Introduction

• Fundamental understanding of textiles, the processes used in making them, and the interrelationship of the different stages of manufacturing are important for understanding fabric selection.

• iTextiles™ is organized sequentially, covering information on fibers, yarns, fabrics, dyeing, printing and finishing. Within each of these categories, information is provided on performance, end use, and textile product care; all are critical elements in the design, product development, and merchandising of textile products.

• The section on Textiles in Today’s World includes information that is applicable to textile products as a whole. It includes Specifications, Regulations, Sustainability, Textile Care, and examples of recent Innovations.
Introduction

This introductory lecture will assist you in **understanding terms** used for:

- Categorizing stages of textile manufacturing.
- Major end use categories referenced throughout the text.
  - Images have been provided to explain the concepts.
  - Video clips in the eTextbook are also available.
  - These terms are relatively easy to understand as they appear consistently on care labels seen in garments and other items.
The textile manufacturing process is divided into:

- **Fiber** - the basic unit from which all textile products are made.
- **Yarn** - a continuous strand made with fibers and used to knit or weave fabrics.
- **Fabric** - the cloth produced by interlacing or interlooping yarns, or by binding fiber webs.
- **Dyeing** - adding color to textile materials or products.
- **Printing** - applying dye, pigment, or other chemicals to produce designs on textile materials or products.
- **Finishing** - typically the last step in the manufacturing process to prepare the fabric for use. It includes a variety of processes to enhance aesthetics and function.
Stages in Manufacturing Process - Fibers
Stages in Textile Manufacturing

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Stages in Manufacturing Process - Fabric

yarns
Stages in Manufacturing Process - Finishing

fabric with stain repellent finish

fabric without finish
Activity to Understand Fibers and Yarns

- The terms textiles, cloth and fabrics are used interchangeably.
- To understand yarns and fibers, pull out a yarn from a sample in your textile kit. Note: A swatch with thicker yarns is preferable.
Fabric Selection

• Some of the major factors that affect fabric selection for an item are:
  o Performance – What is important?
    – aesthetics, comfort, durability
  o Intended use – How and by whom will the product be used?
  o Product care – Can it be washed or will it have to be dry cleaned?
  o Cost – Is the cost comparable to similar items?
  o Consumer preferences – Does the target market prefer eco-friendly products? Do they have a preference for natural fibers?
  o Applicable laws and regulations.

• To gain a better understanding of the selection criteria, think of factors that you consider when buying clothing. For example:
  o Do you consider what is important for the intended use – how it looks, how comfortable it will be, or how long it will last?
  o Do you hesitate to buy clothing that requires dry cleaning?
  o How important is cost? Are there end uses that would justify increased cost?
We see textiles around us in our daily lives; some end uses like apparel and carpeting are very obvious examples, but others such as tea bags, onion bags in the grocery store, and car interiors are not as obvious.

Examples in iTextiles™ are divided into the following categories:

- **Apparel** - Shirts, Blouses, Dresses, Pants, Shorts, Activewear, Sleepwear, Sweaters, Formalwear, Suits, Jackets, and Accessories

- **Household and Institutional Textiles** - Table Linens, Bed Linens, Towels, Blankets, and Shower Curtains

- **Textiles for Interiors** – Window Treatments, Upholstered Furniture, Lamp Shades, Comforters, Wall Hangings, Cushions, Throw Pillows, and Carpets

Nylon, Tufted, Cut Pile, Product Dyed Carpet
Sacks Made of Different Materials – Olefin is now commonly used in place of the jute fibers.
Medical Textiles – Self-adhering, elasticized bandage and absorbent pad used for wound care

bandage wrapped partially to show the pad

no clips
Protective Clothing

Courtesy DuPont Personal Protection
Olefin Tape Yarn – Fibrillated tape yarn used as twine in greenhouses to support tall plants

twine tied to pepper plant

twine opened to show the fibrillation
Fabric Performance

Fabric Performance includes factors that affect appearance, comfort, and durability.

Aesthetics
- Physical Appearance
- Drape
- Wrinkle & Crush Resistance
- Dimensional Stability
- Shape Retention
- Snagging
- Pilling
- Colorfastness

Comfort
- Moisture Management
- Air Permeability
- Thermal Insulation
- Stretch and Recovery
- Static Charge Buildup
- Tactile Properties
- Skin Irritants/Allergens

Durability
- Strength
- Abrasion Resistance
- Weathering Resistance

Note: For certain applications, safety (e.g., flammability) plays an important role.
Aesthetics includes characteristics/properties that affect appearance when an item is new as well as during its use:

- **Physical appearance** includes color, luster, and opacity of a fabric. Physical appearance of a textile is often an important criterion for the consumer.

  - **Color** - with the exception of naturally colored fibers, color is primarily influenced by the selection of colorants and methods of adding color.

  - **Luster** – sheen that results when light reflects off the surface. Luster is influenced by fiber shape, smoothness of the yarns, fabric construction and a few finishes.
**Fabric Performance - Aesthetics**

- **Opacity** is the ability of the fabric to hide the object behind it. It is affected by the transmission of light through the fibers and yarns as well as cover factor (the ratio of the surface covered with yarns to the total surface).
- High opacity is typically desirable for pants and swimwear.
- Low opacity (transparent or translucent) fabrics are desirable for sheer curtains, lamps shades and sheer blouses.

Printed paper placed behind the fabric to demonstrate opacity:

- High Opacity
- Medium Opacity
- Low Opacity
Note: **Opacity** is the ability of the fabric to hide the object behind it. It is affected by the **cover factor** (ratio of the surface covered with yarns to the total surface) as well as the **transmission of light** through the fibers and yarns. Thus, tightly woven fabrics constructed with transparent or translucent fibers may have an excellent cover factor, but not opacity.
Fabric Performance - Aesthetics

- **Drape**
  - The way a fabric falls while it hangs. Flexible fabrics hang in pleasing folds; stiff fabrics do not drape well.
  - Note: Flexibility/stiffness and weight affect both drape and hand. Fabric hand is the sensory response to touch, whereas drape is evaluated visually.
  - Good drape is desired for many garments; stiffer fabrics are preferred for certain styles. Fabric that drapes well is often used for draperies.
  - Fiber content, yarn twist, fabric construction and weight are the major factors that affect drape.
**Wrinkle and crush resistance** refer to the ability of a fabric to return to its original position when distorted due to bending, wrinkling, and crushing.

- **Wrinkle resistance** is important for textiles used in apparel and interiors.
  - Retention of appearance is evaluated by testing to compare different fabrics. If a fabric recovers from folding or creasing, it is said to have good wrinkle recovery.
Wrinkle Recovery Test

Photographed with permission of JCPenney Product Research & Technology Laboratories
• **Crush resistance** is the ability of the material to return to its original configuration after compression.

• Crush resistance is important for pile carpets and rugs as well as other fabrics with a raised surface.

• Wrinkle recovery and crush resistance are influenced by the resilience of the fibers, yarn properties, fabric structure and finishes.
Fabric Performance - Aesthetics

- **Dimensional stability** is the ability of a fabric to resist shrinkage or gain during use and care. Changes in dimension are typically due to:
  - **Relaxation shrinkage/gain** - Because fabrics can be stretched out of shape during manufacturing, some change in dimensions can occur the first few times that the fabric is washed; it is irreversible. Fabrics are preshrunk or heat set to reduce relaxation shrinkage/gain.
  - **Felting shrinkage** (applicable only to wool) - The scale surface of the fibers interlock when the fabric is subjected to moisture, heat, and agitation; it is irreversible.
  - **Residual shrinkage** – A reduction in length results from fiber swelling during washing; it is often reversible.

- **Shape retention** is the fabric’s ability to retain its shape during use. Terms such as sagging are used to describe poor shape retention.
Dimensional Stability is calculated by measuring the fabric along the length and width before and after laundering. Shrinkage or gain is calculated as % of the original length and width. Note: Fabric distortion, an equally important factor, can be determined by measuring the fabric diagonally.
Note: The sweater, washed in warm water and tumbled dry, shrank due to felting. The sweater outline was drawn with a red marker prior to washing.
**Snagging** is the pulling of yarn(s) during use.
- Fabrics with smooth or high twist filament yarns, long floats, and open structure may snag easily.
- Loops in loosely knit fabric may also snag.
- Snags affect fabric appearance (more often in white or pastel colors).

**Pilling** is “the tendency of fibers to work loose from a fabric surface and form balled or matted particles of fiber that remain attached to the surface of the fabric” (Source - *Dictionary of Fibers and Textile Technology*).
- Pills form when a fabric rubs against any other surface during use and care.
- Fiber length and strength, yarn twist, yarn hairiness, and fabric construction are major factors affecting pilling.
Pilling
**Fabric Performance - Aesthetics**

- **Colorfastness** is a product’s ability to retain color during use and care. In some cases, the transfer of color from a colored textile to another textile is also considered.
  - Colorfastness is important for most fabrics and end uses.
  - The color is "fast" if it does not bleed, crock, or fade. Type of dye, method of dyeing or printing, and conditions of exposure contribute to colorfastness problems. Colorfastness is typically more of a problem with dyed natural fibers such as cotton and silk.
  - Laboratory tests are conducted to measure colorfastness to bleach, perspiration, salt water, washing, dry cleaning, rubbing (crocking), light, fumes, and other factors. Testing is based on intended end use.
Colorfastness to ......

- fading
- sunlight
- localized change
- frosting (abrasion)
- staining
- crocking (rubbing)
- color change
- fumes
- bleeding
- water
- perspiration
- staining
Tester to Measure Colorfastness to Light

Photographed with permission of JCPenney Product Research & Technology Laboratories
Colorfastness to Light

Sample A  Sample B  Sample C

Note: Colorfastness tests are conducted for all colors in which the product is available, as there may be differences between dyes from the same dye class due to differences in dye chemistry. The top half of each sample serves as the control.
AATCC Crockmeter to Measure Colorfastness to Crocking
Colorfastness to Perspiration – Appliqué stains certain stripes of the multifiber swatch

Note: The fabric specimen with simulated acid perspiration solution and a multifiber swatch are placed between plastic plates at a set pressure and heat. They are then evaluated for color change and staining.
• Comfort is a complex phenomenon that is often difficult to quantify.
  
  o Factors such as climatic conditions, level of activity, and individual differences in tolerating discomfort also affect comfort.

• Comfort is enhanced by characteristics or properties of the fabric that enable the body to maintain a stable core temperature, allow ease of body movement, and do not irritate the skin.
**Fabric Performance - Comfort**

- **Moisture management properties** play an essential role in maintaining comfort. They include the following:
  - **Repellency** is the ability of the fabric to resist water penetration; water is not held within its structure.
  - **Absorbency** is the ability of the fabric to take in and hold water/perspiration.
  - **Wicking** is the ability of the fabric to transport liquid water or water vapor from one location to another. In textiles, this transport is achieved by capillary action along fiber surfaces.

- Environmental conditions, physical activity, and garment design (loose fitting vs. snug) also affect comfort.
  - For garments such as sportswear, moving the moisture away from the body (wicking) is preferred. Fabric with high absorbency may not be desirable when physical activity is high in a hot and humid climate as the fabric does not dry easily and therefore feels clammy.
  - Note: For applications such as a towel, absorbency is necessary.
• **Air Permeability** is a measure of air flow through a fabric.
  o Often related to the “breathability” of the fabric
  o Openness of the weave is directly related to fabric breathability.
    – Open weave fabrics are more air permeable, more breathable.
    – Compactly woven, satin fabrics are less air permeable, less breathable.

The open weave fabric on the left is more air permeable than the denser weave on the right.
**Fabric Performance - Comfort**

- **Thermal insulation** is the fabric’s ability to provide insulation by trapping air adjacent to the body.
  - Thermal insulation enables the body to maintain its core temperature in cold climates.
  - Fiber content, yarn bulk, and fabric construction affect thermal insulation.

- **Stretch and recovery** relates to fabric’s ability to stretch and return to its original shape.
  - Stretch and recovery allow easy body movement in garments that are snug and do not have design ease.
  - Fiber elongation, elastic recovery, and yarn texturing affect stretch and recovery.
Fabric Performance - Comfort

- **Static buildup** is the charge that builds up in fabrics made of fibers with poor electrical conductivity and low moisture absorption.
  - Fabrics with static buildup cling to the body in dry conditions.

- **Tactile properties (fabric hand)** includes properties such as texture, stiffness or smoothness that affect how a fabric feels when in contact with skin.
  - Fiber flexibility and resilience, yarn structure and loftiness, and fabric structure each affects how the fabric feels when it contacts the skin.

- **Skin irritants/allergens** addresses factors that may cause skin irritations due to allergic reaction or contact with a rough fabric surface.
Durability includes characteristics/properties that affect the ability of the fabric to perform satisfactorily throughout its life. Durability is very important for fabrics used for interiors, especially for commercial places such as hotels and hospitals.

- **Strength** is a measure of the force required to break or tear or in some other manner cause a fabric to rupture. It is often used as an indicator of how long a fabric will last. The following are examples of different types of strength.
  - **Tensile or breaking strength** is the force required to pull fabric apart longitudinally.
  - **Tearing strength** is the force required to rip fabric apart by tearing across the yarns.
  - **Bursting strength** is the force required to burst knit or nonwoven fabrics in a multidimensional manner (rather than along one particular direction of the fabric).

Fiber strength, yarn, and fabric construction affect fabric strength.
Note: The Instron tester is used to measure mechanical properties such as tensile strength, tearing strength, elongation, and fabric fatigue.
Mullen Bursting Strength Tester – Bursting strength is measured for knit fabrics.
**Fabric Performance - Durability**

- **Abrasion resistance** is a fabric’s ability to withstand wear due to rubbing against another fabric or surface. It includes:
  - **Flat abrasion** - wear of a fabric surface when the fabric is flat and stationary (e.g., abrasion of an upholstered chair seat)
  - **Edge abrasion** - wear of a fabric surface along a folded edge (e.g., abrasion of cuffs or collars and pant hems)
  - **Flex abrasion** - wear of a fabric which results from repeated flexing or folding (e.g., abrasion of a seat belt)

Fiber strength, yarn structure, fabric construction and many other factors affect abrasive wear.
Flat Abrasion Test with Martindale Tester

specimen holder

abradant fabric

fabric specimen

abradant fabric

Photographed with permission of JCPenney Product Research & Technology Laboratories
Abrasión – Abrazo plano en una silla tapizada
Abrasion - Edge abrasion in cotton shirt collar

Note: Edge abrasion is a result of the collar rubbing against the neck. Only the collar of this shirt is worn.
**Weathering** is a fabric’s ability to withstand environmental conditions such as sunlight, heat, and moisture as well as exposure to polluting gases. Combinations of these factors are also examined since they interact to create damage in materials.

- The term ageing is used for items that are used or stored for a long period.
- The consequences of weathering/ageing include color loss, strength loss, increase in stiffness or brittleness (or in some cases softness), or other changes that prevent the material from performing well.
Fabric Care

- Major factors that affect cleaning, ironing, and storage of textile items are discussed for all fibers and in subsequent sections of iTextiles™.
  - Although product care is based on all components of a product, fiber properties have a major impact on cleaning, ironing and storage. Therefore, the section on care is covered in greater detail for fibers.

- Knowledge of textile materials assists the manufacturer in determining the care requirements for the products.
  - It is important to note that fabric is only one aspect to be considered in cleaning. Other factors, such as construction and components such as non-textile components, are also taken into consideration.

- Industries related to product care have undergone major changes to minimize impact on health and the environment.
  - Energy efficient washers and dryers are being used.
  - Cleaning aids such as detergents have undergone changes.
  - Dry cleaning solvents have been changed.
Fabric Care

• Labeling requirements vary by country. In the United States care labels on apparel and other textile items are required by law, whereas in Canada it is voluntary.
  o The United States Federal Trade Commission (FTC) enforces the care labeling requirement.
  o Labels must be based on reasonable evidence that supports the care instructions. (See information on care labels under Textiles in Today’s World, Regulations).

• Care labels assist consumers in caring for textile items. Text and approved symbols communicate information regarding:
  o Sorting – e.g., wash with like colors
  o Washing – e.g., wash with cold water, gentle cycle
  o Drying – e.g., low temperature, remove immediately
  o Ironing - e.g., high setting with steam
  o Dry Cleaning – e.g., solvent

• Information under care includes information that relates to cleaning, ironing, and storing of textile items.
Fabric performance determines care. The major factors that affect cleaning (including drying), ironing, and storage are:

**Ironing**
- Ironing Temperature
- Resiliency
- Moisture Properties

**Cleaning**
- **Washing and Drying**
  - Effect of Chemicals
  - Fabric Construction
  - Colorfastness to Washing
  - Action of Heat
  - Dimensional Stability
- **Dry Cleaning**
  - Action of Solvent
  - Moisture Properties
  - Colorfastness to Dry Cleaning
- **Stain Removal**
  - Action of Solvents
  - Action of Oxidizing Agents
  - Affinity for Oils (Oleophilic)

**Storage**
- Resistance to Insect Damage
- Resistance to Mildew
- Fabric Construction
Suggestions for Studying

- At the beginning of the course, browse through the software and get familiar with the features of iTextiles™.

- Use the Lectures as a guide. The slides provide you with an outline and highlight the key points in each section. Additional information is included as notes.

- Utilize resources in the iTextiles™ e-Textbook.
  - Additional Images and Manufacturing Videos in each section.

- Enhance your knowledge by using samples in your textile swatch kit. The kit gives you the opportunity to touch, feel, and examine textile material more closely.

- Use the Interactive Self Study to assess your knowledge.

- Examine material descriptions in online and print catalogs.

- Enjoy the lifelong learning process!