Textiles that are intended to protect the wearer often incorporate finishes or fabric design features that are designed to help achieve that end. However, the workhouse job of protective finishes for fabrics is to protect the fabrics themselves from physical, chemical, and microbiological harm and deterioration during manufacturing, shipping, storage, use, and abuse.

Why protect a fabric? Simply put, all textiles serve a function—from socks that keep your feet warm, to an umbrella or an awning that keeps you dry—and anything that helps to preserve that function is beneficial to the ultimate consumer of that textile as well as everyone else in the supply chain.

**THREATS**

**Light, Air, and Motion**

Fabrics are exposed to a variety of environmental threats during both use and storage. Wrinkling, tearing, and abrasion from movement can damage the aesthetics and function of a fabric. Ultraviolet light exposure can cause fading and physical degradation. Chemicals and air pollutants such as ozone, nitrous oxides, and sulfur oxides can degrade fibers and cause changes in color.

"Whether outdoors or indoors, all kinds of garments or industrial fabrics need protection against chemical, physical, and biological entities and phenomena that assault textiles and require protective strategies," says Curt White of Aegis Environments.

**Stains and Odors**

Stains and odors damage the aesthetic function of the fabric and can even reduce the comfort of a garment. "Odor has a fundamental influence on people’s comfort, sense of wellbeing, and even on their health," notes John D. Payne of Arch Chemicals. Additionally, stains and odors are the cause of more frequent laundering and harsher laundering conditions, reducing the functional life of a textile.

Stains can come from an array of sources, many of them either oil- or water-based. Odors can come from sources like sweat, smoke, or cooking. Bacteria, molds, and mildew can cause both odors and stains, and furthermore cause deterioration.

**Fire and Water**

Moisture can be detrimental to the function of some textiles. According to Rick Sargent of Peach State Labs, the ability to repel moisture can extend the life of a textile. "For example, air-conditioning filters lose effectiveness if they become wet. Moisture also encourages microbial growth."

Mimi Cartee of Ciba Specialty Chemicals concurs that moisture can seriously compromise a textile’s function. "If water gets in between the layers of a bullet-proof vest, it can get"
trapped between these layers. As well as making the vest heavier to wear, the moisture trapped between the layers can deteriorate the fibers and reduce the useful life of the vest.”

On the opposite end of the spectrum, fire can obviously be harmful to textiles as well. In many applications, the ability to resist flammability is a critical part of a fabric’s function.

In Action and at Rest
White notes that besides usage conditions, textiles can be at risk during storage and transportation. He tells of a shipment of shoes manufactured in southern China shipped out during the monsoon season and arriving green and fuzzy from fungal and bacterial growth by the time they got to port. Other shipping and storage problems can include phenolic yellowing of white garments from out-gassing chemicals in plastic storage bags. White says that millions of dollars worth of textile products are lost every year due to damage sustained during shipping or storage. And not just lost dollars are at stake, but lost time, lost advertising, loss of products on the shelf, loss of reputation, and loss of market share can be affected.

PROTECTION
While protecting against various agents is important to preserving the function and extending the life of the fabric, protecting textiles against all available threats would be a supremely complex and costly endeavor. “There has to be a marriage of fabric construction, fibers, and finishes,” says Tom Weinbender, of Schoeller Textil USA. “They all have to work together. The final application must always be kept in mind.” Different applications demand different levels of protection and different kinds of protective finishes.

Antimicrobial Finishes
Antimicrobial finishes are popular in many different applications. Situations like White’s example of shoes shipped during the rainy season, where textiles will be exposed to unusual levels of moisture or humidity during storage or normal use, are often ideal conditions to foster microbial activity.

According to Thomson Research’s Glenn Runciman, “Under ideal conditions, bacteria can double in numbers every 20 minutes.” But not every textile will be placed in a condition that fosters such rampant bacterial activity. And bacteria are not the only microbial threat to fabrics. There are different kinds of antimicrobial finishes, appropriate for different applications and levels of protection.

Sometimes the use of antimicrobials is necessary to maintain the physical integrity of the textile. According to Dave Klein of Thomson Research, the antimicrobial finishes involved in these applications would typically be for rot resistance and stain prevention and would protect against fungi, bacteria, and algae. The antimicrobial performance is a necessity in these applications, with failure to perform resulting in recalls and loss of future product sales. Most of these applications would involve marine textiles or textiles for other outdoor uses such as tarps, awnings, tents, boat covers, and outdoor furniture. Thus, the antimicrobial finish used in these applications must be able to withstand the weathering and soiling that exposure to an outdoor environment would involve.

Another application area where the antimicrobial performance is critical would be in medical applications. According to Payne, many medical applications demand powerfully bactericidal antimicrobials that will perform quickly to help maintain sterile environments. Other medical applications may require antimicrobials to simply minimize environmental bioburdens. Finishes for this application need to be extremely durable to be able to withstand the high temperatures and chlorine bleach used in industrial laundries.

Institutional applications, such as uniforms and hotel and restaurant linen, would be similar in their demand for durability to industrial laundering. However, for these applications the antimicrobial would only be required to have a bacteriostatic effect to control stains and...
odor, not maintain a sterile environment. The action of the antimicrobial can also take place over a longer period of time.

Apparel and home textiles applications such as active wear, linens, hosiery, underwear, carpeting, and upholstery may use antimicrobial finishes to control odor and staining. The antimicrobial action may be antibacterial or antifungal, and need not be extremely powerful or fast acting. According to Payne, the antimicrobial would serve the consumer’s desire for “freshness,” and, in controlling odors, would prevent additional launderings and extend the useful life of the product. The finish would be required to be durable to care such as home laundering for the lifetime of the product.

Antimicrobial finishes can also be applied to disposable textile products such as nonwoven disposable wipes. Durability of the finish is important to minimize dilution and effectiveness when used wet, stop the potential for transfer to food or humans, and to minimize risks of microbial adaptation. Powerful and quick action against a broad range of microbial threats would be required.

UV Protective Finishes

Ultraviolet (UV) protective finishes are also useful in a variety of applications. According to Brad McClanahan of Clariant, “Sustained exposure to UV rays can damage dyes and cause color fading.” Cartee notes that extensive UV exposure can deteriorate textile fibers as well. Because they protect against color fading and fiber deterioration, UV protective finishes are a necessity for applications such as awnings and outdoor furniture. Since automobiles are exposed to large amounts of UV radiation, protective finishes can be important for the textiles in many auto interiors.

Applications such as curtains and window coverings, carpeting, and upholstery can also benefit from UV protection. Although the use of UV protective finishes in outdoor apparel and swimwear is designed to protect the wearer from excessive UV radiation exposure, the addition of the finish protects the fabric from fading and deterioration as well.

Fire Retardant Finishes

Unlike some other finishes, fire retardant finishes are not as widely used in many applications, since textile flammability issues are heavily legislated. According to Mike Zavaglia of Amitech, mandatory testing for efficacy as required by legislation can sometimes be expensive. “The full-size testing required to meet the new California mattress flammability standard can run into several thousands of dollars.”

The purpose of fire retardant finishes in textiles is to prevent the ignition of a fire or limit its spread. Fire retardant finishes are called for in applications that can include curtains, upholstery, and mattresses in institutional situations, and upholstery in airline seating and other transportation applications. New legislation by the state of California may increase applications in consumer upholstery, bedding, and mattresses as well.

Although a variety of solutions exist to meet the legislated standards, flame retardant finishes provide a relatively inexpensive solution versus other solutions available on the market, according to Zavaglia. Flame retardant finishes also expand the range of fibers available for use in these applications. “Using flame retardants, a manufacturer is able to use certain fibers that he would be unable to use otherwise,” notes Cartee.

Stabilizing Finishes

Certain applications may require additional dimensional stability, abrasion resistance, or appearance retention, such as garments, tent fabrics, or marine fabrics. Durable press finishes provide wrinkle resistance to some fabrics, while coatings increase abrasion and pilling resistance and lend additional dimensional stability to others.

Moisture Control Finishes

According to McClanahan, “Water repellent finishes are commonly used in textiles such as upholstery, awnings, and marine covers, among others.” Moisture repellent finishes can be important not just in situations where the textile is expected to get wet, but also for textiles frequently exposed to high levels of humidity. In these situations, discouraging the penetration of moisture may discourage bacterial and fungal growth as well, serving therefore to control odor and prevent staining, discoloration, and possible fiber degradation.

Other finishes try to attract or control moisture rather than repel it, such as those that chemically counter polyester’s natural hydrophobicity and allow polyester fabrics to have the moisture transport and breathability enjoyed by natural fibers. There are also applications that require the control of moisture in order to wick it away from the body, such as in an active wear garment or a pair of socks.

Repellant Finishes

Water is not the only substance that finishes are designed to repel or control.
Since many stains are either water- or oil-based, many stain repellent finishes are designed to repel water- or oil-based substances. “However, certain medical applications may require a finish with the ability to repel alcohol-based stains as well,” says Sargent.

Applications for water- and oil-based stain repellants include garments, upholstery, and carpet. According to Paul Johnson of 3M, stain repellants typically modify the textile substrate so that liquids or particles do not penetrate or are more easily removed. It is especially important to block stains on certain fibers, since once the stain sets, sometimes it can be impossible to remove. “Nylon carpets are particularly vulnerable to acid-dye stains that can result from spilled fruit-flavored drinks,” notes Johnson. Some finishes serve as stain repellants, some serve as stain release agents—allowing stains to be removed more easily—and some enhancements provide a combination of repellency and release.

In many cases, stain repellants, or fabric protectors as they are sometimes called, serve not just to make maintenance easier, but also to extend the life of the textile. “Protectors can delay the ‘ugly’ point,” says Johnson. “That point that each consumer decides the material is no longer acceptable for its intended use.”

### CARE

The intent of finish producers, product designers, and textile manufacturers is that the finish continue to enhance the performance of the fabric for the life of the goods. However, there are important care considerations on the part of the ultimate consumer that can ensure that performance for the life of the textile.

Following any care instructions on hang tags or labels is vital. Finishes are often affected by other chemistries. According to Payne, many antimicrobial finishes are adversely affected by chlorine bleaching. Drycleaning may affect some finishes. High temperature washing and drying may disturb the finish cure, according to Weinbender. He also cautions that coatings and laminations on fabrics may be damaged by cleaning systems that use high heat.

Experts agree unanimously that fabric softeners are an enemy of many performance finishes. “Fabric softeners have a negative effect on stain and water repellants,” notes Weinbender. “The function of these finishes can be harmed in as little as two washings with a fabric softener. Fabric softeners also adversely affect some antimicrobial finishes. Fabric softeners can destabilize a finished fabric, loosen up the fibers, and make the fabric less pill and abrasion resistant.”

### BALANCE

Despite all the useful applications for textile finishes, adding those finishes does not come without cost. “Any kind of finish will add extra cost to the fabric,” says Cartee. “The product designer has to decide if the added performance justifies the added cost.” Besides striking a balance between cost and performance, product designers and manufacturers must be aware of the necessity of striking a balance between improvement of performance in one area and possible loss of performance in another.

The addition of flame retardant finishes may affect the hand, breathability, or weight of the fabric. According to Weinbender, water repellent finishes may affect the fabric’s ability to be bonded or laminated, and stain repellent finishes may affect the fabric’s ability to be printed.

Providing a hydrophobic finish can often result in a fabric becoming attractive to oil-based stains. Conversely, making a fabric hydrophilic to improve comfort factors can also cause problems. “Water can move dirt and stains in with it, and making a fabric more hydrophilic can also mean that you’ve made it a better environment for micro-organisms,” notes White.

“Product designers must be sensitive to these issues,” says White. “The right fibers, the right construction, and the right finishes all sound very simple, but each is filled with different choices and costs. Protecting textiles is an art as well as a science. It demands attention to choosing materials of construction and finishes appropriate for the desired property of the finished goods and with the capability of being maintained for the desired life of the goods.”

### Reference
