

# Science Skills in the Clothing and Fashion Merchandising Industry

**W**HAT IS THE PURPOSE of clothing? Your clothes do more than just make you look good. They keep you warm in the winter and cool in the summer. They protect you from the sun and can even make you feel good about yourself. In this unit, you will learn how science is applied in the clothing industry to achieve all these results and more. You will also learn how fabric is made and how designs are added to fabric to give you more options when you are trying to choose the perfect outfit.



## Objective:



Describe how science is used in the clothing and fashion merchandising industry.

## Key Terms:



ambient

anatomy

capillary action

chromatography

conduction

convection

evaporation

homeostasis

lockstitch

physiology

polymer

radiation

SPF

thermal

thread count

warp

weft

## Science of Clothing

**Physiology** is the study of the function of an object. For example, high-performance protective clothing is studied for use in outer space, varied climates, under water, hunting, military operations, and athletic performance. Fibers and clothing design are studied in conditions that match the performance needed.

Clothing is designed to be **thermal**, which means it has the ability to promote or retain body heat. Clothing is used to compensate for the **ambient** (in the surrounding area) heat, allowing sweat to evaporate. **Evaporation** is the process in which a liquid changes to a vapor without boiling. When clothing is layered, the fabrics insulate people, helping to maintain body heat when the weather is cold.

## HEAT TRANSFER AND CLOTHING

There are three ways in which heat is transferred: conduction, convection, and radiation.

### Conduction

**Conduction** is a heat transfer method in which there is direct contact with the heat source. For example, hunters may wear electric socks, with wires in the fibers, to warm their feet in cold weather. Chemical hand warmers use conduction to transfer heat to hands when the warmers are placed in pockets or mittens.

### Convection

**Convection** is heat transfer through the physical circulation of air (by fan, wind, etc.). Hot air rises, and cold air falls. The COOLMAX® fabric brand is designed for air movement that pulls moisture away from the skin and spreads the moisture across the fabric to increase evaporation. Cooling headbands use a polymer, which produces a cooling effect. A **polymer** is a chemical compound made of many monomers in a chain or other formation that may be natural or synthetic. As the polymer draws moisture to the fabric surface, it cools the neck or forehead.

### Radiation

**Radiation** is waves or rays of heat transferred through space. Dark clothing absorbs radiation heat waves from the sun more readily than light clothing. Some sun-blocking clothing is designed to protect people from the sun's ultraviolet rays. This clothing has an **SPF**, or sun protection factor, number on the label.



**FIGURE 1.** Clothing is designed to be thermal, which means it helps a person retain body heat and stay warm when it is cold outside.

## MASLOW'S HIERARCHY OF NEEDS AND CLOTHING

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Maslow's hierarchy of needs is a theory proposed by psychologist Abraham Maslow in 1943. The theory can be related to clothing. In Maslow's hierarchy, a person moves upward from physiological needs, to safety needs, to psychological needs, to needs for esteem, and finally to self-actualization.

### Physiological Needs

Physiological needs are oxygen, food, water, sex, sleep, and excretion. Physical needs include **homeostasis** (the maintenance of equilibrium in physical needs). Clothing can meet the need of homeostasis with coverings that maintain a constant body temperature.

### Safety Needs

Safety needs include the security of the body. Clothing provides covering for the body. Fibers may be designed for safety, to prevent overheating, or to aid in the retention of body heat.

### Psychological Needs

Love, affection, and belonging are other needs from Maslow's hierarchy. Clothing can be given to someone for reasons of love and affection. A uniform, a specific style of clothing, or a brand name may provide someone with a feeling of belonging.

### Needs for Esteem

Esteem includes confidence. The type of clothing worn in different situations can help improve self-confidence. Safety fabrics may provide the wearer with confidence to complete a dangerous task.

### Self-Actualization

Self-actualization is the highest level of Maslow's hierarchy of needs. All other needs must be met before someone can obtain self-actualization. Creativity in clothing styles may be found in someone who has reached the self-actualization level.

## ANATOMY

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**Anatomy** is the study of the physical structure of the body or an object. The quality of a garment is determined by how it is assembled and whether the appropriate fabric is used. U.S. laws require that fiber content labels be present on all garments. **Thread count** is a number that indicates how many threads are present per square inch. Twist per inch (TPI) measures how many twists a yarn has per inch. Yarns may be one-ply, in which a single thread is twisted,

or two-ply, in which two strands are twisted together, or they could have multiple yarn picks inserted.

## WARP AND WEFT

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Fabric is woven using warp and weft yarns. **Warp** yarns are the lengthwise threads in plain weaving that use an “s” or a “z” twist. The warp yarns hold the tension on the loom. **Weft** yarns are the threads that run parallel to the warp and fill in between the warp yarns in plain weaving. Originally, a shuttle was used to move the weft when the alternating warp was raised.

## VARIED FABRIC WEAVES

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Fabric weaves are varied. The most common fabric weaves are plain, satin, and twill. Other weaves include basket, jacquard, rib, dobby, leno, and oxford.

## QUALITY CONSTRUCTION

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Quality garment construction is apparent by the inside construction fine points and the outside appearance. The use of properly constructed interfacing and linings allows a garment to hold its shape. Seams should be sewn with a lockstitch and should not unravel with one tug of a loose thread, as in garments sewn with a chain stitch. A **lockstitch** is a sewing machine stitch formed by the looping together of two threads, one on each side of the fabric being sewn. The lockstitch produces the sturdiest seam, as the stitch is locked in place. In contrast, a chain stitch forms a chain on the underside of the garment, is quicker to sew, and can easily be unraveled.

Other signs of a quality garment include designs that match and thread that matches the fabric. Transparent thread unravels easily but is sometimes used to reduce costs. Most garments should be stitched with small stitches that are not puckered. Puckered seams cannot be removed by pressing. Quality garments have appropriate seam allowances, width, and finish.

## NATURAL AND SYNTHETIC FIBERS

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Fibers may be natural or synthetic (made by humans). The use of these fibers depends on the purpose of the item being created.

### *Natural Fibers*

Natural fibers come from animal or plant sources. Examples of natural fibers from animal sources are angora fur from Angora rabbits, mohair from Angora goats, alpaca from a member of the camel family, cashmere from Kashmir goats, wool from sheep, and silk from silkworm filament. Examples of natural fibers from plant sources are cotton, linen from the flax plant,

ramie from natural Chinese grass, hemp from the *Cannabis sativa* plant, and bamboo. Cotton fabric is generally selected for garments and home furnishings based on its comfort. For instance, cotton would be a good choice for T-shirts because its characteristics include warmth, strength, and absorbency. On the other hand, cotton is not the best fabric for athletic wear because it does not wick moisture away from the body, and it dries slowly.

## Synthetic Fibers

Human-made fibers are known as synthetic fibers. Acetate is a fast-drying, silk-like fiber used for linings, draperies, upholstery, bedspreads, and wedding attire. Acetate must be dry-cleaned. Acrylic is a wool-like fiber that breathes well. It is widely used in rugs, upholstery, and knits. Aramid, which is a shortened form of “aromatic polyamide,” is a fiber used for Kevlar® bulletproof vests and fire-resistant fabrics.

Modacrylic is a copolymer fabric made from acrylonitriles and other polymers. It is flame-retardant and is often used to manufacture children’s pajamas. Nylon is a silk-like fabric used for dresses, stockings, carpets, and scarves. A DuPont scientist invented nylon just prior to World War II as a replacement for the hard-to-get silk fabric needed for parachutes.

Olefin, also known as polypropylene or polyethylene, is a durable and hard-wearing fiber used extensively for home furnishings, carpet, and some clothing applications. Olefin is created when polymers are melted and forced through a spinneret to create a long fiber.

Polyester is a wrinkle-resistant and resilient fiber product made from synthesized polymers. It holds its shape well and is often blended with natural fibers. Polyester fabric has a good drape and is constructed into shirts, blouses, dresses, and suits. However, it is highly flammable. It is the same material used to make plastic drink bottles.

Spandex is a stretchy fabric made from polymers. It is used extensively for athletic wear and exercise clothing. Spandex is able to expand up to 600 percent and not lose its shape, so it is often a material in foundation garments, bathing suits, and surgical compression bandages.



**FIGURE 2.** Cotton would be a good choice for T-shirts because its characteristics include warmth, strength, and absorbency.

## MANUFACTURED FIBER

Rayon is a fabric that cannot be easily classified as either natural or human-made. It is the oldest manufactured fiber. It was developed in the 1880s in France as an inexpensive alternative to silk. However, it is not considered a synthetic fiber because it is manufactured from regenerated cellulose. Rayon is used in the production of shirts, blouses, skirts, dresses, and evening clothes.





## FURTHER EXPLORATION...

### ONLINE CONNECTION: Batik Fabrics

The batik technique is a lengthy process of adding designs to fabric. Wax or blocks are applied to the fabric, and then dye is applied to the remaining areas. The process may be repeated several times, resulting in a complicated pattern with a variety of colors. The technique is popular in Indonesia. Batik fabrics are ideal for quilting but may be used in many other ways.

Visit the following Web site to view a video that describes the batik technique in detail. The narrator shows the blocks traditionally used in the process. You will also see examples of fabrics created with the batik technique.

<http://www.youtube.com/watch?v=WeSfW1mozDY>

## ADDING DESIGNS

Printed patterns are applied to fabrics with ink or dye. Some fabric printing methods are block printing, roller printing, and direct printing. In block printing, carved blocks are covered with ink and are pressed onto the fabric. In roller printing, a roller is covered with ink or dye, and a continuous pattern is rolled onto the fabric. In direct printing, a digital inkjet printer places the design on the fabric.

Woven patterns are added to fabrics with the use of dyed warp and weft yarns. Dyes from animal, vegetable, and mineral sources are applied to fabrics and yarns via a variety of materials and processes. Dye processes include acid, azoic, basic, disperse, mordant, reactive, and vat.

The batik technique traditionally uses a wax-resist method to design a pattern. Wax is applied to a fabric in a pattern. Dye is then applied to color all the wax-free areas. The wax is then removed from the fabric.

Embroidery patterns are stitched in decorative designs by hand or by machine.

**Chromatography** is a process in which the components of a chemical mixture carried by a liquid or a gas are separated. It uses **capillary action**, which is the force that grasps or sucks a solid or a liquid. The process is used in dyeing certain fabrics. As the dye for a saturated color separates, its components are wicked up into the cloth to varying degrees, depending on their weights and their attraction to the fabric.

## Summary:



Clothing is designed to meet your physiological needs by keeping you warm or cool. It may also offer protection for your skin from sun damage. Some fibers provide even more protection, such as aramid, used for Kevlar® bulletproof vests and fire-resistant fabrics. Fabric is woven using warp and weft yarns. The weaves vary, resulting in different types of fabric. Signs of a quality garment include quality construction, proper use of interfacing, lockstitches, designs that match, and thread that

matches the fabric. Fibers may be natural or human-made. Natural fibers come from animal sources or plant sources. Human-made, or synthetic, fibers include acetate and acrylic. Printed patterns are applied to fabrics with ink or dye in a variety of methods.

## Checking Your Knowledge:



1. What are the three methods of heat transfer?
2. What is Maslow's hierarchy of needs?
3. What are some signs of quality fabric construction?
4. What are some examples of natural fibers?
5. What are some examples of human-made fibers?

## Expanding Your Knowledge:



Examine the tags in your clothing. Do you own more items made of natural fibers or human-made fibers? Think about how much you usually pay for clothing. Go to a store and look for clothing that is significantly more or less expensive than the items you typically buy. Do you notice a trend? Are human-made fibers generally more or less expensive than natural fibers? Determine whether the prices of natural fibers vary based on whether the fibers come from animal sources or plant sources.

## Web Links:



### COOLMAX® Fabric

[http://www.coolmax.invista.com/g\\_en/webpage.aspx?id=15](http://www.coolmax.invista.com/g_en/webpage.aspx?id=15)

### Fabric Care

<http://www.fabrics.net/fabricca.asp>

### Lycra

<http://www.lycra.com/>

### Rayon Fiber

<http://www.fibersource.com/f-tutor/rayon.htm>