THE WARRIOR

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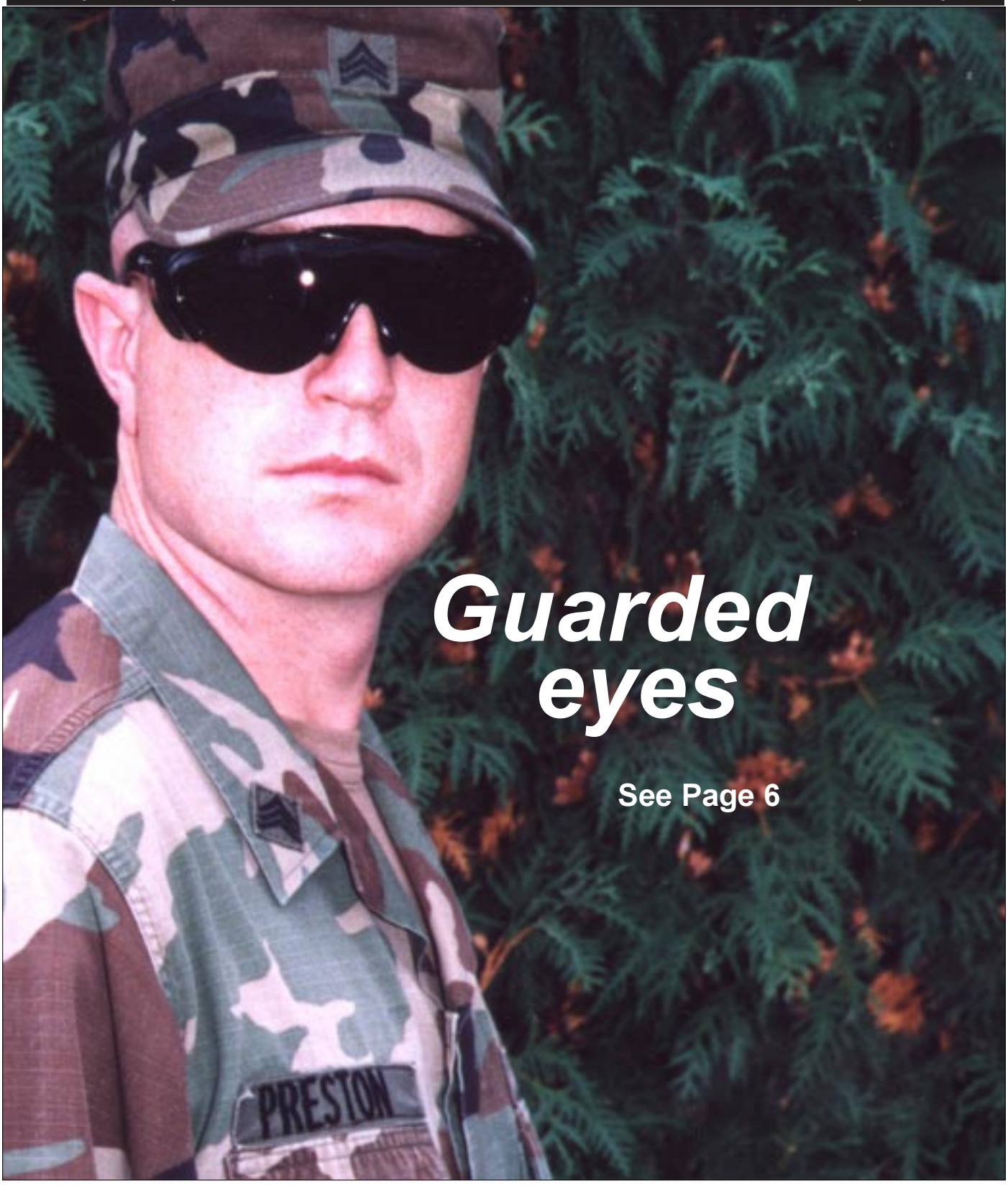

Guarded eyes

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Cover photo: Sgt. Thomas Preston wears the Military Eye Protection System's spectacles with sunglass lenses. (Warrior/ Underhill)

THE WARRIOR
U.S. Army Soldier Systems Center

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Commentary

Engineer endorses Greening Program

By Kristian Donahue
Contributing Writer

In October I had the opportunity to attend a five-day field exercise aptly titled the Greening Program. It was a real eye-opening experience for a civilian and new member of the Natick Soldier Center (NSC) community such as myself.

In mid-July, I began working as a chemical engineer in the Collective Protection Directorate. The ability to research and develop equipment for soldiers is what originally attracted me to join the NSC.

When I heard there was a program that allowed civilians to spend several days in the field living as a soldier would under simulated combat conditions, I knew I had to jump on the opportunity right away. Through contacting the senior enlisted advisor from Operational Forces Interface Group (OFIG), Sgt. 1st Class Samuel Newland, I was placed on a waiting list and eventually selected for the October Greening. It's not every day an engineer can see where the rubber meets the road.

As a civilian, I had preconceptions of the needs and mentality of the Army's infantry soldier.

Before participating in the Greening Program, I was under the impression soldiers were hardened annexes of liberty who received the latest in equipment that allowed them to execute their missions and protect our freedom. I believed soldiers could move on a moment's notice with the swiftness of a New England weather pattern and the effectiveness of an elephant stepping on an ant.

Instead, I learned that an infantry soldier is encumbered by gear, impeded by the load they must carry and demoralized by their footwear. I also learned an infantry soldier is able to break just about any piece of equipment.

The Greening Program was held at the Joint Readiness Training Center (JRTC) at Fort Polk, La. Upon arriving at the airport, I was introduced to U.S. Army Soldier and Biological Chemical Command employees Adam Young and Ron Gamache, who were the other two Greening participants. Corralled into a minivan, we rushed to assemble our gear in hopes of making it into simulated battle zone called the "box" before nightfall.

As we finished assembling our gear, we arrived on base to be issued our Night Vision Goggles (NVGs) and eat our first Meals, Ready-to-Eat (MRE). The MREs, which are developed at Natick, were surprisingly very good.

After dinner, we became familiar with our gear and how to properly pack a rucksack so that you can retrieve your items in the dark. We then loaded up in a Humvee and proceeded into the box to conduct a bivouac in the vicinity of the friendly troops.

The friendly troops consisted of nearly 1,000 soldiers from the 327th Infantry, 101st Airborne Division (Air Assault) who were conducting a 12-day training exercise at JRTC.

While friendly forces conducted their military maneuvers, a highly disciplined guerilla-style unit named CLF (Cortinian Liberation Forces) played the opposing forces.

We witnessed our first dismounted attack through NVGs shortly after securing our bivouac. As our brains struggled to coordinate the green, depth-perception-impaired view of our surroundings, we stumbled and tripped like a bunch of moose through the woods.

Automatic gunfire rang out as the reality of soldiers trusting their lives to NVGs began to manifest.

My respect for soldiers fighting under night conditions soared as I thought of the possibility of forgetting to replace the batteries in the NVGs.

Over the next few days we had the opportunity to observe and question soldiers from both sides. The one universal thread that ran through their words of wisdom was, "You guys need to build a better boot."

The need for a better boot became even more apparent on the third day when we conducted a 2.5-mile road march.

The purpose of the road march was to stress the importance of the need for lightweight, functional clothing and equipment.

With a full rucksack, helmet, rubber M-16 and M-40 protective mask, the lesson was quickly learned. As we nursed our feet upon completion of the road march, we began to realize the magnitude of the need for a breathable, waterproof and comfortable boot.

Fortunately, the Army approved a new infantry combat boot in November, already used by the Marine Corps, that has those attributes.

On the second to last day of the Greening Program, we had the opportunity to role-play as civilians on the battlefield in a mock Third World village appropriately named Shughart-Gordon. Shughart-Gordon was designed to simulate the urban warfare nightmare of trying to attack a fortified town, which has entrenched guerrilla fighters living among the civilians.

The dismounted attack by the 101st Airborne occurred over the course of a day and a half with friendly forces breeching the village shortly after midnight.

The Greening Program was an excellent opportunity to learn the importance of the need for lightweight, waterproof, chemical proof, "GI proof" (durable and unbreakable) equipment firsthand.

I believe the opportunity to use the equipment we are trying to improve upon, under field conditions while interacting with soldiers, is vital to our ability to give the soldier our best possible product.

I highly recommend this program to the entire work force and encourage everyone to at the very least consider the opportunity.

File photo

Paratroopers on low-altitude jumps currently have no automatic opening capability for their reserve parachutes. A system is under development.

Reserve back-up

Automatic opening capability to give paratroopers extra assurance

By Curt Biberdorf
Editor

Four seconds after exiting a military airplane on a low-altitude jump, paratroopers are trained to pull the handle on their reserve parachute if they don't feel the opening shock of their main parachute.

Sometimes the reserve is not opened when it's needed, which is why engineers in the Airdrop Technology Team at the U.S. Army Soldier Systems Center (Natick) are working on a device called the Parachute Reserve Automatic Opening Capability.

The Army vision includes maintaining the airborne infantry as a strategic deterrent and as an early entry force. Jump-related casualties lessen combat effectiveness. Statistics from the Army Safety Center show that between 1974-1999 almost one-third of airborne fatalities could have been prevented if the reserve parachute had an automatic opening capability, said Bill Millette, project officer.

"This device is being designed to address total malfunctions of the main parachute," he said, although effectiveness during partial malfunctions may come later. "A broken static line is the primary failure."

Automatic reserve opening capability has been available for high altitude, low opening jumpers based on a system that uses barometric pressure. If the paratroopers descend to a certain altitude at a speed higher than the main travels, the reserve deploys. The same system is impractical with aircraft dropping paratroopers at about 500 feet.

"That takes way too much time for low-altitude jumps," Millette said. "An incapacitated jumper can't react to a malfunction, and a disoriented jumper has very little time to react. We anticipate training-related fatalities caused by broken static lines or total canopy failures will be eliminated."

The project began in 1999 as a Small Business Innovation Research program with Cybernet Systems, Inc. in Ann Arbor, Mich., and transitioned in October to a Science and Technology Objective program scheduled through 2005 that may also involve other manufacturers.

The current device houses a pressure sensor and three accelerometers inside an aluminum case about the size of a camera body. A hole the diameter of a pencil senses the blast of air a jumper experiences while exiting the aircraft and starts to count. Accelerometers simultaneously record movement in three axes and calculate a total velocity measurement. The battery-powered automatic opener is connected to a small explosive charge to push out the handle if the system senses that an automatic activation is required.

"It's intended to provide enough

information to determine whether the reserve should be activated. If the system doesn't sense the tug of the main parachute within four seconds, it will activate the reserve," Millette said, adding that soldiers will still be able to actively open the reserve.

The Cybernet system uses low-cost accelerometers that were developed for automobile airbags, and the industry has posted a solid reliability record with the microelectromechanical systems, according to Millette.

Still, challenges remain. One capability yet to be handled is how to ensure that the device will not activate during door checks by jumpmasters, since these checks repeatedly expose them to rushing air before leaving the aircraft.

Static line jumps from helicopters are another area that will require attention because the slower airspeed used during helicopter jumps requires paratroopers to count two extra seconds before deciding whether to activate their reserve.

Engineers are considering incorporating extra instrumentation into the system, although Millette said the usefulness of such devices must be balanced against their cost. One desirable device under consideration is a gyroscope, which measures rotation of the jumper.

Warrior/Biberdorf

The current device houses a pressure sensor and three accelerometers inside an aluminum case about the size of a camera body.

"You probably don't need a gyroscope in the system if you're only concerned about responding properly to total malfunctions, such as when the static line breaks," he said. "But if you're looking at more complex situations, such as a towed jumper, a gyroscope may be helpful. You wouldn't want the system to activate the reserve in that situation."

The system is currently designed for use with the Modified Improved Reserve Parachute System, but the activation mechanism could be modified to work with reserve parachutes that use soft loops.

Initial testing consisted of data-gathering drops conducted with mannequins at Yuma Proving Grounds, Ariz. More recently, soldiers and airborne-qualified Natick employees wore the devices to gather data during ramp jumps from CH-47 helicopters and C-130 aircraft. Human testing gathered useful data for the system developer because people are flexible and respond differently to forces, said Millette.

Since the automatic opener records data, it can act as a paratrooper's "black box," which has interested the Army Safety Office as a tool to investigate paratrooper accidents.

"We hope it doesn't get to the point where the Safety Office uses it during a fatality investigation because we expect it to work properly," Millette said. "The device also has the potential to be used to provide jumpers with feedback on their exit technique."

He said one goal is to integrate the automatic reserve opener as a pre-planned product improvement into the future Advanced Tactical Parachute System. It's possible that continued development could lead to the product being trimmed down to the size of a chip.

Warrior/Biberdorf

The battery-powered automatic opener is connected to a small explosive charge to push out the handle if the system senses that an automatic activation is required.

Advanced eyewear

System replaces assortment of military-issued protection

By Curt Biberdorf
Editor

A mixed assortment of protective eyewear is on its way to being replaced by the streamlined Military Eye Protection System (MEPS) developed at the U.S. Army Soldier Systems Center (Natick).

The Army and Marine Corps have used a combination of the Ballistic/Laser Protective Spectacles (BLPS), Special Protective Eyewear, Cylindrical System (SPECS) and Sun, Wind and Dust Goggles (SWDG) since the mid-1990s to shield troops from eye injury.

With the new eye protective gear, the number of lenses is cut in half and the level of protection is increased. Troops will have one system in sleek goggles or spectacles with interchangeable lenses for both.

"Soldier acceptability is tough," said Michelle Markey, project officer at Product Manager-Soldier Equipment. "It is difficult to get soldiers to wear eye protection, especially those who are not used to wearing glasses. They are more likely to wear their eye protection if it is something they look good in, and I think these goggles and spectacles will be well-accepted."

Warrior/Underhill

Loose strap ends on the MEPS goggles fasten with Velcro.

Of course, by wearing them they'll have much more than a fashionable profile.

An estimated 10 percent of battlefield casualties are from eye injuries, a figure that has steadily increased since the Civil War, according to Harold Moody, project engineer. Explosive fragments, tree branches, blowing sand and rocks, and lasers are major battlefield hazards.

Warrior/Underhill

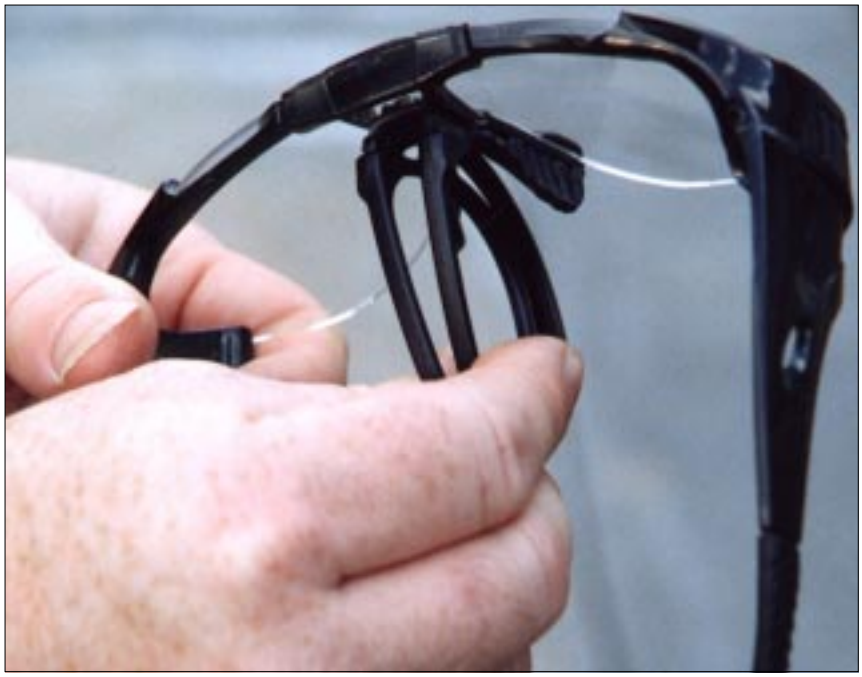
MEPS goggles easily tighten and loosen for fall-to-the-chest capability, a feature important to a gunner looking through his tank or infantry vehicle's internal sights.

"A soldier's eye is easily damaged by fragmentation from a nearby blast," Markey said. "Even small particles such as sand can injure the eye. These injuries are also easy to protect against using polycarbonate. Our eye protection is designed to stop a .15 caliber, 5.7 grain fragment simulating a projectile traveling at 640-660 feet per second."

The new protection system carries over the lightweight yet tough polycarbonate used in the BLPS, SPECS and SWDG that passed tests for ballistic resistance, but now the new spectacles bring peripheral coverage that was limited with the SPECS. Like SPECS and BLPS, they also meet the American National Standards Institute requirements for occupational eye and face protection.

Another military requirement is protection from laser range finders and designators used to acquire targets on the battlefield.

BLPS, SPECS and SWDG use four lenses designed for each item: clear, sunglass, three-line laser protective and two-line laser protective. When lasers are not a hazard, soldiers can use the clear lens to protect against ballistic and ultraviolet



Warrior/Underhill

A prescription lens carrier snaps into the MEPS spectacles. Without the inserts, the spectacles are worn by troops with normal vision.

rays day or night, or use a darkened sunglass lens during the day that adds sun glare protection.

When lasers are a danger, soldiers currently switch to a green lens that blocks two wavelengths for use in dim light or a dark lens that shields three wavelengths for use in daylight. Special coloring and coatings absorb the laser to eliminate or minimize injuries.

"The problem with (the daytime lens) is that it's dye-based and very dark. It is not suitable for use at night, which is why there is a separate two-wavelength lens, which has better transmission properties, for nighttime use," Markey said. "The third wavelength wouldn't likely be used at night anyway because it would be visible."

The new system uses two types of laser reflective technologies sandwiched between two layers of polycarbonate for durability, and it covers a wider band of near-infrared wavelength energy than the current systems. Separate daytime and nighttime lenses are gone.

"We're looking at blocking broad bands of laser while minimizing the impact on color vision," Markey said. "This is critical in order to maintain the soldiers' ability to read maps and use devices such as image intensifiers. We also wanted better light transmission than the current systems, and ultimately would like to have tunable laser protection that adjusts to the hazard."

Other improvements are in fit, comfort and logistical efficiency.

The BLPS was designed to accommodate prescription eyeglass wearers.

They were one size and difficult to properly fit across the user population. SPECS comes in two sizes for a more precise fit, but they can be worn only by those with normal vision. Military-issued eyeglasses fit inside the SWDG, but often with just enough room.

The new system can be worn by anyone and comes in two spectacle sizes for an improved fit while retaining a single size for the goggles. A prescription lens carrier snaps into the goggles and spectacles frames if needed.

Clear, sunglass and laser lenses, all with ballistic protection, are interchangeable between the large spectacles and goggles for simpler supply and storage. Spectacles or goggles, along with two extra lenses, are stored and carried in a rigid foam case with a green cloth cover.

The Military Eye Protection System was tested with more than 26 pieces of equipment to ensure optical and structural compatibility, Moody said.

Markey demonstrated how easily the goggles tighten and loosen for fall-to-the-chest capability, a feature important to a gunner looking through his tank or infantry vehicle's internal sights. Currently used goggles have a simple elastic strap and are stowed on the helmet, which interferes with the proper use of the sighting system in the tank, said Moody.

Goggles are undergoing user evaluation at the Marine Corps Air Ground Combat Center at Twentynine Palms, Calif., and both goggle and spectacle prototypes are being evaluated at Fort Campbell, Ky. Fielding is expected to begin in 2005.

Warrior/Underhill

Military-issued eyeglasses barely fit inside the Sun, Wind and Dust goggles, but eyeglass inserts fit with sufficient room in the Military Eye Protection System goggles.

Rapid slowdown

Retraction softens equipment landings without honeycomb

By Curt Biberdorf
Editor

Slamming into the ground at an average velocity of 28 feet per second, airdrops of vehicles and supplies suffer devastating damage if left unprotected.

Honeycomb cardboard has been used for as long as heavy cargo has been airdropped to absorb energy on impact, but new technology researched by the Airdrop Technology Team at the U.S. Army Soldier Systems Center (Natick) has led to systems that reduce impact velocity to the point where cushioning is unnecessary.

An airdrop with a 10,000-pound load was successfully tested in November at Yuma Proving Grounds, Ariz., using retraction, which decelerates the load to a survivable velocity immediately before landing. The next step is to test loads of 15,000-20,000 pounds.

"This year we're getting closer to a production item," said Brian Bagdonovich, project officer for the Rapid Rigging De-rigging Airdrop Systems. "It looks like we should be able to eliminate paper honeycomb for energy absorption purposes."

That will be a relief to those who rig the equipment before it's loaded onto an airplane and de-rig it once it's on the ground, and benefit the Army in reduced logistics.

Soldiers in airborne units can spend up to eight man-hours rigging a Humvee onto a platform. This consists of packing parachutes, making honeycomb kits to be placed on the platform under the equipment, lifting the equipment onto the platform with a crane and then securing the equipment down to the platform with straps under the supervision of riggers.

"With downsizing, there is a reduction in personnel available to rig equipment. If you can just drive onto the platform, it's much quicker," Bagdonovich said.

Courtesy photo

A retraction system for heavy equipment airdrop undergoes testing at Yuma Proving Ground, Ariz.

On an imperfect landing on the drop zone, the honeycomb may not always crush uniformly and can become entangled in the vehicle. "It can take up to 20 minutes to de-rig if a vehicle's stuck in the honeycomb," he said. "We'd like to reduce de-rigging time to a minute so the soldier can just drive out of harm's way."

Honeycomb needs to be pre-cut, glued and stacked into custom kits for each piece of equipment. It's

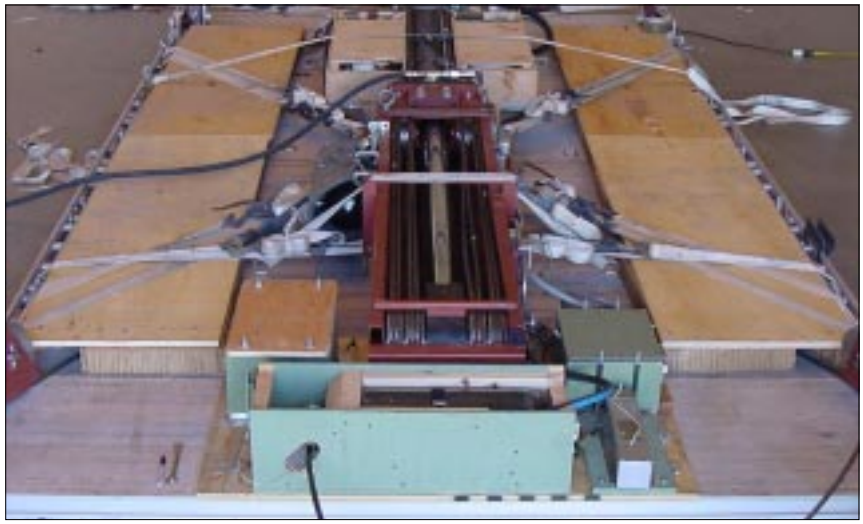
lightweight but bulky, and is costly to purchase, store, transport and dispose. It is used only once, while the new retraction systems will be designed for 25-50 or more airdrops for vehicles, trailers, towed artillery or supplies to support units.

To move away from the passive protection of honeycomb, engineers designed two different retraction soft landing systems that dramatically slow the fall.

"We wanted a system that slows the descent rate down to 8 feet per second, which is the impact velocity a Humvee should handle," Bagdonovich said. "An additional advantage is the payload won't rebound and will have a lower tendency to rollover after ground impact, which can happen with honeycomb."

The Pneumatic Muscle Actuator (PMA) is a silicone tube reinforced with a braided Vectran fiber that's inserted between the cargo slings and the parachute confluence point.

A stick trigger hanging beneath the platform strikes the ground and activates a generator that expands the actuator with a hot gas. When the actuator is inflated at about 20 feet before impact, its diameter increases while its length decreases by 35 percent, pulling the cargo up toward the parachutes and reducing the cargo's landing velocity.



Courtesy photo

The platform of a retraction system holds cable and pulleys that reel in the steel cord to slow the rate of descent just before landing.

"The PMA still requires extensive testing and refinement but has the greatest potential for the widest variety of applications for airdrop equipment," he said.

Cable retraction is another way to rapidly decelerate cargo for a soft landing.

Soldiers would drive right onto a platform to be rigged. When the platform exits the aircraft, the parachutes open and 20-feet of steel cable releases through a pulley system.

A stick trigger activates a nitrogen gas charge at about 14 feet above ground that forces a piston to move the pulleys and reel in the 20 feet of cable. Similar to the actuator, the shortened cable creates an upward force on the cargo toward the parachutes and decelerates the load to 8 feet per second.

A preplanned product improvement program will be introduced as doctrine changes and technology matures to allow for the modernization of the system. Upgrades would support airdrop of vehicles that weigh up to 60,000 pounds at wider-ranging altitudes and at a higher airspeed.

Courtesy photo

A Humvee is driven onto the platform to be rigged with the cable retraction system. Parachutes can be already in place with the help of the surrounding metal frame.

Active fabric

Electronics, optics integrated into clothing shows initial success

By Curt Biberdorf
Editor

From the finger of a glove, a soldier determines if water is safe to drink. Unrolled from his pocket, he plugs in a keyboard to type a message. Calling for support, his radio sends and receives signals with an antenna blended into his uniform.

Through a Small Business Innovative Research (SBIR) program started in 1998 known as Electro-Optic Fabric Concepts for Combat Clothing, researchers at the U.S. Army Soldier Systems Center (Natick) are developing textiles that transport power and data. Unlike traditional textiles, these fabrics are active rather than passive.

"After looking into the state-of-the-art of materials for a variety of protective clothing applications, it became clear that there was potential to achieve a revolutionary improvement in performance if electronics and optics-related technologies could be successfully integrated into textiles," said Carole Winterhalter, a textile technologist.

Although the Battle Dress Uniform (BDU) provides camouflage and environmental protection, it may also become a wearable electronic network that transports data to and from the soldier's wearable computer.

Like a Local Area Network (LAN), soldiers would have their own Personal Area Network (PAN), which opens new opportunities for battlefield lethality and survivability. The network could perform functions such as chemical detection, identification to prevent casualties from friendly fire and monitoring of a soldier's physiological condition.

Courtesy photo

A Universal Serial Bus (USB) cable was manufactured into a thin, flexible and wearable cable with flat, low-profile connectors that can be integrated into clothing.

The first step in developing the PAN was also the program's first success. Natick and SBIR partner Foster-Miller Inc. in Waltham, Mass., developed a textile-based version of the Universal Serial Bus (USB) cable.

Researchers picked the USB, which is used with desktop computers, because it is a commonly used item. The normally stiff and heavy plastic-coated cable was manufactured into a thin, flexible and wearable cable with flat, low-profile connectors. It can be integrated into clothing and is currently under consideration in Product Manager-Soldier Equipment's Advanced Combat Uniform program.

"After testing and evaluation, it actually functioned like a normal USB," Winterhalter said. "The technical feasibility was proven with the USB, so now we're going to survey other military-based electronic wearable systems currently under development, map the electronic architecture, and then build textile-based cabling and wearable connectors."

The success of the wearable cable led to other applications, such as the body-worn squad-level antenna for a tactical communications radio.

A wearable, flexible and textile-based antenna was developed and integrated into the Modular Lightweight Load Carrying Equipment (MOLLE) vest. It has advantages over the standard 30-inch whip antenna in that it is body conformal and visually covert, not compromising the soldier's silhouette.

The antenna vest is a joint development effort with the U.S. Communications and Electronics Command (CECOM), and it supports their advanced antenna science and technology objective. Natick developed the textile-based antenna and led the integration efforts while CECOM developed the electronic

switching devices. A performance evaluation of the vest will be conducted this spring with a follow-on safety effort in the fall.

The technology developed under the SBIR program that supports both the cabling and antenna efforts was patented and licensed to Malden Mills in Lawrence, Mass., for use in their Polartec Heat Blanket. (See related story.)

Knowing that power and data can be sent through textiles, the next step is to determine how and where to place the sensors that will transmit information to the soldier's computer. Winterhalter said sensors could be attached or embedded into the material or be the fabric itself, and could be located on the inside, middle or outside layer of the clothing system. "Integration of both the electronic network and sensors also presents new design issues and human factors issues of safety, comfort, performance and durability," she said.

Graphic by Steve Smith

The Battle Dress Uniform may become a wearable electronic network that transports data to and from the soldier's wearable computer. A MOLLE vest with a built-in radio antenna will be evaluated this year.

Power bus key component to heated blanket

A ribbon-like power bus folded under the fabric binding at each end was the component that enabled Malden Mills in Lawrence, Mass., to manufacture the unique Polartec Heat Blanket.

The power bus, developed at the U.S. Army Soldier Systems Center (Natick), is connected to the heating elements, which are superfine conductive fibers knit right into the fleece material.

It's a successful example of military research in electro-textiles that's been applied to the commercial market.

"We were amazed and pleased with how quickly the technology was transferred and used in this very popular blanket," said Carole Winterhalter, a textile technologist at Natick.

She said Malden Mills was interested in making an improved electric blanket that did not have the stiff and bulky wires that are associated with traditional electric blankets.

Without the thick wires, the new heat blanket is lighter, more flexible, and can be machine-washed and dried.

When plugged into an electrical outlet, the blanket is evenly warmed with a low-voltage current that uses the same amount of power as a 100-watt light bulb. The blanket uses an illuminated round, wireless controller with dual temperature adjustment and is sold exclusively through Lands' End Home catalog.

—*CB*

Courtesy photo

The Polartec Heated Blanket applies electro-textile technology developed at the U.S. Army Soldier Systems Center.