Shade, and the art of daylighting

At its most basic, sustainability means making the most of what you have—and making it last. Fabric shade structures are covering all the bases ... beautifully.

By Todd Willmert

Humans are phototropic, which means we’re drawn to light—particularly sunlight. In fact, Seasonal Affective Disorder (SAD) is a real problem for those susceptible to the effects of reduced natural sunlight. Learning and productivity are wed to good daylighting in schools and workplaces. While light’s importance is widely accepted, its corollary receives less attention; if we seek light, the sheltering shade also draws us. Biblical passages speak to the ‘refuge’ of shade; the Qur’an praises the oasis of a ‘dense’ shade. Depending on the time of year and latitude, among other factors, shade is important for humans throughout the world.

If we talk of daylight, we must simultaneously address the need to moderate that light. On a clear or cloudy day, there are between 2,000 and 20,000 foot-candles of light. Daylight quantity is not the issue—quality is. Plants, trellises and integral building features, like overhangs, can help temper the intensity of daylight. Yet fabric remains the premium option, with awnings, banners, umbrellas and other elements critical in moderating daylight to improve light quality in buildings or create more habitable outdoor areas.

Solar gains, energy losses: harvesting sunlight efficiently

While the impetus to shade is grounded in improving light quality and creating a more comfortable building environment, other benefits quickly multiply. Most importantly, shading also can positively impact a building’s energy use. Arresting daylight reduces solar gains, which in turn cuts cooling costs, increasingly important given energy and sustainability concerns.

In larger buildings, cooling loads are the prime concern. Filled with heat-producing people, copies and computers, offices and schools in most climates are cooled year-round. Thus the goal is to cut solar gains, while simultaneously harvesting daylight to reduce electric lighting demands. We want to shade the skylights or windows; yet if you have to turn on the lights, what has been gained? Balancing these twin—and seemingly contrary—concerns is the art of daylighting.
Fabric has several advantages in addressing daylighting. In top lighting from skylights, fabric can admirably filter and soften incoming daylight. The shading surface is elevated, so the appreciable difference between locating the shading inside the glazed surface—disadvantageous as the solar gains will already have entered the building—and outside is minimized. Obviously, placing banners and shades inside the building poses fewer problems for a number of maintenance and structural reasons, but those heat gains can be vented outside easily through convection, or simply stratify at the roof.

With side lighting and windows, locating the shade outside the glass is most advantageous. In residences and other small buildings, awnings and other fabric shading can reduce heat gain by 55 to 65 percent on a south-facing window. On a west window, the reduction is more than 70 percent. Drapes or shades inside the building are of course another option, with different benefits and drawbacks. From an energy standpoint, interior fabric applications are less advantageous, as with top lighting. But interior applications, like shades, generally are controlled more readily by occupants, among other benefits.

In both top lighting and side lighting applications, fabric color impacts performance, as does the material’s translucency/reflectivity. Most fabric reflects between 50 and 70 percent of the incidental sunlight, and the designer also can control several variables to achieve greater energy efficiency, including layering fabric. Coordinating the mechanical and air circulation to perform is also possible; fabric has a low thermal capacity, making it possible to conduct warm or cool air directly through the material.

Revitalizing outdoor spaces

Considering a building’s context on the city street, fabric also contributes to the creation of outdoor rooms and spaces. In Spain, fabric canopies—toldós—suspended between buildings improve the summer comfort for people in the street. Fabric can make the outdoors more habitable, in the same ways as it improves interior spaces. At Arizona State University, researchers are even experimenting with circulating water through fabric, so the material might shade but also provide evaporative cooling.

Fabric is integral to the streetscape. Think Main Street, with the shopkeeper rolling down the awning to protect goods, and cool the store from the low afternoon or morning rays of the sun. The awning also quite likely announced the store, in the form of signage. Beyond this quaint notion of Main Street, fabric in the community context not only can provide comfort and advertising but contribute to revitalization. Fabric is an economical way to visually improve and spruce up depressed neighborhood districts or streets.

Sustainability in the broad sense means taking advantage of the existing building stock and streets and ensuring the economic vitality of neighborhoods. Fabric not only affords unique aesthetic opportunities, but the material has a capacity to incorporate signage or advertising and help create more habitable outdoor spaces. These factors all illustrate the possibilities of using the material to help with community revitalization.

Of course, there are other obvious benefits associated with fabric and outdoor spaces: sustaining our health. With skin cancer rates rising, UV protection is becoming a real issue. Fabric, with its ability to filter up to 95 percent of the damaging rays, is a prime choice for addressing shade at parks, playgrounds, pools and other outdoor spaces. At farms and nurseries, fabric shading is also important—commonly in the 20 to 50 percent range—in the conservation of water unduly lost through evaporation, and to otherwise protect certain susceptible plant species.

Recycling, all around

Aside from contributing to more sustainable environments—both inside buildings and outdoors—fabric itself is sustainable. Natural materials, like cotton or wool, harvested annually from agricultural resources, are of course renewable. Synthetic fibers are commonly made from petrochemicals, but plant-based synthetics are also available, and fabrics can also be woven even from recycled polyester or polyethylene.

Specifying sustainable fabric is important. It’s not only critical to understand material composition; understanding that the same material with different colors might have a different environmental impact is also necessary. Fabric dyes and pigments can be harmful, with some bright colors or dye retention processes associated with those notorious heavy metals. Fabric durability is also an issue: if a material has to be replaced too frequently, it is obviously not sustainable. The designer must consider fabric life-span in specifying.

The most sustainable fabric applications address the possibility of adverse weather events. Sustainable designs consider the fabric material itself as well as its frame and mechanical attachment. With the recent spate of devastating hurricanes, we know that fabric can be retracted or removed from a fixed frame before the storm strikes, to survive undamaged. Wood or metal structures may not be so fortunate.

Shade and consequences

The need to shade crosses continents, climates and cultures, and fabric is a favored choice. Fabric can be utilized inside or outside the building envelope to slash cooling loads. Its capacity to create outdoor spaces and rooms is unrivaled. In most applications, fabric can be flexibly ‘tuned.’ that is, retracted or deployed in response to varying conditions, or easily safeguarded before a devastating storm. This amply demonstrates the materials’ sustainable aspects, to say nothing of the fact that fabric itself can be sustainably fabricated.

When we speak of the ‘fabric of life,’ we mean the material metaphor for the interconnectedness of life on this earth. With sustainability concerns making us ever more aware of ecological systems and interdependence, fabric is more than a figurative metaphor; it is a material that very literally contributes to a more sustainable environment.

From the editors:

Fabric shade structures, in their infinite variety, are a sustainable choice for all of the preceding reasons, and more. They’re also the natural choice in a wide variety of markets, from agriculture to sports stadiums. In the following pages, we’ve chosen 11 different installations that we think best illustrate some of the incredible versatility of fabric shading. As you create others, we hope you’ll let us know.
When the architects at ProgressiveAE sat down to design a transit structure for the commuters of Grand Rapids, Mich., the swiftly flowing Grand River—the city’s major estuary and geographic landmark—was a natural model and source of inspiration. Opened in June, 2004, as the Rapid Central Station ('the Rapid' for short), the Interurban Transit Project (ITP) was quickly recognized by area commuters as an elegant confluence of form and function.

The three interplaying waves of fabric that make up the canopy make a broad statement standing opposite the Grand Rapids business district. One of the intents behind the design was simply to promote the city’s transit system. “The owner wanted to have the center make a very strong statement about the community’s commitment to public transportation,” recalls Jim Vander Molen, senior designer for the ITP project. “It needed to convey the sense of coolness, excitement [of using the system], something that enlightened, ecology-minded, future-oriented people do.”

The sheer size of the structure goes a long way in making this statement. Standing 173m in length and 30.5m in width, it is clearly a landmark to anyone approaching from downtown. Because the fabric panels have both reflective and translucent qualities, the structure itself becomes a comforting beacon for travelers when lit at night. Fiber optic lighting around the curves of the canopy gives definition and movement to the structure’s nighttime appearance. “The more we twisted it, the happier the membrane became in terms of stability. Now the concept and the medium were really integrated,” says Vander Molen.

The choice of a fabric covering also had an impact in terms of cost. Since the lighter fabric material makes less demand of the supporting steel, savings were realized in the building of the supporting structure. Maintenance costs were also minimized by the choice of a Teflon®-coated fabric that sheds much of the dirt and exhaust from the surrounding roads. The fabric used was Sheerfill 1 by St. Gobain Performance Plastics. Taiyo Birdair Inc. fabricated the cover.

According to Jeff Remtema, who oversaw the LEED certification effort for ProgressiveAE, “The fact that the canopy is a very light white color reduces the urban heat island effect.” The use of translucent fabric, while providing shade from direct sun, allowed enough light for the inclusion of a naturally cooling garden area within the platform. Highly recycled materials used in the supporting structure and the use of fabric as a safe and efficient reflector for lighting contribute to an overall design that meets high sustainability standards. As a result of careful and imaginative planning, the Rapid has received award citations from state and local chapters of the AIA, and also played a role in winning national honors for the city’s transit system.
On the road

Cruise control

The Port Canaveral Cruise Line terminal panels were designed and manufactured to decorate the outside of a five-story parking garage at a high-profile cruise terminal in Orlando, Fla. The colorful panels were designed to ignite excitement and eye appeal for cruise guests as they leave their cars behind in an otherwise drab building. Mesh fabric used in the panels allows visibility from within while still providing a good printing surface. The panel graphics can be seen from over a half mile away, heightening the anticipation of vacationers and advertising the terminal to passers-by. Functional as well, the panels provide a protective shade from long hours of subtropical sun. Sundance Awnings and Fabric Structures fabricated the project that was designed for Outdoor America by artist Margo McKnight.

A custom-welded frame by Wells Engineering was applied; the panels angle toward the ground for full visual effect after installation. The steel pipe frames were built in sections that sleeve together in the field. When finished, the panels ranged from 18m to 30m long and approximately 15m tall. The fabric for each panel was digitally printed with artist’s illustrations featuring wildlife indigenous to the Florida coastline.

The lovely bones

When Architectural Nexus Inc. added angular shade structures for a center car park, it solved several problems for the University of Utah Orthopedic Center in Salt Lake City. The sunshades were proposed as a compromise to the more problematic installation of planters: they break up the surface of the parking for those viewing this hillside site from above, but do not include the heavy loading of earth nor the complications associated with irrigating plants (such as leakage on cars below and freeze protection). The design of the shade structures (by Layton Construction) takes its cue from the building itself, which is composed of angled elements skewed one to another in an effort to reflect the broken and translated bone structures often found in orthopedic injuries.

Solar fabric Awntex 120 (The Astrup Co.) was selected for its translucency, durability and lightweight nature. One challenge that was managed by structural engineers Halander Engineers and fabricators Sugar House Awning and Canvas Products was the wind loading: by working together, the teams were able to find solutions to the cantilevered connections that preserved the intent of the design (maximized surface area) while ensuring that the structures would be safe in proximity to cars and pedestrians.

A visually exciting design for this parking garage terminal in Orlando, Fla. entices visitors to use the facility.

Architectural Nexus Inc.
Centennial Hill’s Park ‘kiddie land’ oasis is a colorful, inviting and safe outdoor play area for children of all ages.

**Float like a butterfly, shade like a tree ...**

Fabric shade structures can be designed in a variety of shapes and sizes. Tensioned fabric can be twisted, overlapped and angled into a virtually unlimited number of forms utilizing light, color combinations and translucency often found to be visually spectacular.

Architect Samuel J. Armijos, AIA, with Sun Ports International Inc., states: “Let’s not forget the benefits of a shade structure in improving social performance. Social performance is improving a place or space where social interaction can occur. This normally occurs through ‘space making’.” One space where “Fun Meets Shade Meets Creativity” is Centennial Hills. This masterplan community located in the far northwest corner of Nevada’s Las Vegas Valley is home to an eponymous park, formerly known as Deer Springs Park.

Centennial Hills Park incorporates Adventure Playground, replete with a splash pad to cool the furrowed brow and larger-than-life “natural” elements—daisies, mushrooms, frogs, toadstools, butterflies and caterpillars. Stantec Consulting Inc., of Las Vegas, and Cary Baird, landscape architect principal, prepared the master plan for Centennial Hill Park’s full build-out, then the working drawings for phase one (22 acres) of this ultimate 100-acre, multi-use city park. The custom playground, walking trails, dog runs, group and single picnic pavilions, professional volleyball complex and regulation soccer fields make this park stand out from others in southern Nevada. Sun Ports won an Industrial Fabrics Association International “Award of Excellence” for their innovative shade structures at Centennial Park.

The playful park features 25-foot by 25-foot freestanding butterflies and flowers in varying angles utilizing HDPE fabric. The different wing angles of the butterflies were meant to simulate the creatures flying through the flower patch—a theatrical touch that makes the park all the more unique and inviting. The appealing butterfly shade structures are supported by a sand-blasted powder-coated steel frame and steel connecting components.

The ShadeSure® fabric utilized by Sun Ports and other shade manufacturers is a unique knitted polyethylene mesh fabric which allows for cool air flow while blocking up to 98 percent of the sun’s harmful UV-B rays. The cloth is guaranteed to stand up to the conditions of any public area. Engineered and manufactured in South Africa by Multiknit 2000, ShadeSure’s fading is marginal after five years and life expectancy is estimated at a minimum of 10 years with continuous exposure. Fabric tops can be removed easily in severe weather conditions such as snowstorms or hurricanes.
At play

Private dining

West Coast awning and canopy design and fabricator Academy Awning worked closely with the chief engineer at a private elementary and middle school in Pacific Palisades to blend a subtle but highly effective free-standing canopy into the school’s sports field. The school had built an open-air lunch area beside one of the courts but soon realized they needed solar protection. Academy Awning matched the food area’s semi-circular plan with a sloping half circle canopy using Sunbrella Firesist, Forest Green from Glen Raven for the canopy and Textilene dark green mesh from Twitchell Corp. for the sidewall. The results satisfied the school’s weather concerns and aesthetic needs to perfection.

An attractive free-standing canopy shades an outdoor lunch area at a private school in Pacific Palisades.

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OBRA Architects, a New York City-based firm, selected Naltex netting as the primary shade cover in BEATFUSE!, their award-winning outdoor installation for the Seventh Annual Young Architects Program organized by The Museum of Modern Art and P.S.1 Contemporary Art Center. Custom-designed Naltex polyethylene netting serves as a shade cover over the largest of three outdoor spaces. The artwork encompasses seven curved, interconnected shells made of plywood in a triangular shaped courtyard.

The Naltex mesh, cut into hexagonal sheets, covers the open plywood structure. Each “scale” spans three to five feet and is attached in only one location, allowing it to flex under windy conditions. One of OBRA’s principal architects, Jennifer Lee, says that the mesh “created a certain level of shade to counteract sun in an outdoor environment and offered a moiré effect with layering that was an added, incredible phenomenon. The Naltex mesh suited our application because of its rigidity and openness. This wonderful combination of qualities allowed it to span a particular distance and be lightweight.”

Specific considerations were made to ensure the UV-stabilized mesh could withstand up to one year in an outdoor environment. Plus, the product was supplied in custom-sized sheets that could be easily handled and converted into the hexagonal shaped scales needed for OBRA’s design. The OBRA construction team found this decision to be a critical time saver, and they were pleased to complete the entire installation easily in time for the public opening.
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Architects Ball & Nogues warp time and space with the ‘Maximilian’s Schell’ installation in Los Angeles.

In the arts

**Maximum Schell**

‘Maximilian’s Schell’ is a vortex-shaped outdoor installation the size of an apartment building that has been stopping traffic in front of the Material & Application Gallery in Los Angeles since its unveiling in July, 2006. Constructed with tinted Mylar™ resembling stained glass, the swirling creation functions as a shade structure above the outdoor gallery. The interior of the experimental installation creates an environment for enhanced social interaction and contemplation by changing the space, color, and sound of the M&A gallery courtyard. During the day, the canopy casts reflected sunlight in colored fractal light patterns onto the ground, while underfoot a tranquil subsonic drone emanates from an integrated ambient sound installation by composer James Lamb entitled “Resonant Amplified Vortex Emitter.”

Architects Benjamin Ball and Gaston Nogues manipulated the Mylar—inernally reinforced with bundled nylon and Kevlar™ fibers—with a sophisticated computer-controlled cutting machine. The transparent amber-colored film offers UV resistance through a golden metallic finish. The result is not a tent-type structure, but a unique tensile matrix. The extreme intricacy and repetitiveness of the assembly pay homage to actor Maximilian Schell’s character Dr. Reinhardt in Disney Studios’ classic science-fiction thriller The Black Hole. The installation—on display until November 26 of this year—will accompany a series of open-air discussions on design, technology and culture throughout the summer at M&A. (For more information, visit www.emanate.org.)

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Following the sun

Located one-hour northwest of San Antonio, Kerrville is smack in the middle of Texas Hill Country, where the sun shines bright and hot. It is also home to the Texas Lion’s Camp, a 200-hectare facility for children with physical disabilities, life-threatening diseases, and Type II diabetes. More than 1,500 children attend Lion’s Camp each year, where they learn how to maximize their personal growth and self-esteem through a “can-do” philosophy.

In the 1960s, Marmon Mok Architects of San Antonio did a site masterplan and since has designed a number of the camp’s indoor and outdoor projects. The Lion’s Camp provides more than 30 facilities to support its expansive programming. One of the most notable is the outdoor amphitheater completed in the early 1980s. A spare, cleanly designed gathering spot, the amphitheater consists of five wide, grass-covered terraces contained on the periphery by a stone wall. Unexpectedly, it turned out that the amphitheater was unusable on many days: the sun and heat proved to be too relentless.

The specific challenge was to find a way to mitigate the sun and heat without diminishing or obstructing the open air and blue sky view: something light, transparent and unimposing. First, project architect Steve Souter and his team constructed a 3-D site model to fully understand specific issues. They also used Global Positioning System (GPS) and other computer programs to register longitude and latitude to determine the exact path of the sun above the amphitheater over the May-to-July time period.

Marmon Mok’s innovative solution was a visually simple but highly sophisticated design scheme of brightly colored, mesh fabric elements used as sunshades. Banner-like in their appearance, these red, yellow, blue and green ribbons of Ferrari Soltis 86 fabric are suspended horizontally between two steel cables at varying angles above the amphitheater in roughly parallel rows. This confirmation of elements provides an ingenious “stepped shield” against the sun as it moves across the sky. Additional pieces of fabric were mounted in wide vertical panels between steel poles, forming a stepped screen at certain peripheral points of the amphitheater, further blocking the sun’s rays as it approaches the horizon.

The Chism Co. of San Antonio furnished the product and engineering, including manufacturing the physical components to replicate Marmon Mok’s conceptual design. Company owner Roy Chism noted: “The concept is the most important factor: a design of total shade achieved absent the overhead application of fabric.”
In the field

Elements of refreshment

Pizza Hut Park, the soccer and entertainment center located in Frisco, Texas, is a 115-acre facility featuring a state-of-the-art stadium that seats over 20,000 spectators. Seventeen championship-quality soccer fields are located just north of the stadium. The Center was developed by the Hunt Sports Group (HSG) and includes shade structures provided by FabriTec Structures.

“The structures were designed to provide maximum sun protection while allowing minimal viewing obstruction” says USA Shade & Fabric Structures chairman and CEO Basil Haymann. The four separate PVC with PVDF fabric structures are located in the corners of the north and south ends of the stadium and span 96 feet wide by 49 feet deep, peaking at a height of nearly 20 feet.

Designed by FabriTec in conjunction with HKS Architects of Dallas, the sporty, arched cantilever structures cover refreshment areas and will keep fans comfortable in spite of toasty Texas elements. FabriTec also plans to add several awning structures for the surrounding food court areas.

Pizza Hut Park: shade for soccer fans under big Texas skies.
**Grape expectations**

Kevin Bennett’s design of a total enclosure for an outdoor pavilion of an upscale winery reflects a worthy vineyard. All sides and the roof of the enclosure are covered in retractable fabric covers with a system that required 18 motors, 14 screens and two 97.5m wide retractable roofs. The walls of the pavilion were recessed to accommodate the screens, and a low-profile support structure was built to hold the retractable roof and handle rain runoff. Located in oft-rainy British Columbia, Canada, the client requested unobtrusive retractable shading and weatherproofing to prevent disruption of special events taking place in the pavilion. Local fabrication experts at Valley Canvas & Awning Ltd. were happy to oblige, providing elegant, robust and attractive protection to prevent any disruption in the event of inclement weather. The side screens are recessed into the walls so that the mechanism is invisible. Sunbrella and Awntex fabrics were used, supplied by the Astrup Co.
In the stacks

Undercover books

Foster and Partners’ latest project at the Free University in Berlin is all wrapped up. Literally. The company has designed and built the university’s new Philology Library “with the idea of a wide parachute or balloon that would wrap over the whole thing,” says Stefan Behling, Foster’s ecology expert. The building combines a concrete structural mass with a curved translucent double-layered skin, cloaking the study space in a translucent, glass fiber material that dramatically diffuses daylight and naturally ventilates the space.

Containing the collections of 11 former libraries, the Philology Library arches over the center of campus, covering an area once occupied by six university courtyards. The dome’s outer layer is a striking mosaic of sliding glass and aluminum panels. Inside, the glass fiber membrane filters daylight and allows views of the sky through translucent openings scattered along its surface. “In the library, if you are reading and look up from your book, you actually notice how clouds move over the building. It’s like a natural light projection screen,” says Behling.

A glass fiber membrane filters daylight and allows views of the sky while protecting the precious books below.
Material that isn’t sewn together has to be bonded using some form of adhesive, whether it is a tape, glue or specialized seam welding film, or an inherent quality in the fabric itself. Updates in adhesive technology (and in workplace safety) mean that specialty fabrics companies need to keep abreast of new products and applications.

What used to be something as simple as taping over an awning stitch in order to bond and waterproof it has turned into a more complicated process, because all adhesives are not created equal. With a wealth of carrier materials, thicknesses and bonding properties, to many manufacturers, it feels like no two adhesives can be used in the same way. Two decades ago many of the brush-on glues and epoxies were problematic due to the application process, set-up, drying times, and hazardous fumes associated with them; but today’s adhesive technologies range from aerosols and liquids to seam-welding machines that help create clean seams that are durable, consistent and environmentally friendly.

The search for substrates
In the garment industry, fabric adhesives always been been very popular in the production of intimate wear and shoes; now, adhesives have grown to encompass a variety of materials including nylon, polyurethane, wool and foam. And according to manufacturers, it all depends on the substrates.
Bemis Associates Inc. in Shirley, Mass., manufactures adhesives, coatings, specialty films and seam tape using thermoplastic technology to join fabrics together. Chris Parlee, marketing manager at Bemis, says that every product is thoroughly researched to ensure that each fabric performs well after being bonded. Since each adhesive has a different melting point, finding the perfect complementary fabric requires a lot of research.

“There has to be a brief analysis to insure that the adhesive, once applied, does not come apart,” she says, noting that polyurethane bonds well to itself but not to anything else. “We offer testing for our customers and then make a recommendation depending on the type of fabric being used.”

Parlee says that over the years, they have developed tapes that are fabrics themselves, creating a seam that mimics a stretch-and-recovery process. New technology has made it easier than ever for fabrics to be joined to other surfaces.

“We can pretty much adhere to anything, but some leathers and rubbers still present a problem,” she says.

Today, Parlee’s customers in specialty fabrics want to move away from sewing and sealing but still want a lightweight, waterproof tent or awning.

Adhesives Research Inc.’s Engineered Tapes Division in Glenrock, Pa., also works to create custom adhesive solutions by using a broad range of technology. Not only do they work with specialty materials, but also many of their products are involved in the high-strength bonding of technical fabrics used in the military, pharmaceutical and aeronautical industries. Their products have to withstand high temperatures, resist harsh environments and must be easy to process.

“Typically we are working in the more demanding areas of seam sealing and bonding,” says Rod Daly, Engineered Tapes Business Manager in the ARcare® division. “Adhesives Research is able to custom-engineer adhesives to work with specialty fabrics, textiles, nonwovens, fiberglass, composites, technical fabrics, and films.”

When it comes to choosing an adhesive for the job, Daly says a full analysis of the fabric must be completed. Selection is based on the needs of the application and the ability of different types of adhesives to work with the different fabrics.

“The nature of the fabric and its end application generally dictates the type of adhesive used,” he says.

Although confidentiality agreements prevent Daly from discussing specific products, he notes some areas in which his company is working.

“We do have technologies such as high-performance radiation curable systems; silicone, rubber, and acrylic adhesives, not to mention flame-retardant, thermally activated adhesives; high-strength bonding PSA’s and high-heat seam sealing tapes,” he says.

**Applying the adhesive**

The application of an adhesive can vary as much as the composition of the adhesive itself. Camie-Campbell Inc. in St. Louis, Mo., creates specialty aerosol adhesives for different applications; and, according to Tom Shelby, chairman and CEO, it can be a difficult process.
THE STICKING POINT

OSHA mandate: to your health

Most of us are familiar with the movie: In 1993, Erin Brockovich, a woman who lacked a formal law school education, took on the $30 billion Pacific Gas & Electric Co. of California. The case alleged contamination of drinking water with hexavalent chromium in Hinkley, Calif. The case was settled in 1996 for $333 million, the largest settlement ever paid in a direct-action lawsuit in U.S. history.

Chromium hexavalent (CrVI) compounds, often called hexavalent chromium, exist in several forms. Chromates are often used as pigments for photography, and in pyrotechnics, dyes, paints, inks, and plastics. They can also be used for stainless steel production, textile dyes, wood preservation, leather tanning, and as anti-corrosion coatings. Some 550,000 workers are exposed to CrVI on the job, according to the Occupational Safety and Health Administration (OSHA). Hexavalent chromium is a potent human carcinogen, and can also cause dermal irritation and kidney and liver damage.

In some cases, using some materials, companies welding fabrics may be producing these compounds in their shops and putting workers at risk of exposure.

Last February, OSHA published rules that deal with workplace exposure to CrVI for general industry, setting a permissible exposure limit of five micrograms (ug/m3) of Hex Chrome per cubic meter of air as an eight-hour time weighted average. The standard also includes provisions relating to preferred methods for controlling exposure, respiratory protection, protective work clothing and equipment, hygiene areas and practices, medical surveillance, hazard communication and recordkeeping.

“OSHA has worked hard to produce a final standard that substantially reduces the significant health risks for employees exposed to hexavalent chromium. Our new standard protects workers to the extent feasible, while providing employers, especially small employers, adequate time to transition to the new requirements,” said Jonathan L. Snare, acting assistant secretary for OSHA.

These regulations become effective in November, 2006, for firms with 20 or more employees, and in November, 2007, for firms with fewer than 20 employees. The possible expense associated with implementing these new standards is causing some concerns form the National Association of Manufacturers (NAM).

For information, visit www.osha.gov.

On this larger volume press machine, the adhesive was pre-cut and applied to the pre-cut patterns in one fusing step.

“It can get complicated as far which adhesive will work for what application,” he says. “It varies from application to application; there are web adhesives and mist adhesives … there are so many variables to each application because there is no universal adhesive.”

Shelby says that Camie strives to look at industries and then formulate products that will meet the current and future needs of their customers. He says that they will even create customized adhesives, provided that they meet the regulatory standards for VOCs (Volatile Organic Compounds).

Camie-Campbell produces solvent-borne adhesives that quickly evaporate when they are sprayed onto the substrate. Shelby notes that this is a very practical solution for small businesses (his customer base) because they don’t have to wait for a water-borne adhesive to evaporate.

“When an adhesive comes out of an aerosol can, it comes out in an atomized uniform spray pattern, and that is important for getting the proper amount of adhesive to the substrates to bond the two substrates together,” he adds.

At Bemis, once a fabric and adhesive are chosen, the bond is applied using a flat-bed fusing process, which eliminates cut-and-sew techniques and allows seams to be created in a continuous fashion. Using this thermoplastic technology, Bemis is able to offer a wide range of products geared for many specialized markets, including the woodworking industry, fabrics, and composites.

“The machinery is getting more sophisticated with ultrasonics,” says Parlee. “We are getting away from R/F welding because it is a more stationary process.”

Daly notes that Adhesives Research uses pressure-sensitive adhesives as well as dry films that are heat-activated, while others are activated using R/F welding as well as ultrasonic welding.

Hot-air sealers have been around for years, says Bemis’ Parlee, but the idea of gluing fabrics together presents a whole new set of challenges. Bemis continues to research the technology extensively to increase their already substantial knowledge of fabric and develop tapes that last. Product development is becoming much more complicated. And customers, while they may use the company’s Web site to
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manufacturers also strive to ensure that the chemical solutions as well as the machinery are environmentally sound. At the Performance Coating and Adhesive group of Worthen Industries in Nashua, N.H., Andy Paraskeva says that his company deals with a small portion of the market, primarily in liquid adhesives that are used in lifejackets, air mattresses and life rafts. Using water-borne urethane adhesives as well as some solvent-borne adhesives, the company offers an eco-friendly alternative for bonding various materials.

By using films, Paraskeva says, he is able to apply more weight in one application compared to the energy and emissions it takes to apply an aggressive layer of adhesive. "We sell them to people who coat and laminate fabric using floating knife coaters and knife-over roll coaters, and have very long ovens that can dry these solvents in high heat," he says. "Solvents are the only real safety issues. You have to make sure they are handled properly, and those guidelines vary from state to state."

Like Worthen Industries, Bemis, Adhesives Research and Sinclair are all committed to providing earth-friendly products and machinery, and to creating a safe environment for workers. "Our products are made by casting solvent-borne solutions onto a moving web and then drying the solvents, which are cleanly disposed of," says Daly. "Out of all of our adhesives, about 95 percent of them are eco-friendly," Parlee adds. "That’s why they have done so well."

Shelby says that even though his company uses aerosols, they are still conscious of the environment, and their products are very safe. He adds that the solvents that used

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Bemis makes a wide variety of adhesive films. No color matching is required (as there is with stitching), so adhesive films are applicable for nearly any type of fabric.

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One of Bemis’ rolls of adhesive release paper. According to Chris Parlee, most machines strip away the release paper as the tape is being applied.

ozone-depleting elements have been phased out over the last 25 years. “We aren’t getting into the atmosphere and doing anything bad to it,” he says. “The material safety data sheets help you monitor levels from an environmental standpoint.”

He adds that anytime you are working with mists, sprays or any type of solvent, there is a chance something can happen; but those chances are lessened if you work in a well-ventilated area and use common sense. Shelby says that one of the challenges Camie-Campbell faces is the fact that 15 or 20 years ago, the adhesive’s safety data sheet was good for five or 10 years; but today, they seem to be reformulating every two to three years. “We are very good at following regulatory compliance, and we’ve made it part of our mission statement,” he says. “I think it is important that we work under the safest guidelines, and that we have all the facts when making decisions on what products we should and shouldn’t make.”

No matter what kind of adhesive is being produced and applied, this is another part of the industry in which research and technology are continually advancing—and the pace of those advances is increasing as well. Today’s fabricators have more opportunity than ever to work with a wider variety of adhesives, substrates and applications in a variety of industries; cutting labor costs, enhancing productivity and creating a more appealing product for customers.

To offer feedback or comment on this article, please contact Galynn Nordstrom, senior editor, at +1 651 225 6928, e-mail gdnordstrom@ifai.com.

Turn to page 102 for contact information on the sources used in this article.
A specialty fabrics shop with 19th-century roots has remained in the forefront as a quality manufacturer, due to a demonstrated ability to handle virtually any project.

By Sally J. Peterson

Near the shores of Lake Winnebago, the second-largest lake in the United States, is the Wis.-based Oshkosh Tent & Awning Inc., a long-time manufacturer that handles marine projects, awnings, tents, military and athletic gear—just to name a few.

"Diversification for a tent and awning company in the north is practically required," says Brian Hegner, vice president of Oshkosh Tent & Awning. "Our divisions include our original awning and tent rental activities; canvas products (military products, custom sewing, factory and residential curtains); athletic gear and padding; signage; and marine products (boat covers and sails).

"We have about 15 full-time employees," Hegner says. "Three are in the office, and two of them also do sales. We have four workers who sew, and the rest are installers or manufacturers. This versatility suits us well, because we've made a point of product diversification so that we have enough work to keep our employees busy the year round, summer and winter—and we do. We also have low employee turnover, which is really nice for everyone."

The company is always trying something new. "We've tried some goofy things and some things that haven't worked," Hegner says, "but every so often we run across a product line that fits right into what we do. We often discover, for instance, that one product line may draw in customers for our other lines, and our sales people are able to help our customers make those connections and sample our variety."

During the last year or so, new ideas have been popping up everywhere. "Recently we bought out a former supplier of ours and added a sign division for awning and vinyl graphics. Now we can do our own banners and truck sides," Hegner says. "Also, less than a year ago a local yacht sail-making company closed down, and we hired one of its most experienced employees. He's brought to us a wealth of information we didn't have before; I allow him a lot of latitude to just do his thing.

"Last year, we started to work with promotional clothing and ad specialties, and are finding that both interesting and profitable. We're getting into screen-printing and embroidery as well, both of which give us good opportunities to promote the other things we're doing. My wife is working now with the ad specialty stuff, selling radio promos for the products, and for us as well."

Sally J. Peterson is a freelance writer based in Black River Falls, Wis.
Major juggling, with style

With all of this varied activity, keeping everything on track can be a real hassle. "And I’m in charge of scheduling," Hegner says with a wry smile. "We write everything down on a big board in the back and then try to keep all of our balls in the air." He juggles an ad-specialty stress ball as he talks. "Sometimes parts come in late or deadlines change. You have to be flexible in this business. You have to work smart. And you can’t do it all yourself.” Hence the care he takes to keep his employees happy.

The projects that come through the doors at Oshkosh Tent & Awning are varied, and include all kinds of specialty fabrics. "Basically we use a lot of Sunbrella®, Ferrari®, Top Gun®, and Top Value fabrics for awnings and marine applications," Hegner says. "We use laminated and coated vinyls for curtains, tarps, and canopies. We use cotton ducks for bags and covers, and Aqualon for boat travel covers. We also order some miscellaneous nylon for miscellaneous projects."

Location, location, location

Marine work is obviously good in Oshkosh, situated as it is on the western shore of Lake Winnebago in east-central Wisconsin, southwest of Green Bay. The lake’s 137,700 acres offer room enough for any water activity from power boating, sailing, wind surfing, and fishing to ice boating and ice fishing. At 28 miles long and 11 miles wide, Lake Winnebago is so big that it’s part of three Wisconsin counties and sports 85 miles of shoreline. Oshkosh Tent & Awning has been in business here since 1876, starting as a storefront and doing government work … perhaps buggies and the like.

“Our early history is vague, as the company moved around Oshkosh a lot in the early 1900s,” Hegner says. “My grandfather bought the company from a neighbor of his in the 1960s and took it over. He’s still president, but I’m in the process of buying it from him. I’ve been here since 1984—22 years in all.”

Oshkosh Tent & Awning moved to its current location in an industrial park in 1998, when it got big enough to support the move. "Our new building has 15,000 square feet," Hegner says, "and we built more onto the back to allow us to bring customers’ boats in where they’re safe and can be worked on inside, and for expansion purposes down the road.”

Besides the lake and its water sports, the Oshkosh area hosts the annual EAA AirVenture Convention, a huge event for airplane aficionados. “EAA contracts for most of its tents in a big batch, so we handle peripheral event tents for companies like Target that display there. We don’t make tents,” he notes; “we rent them. So tent-rental isn’t a big part of our business anymore, and it’s not an area I really plan to grow—unless my kids [three boys now 17, 16, and 10] want to step in.”

Some of his major customers include Flow International of MacGregor, Minn., for boat covers; the company also does a lot of work for heavy-duty Oshkosh Truck.

Getting the word out

As any company with diverse product lines, Oshkosh Tent & Awning markets itself in several different ways. “Our sales people are our most important marketing tool,” Hegner notes. “We also advertise in the Yellow Pages. We rely heav-

"There are opportunities in this business, but you have to provide products of superior quality; it’s not like nailing two-by-fours together."

—Brian Hegner, Oshkosh Tent & Awning
ily on word-of-mouth. In addition, we have a Web site [www.otainc.com] that we’re in the process of updating to a tool that should be of real help both to our customers and to us. On the whole, however, our business is based on face-to-face customer service. We don’t drop off a big catalog; we do business on just a handshake backed up by quality work.”

“Oshkosh Tent & Awning has been a member of IFAI for 54 years,” he says. “I find the major benefit to be the conventions, where vendors meet other vendors. I’ve found that most people in this industry are really good people putting out really good stuff. And the competition is good for us. A lot of people are doing a good job out there, and that means we have to do the same. I probably go to the convention every couple of years, and I send different employees as well. Also, I find information from IFAI’s Review magazine to be invaluable.” He also notes that IFAI professional certification has been valuable to both him and his father, but that he’s finding that he lacks the time to maintain it, a situation he is currently discussing with IFAI.

MEMBER PROFILE

Four employees sew for Oshkosh. The shop offers enough diversity to keep the seamsters, and other employees, busy all year.

A smooth boat cover fabricated by Oshkosh Tent & Awning caters to the local area’s sports and fishing enthusiasts.
Global economics and the small shop

Surprisingly, Hegner says he doesn’t feel as much pain from recent natural and manmade disasters as he might have. “Because most of the work we do involves custom sewing, we haven’t suffered a lot from work going overseas,” he notes. “We would if a customer suddenly pulled large quantities, but for the most part we don’t work in quantity anyway.

This rather complicated enclosure is actually a screen canopy that features mesh and heavy-duty fabric, built to discourage the elements from distracting the owner from enjoying the space.

“Globally, prices have affected us; they went up more than 60 percent following Hurricane Katrina, with more increases to follow. Margins are narrower now than they’ve ever been; we have to do more to make less. Also, because we provide products that are not necessities, our pricing really has
to be competitive or our customers will decide simply to do without. We’ve had to make up the difference with volume; our sales have probably tripled in the last 10 years.

“We do, of course, see costs going up overall—raw materials, labor, benefits, transportation—but we’re probably charging less now than we did ten years ago,” he adds. “We’ve had to learn to be more efficient, and thanks to technology, we are. The companies that can adapt are the ones that will grow, and I see Oshkosh Tent & Awning in that group.”

This small company has high, aggressive growth expectations for itself. “I want to ensure that the employees we have—and I consider them all key employees—make a good living,” Hegner says. “All my expectations, in fact, revolve around my employees, and their cost of living certainly is not going down.” Hegner’s general business philosophy: “Get your hands dirty and your employees will respect you. Don’t ask them to do anything you wouldn’t do.”

As for advice to others in the specialty fabrics arena, he says, “I’d say that yes, there are opportunities here, but you have to provide products of superior quality. This work is not like nailing two-by-fours together. You have to have creativity and construction skill, along with business sense, to make a go of it.”

Hegner’s mission statement isn’t written down anywhere, he says. “But I guess it would be this: Our main objective is to provide quality products at competitive pricing, with excellent customer service being our best sales tool. Our goal is never to make a promise we can’t keep, and to be upfront with all of our customers.”

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Makers of retroreflective fabrics are in all kinds of businesses: They sell products in the safety and protective, sportswear, pet product, and incident-response markets, among others. But they always share one goal: enhancing visibility. They all seek to make users, wearers, and objects more conspicuous.

The word “retroreflective” isn’t commonly heard by laypeople. It’s a very specific scientific term that defines a particular kind of visibility enhancement. There are several ways to make an object easier to see, and retroreflectivity is only one of them.

“When we talk about high-visibility materials, typically we break those out into two categories: active and passive,” says Gary Lesley, president of Head Lites Corp., a St. Paul, Minn.-based manufacturer of visibility-enhancing materials and garments. “Active involves something that you can turn on or off, such as a strobe light that a cyclist might strap to his or her helmet. Passive is typically a construction that isn’t wired or powered.”

Within the passive category, he says, there are two main strategies that are employed. One is fluorescence, which is most useful in the daytime and, to some degree, at dusk. When electrons within fluorescent yarns are exposed to light, they absorb the light and become excited. They then emit electromagnetic radiation, generally in the form of visible light. In other words, they appear bright.

But fluorescent materials aren’t much good in the dark, because there isn’t sufficient incident light to excite them. That’s where retroreflectivity comes in. It’s a way to take advantage of very small, directed beams of light such as those created by headlights.

In physics, a retroreflector is any instrument that causes reflected radiation to return along paths parallel to those of their corresponding incident rays. That means that if a headlight shines on a retroreflective material, it sends the light directly back at the headlight. The driver of the vehicle, then, can see the light shining.

Why not just say “reflective”? It turns out that’s not specific enough. There are several kinds of reflectivity, and not all of them are useful when you’re trying to make a person or object conspicuous in the dark.

“Anything that we can see—anything that makes it to our optic nerve—is, by definition, reflection,” Lesley says. “Specular [reflectivity] is basically what a ceiling does when you look up at it. Light is striking it, and it’s dispersing it all about. So if you had something that was made up of just a white fabric or a dark fabric, yes, it’s still reflective, but it doesn’t really send back the kind of strong intensity that would help somebody be seen at a distance. And then there’s mirrored reflectivity, which sends light back at an angle. If you outfitted somebody in mirrored material, you’d have certain angles where it might be very bright, but you’d have certain angles where all of the light is being misdirected somewhere else.”
So retroreflective materials are by far the most useful for nighttime visibility: They take in the light from a beam and send it straight back where it can be seen.

Of course, there’s no rule that makers of visibility-enhancing gear must use only one method. What they tend to do is to combine several strategies—to cover all their bases, so to speak.

“When you see a DOT [Department of Transportation] vest, it’s using two types of passive high-visibility fabrics,” Lesley says. “It’s using fluorescent fabrics, and it’s using reflective fabrics, trims, or materials. The idea is to try to enhance that person’s visibility 24 hours a day. The fluorescent materials are assisting during the daytime and in the low-light transition conditions of dusk and dawn, maybe before headlights are on or before something retroreflective is really serving its purpose. Then, in darkened conditions, fluorescent colors are not as effective because of the kind of artificial lighting that hits them. That’s when retroreflective materials are most important.”

### The best of all parts

Retroreflective materials were pioneered in the 1930s by Minnesota Mining and Manufacturing Co. (now 3M), says Peter Smith, president and CEO of Ashland, Mass.-based Reflec, maker of illumiNITE retroreflective materials. “When they were down in the mines, they saw something reflect, and that’s where it really began,” he says.

The safety industry is very conservative—”as it should be,” Smith notes—and perhaps as a result, little about the basic mechanism of reflectivity has changed in seven decades. It’s still done in one of two ways.

One method, glass bead technology, works a bit like a cat’s eye. Glass microspheres, applied as a coating to a substrate, are coated on their back side with aluminum; light comes in and is focused at the back, bounces off the sides, and is directed outward in a concentrated beam. The other method uses a coating of oriented microprisms for a similar effect.

Nowadays, 3M’s Scotchlite™ brand competes with several other domestic and international brands in the retroreflective materials market. All use one of the two technologies to accomplish their goal. But glass beads and microprisms can be affixed to materials in a variety of ways, and that’s where a lot of innovation has taken place.

One of the most common methods for making fabric retroreflective is to sew, glue, or heat-seal a pre-made tape (from 3M, Reflexite, or another manufacturer) onto fabric. On a narrow fabric such as a dog leash or a harness, the tape can cover the entirety of one or both sides; elsewhere, it’s a bright, conspicuous stripe.

“That [retroreflective tape] is something that we purchase,” says Rob Hanna, business development manager at BioPlastics Co., North Ridgeville, Ohio. “We extrude polyurethane and PVC over narrow fabric. We then take a narrow reflective tape and we hot-air weld it to our polyester/nylon belting. Hot-air welding is the easiest thing to do for long, continuous runs.”

Sales manager Eric Munn says his company, King Tech Industries of San Diego, wholesales tapes printed with glass beads or microprisms to end-product manufacturers. But the company also sells retroreflective fabrics and yarns, as well as completed safety vests made of multiple components.

“True reflective yarns are composed of very small reflective crystals imbedded within a substrate,” explains Louis C. Franconi, new business development at narrow fabric manufacturer Bally Ribbon Mills, Bally, Pa. “The crystals catch light that is shined onto them and reflect it back to the viewer. The big difference [between the tapes and the yarns] is that these yarns are woven into webbing to create a reflective surface that is a part of the actual webbing.”

One of the advantages of weaving retroreflective yarns into a fabric is that you can create designs or stripes, Franconi says. It can be one-sided, or it can show through on both sides. Fabric woven from retroreflective yarns is more durable than fabric with a film attached to it. The only downside is that up until this point, it has been far more expensive to use the highly engineered yarns than to simply affix a tape.

Thanks to Reflec’s illumiNITE fabric technology, however, that last point may be in the process of changing.
THAR SHE GLOWS

Makers of visibility-enhancing gear tend to combine several materials and types of reflectivity: fluorescent materials help during the daytime, and retroreflective materials work in darkened conditions. The end result is 24-hour visibility.

“Ours is actually not an expensive system,” Smith says. “If you look at a typical jacket from a leading sportswear company such as Nike or Adidas, an illumiNITE jacket would typically be in exactly the same price range. It’s the same with industrial clothing. These systems need to comply with standards for best performance, but they have to be cost-effective in order for people to use them.”

Why was Reflec eager to develop affordable retroreflective fabrics and yarns in addition to films and tapes? The answer lies in a series of scientific studies done in the 1980s. Scientists questioned motorists about what they saw when driving at night and found that there were two components to making a person or object easy to see.

“The first one was that the human eye needed to be stimulated to know that there was something out there,” Smith says. “For that, contrast was the key. Obviously if you’ve got a very dark background and there’s something light shining, the human brain is able to decipher it and say there’s something out there.”
The second component had to do with the fact that humans are hard-wired to recognize objects by their outlines. “If you ask a child to draw a bird, he or she will draw the outline of the object,” Smith says. “So this study determined that it was important that the visibility provide, as best as possible, the shape of the human being.”

Traditionally, retroreflective materials were affixed to what Smith calls “strips and stripes,” which do not provide a recognizable human outline for the wearer. But if a person’s clothing is completely retroreflective, they are easily identifiable.

“Our illumiNITE is actually fabric in the true sense of the word,” Smith says.
“We basically impregnate the fabric with spherical lenses of glass beads. It comes in 60-inch-wide goods, just like any fabric, and [the technology] can be incorporated in any kind of fabric, ranging from flame-retardant fabrics like Nomex to stretch fabrics to ANSI-107-compliant polyesters.” (ANSI 107-1999 is a voluntary standard of performance specifications for reflective materials in the safety industry.)

Another advantage, besides better shape recognition, is that fabric made by this process is breathable. In this way, it’s very unlike adhesive-coated retroreflective tapes, which do not allow the transmission of air or moisture. Lack of breathability is bad enough in a sports garment, but it’s actually dangerous in firefighters’ clothing, where the tapes can cause burns because they do not let heat dissipate.

Of course, as in all things, there are trade-offs. The retroreflectivity of breathable fabrics is somewhat less than that of the 100-percent-saturated tapes. That’s why Smith says the ideal high-visibility garment will contain a combination of bright fabric and eye-catching tape.

And, for firefighters eager to get away from potentially dangerous reflective tapes, Reflec will be releasing a new tape system at this November’s National Safety Congress. It’ll be breathable, but still bright enough to be used where traditional retroreflective tapes are used.

As in all things, there are trade-offs. The retroreflectivity of breathable fabrics is somewhat less than that of the 100-percent-saturated tapes. The ideal high-visibility garment will contain a combination of bright fabric and eye-catching tape.

“Lately, we have a customer who’s been using [retroreflective belting] as a barrier to stop cars from getting onto drawbridges,” Hanna adds. “They are using a 2-inch version of our belting with a 1-inch-wide reflective strip on it. It’s high-visibility so that people know to stop.”

Bally Ribbon Mills markets its retroreflective narrow fabrics mostly to the safety and fire industries. In both cases, the end products are usually made of fire-resistant fabrics such as Kevlar or Nomex. The fabrics are woven into webs and slings, or used to make suspenders for firefighters.

“There’s some demand for the dog leash thing, too,” Franconi says. “But the real growth is in clothing–jogging outfits, sneakers, things like that. A lot of folks are jogging early in the morning and late at night. And they are out walking their dogs. I think that there should be a natural growth there.”

Lesley is quick to point out, though, that growth in the industry is offset by the tendency of manufacturing to move offshore.

“In the last few years, Head Lites Corp. has divided its efforts between material conversion and end-product manufacturing. It manufactures retroreflective fabrics and tapes that are used by companies such as Patagonia, Land’s End, and Canadian Uniform. At the same time, the company is selling finished products such as personal protective vests and headwear.
“Our Force Pro brand is where we produce our vest systems,” Lesley says. “We hope and we believe that it’s a growth area. Some of the key features on the vest systems are reflective options and, of course, high-visibility panels and identification markings. They’re used for DOT, police, security, or responder networks.”

In an emergency, well-designed retroreflective materials and garments can make people safer among vehicles and machinery, but it can also help reduce disorder and confusion.

“God forbid the Mall Of America blows up,” he says. “I think you can envision that as chaotic and as difficult as that would be, it’s arguably one percent better if people can tell who’s who and who’s where. That’s where we are looking at opportunities: How can we incorporate high-visibility features and options into the kind of gear and equipment that those kind of responders, law enforcement, fire service, EMS, and the various federal, state, and local agencies need? Everybody can’t just show up in a windbreaker. That’s not going to cut it. Our goal is to make people conspicuous to the degree that they can be seen readily without an extended search.”

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