns.

- Fibrillated tape yarns are produced by either slitting or splitting films. For example, yarns are used to produce twines, ropes, and artificial turf.
Yarn Classification

- Based on method of construction, yarns are classified as:
  - Simple
  - Novelty (also known as fancy)
  - Composite

- Both spun and filament yarns can be used to produce simple, novelty, and composite yarns.

- Both blend and combination yarns can be used to produce simple, novelty, and composite yarns.
Yarn Classification

Simple
- Single
- Plied
- Cord
- Rope

Novelty or Fancy
- Slub
- Flock, Flake, Seed*
- Nub, Spot, Knot*
- Bouclé, Loop**
- Corkscrew, Spiral*
- Chenille
- Others***

Composite
- Covered
- Core-spun

Notes: * Terms used interchangeably
** Yarns with similar construction
*** Includes novelty yarns not included in the categories listed above.
Simple Yarns

- **Simple yarns** have uniform size and a regular surface. They include single, ply, cord and rope yarns.
Simple Yarns

Single and ply yarns are typically used for woven and knitted fabrics.

- Single yarn, the simplest type of yarn, is commonly produced by twisting together staple or filament fibers. Single yarns include spun, monofilament, and multifilament yarns.

- Plied yarns are produced by twisting two or more single yarns. Each strand of single yarn is referred to as a ply; two single yarns twisted together would form a 2-ply yarn.
Single Spun Yarn

untwisted yarn

staple fibers
Plied Yarns

- 5-ply yarn
- 4-ply yarn
- 3-ply yarn
- 2-ply yarn
**Novelty/Fancy Yarns**

- **Novelty** or **fancy** yarns, typically made of two or more strands, provide decorative surface effects.

- Many novelty yarns are composed of:
  - **Base/core** strand that provides structure and strength.
  - **Effect** strand that creates decorative details, knots, or loops.
  - **Binder** that ties the effect yarn to the base yarn if binding is necessary.
Novelty/Fancy Yarns

- **Slub** and **thick-and-thin** yarns
  - Thick areas are created by change in yarn twist during spinning.
  - Slub yarns are staple yarns; thick-and-thin yarns are produced with filament yarns.
Novelty/Fancy Yarns

- **Flock, seed, and flake** yarns
  - Small tufts of different colored fibers are added at intervals to the yarn.
Novelty/Fancy Yarns

- Nub or knot yarns
  - One strand serves as the base yarn and the other as the effect yarn.
  - The nub or knot is created when the effect yarn is twisted several times around the base.
  - The nub or knot cannot be pulled from the yarn.
Novelty/Fancy Yarns

- **Bouclé, loop, and ratiné yarns**
  - These yarns are typically made of three strands.
  - The effect strand forms loops at intervals around the base strand.
  - The binder binds the effect strand to the base. Some yarns have two strands that crisscross to hold the loops in place.
Novelty/Fancy Yarns

- **Spiral** and **corkscrew** yarns
  - They are plied yarns where one ply is soft and thick and the other is fine.
Novelty/Fancy Yarns

- **Chenille** yarns
  - Pile fibers are held between two, highly twisted base yarns (also known as core yarns).
Composite Yarns

- **Covered** yarn is “a type of composite yarn made by wrapping a spun or filament yarn around a core of bundled fibers or another yarn. The core may also be an elastic yarn such as spandex” (Source - *Dictionary of Fibers and Textile Technology*).
  - Includes **double-covered** yarns that are produced by wrapping two yarns around a core yarn.

- Elastomeric filaments are covered with one or two yarns to produce stretch yarns.
  
  Uses - support hose and elastic cord/string to secure tags.

Double-covered yarn from elastic cord unwrapped
Composite Yarns

- Metallic strand is wrapped around other strand(s) for decoration. Examples:
  - A multifilament yarn wrapped with a metallic yarn.
  - An elastomeric monofilament yarn wrapped with a multifilament strand and then a metallic yarn. This yarn has stretch and a metallic appearance.
Composite Yarns

- **Core-spun** yarn is “made by twisting fibers around a filament or a previously spun yarn, thus concealing the core” (Source - *Dictionary of Fibers and Textile Technology*).
  - For example, cotton or another staple fiber is twisted around an elastomeric filament for comfort stretch fabrics.
  - Cotton fiber spun around a polyester core for sewing thread is another example.
Stretch Poplin - 97% cotton/3% spandex, core-spun yarns in the filling direction