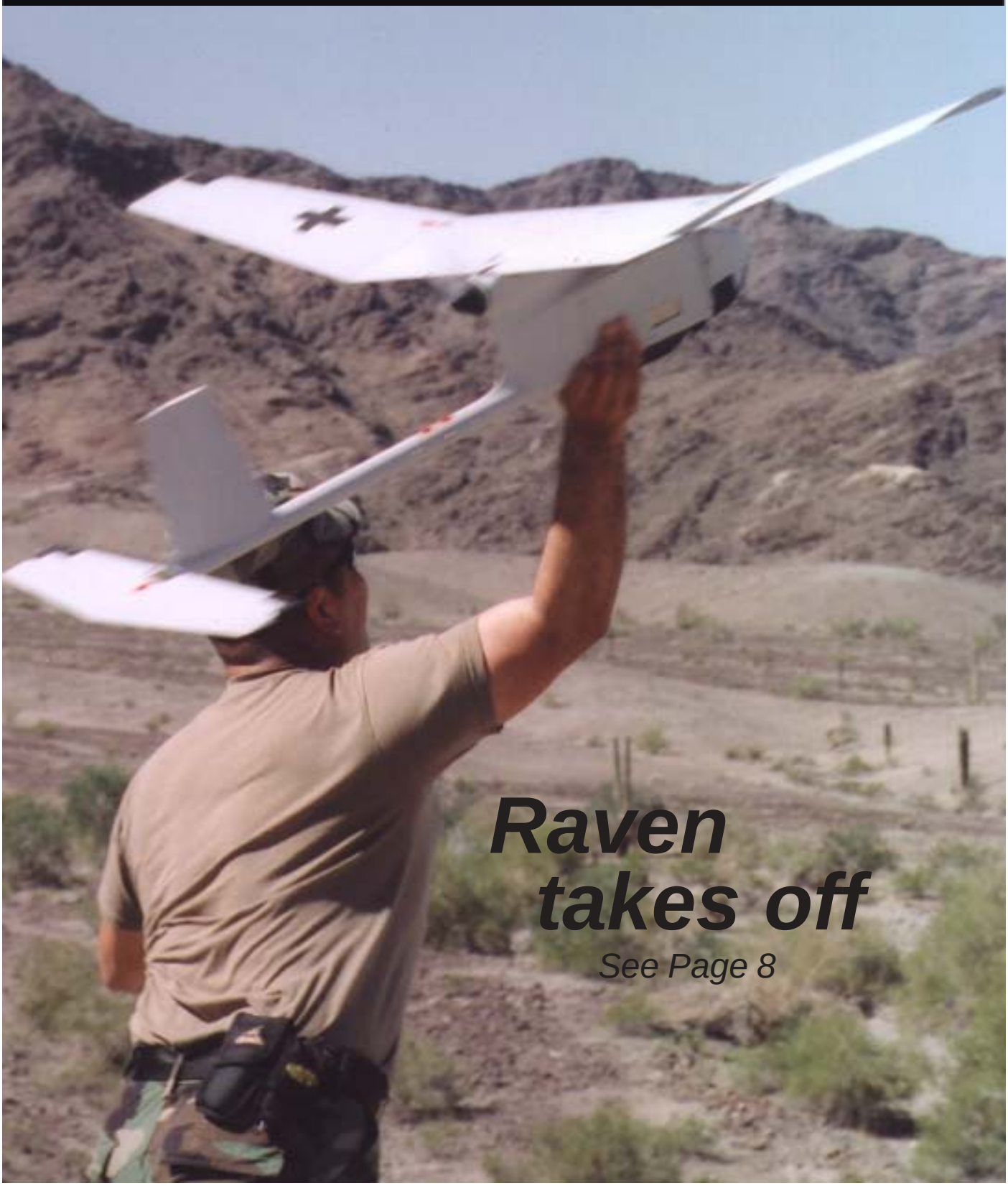
US ARMY SOLDIER SYSTEMS CENTER
Protecting Those Who Serve

THE WARRIOR

Natick, Massachusetts

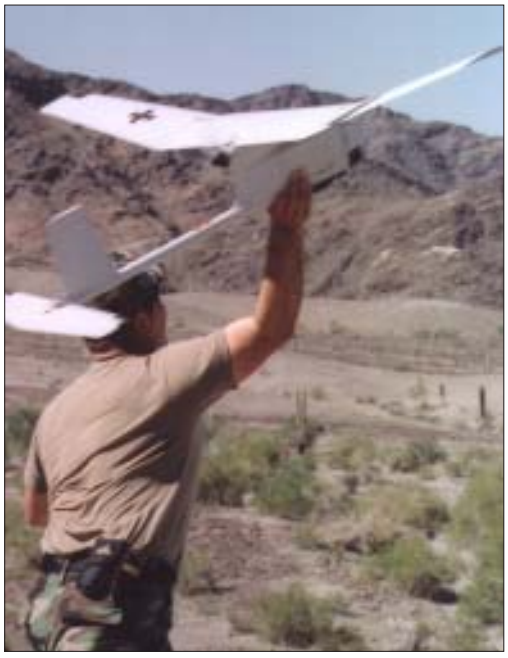
May-June 2004



Raven takes off

See Page 8

Contents



Cover photo: The Raven small unmanned aerial vehicle is launched into flight during training at Yuma Proving Ground, Ariz. (Warrior/Underhill)

THE WARRIOR
U.S. Army Soldier Systems Center

Installation Commander
Col. David J. Bongi

Garrison Manager
Lionel E. Dube'

Chief, Public Affairs
Jeremiah A. Whitaker

Editor
Curt Biberdorf

Staff Photographer
Sarah E. Underhill

The Warrior is published bimonthly by the U.S. Army Soldier Systems Center Public Affairs Office in Natick, Mass., and is available online at: www.natick.army.mil/about/pao/pubs/warrior/index.htm

The Warrior is authorized by Army Regulation 360-1. The views and opinions expressed are not necessarily those of the Department of the Army. Questions and comments concerning any articles in this publication should be addressed to:

U.S. Army Soldier Systems Center
Public Affairs Office
ATTN: AMSSB-OPA(N)
Bldg. 45, Kansas Street
Natick, MA 01760-5012
(508) 233-4300/5340
DSN 256-4300/5340
AMSSB-OPA@natick.army.mil

U.S. Army Soldier Systems Center
Internet link
http://www.natick.army.mil

Printed by Document Automation and Production Service, Natick, Mass.

Sip 'n zip

Pouch takes cleanup out of military beverages

By Curt Biberdorf
Editor

Pouches that can be resealed are changing the way troops drink.

Drink pouches developed by the Department of Defense Combat Feeding Directorate at the U.S. Army Soldier Systems Center in Natick, Mass., in partnership with packaging companies Pactech in Rochester, N.Y., and Kapack in Minneapolis, Minn., allow warfighters to pour water into a package holding a powder mix, shake and consume the beverage from the opening. If they want to save some for a little later, the plastic zipper seal holds it in.

Often they didn't bother preparing a beverage in a separate container. Field data showed that about half of the Soldiers are not consuming the Meal, Ready-to-Eat (MRE) beverage base mix because of the inconvenience of using and cleaning the canteen cup, said Lauren Milch, a physical scientist at Combat Feeding who managed package development. Pouring the mix into a canteen full of water is prohibited according to Army doctrine, so the packages are frequently thrown away unopened.

The 12-ounce beverage pouch is the first project of the Individual Combat Ration Team's Improved Packaging for Combat Rations program aimed at reducing packaging and increasing consumption, said Vicki Loveridge, a senior food technologist and project officer for improved packaging.

She said including a resealable plastic bag was a partial solution, but the drink pouch takes care of everything by replacing the current dry mix package with a disposable drinking vessel.

Originally intended to replace the MRE beverage base mix, the beverage pouches could be used for any of the military ration beverages or liquid foods, such as dairy shakes. For hot cappuccino or cocoa, the pouch was designed to fit into the flameless ration heater.

A rectangular drink pouch with a plastic zipper was evaluated in 1991, but it was shelved because the cost was considered "extravagant" at 25 cents apiece, Loveridge said.

In the last three years researchers developed prototype pouches with a non-reclosable tear-off spout, reclosable sports-type pull cap and a twist-off cap that were studied along with the final package design.

"We wanted something reusable, and they didn't want or need (a pouch) to stand up, just a way to set it down," Loveridge said. "The extra expense of a stand-up pouch was unnecessary, and it's a harder pouch to keep from cracking."

In the first evaluation with a twist-off cap pouch in 2001, 91 percent of the troops consumed their beverages, but the twist-off cap was too bulky and expensive. The latest prototype has a tear-off portion just above a resealable interlocking plastic zipper on top and slight hourglass shape for easy holding.

Warrior/Underhill

A filled up beverage pouch is sealed shut with a plastic zipper. The hourglass shape is designed for easier handling.

"What's very different from what you see at the grocery store is the zipper with a multi-laminate foil and three-year shelf life requirement," Loveridge said. "It's difficult to incorporate a zipper without compromising the foil."

With four studies already showing substantial percentage increases in the number of troops using the beverage pouch, another field test is scheduled to determine how warfighter performance improves with increased hydration.

An order of 7,000 beverage pouches has been placed for two Combat Feeding developmental products, the Remote Unit Self Heated Meal and First Strike Ration, according to Loveridge. An electrolyte-based drink powder beverage pouch was approved for four varieties of the 2004 MRE menu and could be fielded as soon as September.

"The drink pouch is something they really need, and it's designed to add minimal cost," Milch said. "We hope it takes off in popularity like the mini bottles of Tabasco sauce and flameless ration heater."

Climate control

Protective Combat Uniform covers 'special' field request

By Curt Biberdorf
Editor

Calling from a bomb crater in Afghanistan in the winter of 2002, the Special Forces Soldier had a pointed request for the Special Operations Forces (SOF) Special Projects Team at the U.S. Army Soldier Systems Center in Natick, Mass.: Send warm clothing.

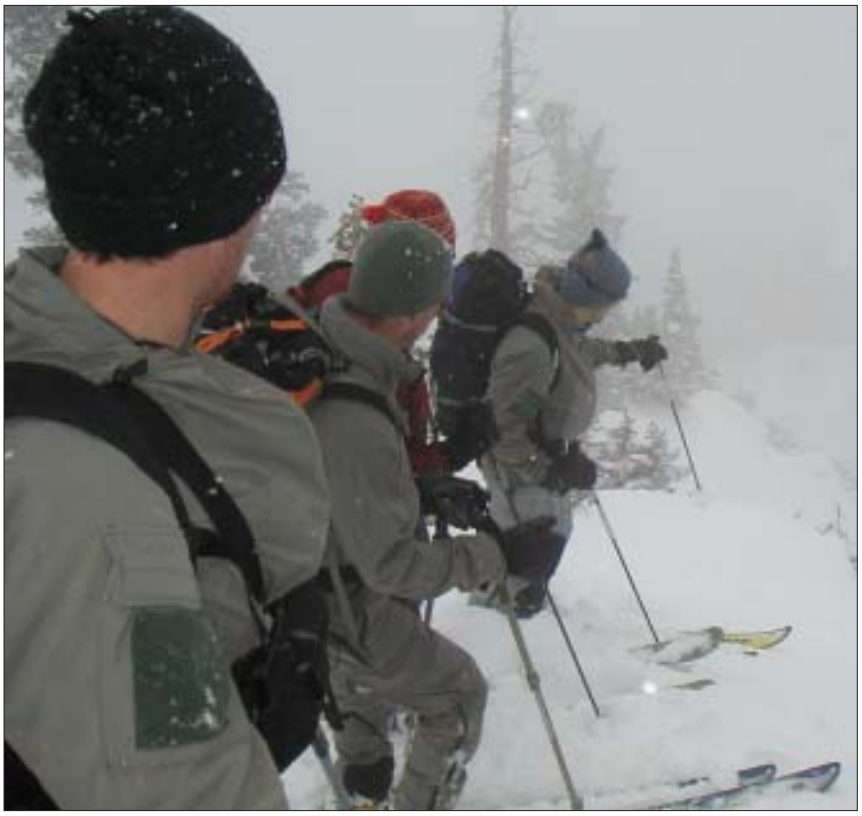
About one year later, special operators working in frigid battle zones got what they wanted in the Protective Combat Uniform (PCU), an interchangeable 15-piece, seven-level ensemble that can be worn in layers appropriate for the mission.

"He said 'We're cold. You gotta do something to help,'" said Richard Elder, an equipment specialist on the Special Projects Team and project officer for the PCU, recounting the conversation that started the process. "It's exciting that in less than 12 months, the system was fielded into theater. That's never been done before."

The PCU will replace the existing Lightweight Environmental Protection (LEP) developed under the Special Operations Forces Equipment Advanced Requirements (SPEAR), a program to produce modular equipment systems that focus on mission tailoring, enhanced survivability, and enhanced mobility while reducing weight, bulk and heat stress.

The LEP consists of light and midweight underwear, medium stretch bib overalls, pile jacket and wind-resistant jacket along with the outer water-resistant shell of the Extended Cold Weather Clothing System parka and trousers. Special operators' other option was to purchase commercial items on their own.

The PCU takes cold-weather gear to the highest level.



Courtesy photo

Special operators on skis conduct winter warfare training wearing the Protective Combat Uniform.

"The goal is to give the special operators a system as good or better than anything commercially available and build a system that stays with the commercial market instead of falling behind so you're not getting six-year-old technology," Elder said.

In place of gathering and assessing clothing sold in stores, the Special Projects Team started from scratch. The team consulted with extreme alpinists and outdoor apparel companies, and followed recommendations from a joint panel of special operators to introduce a product the Special Operations community would approve.

"We wanted to make sure we didn't overlook anything. As a system, we wanted it competed nationally," Elder said. "This acquisition model has proven itself to be extremely efficient. To build something in real-time to meet users' needs is how it should be done all the time."

Wearing the PCU is a matter of mixing and matching the gray garments according to the anticipated conditions and activities of the user. Comfort levels range from minus 50 to 45 degrees F, and although there are seven levels of protection, Elder said clothing in each level is not progressively added or removed the colder or warmer the environment.

"We actually get more out of fewer pieces by training the SOF operator how to pack and because of the efficiency of the clothing itself," he said.

He said the key to staying warm is moisture management. The latest Polartec fabrics by Malden Mills insulate and wick moisture away from the skin, while outer garments made with silicone-encapsulated fibers by Nextec Applications, Inc. allow sweat to escape while being highly water and wind-resistant. The idea is to remove moisture faster than he can produce it.

The product also breaks new ground for military protective clothing with anti-microbial fibers, a stretch shell, and a design that func-

tions as a complete system through its seaming, grading and fabrics.

Army Rangers, Marine Force Reconnaissance, Army Special Forces and Navy SEALs successfully evaluated the uniforms in Alaska in August 2002. By the time the uniform officially fields in 2006, the product will have been upgraded several times with another shell system and alternate vest as part of a catalog of components to further adjust to the specific mission. Until full fielding, those who need the uniforms are getting them and are involved in the evolution of the design with their comments from the battlefield.

"They like it. They're taking it as soon as they can get it," Elder said. "It was exactly what they were looking for. They're even wearing it outside of the profile it was designed for. It speaks well to the system that they're even doing that."

The bubbling capsule depicts the PCU's high water-resistance of its fabrics without compromising its moisture-wicking ability (above). The PCU is shown worn by a manikin. Wearing the PCU is a matter of mixing and matching the gray garments according to anticipated conditions and activities of the user. (Warrior/ Biberdorf)

Seven levels of PCU

Level 1

A durable, silkweight Polartec Power Dry fabric worn next to the skin wicks away moisture and dries fast. It consists of a crew neck T-shirt and boxer shorts, or is available in long-sleeve top with invisible zipper and pants, built for comfort and minimal weight.

Level 2

A long-sleeve shirt and pants made from Polartec Power Dry fabric are worn next to the skin for extra warmth in extreme conditions, but still wicks away moisture quickly from skin and dries fast. An inserted side panel of Polartec X-Static fabric enhances fit and flexibility.

The top has a front 15-inch zip for extra venting and a soft lining around the collar. Comfort features include an articulated side seam on the pants to minimize chafe on the kneecap.

Level 3

An insulative mid-layer jacket made from Polartec Thermal Pro fabric is water-repellent yet breathable. It is worn as an outer jacket in mild temperatures or as a heavy insulative layer in extreme cold. Seamless shoulders minimize chafe, which are then lined for extra warmth and padding for heavy pack straps.

Level 4

The soft windshirt is made from an encapsulated microfiber that repels water but also breathes for a variety of conditions. It's designed to pair with a next-to-skin layer for intense activity in cooler temperatures or with the Level 5 soft shell as a mid-layer. It stuffs into its own pocket for easy packing.

Level 5

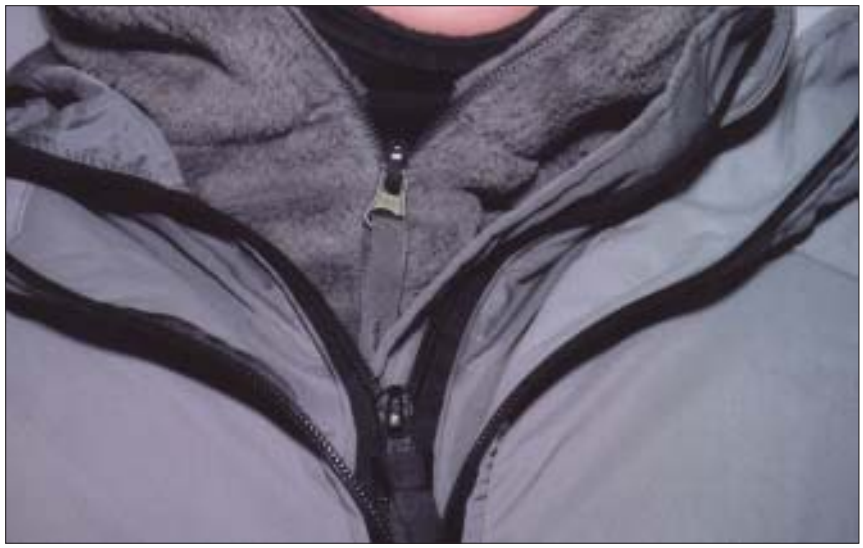
The key to the entire system, this soft shell fabric jacket and pants are made with fibers encapsulated with silicone that are highly stretchable, windproof, water repellant and breathable. They are paired with Level 1 or 2 next-to-skin layers, ready for any cold weather aerobic activity.

Level 6

A lightweight waterproof and coated nylon hard shell is slightly oversized to fit easily and quickly over gear. The jacket features water-resistant zippers and armpit zips for maximum ventilation, pocket openings to quickly access inside layers and a hood that incorporates a stiff brim. The pants borrow the same design from Level 5 but provide waterproof protection.

Level 7

For extreme conditions, this lightweight, loft-insulated level in a jacket, vest and pants has the feel of down but retains its warmth when wet. Silicone-encapsulated fabric sheds water and is paired with Primaloft insulation for maximum warmth while the liner pulls away moisture.



Bone scanned

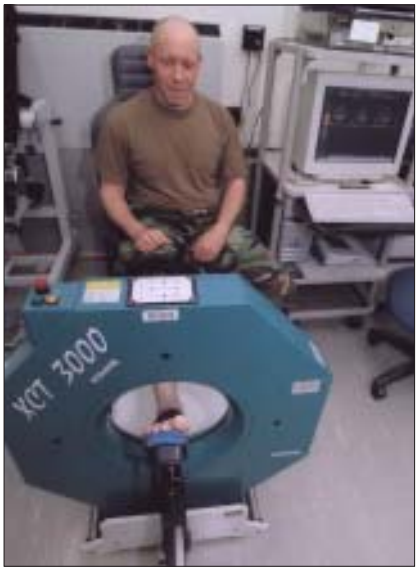
Lab research tackles problem of stress fractures in military

By Curt Biberdorf
Editor

Stress fractures caused by repetitive pounding activities of physical training take a toll on enough of the military population, specifically recruits, that a major research program called "Bone Health and Medical Military Readiness" was started in 1997 to solve the problem.

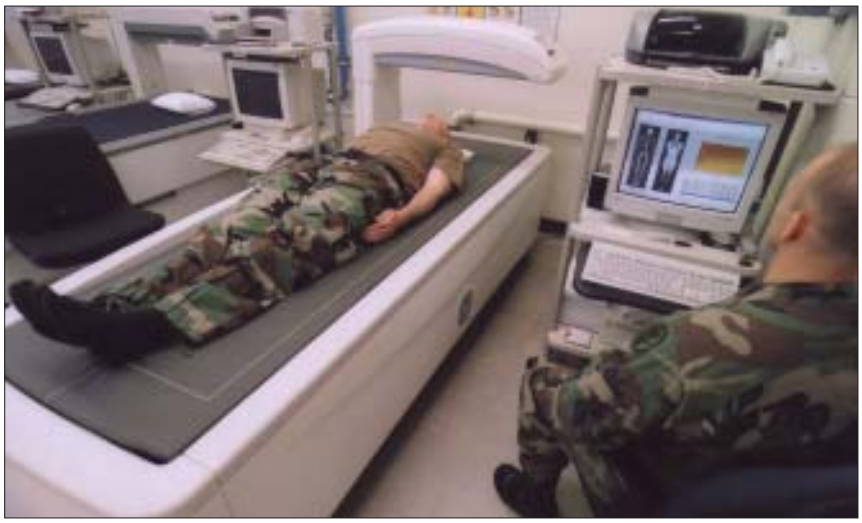
With a collection of the latest research tools acquired in the past year, the Bone Health and Metabolic Laboratory at the U.S. Army Research Institute of Environmental Medicine (USARIEM), located at the U.S. Army Soldier Systems Center in Natick, Mass., is ready to examine its piece of the puzzle.

"The goal of the whole program is to ultimately eliminate stress fractures," said Maj. Rachel Evans, a research physical therapist and director of bone health research. "Stress fracture cases have been reported since the late 1800s and today are one of the most common and potentially debilitating overuse injuries seen in military recruits, particularly in women."



Warrior/Underhill

Spc. Heath Isome is scanned for bone density and geometry on the peripheral quantitative computerized tomography machine in the bone health lab.



Warrior/Underhill

Spc. Heath Isome is scanned on the Prodigy DEXA machine as Spc. Daniel Catrambone sits at the control station.

Stress fractures are overuse injuries that occur when muscles transfer the overload of strain to the bone, most commonly in the lower leg, and cause a tiny crack. They're tricky to see on X-ray and disrupt physical training, sidelining troops while costing the Defense Department as much as $100 million annually in medical costs and lost duty time, according to Evans.

Funded in part by Congress through the advocacy efforts of the National Coalition for Osteoporosis and Related Bone Diseases, and the American Society for Bone and Mineral Research, and managed by USARIEM, overall research is multifaceted, examining factors such as gait mechanics, impact attenuation and genetics. USARIEM research physiologists are studying specifically how exercise and nutrition influence stress fractures.

"A systematic approach to the study of stress fracture was needed but hadn't been done," Evans said. "With this focused effort, and recent breakthroughs in technology, we're hoping to come up with science-based strategies to identify individuals at risk for stress fracture, and then prevent their occurrence through innovative training interventions."

Col. Karl Friedl, USARIEM commander, earlier in his career led a study on bone health at Fort Lewis, Wash., and said the understanding of bone physiology is significantly advancing and has widespread ramifications on health.

"There has been no program in the DoD that paid attention to bone health in the past," Friedl said. "Anything we can provide has the potential to save millions of dollars and enhance readiness through reduction in lost duty time, attrition from the military and medical cost avoidance. We want to avoid occupationally-induced stress fractures now, and osteoporosis and osteoarthritis later."

Noninvasive methods of studying bone health at USARIEM started in the early 1990s with the first Dual Energy X-ray Absorptiometry (DEXA) machine to measure bone density. Still in the lab, the older DEXA machines have been superseded by the superior software and scanning times in a new Prodigy fanbeam bone densitometer, according to Robert Mello, a research physiologist and the lab director.

The Prodigy scans total body bone density in 5-inch instead of 1-inch increments, increasing precision and cutting scan time from 30 minutes

to six minutes. Improved software provides a clearer picture of total body composition and bone mineral density.

"We can look at regional areas of interest, such as sections of the tibia, forearm or hip," Mello said. "Before you had to scan an entire area. Just to have that capability is a major advance."

The Prodigy also allows researchers to scan small animals for studies on bone health, Evans said.

While the Prodigy gives a front-to-back, two-dimensional view, the peripheral quantitative computerized tomography machine allows researchers to analyze 3-D cross sections of spongy and outer bone. It's designed to reconstruct a volumetric model of bone, from which bone density, and for the first time, bone geometry, can be determined, Evans said.

"We can now look at cross-sectional images where stress fractures are most common," she said. "There's also software to quantify muscle mass at that point."

Another scanning instrument is the handheld ultrasound bone sonometer, which examines bone quality by measuring the speed of sound of ultrasonic waves axially transmitted along the bone.

The results can then be used as an aid in the assessment of bone strength. "We can identify bones that may be at risk," Mello said. "The big thing is the portability so that it can easily be taken to the field."

Warrior/Underhill

A Soldier is measured for muscle strength and endurance at the ankle with the isokinetic dynamometer.

To help understand the relationship between muscle mass and bone strength, the lab purchased an isokinetic dynamometer to assess muscle strength and endurance for the major joints of the body, except the neck.

Although research is focused on preventing stress fractures in the military, Evans said the information they learn can apply to any population of physically active people to help prevent stress fractures.

Studies planned to discover ways to strengthen bones

Four studies by USARIEM are planned in the next year to try to answer how muscle structure and function relates to bone quality.

Researchers will examine whether differences in bone density and geometry exist between the right and left tibia, and then look at how that changes through physical training. One objective is to find out the proper training balance, to see where bone strengthening ends and weakening begins.

A third study will look at the effect of three 12-week exercise programs—aerobic training, strength training, and a combination of the two—against a sedentary control group. "We want to look at what factors might build up bone," said Maj. Rachel Evans, director of bone health research at USARIEM. "Maybe we can give (recruits) a program before going to basic training to ward off problems."

Building on what they've learned in the experimental study, the plan is to transfer that information to actual basic combat training units to examine what risk factors, such as slender bones or low bone density, predispose trainees to injury.

Evans and Col. Karl Friedl, USARIEM commander, gave examples of expected outcomes from current projects that USARIEM is managing. Soldiers with high risk for fracture may simply stand on a platform for 15-minute daily treatments of low-frequency vibration to stimulate bone development.

Recruits might benefit from specific guidance on physical training, and calcium and vitamin D supplementation resulting from studies now with Navy basic trainees.

Various studies at USARIEM could lead to new recommendations on zinc and protein content in operational rations to optimize bone health.

Even basic biology studies, such as one that demonstrated a refractory period in response of bone cells after mechanical stimulation, may affect military training with science-based advice to break up physical training into more than one session per day to maximize the benefit to bone health.

Raven reviews

Small unmanned aerial vehicle flies into combat zones

By Curt Biberdorf
Editor

Ground troops in company-size or smaller units are getting new help from above with an emerging class of Unmanned Aerial Vehicles (UAVs) compact enough to be carried in rucksacks.

The stealthy Raven, developed by the U.S. Army Soldier Systems Center in Natick, Mass., U.S. Special Operations Command (USSOCOM) Special Operations Acquisition Logistics—Technology, and AeroVironment, Inc. in Monrovia, Calif., is among the latest in small UAVs that give Soldiers a bird's-eye view of the battlefield for beyond line-of-sight reconnaissance and surveillance.

Connected to the ground control unit in front of them, Soldiers training on the Raven at Yuma Proving Ground, Ariz., view video of the aircraft's flight from the video display terminal shielded by a hood (above). The pilot directs flight path and altitude with the aircraft controller's toggle switch, joystick and autoland buttons. Remaining buttons are used to scroll through the controller screens or select options from the screens. (Warrior/Underhill)

The Raven resulted from the Military Operations in Urban Terrain Advanced Concept Technology Demonstration (MOUT ACTD) intelligence gathering and dissemination requirement.

The demonstration sought to improve operational effectiveness of Soldiers and Marines operating in urban and built-up areas through integration of advanced technologies and associated tactics, techniques and procedures.

Among the candidates of commercial products, the Pointer UAV from AeroVironment was selected during a 1998 market survey.

With the completion of MOUT ACTD in 2002, the ACTD and Urban Technology office at Natick transitioned to the USSOCOM-sponsored Pathfinder ACTD, an effort to integrate unattended ground vehicles, UAVs and smart sensors into a mobile, self-forming network providing enhanced situational awareness, command, control and communications to commanders and assault forces for urban reconnaissance.

Raven, introduced last year, has its roots from Pointer and was born out of the MOUT and Pathfinder ACTDs.

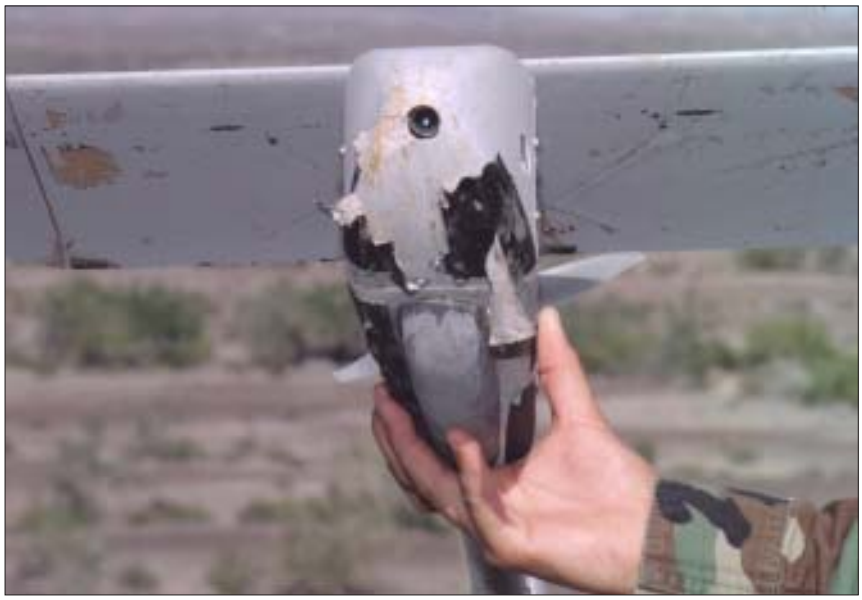
"Up until (MOUT ACTD), UAVs were used as a strategic asset at higher echelons," said Andy Mawn, ACTD and Urban Technology program manager. "The breakthroughs were that we could make them for light infantrymen, and the technology became viable to operate it in that size."

"We understand Soldiers at the dismounted infantry level," Mawn added, explaining how his office became involved with aircraft. "From MOUT ACTD, we had constant interaction with Soldiers. They're the real designers. We always kept it focused on small and simple."

The Raven adopts the same basic design and function of the Pointer but in a smaller package Soldiers wanted, shrinking the aircraft's wingspan from 9 to 4 1/2 feet and weight from 9 to 4 pounds.

It's designed for two operators, a pilot and mission controller, although one operator is possible, and is de-

The Raven aircraft flies during a training mission. Weighing 4 pounds, the aircraft cruises up to 30 mph powered by an electric motor at altitudes as high as 1,000 feet (right). Scuffing and peeling result from "controlled crashes," but the aircraft survives the trauma. The detachable nose carries a daytime video camera with simultaneous front and side view, an infrared video camera with front view or infrared video camera with side view. (Warrior/ Underhill)



ployed with four to six troops who can share the equipment load and secure the perimeter, according to Mawn. Other components in a Raven package are the ground control unit, video display terminal or laptop monitor, and batteries totaling about 30 pounds.

"They're learning it's worth the extra weight. You know they like it when they're willing to carry it without being ordered," said Susan McKinney, deputy program manager.

The aircraft is assembled in less than three minutes using plastic clips to fasten seven gray modular Kevlar composite pieces stored in two cases. Depending on the mission, the aircraft's detachable nose carries a daytime video camera with simultaneous front and side view, an infrared video camera with front view or infrared video camera with side view.

Hand launched from a standing position like passing a football, the aircraft gains altitude quickly and is directed with an operator controller in the full manual mode, steered left or right at a constant altitude in the semi-autonomous mode or completely controlled free of any operator input in the autonomous mode.

Powered by a single propeller connected to a direct-drive electric engine, the aircraft's advanced avionics steady the flight while a Global Positioning System and electronic compass provide redundant navigation systems in case one fails. The ground control unit guides the aircraft, programs mission waypoints and displays what is seen by the aircraft.

From as far as 6 miles away, the system transmits live airborne video images and location information to the ground control unit and remote video terminal, and records the video for later analysis.

Troops can track the enemy, secure convoys, protect base camps, identify targets and assess battle damage.

"A lead vehicle in a convoy can fly the Raven and see what's up ahead. It helps Air Force tactical air controllers describe the target from a pilot's perspective," Mawn said. "They're still figuring out uses for it. Flying is simple, but what to do with the information is the challenge."

In the event of a lost radio signal, the aircraft goes into "fly home" or "rally point" mode so that it can be safely recovered. Flight time is limited to about 90 minutes, and landing is nothing less than an operator-controlled crash, the pieces scattering apart as it is commanded into a "deep stall." Underbelly padding helps dissipate energy, but it's subject to damage if it strikes a pointed surface, such as jagged rock, Mawn said.

More than 100 of the Raven systems are going into production this year and will be deployed to support troops in Afghanistan and Iraq, according to Mawn. Training is ongoing for units planning on flying the Raven.

"Demand has been so high for the system, we would have experimented with them more, but we haven't had the chance to quantify system performance or work with the TTPs (tactics, techniques and procedures)," Mawn said.

Planned upgrades include an even smaller and lighter ground control unit, a higher resolution video screen, enhanced infrared video camera resolution, simultaneous front and side infrared camera capability, and an antenna that reduces potential exposure to the enemy.

Tortuous paths

Nanotechnology applied to military food packaging

Story by Jeanne Lucciarini and Jo Ann Ratto
Photos by Sarah Underhill

Danielle Froio, a plastics engineer with the Materials Science Team, pours polymer pellets into the ThermoHaake Twin Screw Extruder during a production run of experimental blown-film nanocomposites.

Carried within the Meal, Ready-To-Eat (MRE) packaging is the food that fuels the nation's military when hot, cook-prepared meals are unavailable. After MREs are consumed, however, the empty flexible packages, which make up one third of the weight of the MRE, contribute to significant waste problems for the Army.

More than 14,000 tons of packaging solid waste are generated annually from the nearly 47 million operational rations consumed by America's military, according to a report from the Department of Defense Combat Feeding Directorate at the U.S. Army Soldier Systems Center in Natick, Mass.

Environmental research programs focusing on solid waste reduction exist in the Defense Department and we, as well as Mona Bray, environmental program manager at the Natick Soldier Center, have been instrumental in obtaining funding at the basic research to advanced technology development levels for reducing MRE packaging waste.

Research is focused on using nanotechnology to develop a new MRE packaging system consisting of nanocomposite film pouches to protect the food.

Current packaging for the MRE entree consists of a retortable four-layer pouch using aluminum foil as the barrier along with polyethylene, nylon and polyester. Other food items, such as crackers, are packaged in three-layer foil pouches. This system can only be landfilled because of the aluminum foil.

The goal of the research is to remove this aluminum foil barrier layer and replace the pouch with nanocomposite films. Overall, the amount of trash generated from MREs will be reduced because the packaging will be thinner and lighter as well as being recyclable, biodegradable or both.

The MRE's shelf life is three years at 80 degrees F and six months at 100 degrees F. With such stringent shelf life requirements, an exceptional barrier material is necessary for this application. The packaging also needs to be robust enough to withstand airdrop and rough handling associated with the military logistics system.

The outer meal bag that holds all the individual components is now made from a thermoplastic polyolefin, but is extremely thick to resist burrowing insects. MREs also suffer from flex cracking or pinholing in the foil-based laminates, especially when exposed to cold weather.

To reduce packaging without sacrificing performance, engineers at the Natick Soldier Center are investigating various recyclable thermoplastics and biodegradable polymers blended with nanosized fillers. Nanocomposite food packaging is a potential solution for food preservation because of the high oxygen and moisture barrier properties of films containing nanosized platelets.

With polymer nanocomposites, not only are the barrier properties improved when compared to the pure or neat polymer, but the mechanical and thermal properties improve as well. This could improve structural integrity during handling at the manufacturer as well as when the MREs are exposed to cold weather during storage.

If used in the outer meal bag, nanocomposites could potentially replace high barrier foil laminates used for MRE components. Removing the aluminum foil barrier layer dramatically improves potential for disposal and recycling. Polymeric packaging systems also can be thermoformed with a deeper configuration, enabling multiple items to be cluster-packed to eliminate redun-

A pile of Meal, Ready-to-Eat wrappers lies on the ground. Nanocomposite films are being developed to reduce packaging waste.

dant overwraps and paperboard cartons, thus reducing weight and volume.

Our research team has formulated and produced polymers with a 1-5 percent clay platelet mixture by using in-house twin screw and blown film extrusion equipment.

In the extrusion process, chemically-treated clay platelets are mixed into the polymer to maximize clay dispersion and orientation. The surface of the clay platelets is modified in order to incorporate it into plastic resins on a nanoscale size, 1 billionth of a meter. This is 1,000 times smaller than conventional additives or composite material fillers, such as starch.

Because nanoclays contain so many individual particles in a relatively small amount of material, it takes a low percentage of clay to obtain a high concentration of constrained areas within the polymer, which lowers bulk and weight. The clay platelets disrupt the diffusion path of the oxygen and water molecules. The more tortuous the path is through the polymer chains, the better the barrier.

Research has focused on materials such as polyethylene, polyester and ethylene co-vinyl alcohol (EVOH) nanocomposites. The low-density polyethylene (LDPE) has obtained an 80 degree C increase in thermal stability and a 100 percent increase in Young's Modulus. A biodegradable nanocomposite consisting of polylactic acid (PLA) has increased the water vapor transmission rate by more than 200 percent compared to pure PLA while also significantly increasing mechanical properties such as toughness and modulus.

The EVOH nanocomposite achieved the oxygen barrier requirement for the MRE. However, these properties are dependent on temperature and humidity. Currently, EVOH nanocomposite layers are being sandwiched in-between LDPE using a new in-house co-extrusion line to make multilayer films.

Nanoclay materials in MRE production are projected to cost 10-30 percent less than current foil-based laminate materials, with a projected total life cycle cost savings estimated at $1 million-$3 million. Nanocomposite films showing the most potential will be tested, downselected, further evaluated and compared to the existing MRE packaging to determine compliance with military requirements.

The films will be further evaluated by the Advanced Processes and Packaging Team for compatibility with novel advanced food processing technologies that are incompatible with current high-barrier foil laminates.

From there, the Individual and Group Rations teams will take over on the way to manufacturing and procurement of the same warfighter-tested, warfighter-approved product with reduced packaging waste.

Editor's Note: Jeanne Lucciarini is a materials engineer in the DoD Combat Feeding Directorate. Jo Ann Ratto is a research engineer in the Supporting Science and Technology Directorate.

A blown-film nanocomposite flows out of the ThermoHaake Twin Screw Extruder.

Public Affairs Office
U.S. Army Soldier Systems Center
ATTN: AMSSB-OPA(N)
Kansas Street
Natick, MA 01760-5012

TO: